

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 9,955,551

**DECLARATION OF DR. NIKOLAOS PAPANIKOLOPOULOS
IN SUPPORT OF MERCEDES' PETITION FOR *INTER PARTES* REVIEW
OF CLAIMS 8, 10-18, 24-47 OF U.S. PATENT NO. 9,955,551**

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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. 9,955,551 (EX1001) (the “**551 Patent**”) and prior art references relating to its subject matter.

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.

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 Sentera 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.

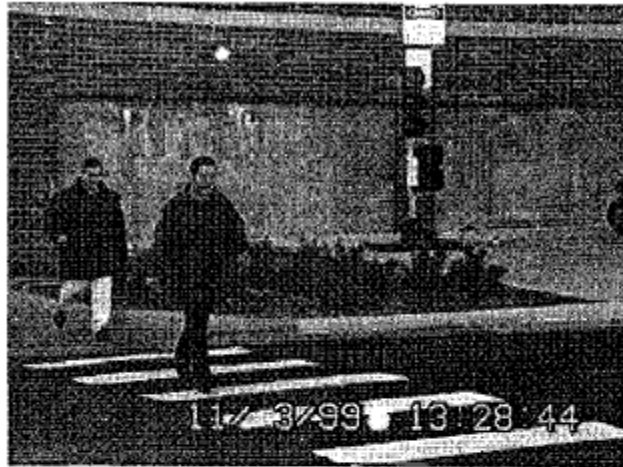


Figure 6.3 The traffic light is flashing red when there are pedestrians at the intersection.



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.

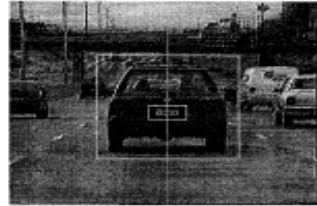
18. For more than a decade, I have been developing computer vision-based systems to assess truck parking availability at truck rest areas. The funding

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.



(a)



(b)



(c)



(d)

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 '551 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 '551 Patent and its prosecution history, as well as the other materials referenced in Appendix C. Counsel has informed me that I should consider these materials through the lens of one of ordinary skill in the art related to the '551 Patent, at the time of the earliest purported priority date of the '551 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 '551 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 C.

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

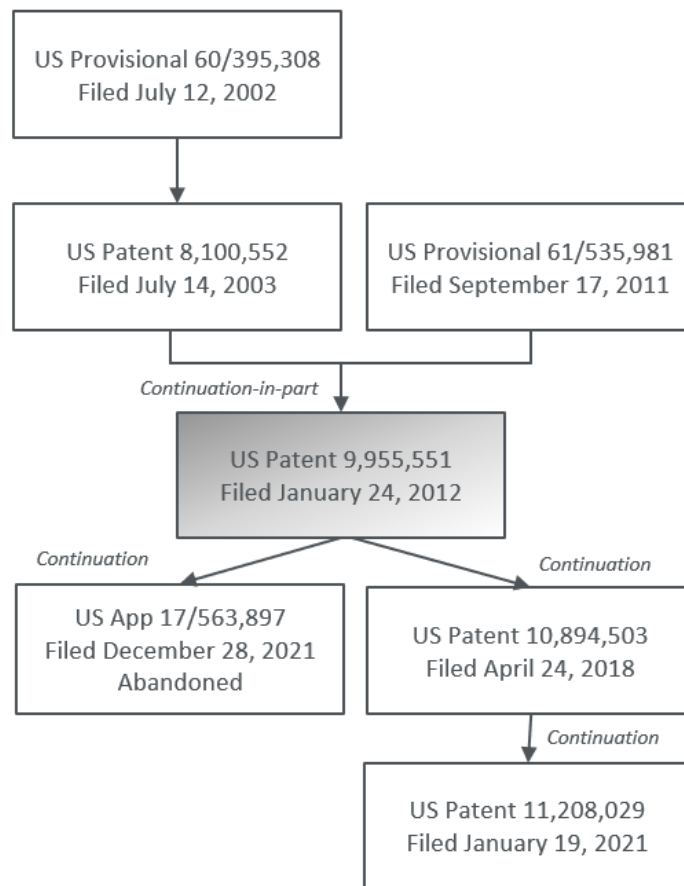
information in further analyses—including documents that may not yet have been provided to me.

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 '551 PATENT

A. The '551 Patent

28. I understand the '551 Patent was filed on January 24, 2012, and issued on April 24, 2018. I also understand that the '551 Patent is part of the following patent family:

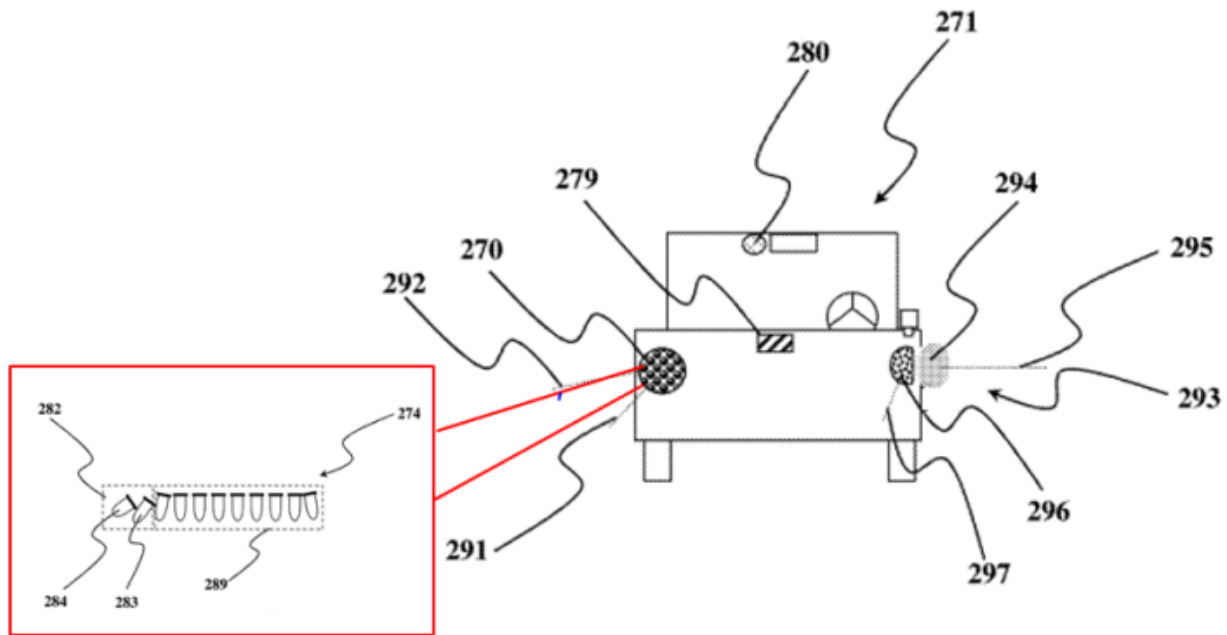


29. I have assumed, for purpose of this declaration, that the '551 Patent is entitled to this Critical Date of July 12, 2002.

30. The '551 Patent alleges that in the “prior art,” lighting fixtures were often single, large lights that were “generic” and “universal.” ('551 Patent, 5:36-46, 11:1-5, 11:45-49.) The '551 Patent further alleges that these lights were not tailored to individual applications, produced light in more places than needed, and required reflectors and refractors to re-direct light. (*Id.*) For example, the '551 Patent states that many prior art light sources were “universal” sources that emitted

light in many directions up to 360 degrees light distribution, even where only a more limited angular distribution of light was needed. (*Id.*) The '551 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.*, 11:8-13.) The '551 Patent alleges that it can 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.*, 11:56-62.)

31. The '551 Patent gives various example applications of this Digital Lighting Fixture, but its claims are directed to use of the alleged invention in a “headlight system” for vehicles. (*Id.*, Claims 24, 32, 40; *see also* Abstract.) The claims recite how light clusters or light sources (*e.g.*, LEDs) can be included in a headlamp on a vehicle, such as shown in Figure 15 of the '551:



(*Id.*, Fig. 15 (annotated).) As can be seen in the figure above, the headlights of the vehicle are made up of a plurality of light sources, which may be LEDs. The claims recite that “sensors,” like sensor 280 shown in Figure 15 above, obtain relevant situational data, including detecting things like headlights of oncoming vehicles. (*See, e.g., id.*, Claim 24, 50:38-52:54; 53:13-55:42.) A “processor” can then determine, based on this, how to adjust the output from the individual lights (or LEDs), *e.g.*, “to reduce glare” in a particular area in the field-of-view, such as where other vehicles are detected whose drivers or passengers could experience glare. (*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 '551 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 '551 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 (a.k.a., “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 8, 10-18, 24-47 OF THE '551 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 8, 10-18, 24-47 of the '551 (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**”) (EX1006), U.S. Patent Application No. 2002/0057572 (“**Kondo**”) (EX1007), and PCT Patent Publication WO2001070538 (“**Stam**”) (EX1008).

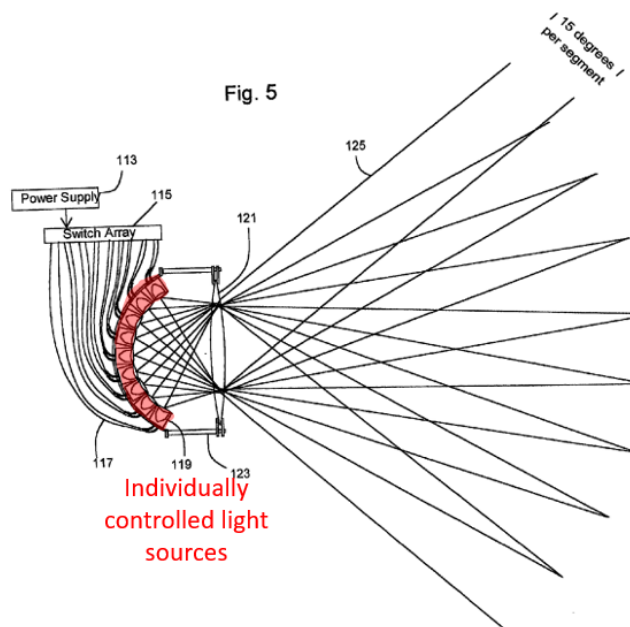
45. My analysis of these prior art references relative to the elements of the Challenged Claims—specifically, how and where the prior art references disclose the limitations of the challenged claims—is provided below. The citations that I have included are not intended to provide an exhaustive list,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

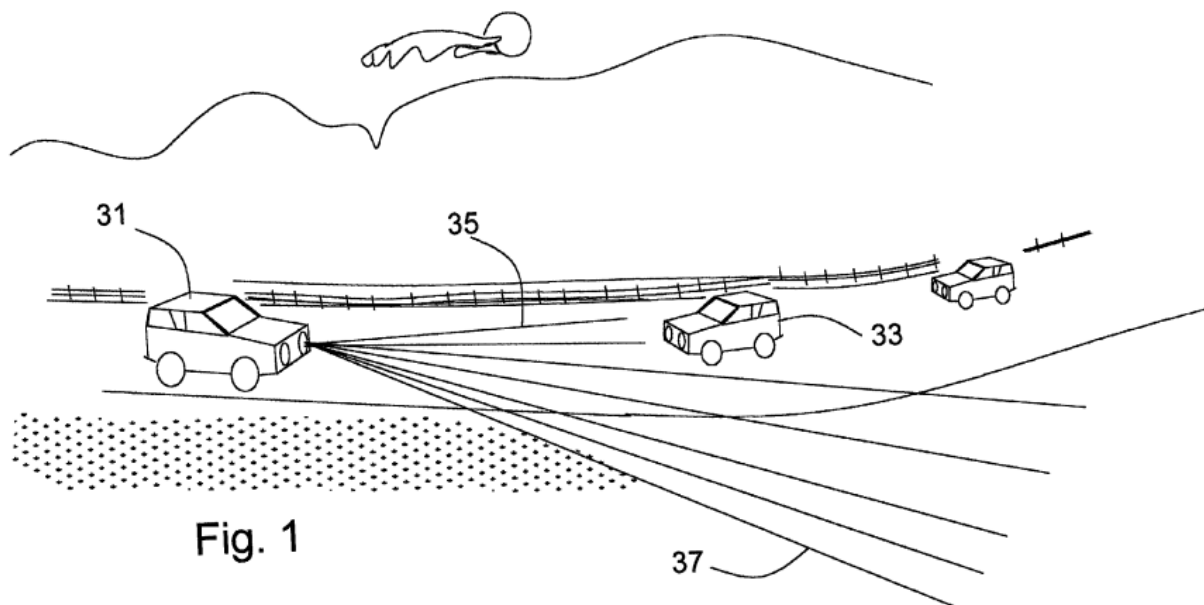
47. My review of the '551 Patent file history shows that Alden was not considered during prosecution of the '551 Patent.

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 headlight 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].)

A. Ground 1 – Alden Anticipates or Renders Obvious Claims 24-27, 29-35, 37-43, and 45-47

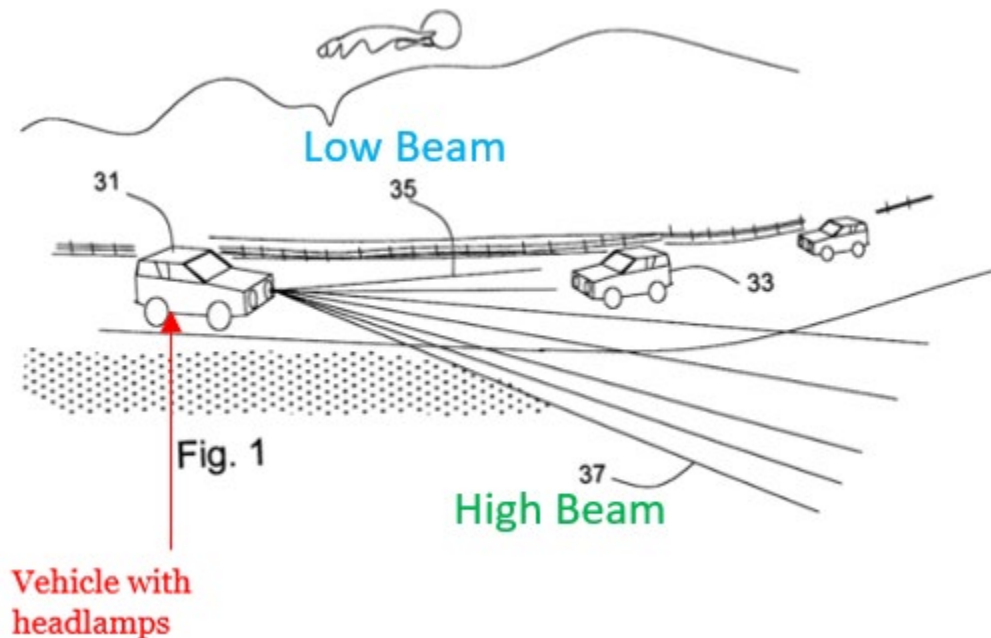
1. Independent Claim 24

50. As viewed by a POSITA, Alden anticipates and renders obvious Claim 24.

24[pre]: *An illuminating device having automatic control of light provided to an illuminated area comprising:*

51. Alden discloses Claim 24[pre] to the extent the preamble limits the scope of the claim. Alden’s headlight system is “for ***automatically controlling*** the distribution of a headlight in response to environmental conditions.” (Alden, [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”:

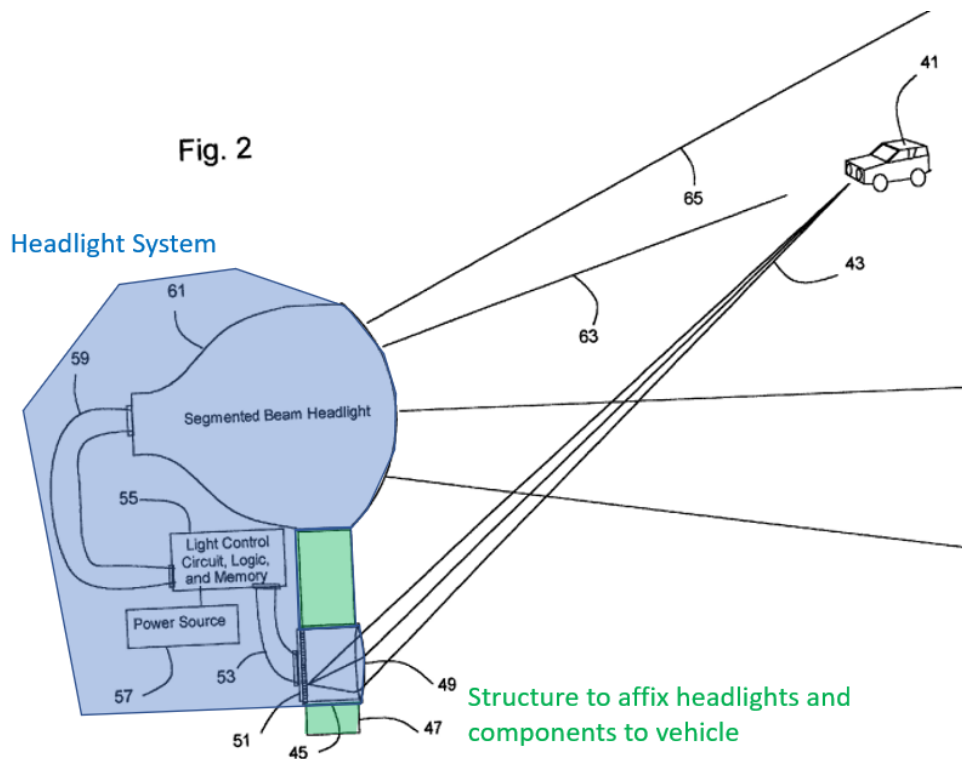


(Alden, [0025], Fig. 1 (annotated); *see also* [0026], [0029].)

24[a]: a structure for incorporating illuminating device elements, wherein the structure comprises a motor vehicle;

52. Alden discloses Claim 24[a]. Alden's system is for "one or more headlamps," or headlights, on a "structure compris[ing] a motor vehicle." (Alden, Figs. 1-2, Fig. 11, [0025].) *See also supra* ¶51 (Claim 24[pre]). 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.)

53. Alden's headlight system includes numerous components ("illuminating device elements") to incorporate into the vehicle, including: "segmented beam headlight" (61); "sensor unit" (45); and "light control circuit, logic, and memory" (55):

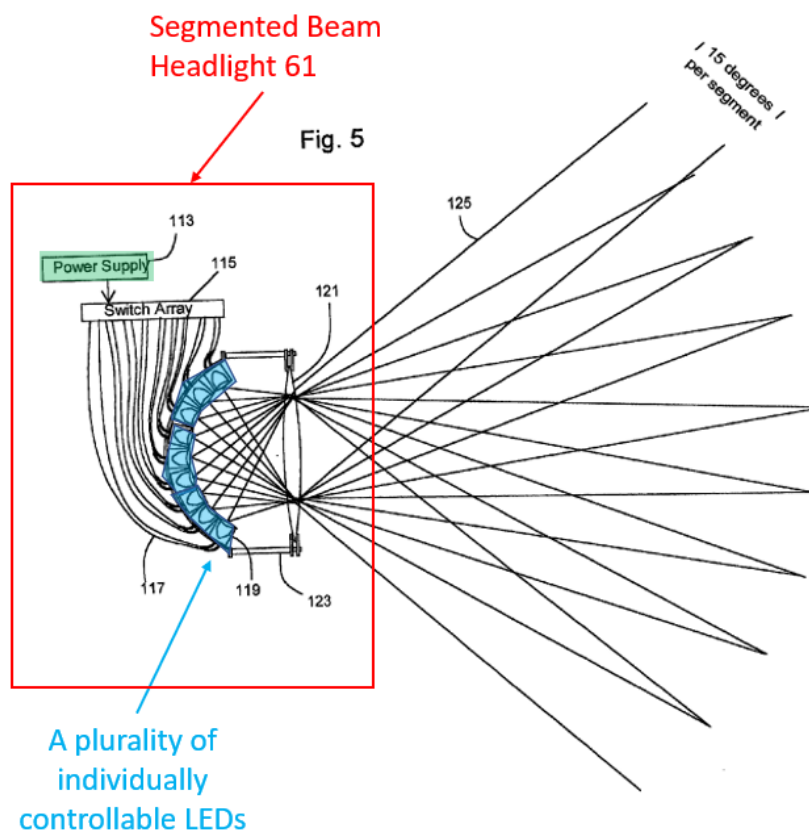


(*Id.*, [0026], Fig. 2 (annotated).) Alden explains these are “mounted on an equipped automobile 47 (47 being a part of the automobile—the [full] automobile is not shown).” (*Id.*, [0026].) As can be seen from this Figure, the Alden system components are connected together in such a way that they can be easily incorporated into a structure in the vehicle. The ability to incorporate Alden’s components into the vehicle of course makes sense, too, since the point of Alden’s system is to provide an improved headlight *for a vehicle*.

24[b]: a plurality of individually controllable LEDs incorporated in the structure via at least one headlamp mounted to the structure, each headlamp including at least one of the LEDs, the LEDs in communication with a power source;

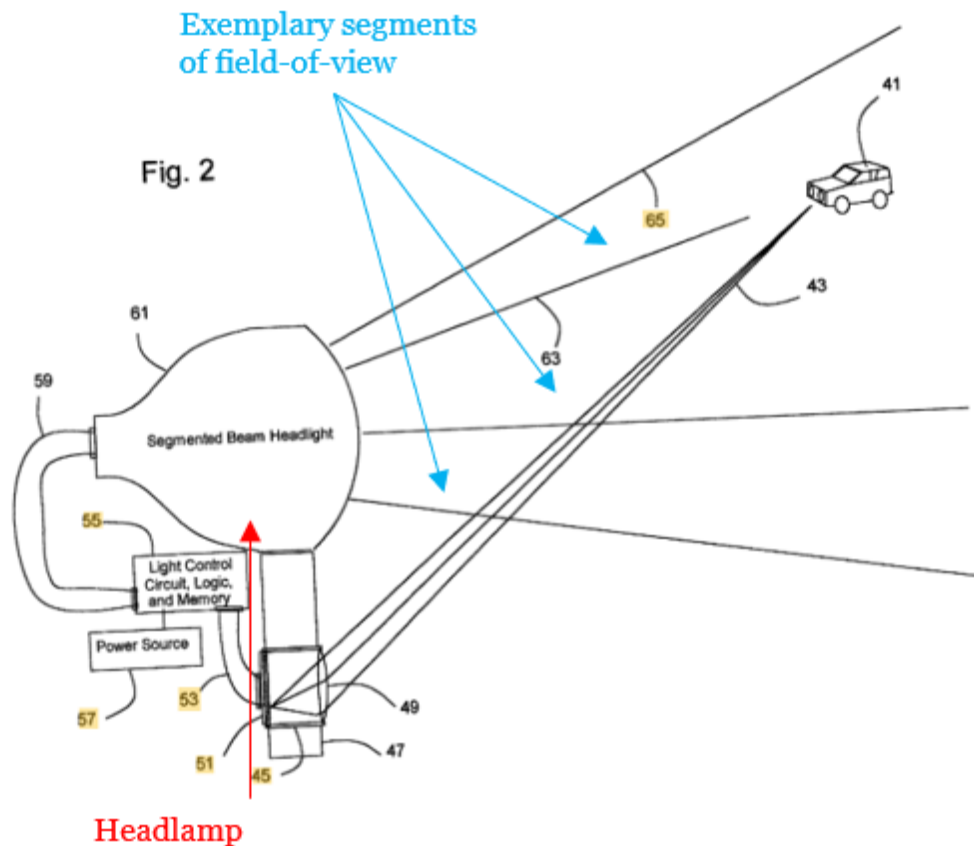
54. Alden discloses Claim 24[b]. As discussed, Alden discloses that its “segmented beam” headlights 61 are incorporated into a vehicle 47. (*See supra*

¶¶52-53 (Claim 24[a]); *see also* Alden, Figs. 1-2.) Each headlight can include an “array of individual lighting elements,” with each lighting element being a “white **LED** (or alternate lighting mechanism).” (Alden, [0029].) That is, the plurality of LEDs are incorporated in the motor vehicle structure by being included in headlights 61, which are mounted to the vehicle. (Alden, [0026], [0029], Fig. 2.) Further, this LED array (“lighting elements 119”) is in communication with a power source (“power supply 113”) via a “switch array 115” and “segment wire 117”:



(*Id.*, Fig. 5 (annotated), [0029]; *see also* Fig. 2.)

55. Each lighting element 119 (*e.g.*, LED) is also “*independently controlled* by... an array of switches.” (*Id.*, [0029].) Alden discloses that each LED is at a different angle based on its position along a curve in the headlight, such that light from each LED “falls within a defined area of the light distribution area.” (*Id.*) Alden further discloses that the power to each LED 119 “is controlled by the CPU which dictates its respective switch characteristics at [switch array] 115 such that the power from a power supply 113 carried via segment wire 117 is controlled in response to the sensed environmental conditions.” (*Id.*) This individual control over each LED enables Alden to produce different illuminations in different areas, such as “a high beam in a first sector 65 [where there is no other vehicle] while concurrently producing a low beam in a second respective sector 63 (or dim beam) where the 41 [other vehicle] is sensed”:

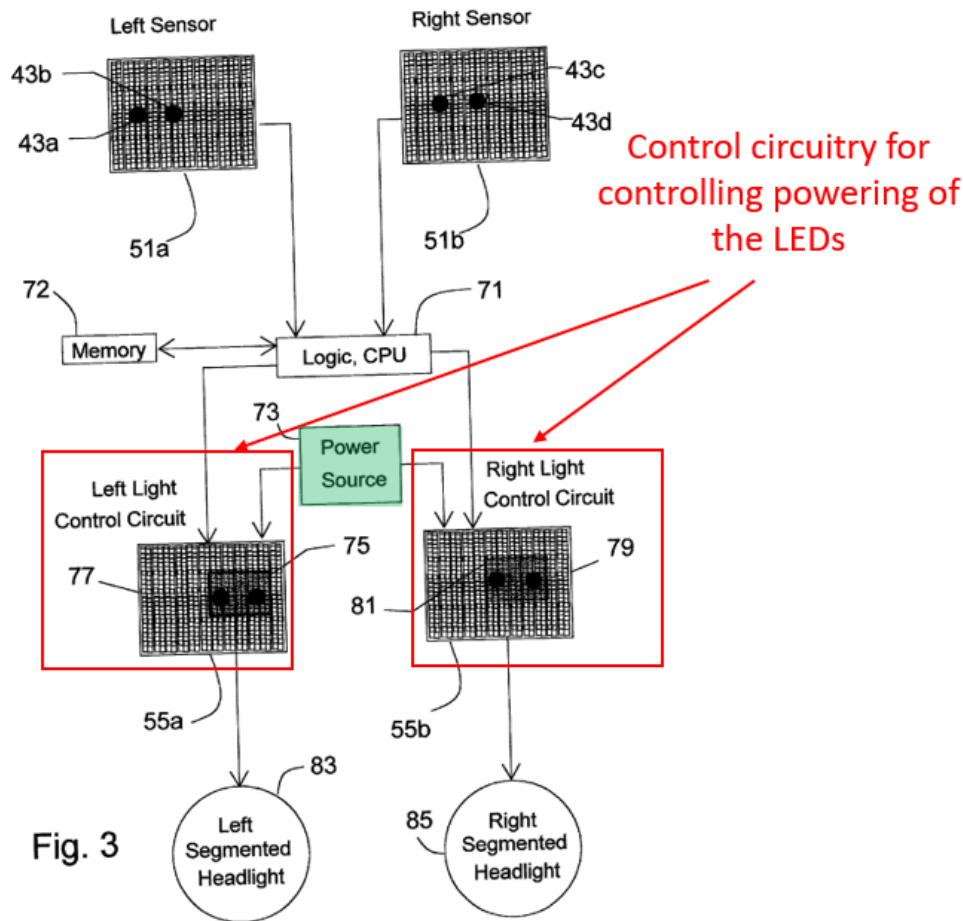


(*Id.*, Fig.2 (annotated), [0026]; *see also* [0027]-[0029], Figs. 11-13, [0036]-[0038].)

In sum, control of the switches controls how much power is supplied to each lighting element from the power supply. Where less power is supplied, the illumination from the lighting element will be lower. Where more power is supplied, the illumination will be higher.

24[c]: electronic circuitry apparatus for the controlled powering of the LEDs and other of the illuminating device elements;

56. Alden discloses Claim 24[c]. Alden's headlight system includes a "left light *control circuit*" (55a) and a "right light *control circuit*" (55b):

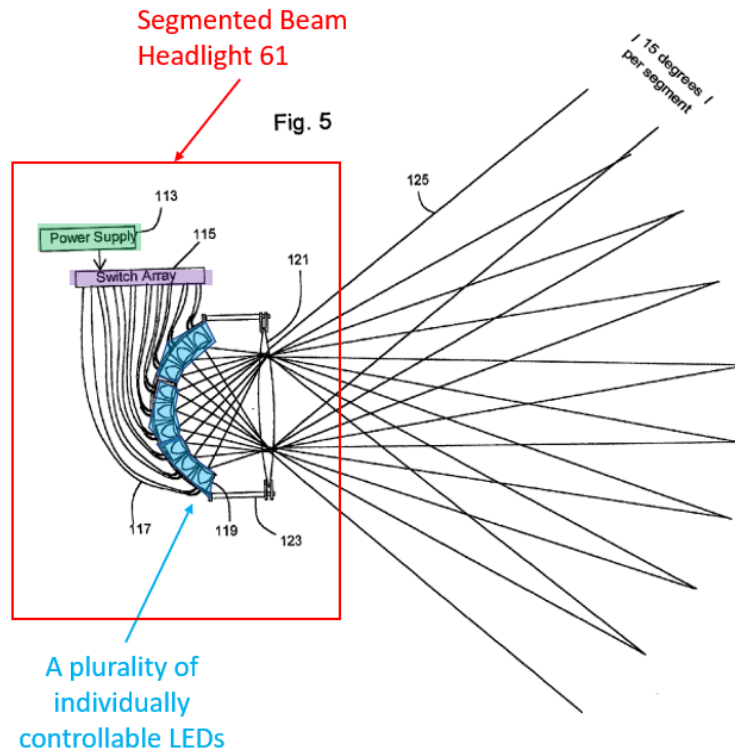


(Alden, Fig. 3 (annotated).)

57. These control circuits (*e.g.*, “electronic circuitry apparatus”) control power to various “illuminating device elements,” including segmented power cables or wires which carry the power to the left and right segmented headlights and LEDs in each headlight. (*Id.*, [0026], [0029], Figs. 2, 5.) In particular, based on information received from the sensors, the control circuitry “controls the power flow” to the segmented headlights to independently control the LED 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 that the headlight “distributes high beams throughout its distribution areas except in a box in the direction of the 41.” (*Id.*, [0027].)

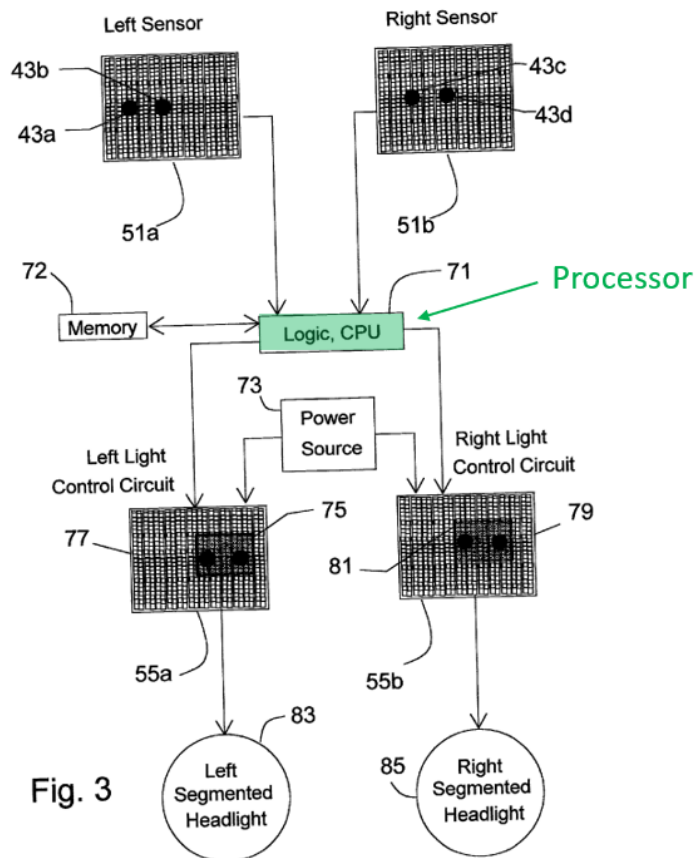
58. Alden further discloses that the control circuits can include “segmented headlight control switch array switches,” which provide power to the different light elements in the segmented headlights, causing certain “portions” of the headlight to “dim” while other portions are switched “on high beam.” (*Id.*, [0027].) This switch array control circuitry is further illustrated in Figure 5 in Alden, where the individual lighting elements are “individually controlled” by a “switch array,” with each switch being “controlled by the CPU and logic previously described. For example, the power to 119 is controlled by the CPU which dictates its respective switch characteristics at 115 such that the power from a power supply 113 carried via segment wire 117 is controlled in response to the sensed environmental conditions.” (*Id.*, [0029].) That is, the “switch array” controls power flow to each “segment wire 117” and corresponding “lighting element 119”:



(*Id.*, Fig. 5 (annotated).) As shown in the figure above, Alden discloses that the “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. Each other lighting element similarly falls within a defined area of the light distribution area. Thus the light sent to the area of 41 (where another vehicle is sensed) is dimmed using a headlight with segmented lighting means.” (*Id.*) That is, as shown in Figure 5, control of the switches controls how much power is supplied to each lighting element. Where less power is supplied, the illumination from the lighting element will be lower. Where more power is supplied, the illumination will be higher.

24[d]: one or more processors;

59. Alden discloses Claim 24[d]. Alden discloses “one or more processors”:

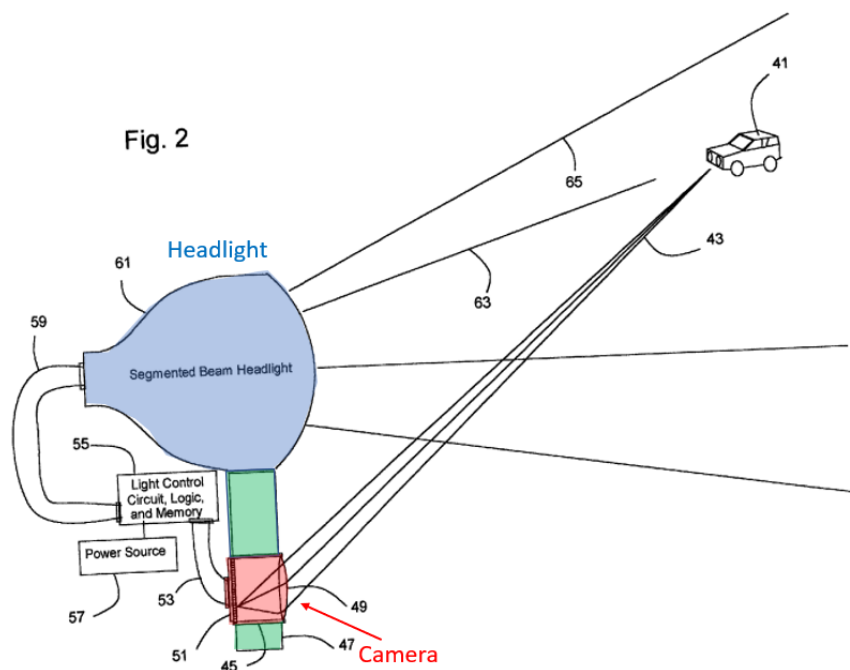


(Alden, Fig. 3 (annotated); *see also* Fig. 2, [0026].) As shown in Figure 3, left and right sensors 51a-51b are connected to CPU 71 comprising logic. (*Id.*, [0027].) The CPU is connected to memory 72, and “[i]nformation from the [memory] 72 and [CPU] 71 is sent to control the power flow from a power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

Figure 5. (*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. For example, the power to 119 is controlled by the CPU which dictates its respective switch characteristics at 115 such that the power from a power supply 113 carried via segment wire 117 is controlled in response to the sensed environmental conditions. All of the other light elements are similarly individually controlled.”))

24[e]: [1] *one or more sensors, including one or more cameras, placed on the structure* [2] *for detecting coordinate-specific information about the illuminated area*, [3] *at least one of said cameras in communication with power, and in communication with at least one of the one or more processors*;

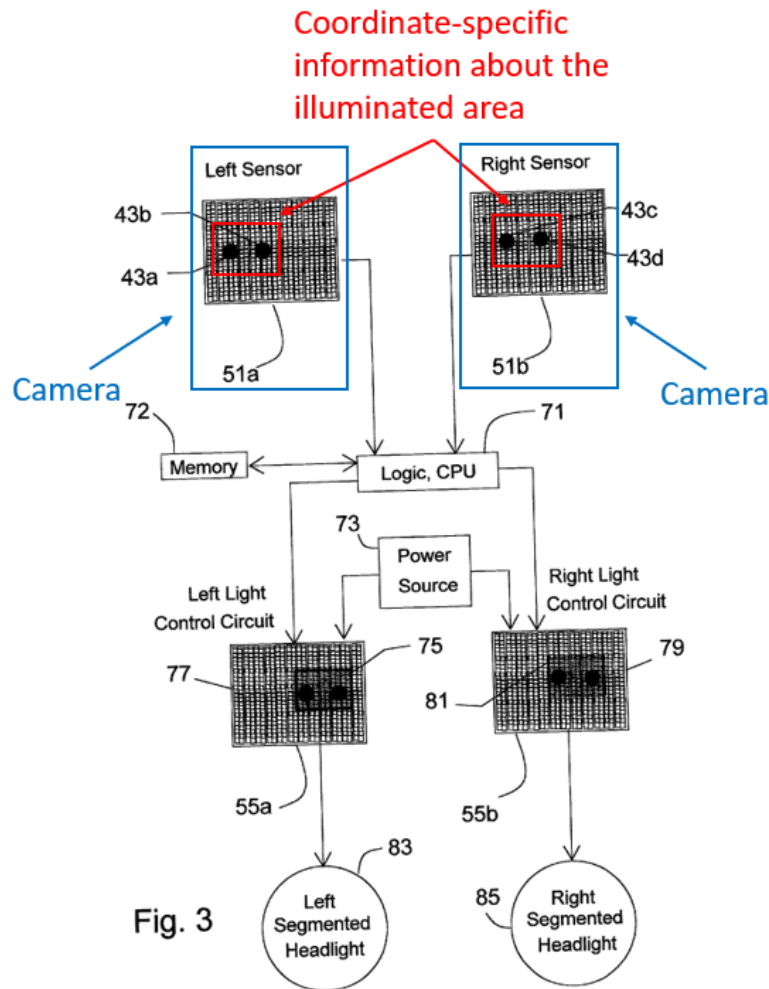
60. Alden discloses Claim 24[e]. First, Alden discloses one or more “sensors” including “cameras” that are placed on the “structure” (*i.e.*, vehicle). Each headlight in Alden’s system includes a “sensor unit 45” mounted on “vehicle 47” that can detect the presence of other vehicles:



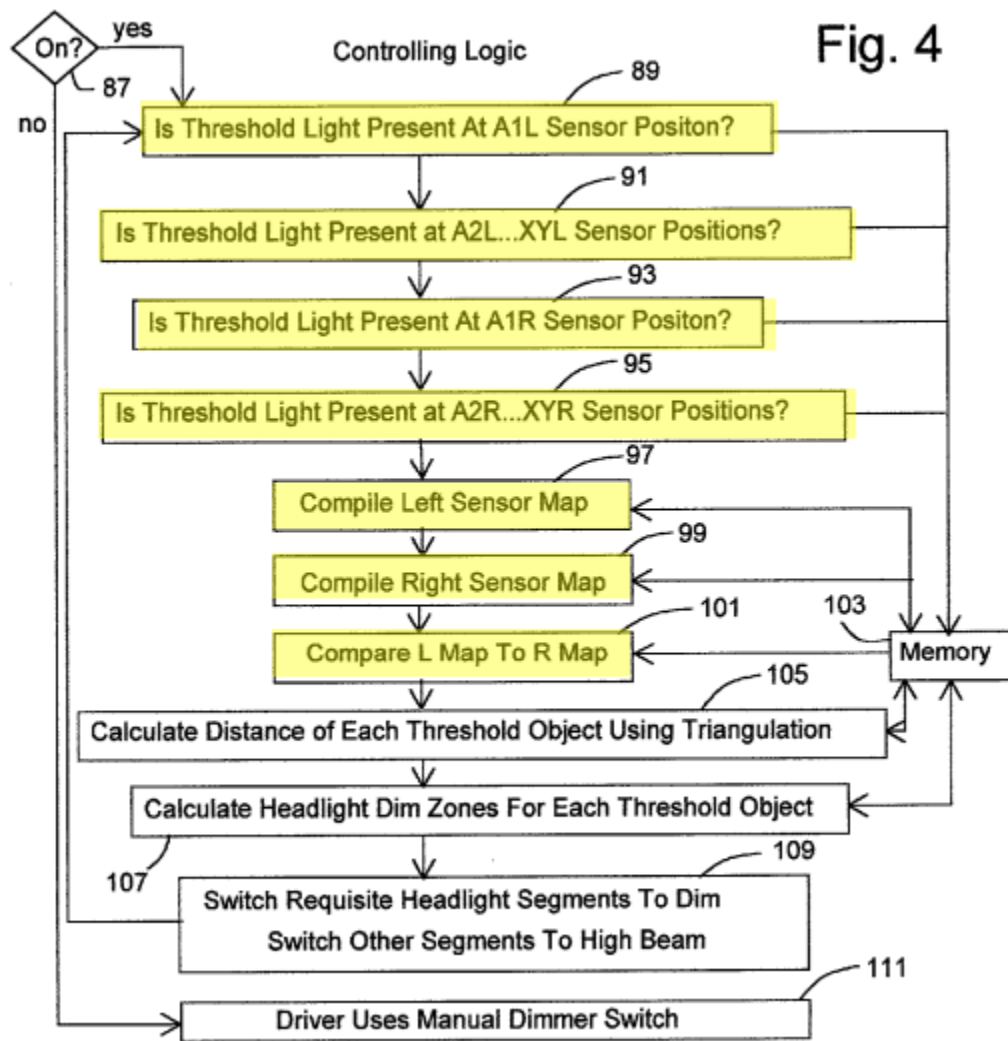
(Alden, [0026], Fig. 2 (annotated).) Alden discloses that each “sensor unit 45” in the left headlight and right headlight can include a primary *lens 49* and a *detector array 51*, and that the detector array can be a photodiode array or CCD (*i.e.*, camera sensors) that detects photon intensity (*i.e.*, 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. (*Id.*, [0026]-[0027].) A POSITA would have known that a photodiode array or a CCD detector can be viewed individually as essential parts of a camera since they both capture and convert light to electrical signals, which then are processed to become images. For example, a photodiode array has a set of photodiodes where each one of them acts as a pixel that captures the light and transforms it to electrical signals. These

signals from all the photodiodes are collected and processed in order to create the images.

61. Second, Alden discloses that its sensors detect “coordinate-specific information about the illuminated area.” In Alden, the system includes a “left sensor 51a” and a “right sensor 51b” which are used concurrently. (*Id.*, [0027].) The left sensor 51a detects the “position and intensity” of two headlights of an oncoming vehicle “at a first illuminated spot 43a and a second illuminated spot 43b respectively,” *i.e.*, coordinate specific information about the illuminated area. (*Id.*) Similarly, the right sensor 51b detects position and intensity of the headlights of the oncoming vehicle as a first spot 43c and a second spot 43d respectively. (*Id.*)



(*Id.*, Fig.3 (annotated).) Alden discloses that the position of each light spot (*i.e.*, “coordinate specific information”) is determined by checking the status of respective “sensor sectors” of each light sensor in an iterative process. (*Id.*, [0028], Fig. 4.) Each sensor sector corresponds to a coordinate, and the Alden systems checks each sensor sector, or coordinate, to determine whether threshold light is present. (*Id.*) And, Alden uses this coordinate-specific information from each sensor position to compile a “left sensor map” and a “right sensor map”:



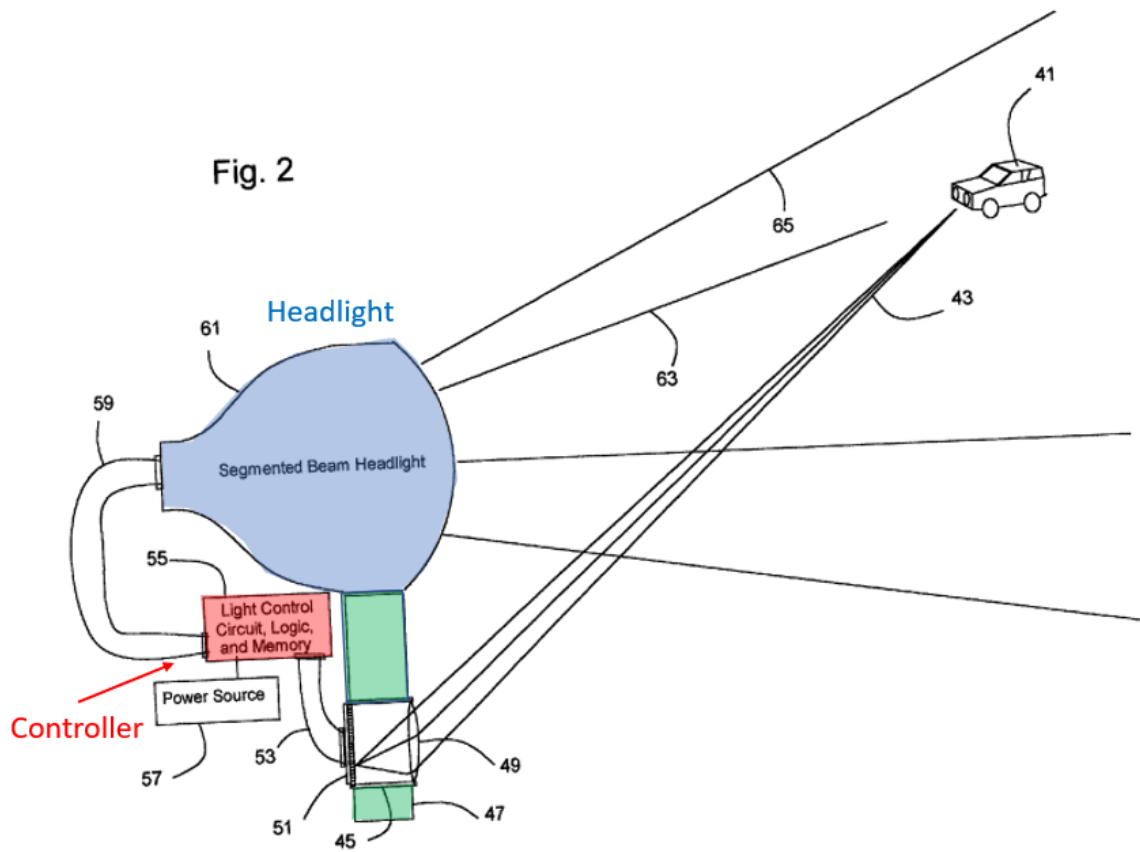
(*Id.*, Fig. 4 (annotated), [0028].) Alden explains that the left and right sensor maps, made from the information from the sensors, are compared and a triangulation process is used to determine the location of, and distance to, the sensed oncoming vehicle. For the system to be able to perform such a comparison and triangulation to determine position and distance of the oncoming vehicle, the data from the sensors must include coordinate-specific information. And, for the system of Alden to accurately control the LEDs to direct the appropriate light (e.g., high beam or low

beam) in the appropriate sectors, the CPU requires this coordinate-specific information. (*Id.*, [0027]-[0029].)

62. Third, the left and right camera sensors 51a-51b are in “communication” with both the power supply (“power source 73”) and processor (“CPU 71”), as these components are connected to each other through cables or wires. This can be seen in, for example, Figure 3 of Alden which shows the interconnections between the components. (*Id.*, Fig. 3; *see also* Fig. 2, [0026] (discussing ribbon cable connection between power supply and sensors), [0027].)

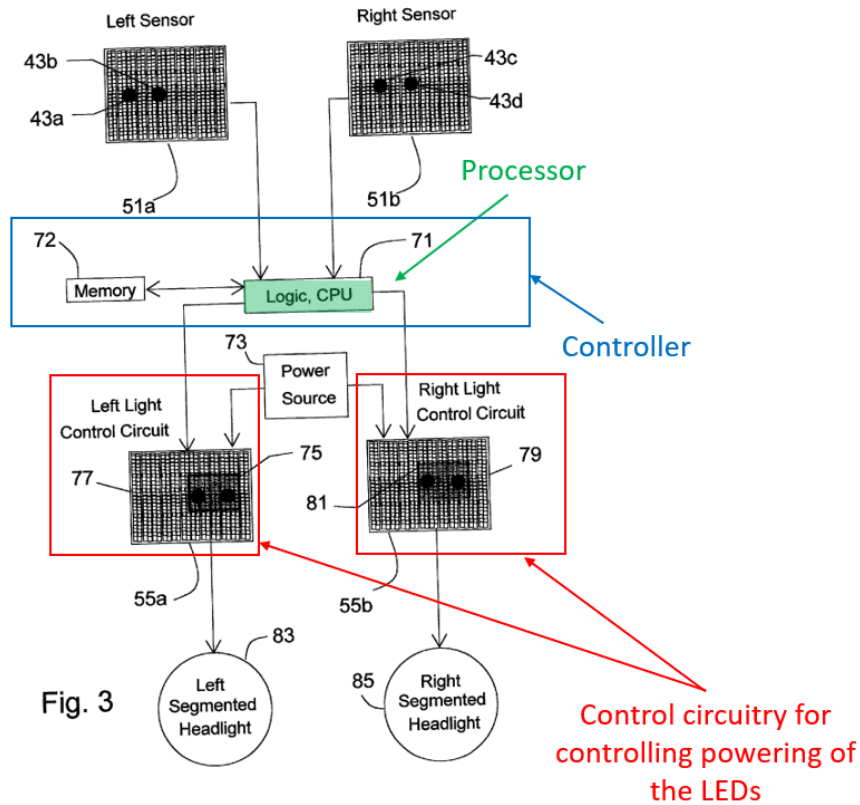
24[f]: a controller, including at least one of the one or more processors, integrated with the structure via mounting, in communication with the LED controlling power electronic circuitry apparatus,

63. Alden discloses Claim 24[f]. First, Alden discloses a light control circuit 55, which is integrated with the motor vehicle structure 47 via mounting:



(Alden, Fig. 2 (annotated), [0026].) *See also supra* ¶¶52-53 (Claim 24[a]).

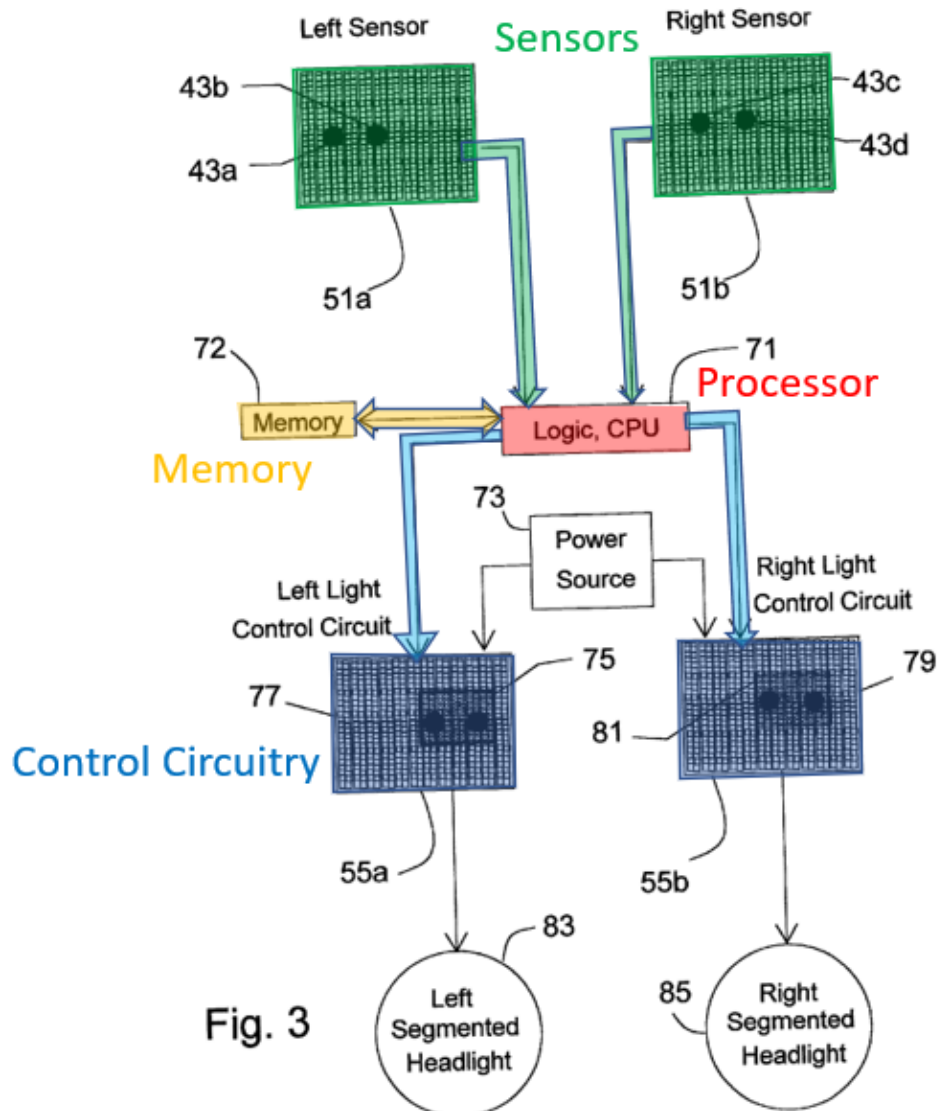
64. Second, Alden discloses that this includes “controller” with a logic and CPU 71 (*i.e.*, “processor”) and memory 72:



(Alden, Fig. 3 (annotated), [0027].) As can be seen in Figure 3, the CPU 71 is connected to and in direct “communication” with the left and right control circuits 55a-55b which control power to the LEDs. (*Id.*, [0027], [0029]) Alden further discloses that the CPU and control circuits are in “communication” when “[i]nformation from the [memory] 72 and [CPU] 71 is sent to control the power flow from a power source via a left light control circuit 55a and a right light control circuit 55b.” (*Id.*, [0027].)

24[g]: said controller arranged to process the information communicated from the cameras and to automatically control the light provided to the illuminated area; and

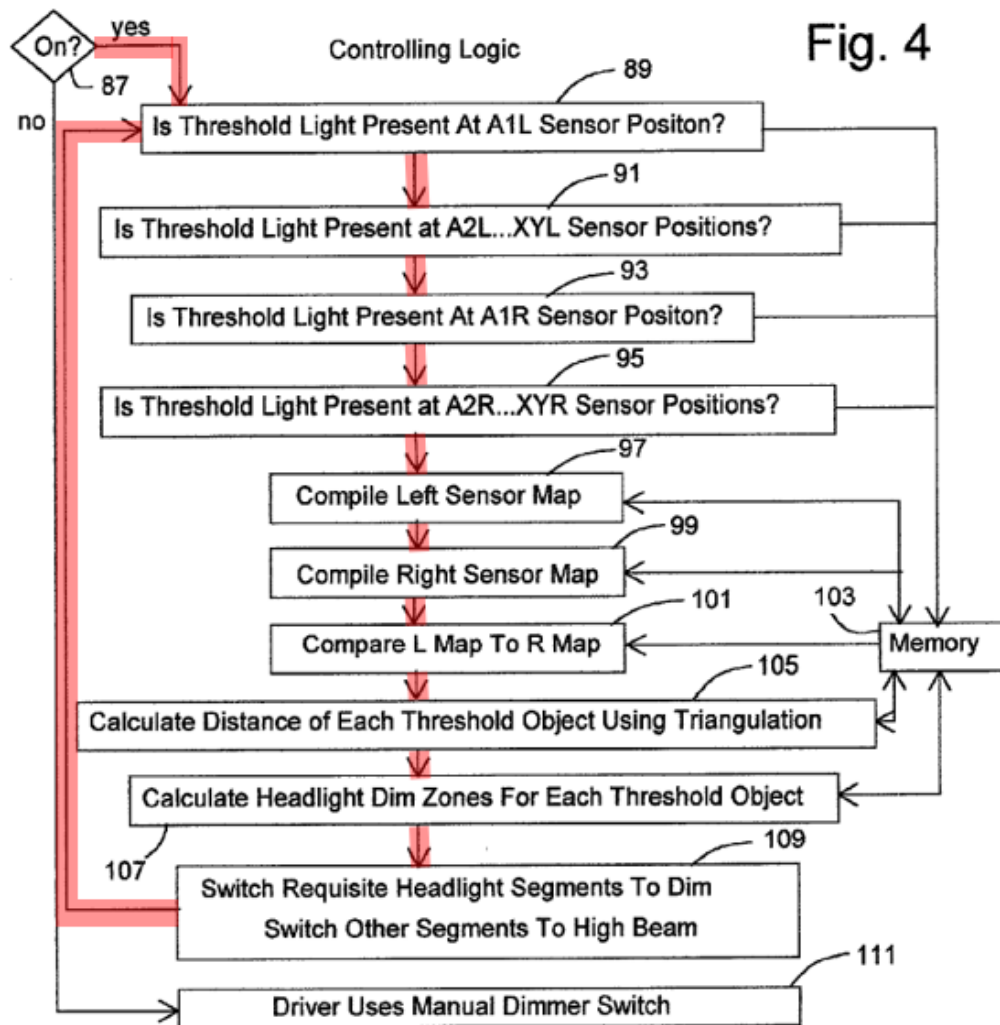
65. Alden discloses Claim 24[g]. As described above, information sensed by the sensor unit 45 (i.e., the camera) is sent into the light control circuit 55, specifically to CPU 71. (See *supra* ¶¶60-62 (Claim 24[e]).) Alden further discloses that CPU 71 is configured to process the sensor data from the left and right camera sensors 51a-51b to determine illumination requirements in the area illuminated by the headlights:



(Alden, (*Id.*, Fig. 3 (annotated), [0027]; *see also* [0026].) As shown, logic CPU 71 is connected to sensors 51a-51b and receives information from the 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.*” (*Id.*) *See also supra* ¶¶60-62 Claim 24[e].

66. CPU 71 “processes” this sensor data to: determine a location of the other vehicle based on the detected headlights of such vehicle; determine which sectors that other vehicle is located in; and instruct the control circuitry to power the individual lighting elements in each headlight to switch to dimmed, low beam light or to high beam light, depending on whether they direct light to the sectors where the other vehicle is located. (*Id.*, [0027]-[0029].) Again, each individual LED directs light to a particular sector of the headlight distribution area in Alden, and the processor uses the sensor data to control the power circuitry so that LEDs directing light to a sector where the other vehicle is located are switched to dim, low beam light. (*Id.*) And, similarly, the processor controls the power circuitry so that LEDs that direct light sectors with no other vehicle are switched to high beam light. (*Id.*)

67. Alden further discloses that this illumination control of the different sectors is done with an “automatic segmented illumination” system. (*Id.*, [0006], [0008], [0025].) As part of this, its CPU continuously, automatically determines illumination requirements for different sectors, or zones, in the area illuminated by the headlights using “controlling logic,” such as shown in Figure 4:



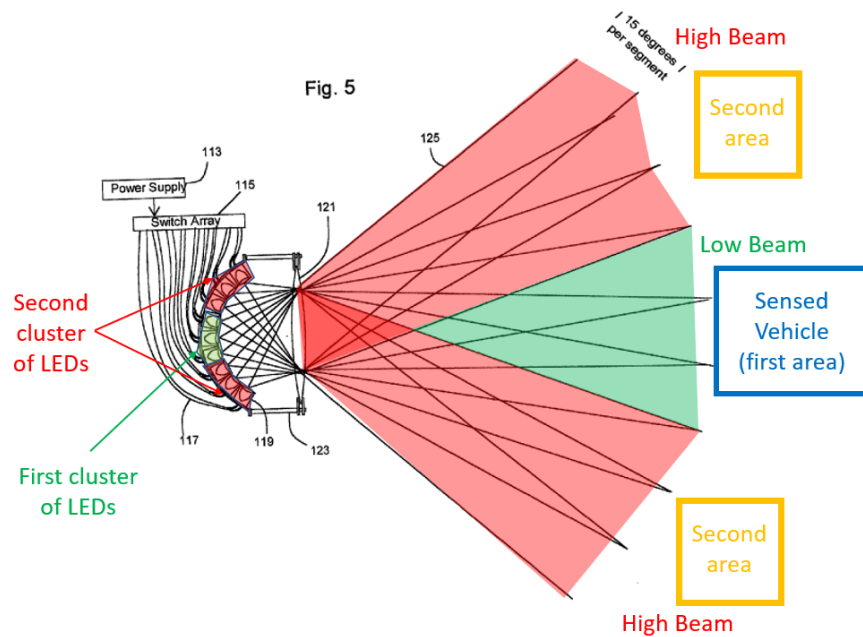
(*Id.*, Fig. 4 (annotated); *see also* Fig. 3, [0026]-[0028].)

68. As shown in Figure 4, the logic process used by the CPU can include:

- (a) processing sensor data to determine whether light above a threshold value is detected at each sensor sector location (steps 89, 91, 93, 95), including categorizing the position and intensity of light sensed (*id.*, [0027]); (b) compiling left and right sensor maps from the information on whether threshold light is detected at each sensor sector location (steps 97, 99); (c) determining the “distance

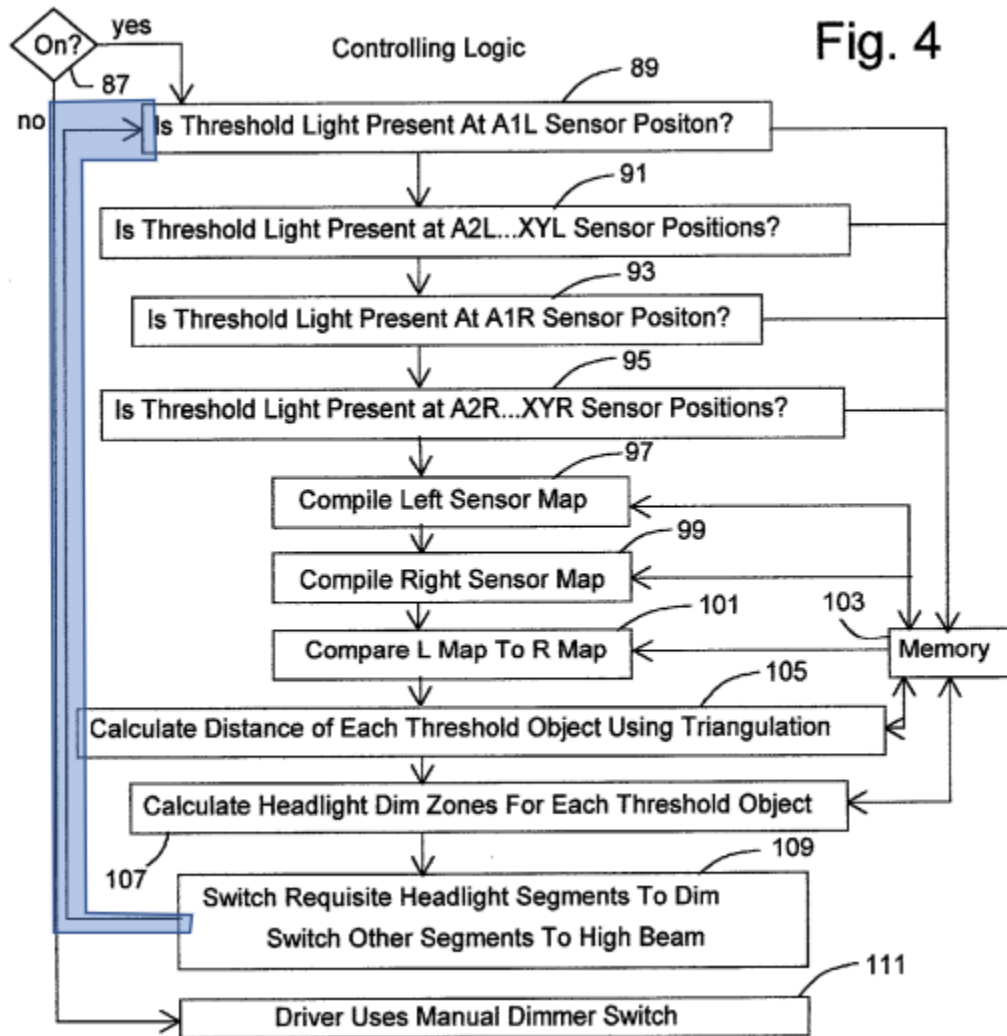
and intensity of each object sensed in a calculating process 101,” where the sensed object can be an oncoming vehicle for example; and (d) calculating distances to objects such as an oncoming vehicle using a “triangulation process 105.” (*Id.*, Fig. 4, [0028]; *see also* Fig. 3, [0026]-[0027].) The CPU uses the distance data to “determine the intensity of light that will be produced by the 61 [headlight] in the corresponding headlight sectors,” as shown in step 107—*i.e.*, selecting which LEDs to dim and which to set to high beam. (*Id.*) It then sends signals to the control circuits to switch some sectors to dim, low beam light, and to switch others to high beam, as shown in step 109. (*Id.*, Fig. 4, [0027]-[0028]; *see also* Fig. 3, [0025]-[0026].)

69. As an example, when the CPU detects an oncoming vehicle in a particular sector, it will select and cause the group of LEDs pointing in the direction of that sector to dim, while selecting and causing other LEDs (*e.g.*, those not pointing at that sector) to switch to high beam, such as shown in Figure 5 below (annotated). As a result, “the light sent to the sensed vehicle location is dimmer than the light sent to all other areas of the headlight distribution area.” 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.*; *see also* Abstract, [0005].)



(*Id.*, Fig. 5 (annotated).)

70. Alden further explains that this is a real-time, automatic 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*.”).) This can be seen in Figure 4, where an arrow indicates that after the lighting elements are controlled to switch some to dim and some to high beam based on the determined position of the other vehicle, the process starts right over again by checking whether threshold light is present at the first sensor sector position:

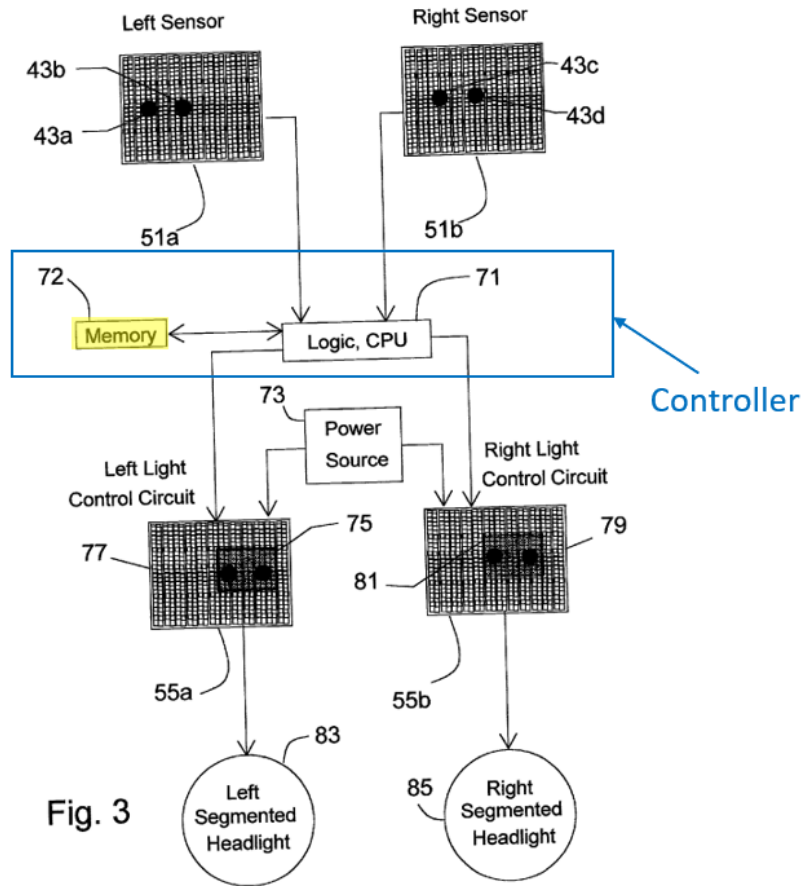


(*Id.*, Fig. 4 (annotated).) Thus, if environmental conditions, including the location of other vehicles, change, the determined light distribution pattern for the headlights will also change. Alden explains that if threshold light is detected at certain sensor positions indicating the presence of an oncoming vehicle, a determination is made that the intensity of light for the headlight sectors corresponding to those sensor positions should be switched to dim, or low beam. (*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.*) That is, if a sensed other vehicle is moving relative to the vehicle equipped with Alden's system, then each time the process repeats in real time, the new location of the vehicle will be determined. Lighting elements that illuminate sectors corresponding to this new vehicle position will be switched to dim light. And any lighting elements directing light to a sector where the other vehicle was previously located, but is no longer located, will be switched from dim, low beam light to high beam light. In sum, as part of the real-time process, Alden is continuously determining whether each sector should be low beam or high beam.

24[h]: *memory storing instructions that, when executed by one or more processors of the controller, enable the controller to:*

71. Alden discloses Claim 24[h]. Alden discloses that its "CPU 71 ("processor[]" of the controller") includes "logic" and is coupled to memory 72 and detects objects and determines whether to adjust lighting elements:

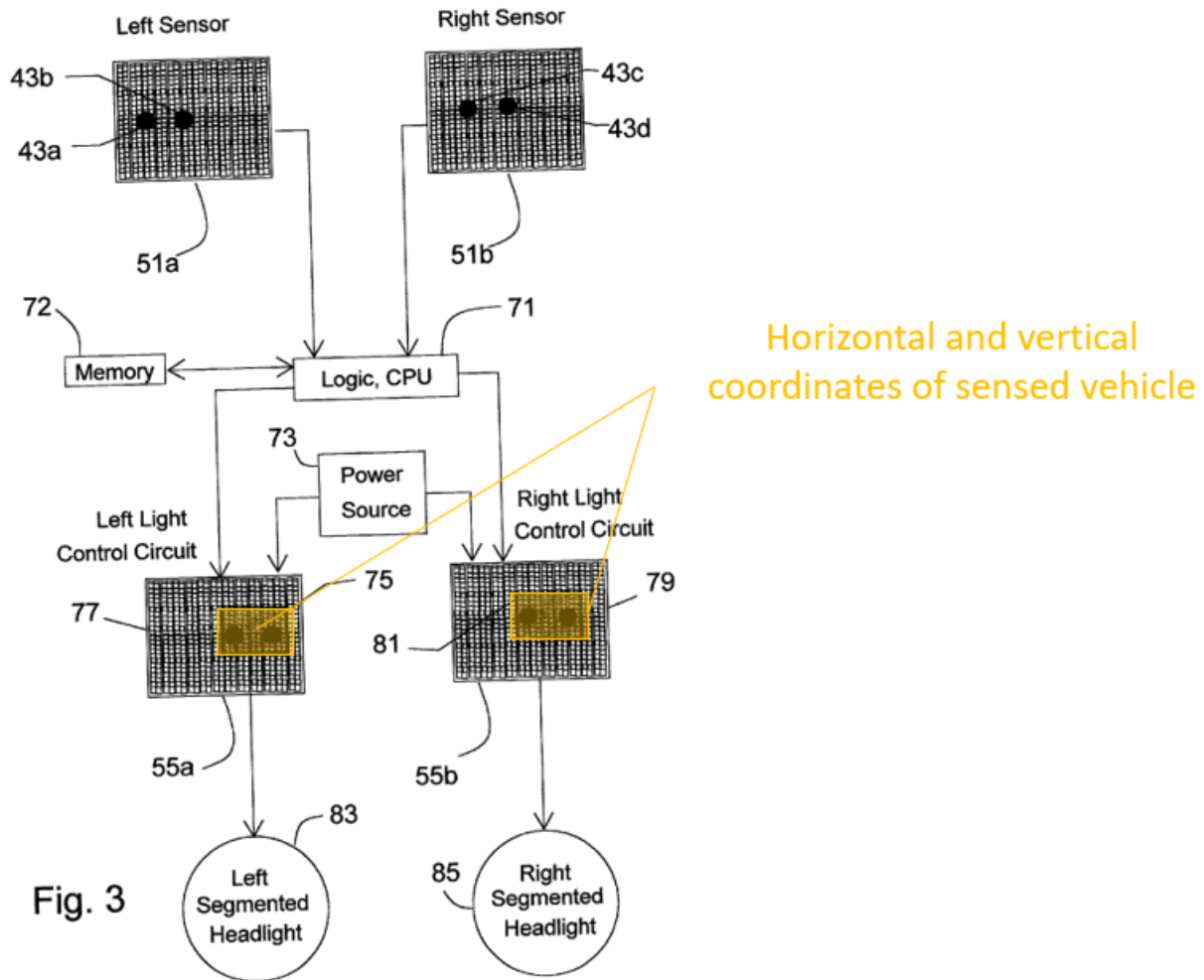


(*Id.*, Fig. 3 (annotated), [0027] (describing logic used and data being “stored in a memory 72”); *see also* Fig. 2, [0026].) Alden further discloses in Figure 4 the instructions that the CPU 71 may execute, which would be stored in the memory, to process sensor data and control the power flow to each LED within the headlights. (*Id.*, [0028], Fig. 4.) 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. *See also supra* ¶¶65-70 (Claim 24[g]). 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.

24[i]: determine coordinates corresponding to another vehicle based on the coordinate-specific information; and

72. Alden discloses Claim 24[i]. As discussed, Alden discloses determining the location, or coordinates, of a sensed other vehicle based on the coordinate-specific information from the left and right light sensors 51a-51b. *See supra* ¶¶60-62 (Claim 24[e]), ¶¶65-70 (Claim 24[g]). A POSITA would have understood that the sensor needs to have coordinates associated with its elements so the data can be analyzed and processed in a meaningful way. For example, Alden’s sensors detect light from the headlights of an oncoming vehicle in an array having both horizontal and vertical dimensions (43a-43d), and this coordinate-specific information is then used to determine the position of the oncoming vehicle, as can be seen in Figure 3:

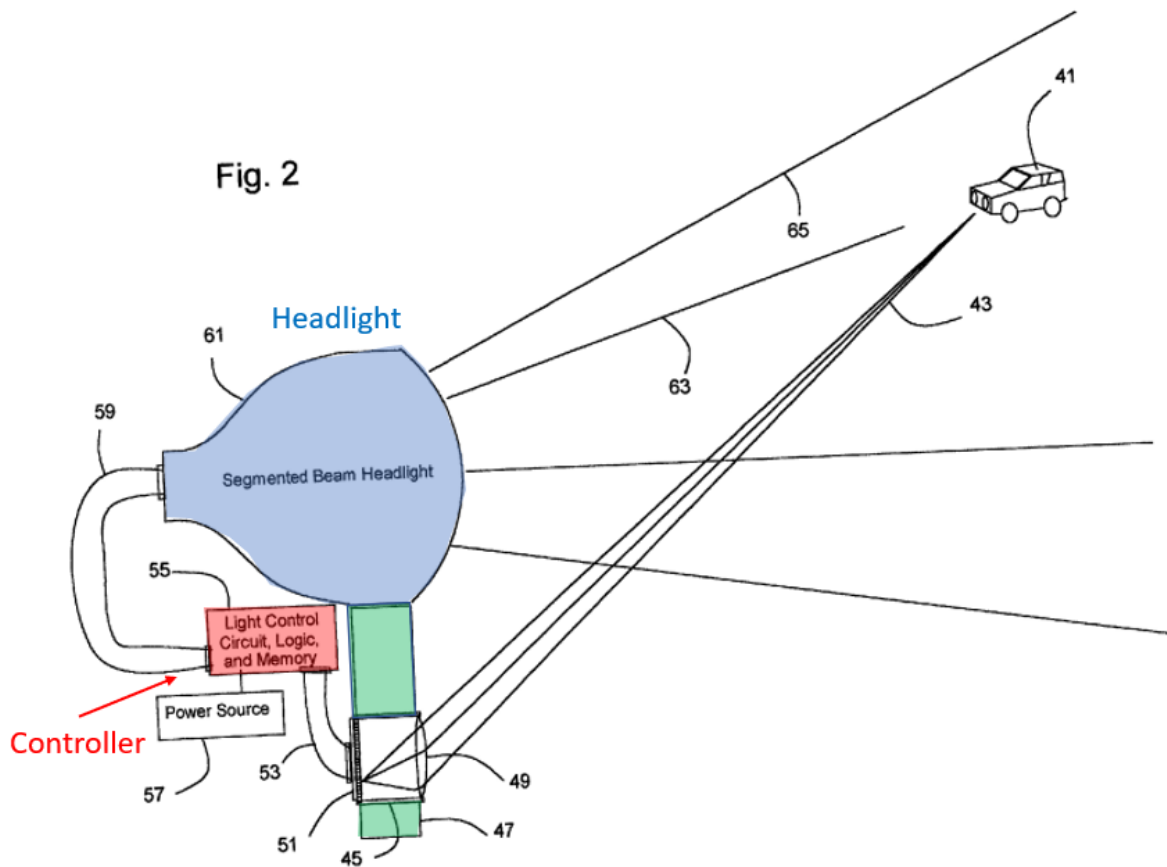


(Alden, Fig. 3 (annotated), [0027].)

24[i]: *select a cluster of the LEDs that emit light toward at portion of the other vehicle based on the LEDs having emission aimings associated with the first coordinates; and.*

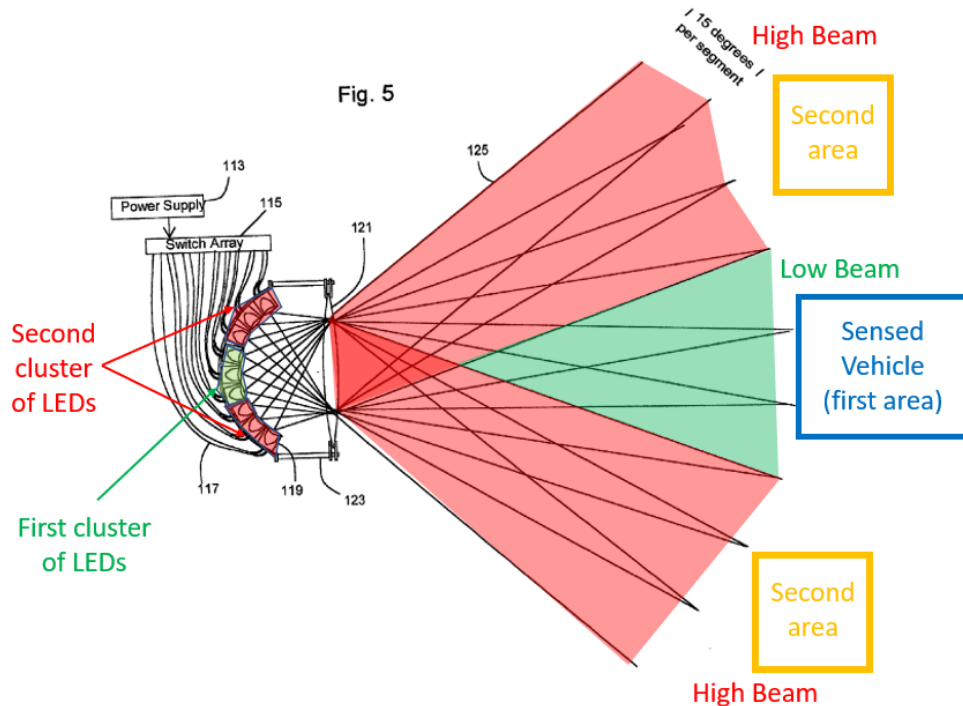
73. Alden discloses claim 24[j]. First, Alden discloses illuminating a portion of sensed other vehicles by selecting a “cluster of LEDs” to emit light (e.g., low beam) in an area that includes the other vehicle. *See supra* ¶¶65-70 (Claim 24[g]). As discussed, Alden’s CPU 71 processes the sensor data to determine which LEDs direct light to the area of an oncoming vehicle and causes those LEDs

to emit low beam in the area (63) of the detected vehicle (41), while other LED groups, such as in other areas (65), are switched to different light:



(Alden, Fig. 2 (annotated), [0026].)

74. Second, the “cluster of LEDs” selected to illuminate the area is based on those LEDs having “aimings” associated with positions of the sensed vehicle. As discussed, 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:

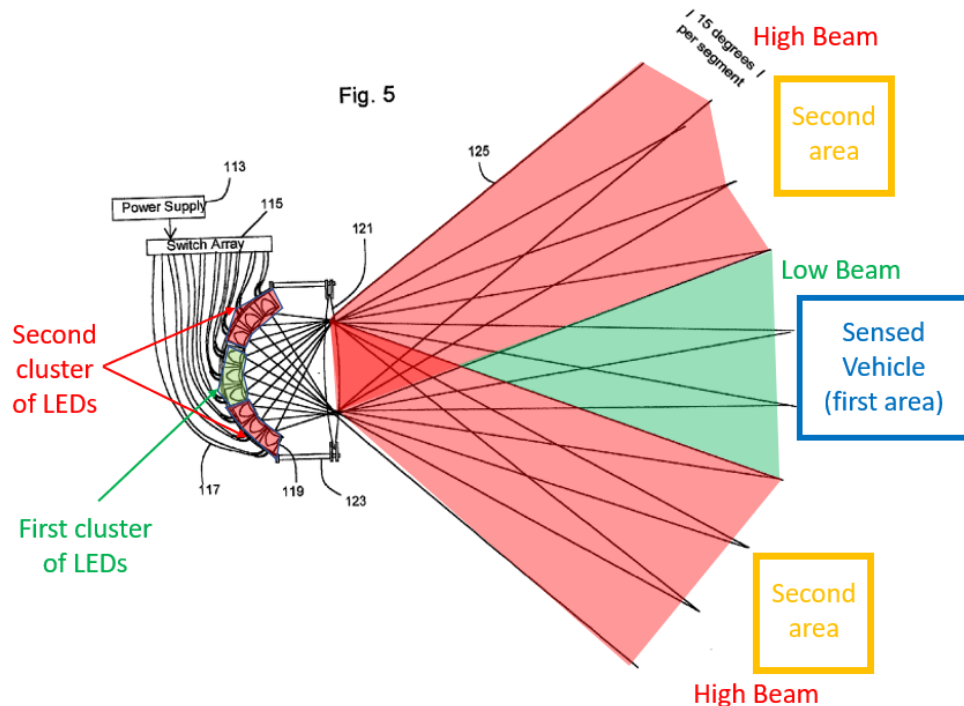


(Alden, [0029], Fig. 5 (annotated).) Thus, each lighting element is directed to a “specified” area, and when Alden illuminates an area (such as one with an oncoming vehicle) with low beam light, it will select and adjust those LEDs that are directing light into that corresponding area where the vehicle is. (*Id.*, [0027]-[0028]) See also *supra* ¶¶54-55 (Claim 24[b]), ¶¶65-70 (Claim 24[g]).

24[k]: *change emission of the selected cluster of LEDs relative to emission of other LEDs not included in the cluster to create headlamp illumination illuminating past the other vehicle while preventing glare to a driver of the other vehicle.*

75. Alden discloses claim 24[k]. As discussed, Alden discloses (a) changing emission of the selected cluster of LEDs, which direct light to sectors determined to contain another vehicle, to dimmed “low beam” intensity light, and (b) setting the light emitted from other LEDs, which direct light to sectors where

no other vehicle is detected (*i.e.*, “other LEDs not included in the cluster”) to be “high beam” intensity light:



(*Id.*, Fig. 5 (annotated), [0026]-[0029].) *See also supra* ¶¶65-70 (Claims 24[g]), ¶¶73-74 (Claim 24[j]). That is, the selected cluster of LEDs has their emission changed to be dimmer, lower intensity light as compared to “high beam” light emitted from other LEDs. As a result, “the light sent to the sensed vehicle location is dimmer than the light sent to all other areas of the headlight distribution area.” (Alden, [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.*, [0027]-[0028]; *see also* Abstract, [0005].) *See also supra* ¶¶65-70 (Claim 24[g]).

2. Dependent Claim 25

76. As viewed by a POSITA, Alden anticipates or renders obvious Claim 25.

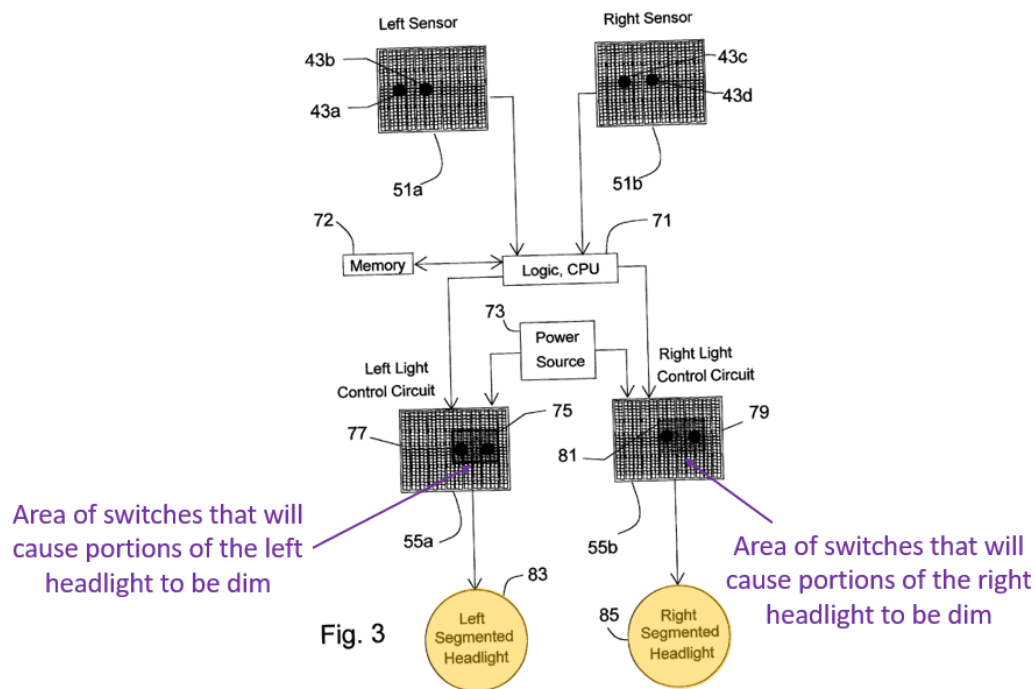
25[a]: The illuminating device of claim 24, wherein: the changed emission includes a change to at least one of intensity or color or a change of at least one LED of the cluster to a non-emitting state; and

77. Alden discloses Claim 25[a]. Alden discloses that the changed emission of the cluster of LEDs that direct light into sectors where another vehicle is detected includes reducing the “intensity” of illumination to be dimmed, low beam light. Reducing the intensity of illumination to dimmed, low beam light is a “change of intensity.”. *See supra* ¶¶65-70 (Claim 24[g]), ¶75 (Claim 24[k]).

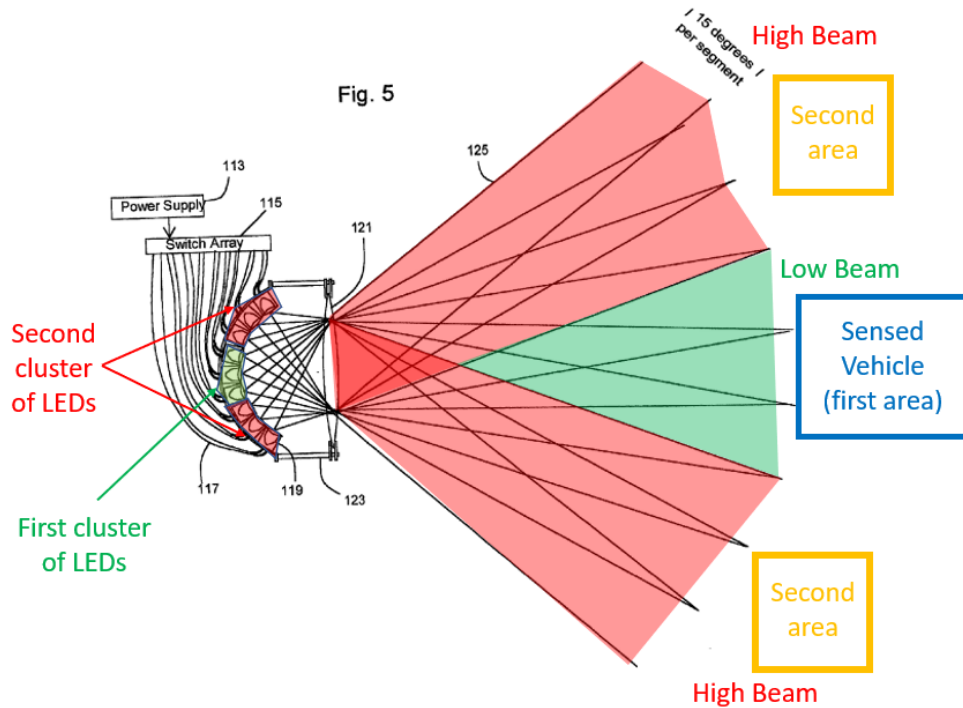
25[b]: the cluster includes a plurality of the LEDs and the cluster includes non-contiguous LEDs.

78. Alden discloses Claim 25[b]. As discussed, Alden discloses that the cluster of lighting elements includes a plurality of LEDs, i.e., more than one LED. (Alden, [0029], Fig. 5.) *See supra* ¶¶54-55 (Claim 24[b]). The cluster can also include “non-contiguous” LEDs. For example, Alden discloses that the overall beam distribution is from both the left and right headlights. (*Id.*, [0027], Fig. 3.) In both headlights, certain LEDs form a cluster that will be dimmed to direct low beam at a sensed vehicle, while the rest of will emit high beam. (*Id.*) That is, the overall emission from the LEDs in both the left and right headlights illuminates the area in front of the vehicle, including where other vehicles are detected, and the

cluster of LEDs that are dimmed is comprised of LEDs in the left headlight and LEDs in the right headlight. (*Id.*, [0026]-0029], Figs. 1-3.) Because the two headlights are separated from each other, LEDs in the cluster creating low beam light in the direction of a sensed vehicle are non-contiguous, as they are located in separate headlights and they are also separated from each other by other LEDs in each of the two headlights.



(*Id.*, Fig. 3 (annotated).) Additionally, a cluster of LEDs in a single headlamp can also include non-contiguous selected LEDs. For example, if three LEDs are selected (such as those in green), then the top and bottom-most LEDs would not be touching or sharing a border, and thus are non-contiguous:



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

3. Independent Claim 32

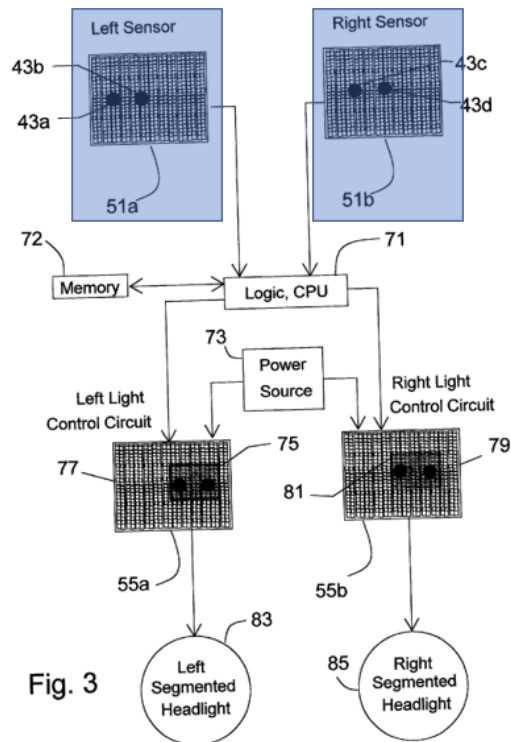
32[pre]-32[h]

79. Claims 32[pre]-32[h] are nearly identical to Claims 24[pre]-24[h], see Appendix A. Therefore, Claims 32[pre]-32[h] are anticipated or rendered obvious by Alden for the same reasons given above. *See supra* ¶¶51-71 (Claims 24[pre]-24[h].)

80. Claim 32[e] additionally recites one or more cameras “positioned to capture an image of at least one target.” *See* Appendix A. This is disclosed by Alden. Alden discloses that its “sensors” include a lens 49 that directs light to photodiode arrays or CCD detectors 51 (*i.e.*, “camera sensors”), which image lights

of oncoming vehicles. (Alden, [0026]-[0028], Figs. 2-3.) This image data, collected from the photodiode arrays or CCD detectors 51, is sent to the CPU 71 and stored in memory 72. (*Id.*) A POSITA would have known that a photodiode array or a CCD detector can be viewed individually as essential parts of a camera sensor since they both capture and convert light to electrical signals, which then are processed to become images. For example, a photodiode array has a set of photodiodes where each one of them acts as a pixel that captures the light and transforms it to electrical signals. These signals from all the photodiodes are collected and processed in order to create the images. *See also supra* ¶¶60-62 (Claim 24[e]).

81. For example, Alden discloses that when there is an oncoming vehicle in the area of the vehicle equipped with Alden's headlight system, light from the oncoming vehicle "passes through [the] primary lens 49" in the sensor unit 45, converges, and "fall[s] upon one or more sectors [] within the detector array 51 where it is detected." (Alden, [0026].) In particular, Alden discloses that its system includes a "left sensor 51a and a right sensor 51b" that detect light, such as from headlights of another vehicle, at multiple positions 43a-d:



(Alden, Fig. 3 (annotated), [0027]-[0028].) Specifically, Alden discloses that the sensor data comprises detection of “illuminated spot[s]” “fall[ing] upon a photon detector array which otherwise doesn’t receive significant light.” (*Id.*, [0027]; *see also id.*, [0026], Fig. 2.) The logic of the Alden system interprets this received data with the objective of detecting headlights of an oncoming vehicle. (*Id.*, [0026]-[0028]; *see also id.*, Figs. 2-4.) Thus, Alden discloses that one or more cameras are positioned to capture an image of the “two headlights” of an oncoming vehicle (i.e., a potential target) as “illuminated light spots,” which are stored as a “map of sensed light.” (*Id.*, [0027]-[0028], Figs. 3-4.)

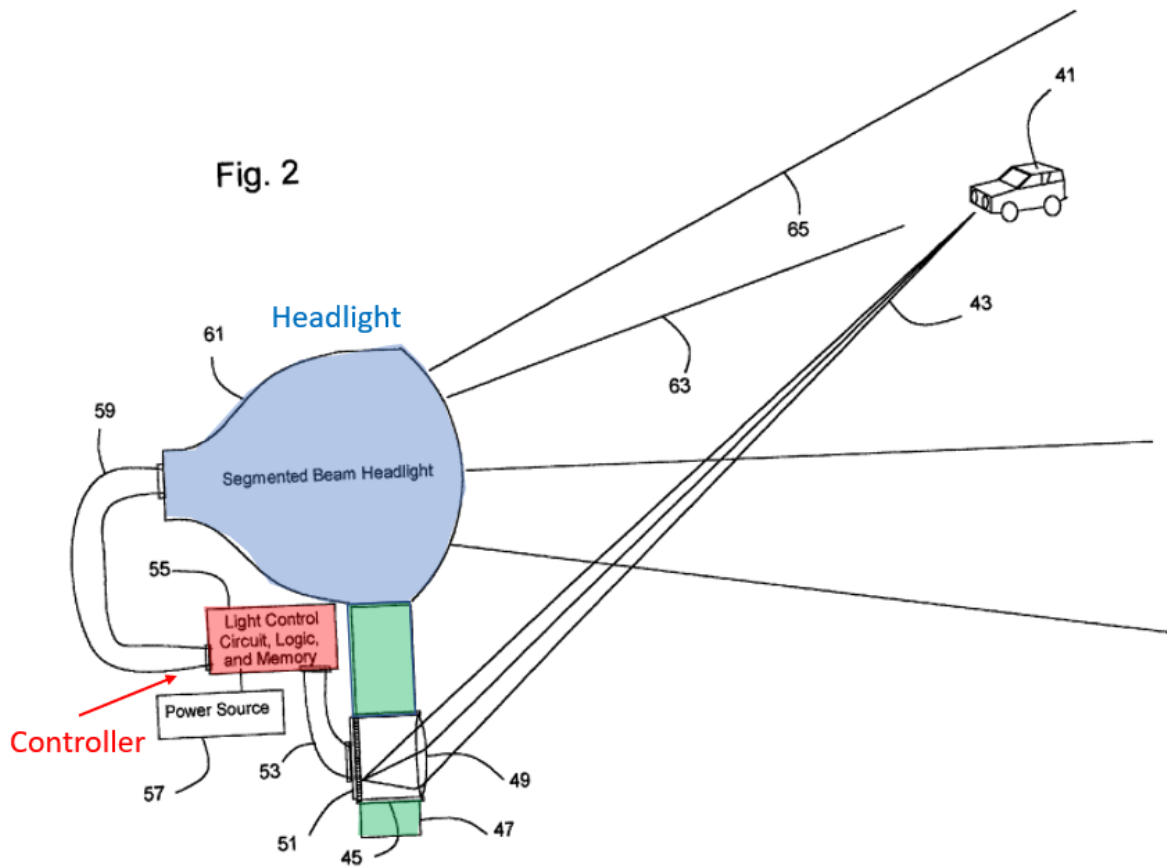
32[i]: [1] *create a beam of diminished illumination illuminating at least a portion of the at least one target with non-glaring illumination, created in a broader field of illumination having different intensity than the beam,* [2] *by one*

or more changes to characteristics of first light of a cluster of the LEDs providing the first light directed at the at least a portion and creating the beam, [3] the beam diminished in intensity relative to the broader field of illumination illuminating at least above and on both sides of the beam; and

82. Alden discloses Claim 32[i].

83. First, Alden discloses illuminating an oncoming vehicle (the “target”) with dimmed low beam light to “reduce glare,” *i.e.*, “non-glaring illumination,” and illuminating a broader field of other areas where no other vehicle is detected with “high beam” intensity light. *See supra* ¶¶65-70 (Claim 24[g]).

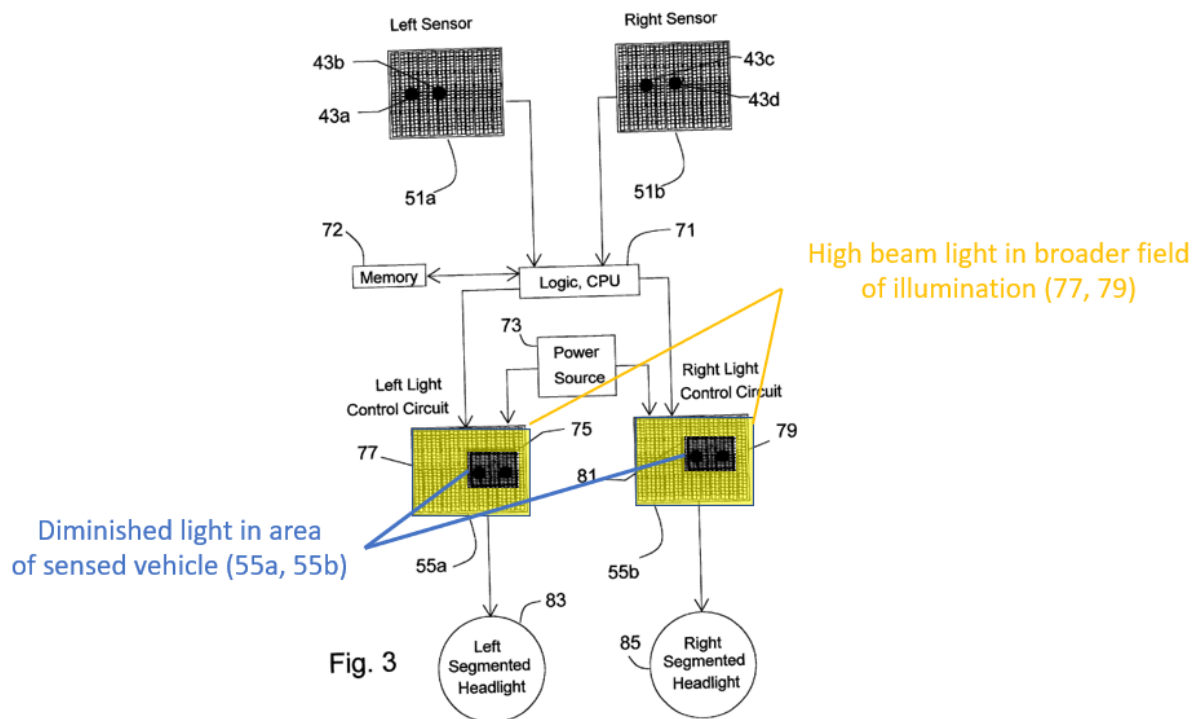
84. Second, in Alden this illumination is done by selecting a cluster of LEDs to emit a “first light” (*e.g.*, low beam) in an area that includes the object. As discussed, CPU 71 processes the sensor data to determine which LEDs are in the area of an oncoming vehicle and causes those LEDs to emit a “first light” (*e.g.*, low beam) in the area (63) of the detected vehicle (41), while other LED groups, such as in other areas (65) (*i.e.*, “the broader field of illumination”), are switched to different light:



(Alden, Fig. 2 (annotated) (for example showing sector 65 above and to the side of the other vehicle), [0026].) *See also supra* ¶¶65-70 (Claim 24[g]).

85. Third, the beam illuminating the “target” is diminished in intensity relative to the broader field of illumination above and on the sides of the beam. For example, as shown in Figure 2 above, the broader illumination in other areas (65) is high beam at least above and on both sides of the beam in the area (63) of the detected vehicle (41). Additionally, Alden senses the position of light emitted from oncoming headlights, such as 43a-43d, in its sensor array, and uses this information to determine the spatial (horizontal and vertical) position of the

oncoming vehicle. *See supra* ¶¶60-62 (Claim 24[e]), ¶72 (Claim 24[i]). As Alden is diminishing light in the area of the sensed oncoming vehicle (55a-55b), only the intensity of that light is reduced relative to the broader field of illumination (77, 79) surrounding it:



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

86. Further, Alden’s system enables one to look “around corners,” “up a hill,” and “down a hill,” all “in response to road conditions,” and a POSITA would have understood that these features would similarly enable the system to diminish light intensity in the area of a detected vehicle while switching to high beams in areas to the side and above the oncoming vehicle. (Alden, Figs. 11-13, [0036]-[0038].)

32[j]: follow, based at least in part on data from one or more of the cameras, the at least one target with the diminished illumination as the at least one target changes location relative to the motor vehicle.

87. Alden discloses Claim 32[j]. As I mentioned, Alden discloses continuously: collecting sensor data from left and right light sensors 51a-51b (camera-sensors); calculating the position of a detected oncoming vehicle based on the sensor data; determining which portions or zones of the headlight distribution area are directed towards the detected vehicle; and determining control of the lighting elements, so that lighting elements corresponding to the portions or zones where the detected vehicle is located are switched to dim, low beam light, while lighting elements corresponding to portions or zones with no detected vehicle are switched to high beam light. (Alden, [0027]-[0028] (noting that the result of the process is that “the light sent to the sensed vehicle location is dimmer than the light sent to all other areas of the headlight distribution area” and that the process “then ***begins again*** so as to be responsive to changing environmental conditions in ***real time***.”).) *See supra* ¶¶65-70 (Claim 24[g]). That is, the determination of vehicle location and which lighting elements need to be switched to dim, low beam light and which need to be switched to high beam light is done continuously “in real time” in response to the sensor data from Alden’s light sensors. Again, the iterative real-time process of determining vehicle locations and controlling the lighting elements is illustrated in Figure 4, which shows the logic steps implemented the

processor which are repeated certain headlight sectors are switched to low beam and others are switched to high beam. Thus, Alden discloses a real-time process where the position of the other vehicle is continuously sensed and the LEDs are continuously controlled to “follow” the sensed vehicle with dimmed, low beam illumination, as it is moving relative to the vehicle implementing the Alden system.

4. Dependent Claim 33

88. As viewed by a POSITA, Alden anticipates or renders obvious Claim 33.

33[a]: memory further stores instructions that, when executed by one or more processors of the controller, enable the controller to select the cluster of LEDs based at least in part on known aimings of the first light associated with the first cluster having a correlation to the at least the portion, the known aimings based at least in part on at least one of known directionality of light emitted by the first cluster or known directionality of light emitted by the first cluster exiting the headlamp;

89. Alden discloses Claim 33[a]. As discussed, Alden’s memory stores instructions which are executed by logic CPU 71 (such as those shown in Figure 4) and which enable CPU 71 to control the LEDs, so as to illuminate the portions of the headlight distribution area containing a detected vehicle in dimmed, low beam light. *See supra* ¶¶65-70 (Claim 24[g]). As also discussed, Alden’s LEDs are positioned on a curve in different directions or aimings, and if an oncoming vehicle is detected, the processor of the controller (*e.g.*, CPU 71) selects the appropriate

LEDs to dim based on whether they are positioned to emit light in the direction of the oncoming vehicle. *See supra* ¶¶73-74 (Claim 24[j]).

33[b]: the data includes image data;

90. Alden discloses Claim 33[b]. Alden’s “camera sensors” include a lens 49 that directs light to photodiode arrays or CCD detectors 51, which image lights of oncoming vehicles. (Alden, [0026]-[0028], Figs. 2-3.) The image data, collected from the photodiode arrays or CCD detectors 51 is provided to the CPU 71 and stored in memory 72. (*Id.*) Alden further discloses that “maps” of sensed light from the sensors are determined from the sensor data and stored in memory. (*Id.*, [0029], Fig. 4.) These “maps” are images of the detected light, including headlights of oncoming vehicles. *See also supra* ¶¶60-42 (Claim 24[e]). Again, a POSITA would have known that a photodiode array or a CCD detector are parts of a camera sensor, since they both capture and convert light to electrical signals which then are processed to become images of the detected light. For example, a photodiode array has a set of photodiodes where each one of them acts as a pixel that captures the light and transforms it to electrical signals. These signals from all the photodiodes are collected and processed in order to create the images. *See also supra* ¶¶60-62 (Claim 24[e]).

33[c]: *the one or more changes to characteristics of the first light include a change to at least one of intensity or color or a change of at least one LED of the cluster to a non-emitting state; and*

91. Claim 33[c] is substantially identical to Claim 25[a], and is disclosed by Alden as discussed. *See supra* ¶77 (Claim 25[a].)

33[d]: *the cluster includes a plurality of the LEDs and the cluster includes non-contiguous LEDs.*

92. Claim 33[d] is substantially identical to Claim 25[b], and is disclosed by Alden as discussed. *See supra* ¶78 (Claim 25[b].)

5. Independent Claim 40

40[pre]-40[h]

93. Claims 40[pre]-40[h] are nearly identical to Claims 24[pre]-24[h], see Appendix A. Therefore, Claims 40[pre]-40[h] are anticipated or rendered obvious by Alden for the same reasons given above. *See supra* ¶¶51-71 (Claims 24[pre]-24[h].)

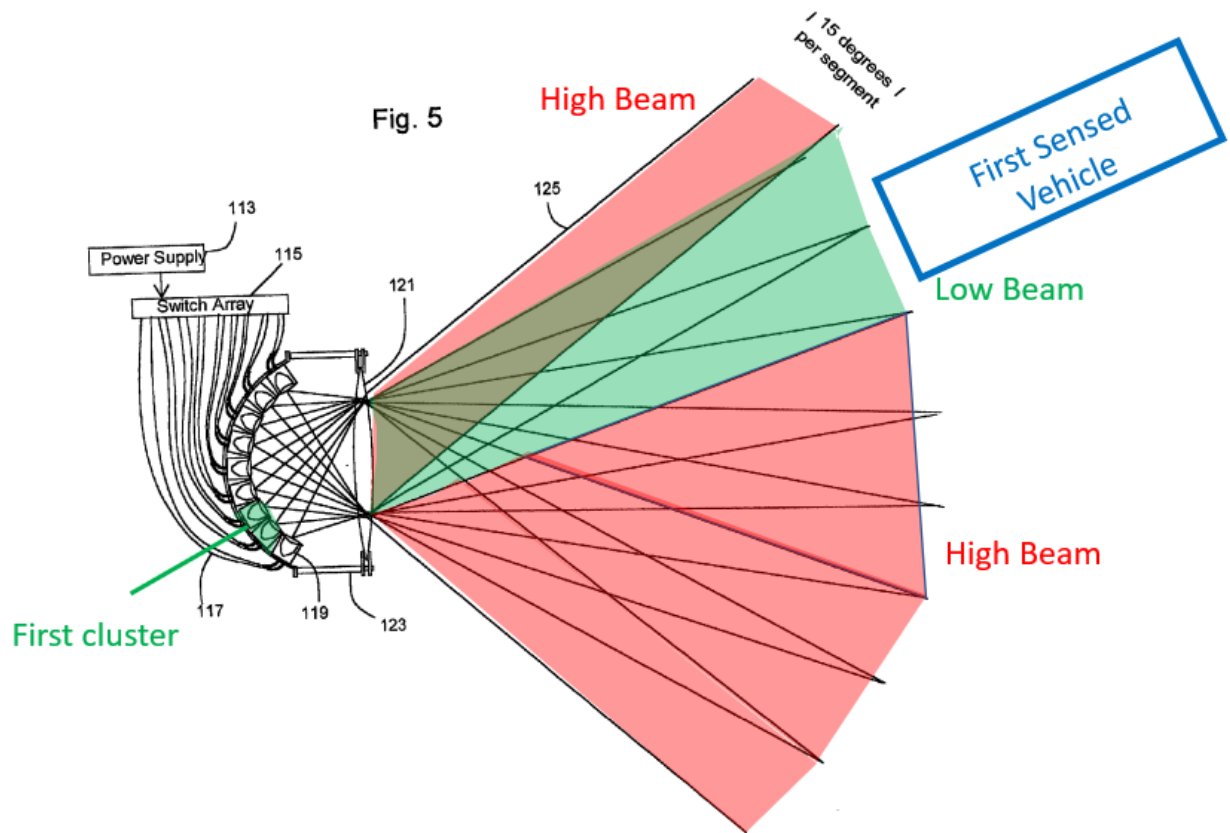
94. Claim 40[e] additionally requires one or more cameras “positioned to capture an image of at least two other vehicles,” which is substantially identical to Claim 32[e] and is thus disclosed by Alden for the reasons above. *See supra* ¶80 (Claim 32[e]).

40[i]: *determine a first cluster of the LEDs illuminating at least a first portion of a first other vehicle based at least in part on data from one or more of the sensors indicating a first position associated with the first other vehicle;*

95. Alden discloses Claim 40[i]. As discussed, Alden discloses selecting (“determining”) a first cluster of LEDs that emit light toward an oncoming vehicle, based on in part on sensor data indicating the position of that vehicle. *See supra* ¶¶72-74 (Claims 24[i]-24[j]).

40[j]: *diminish glaring illumination of the first other vehicle by a first change to one or more characteristics of first light of at least the first cluster;*

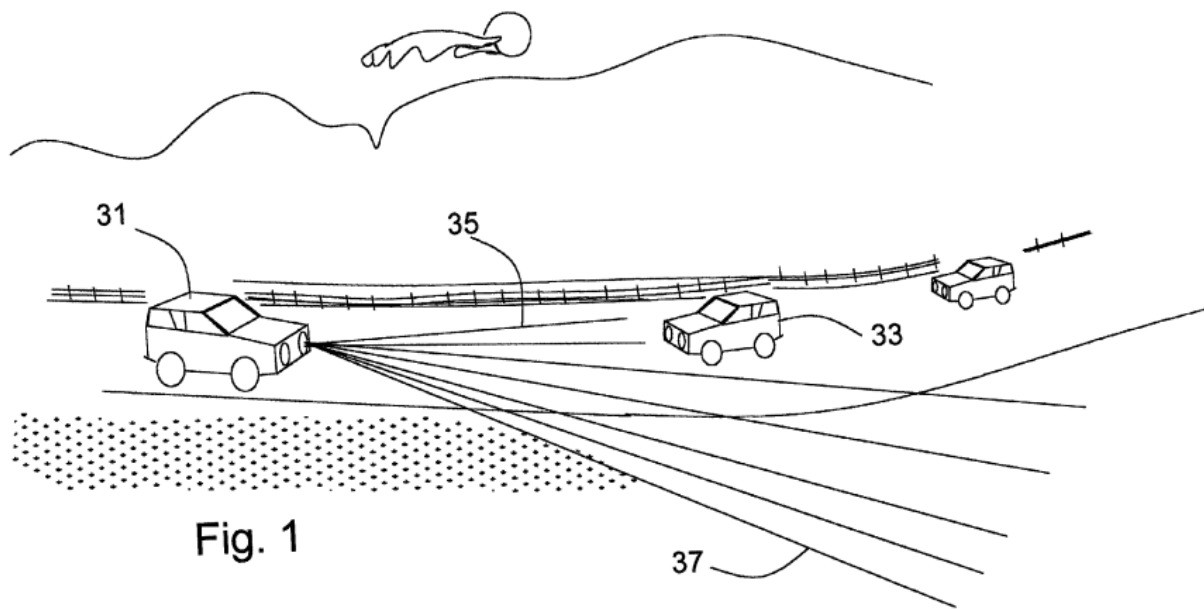
96. Alden discloses Claim 40[j]. As discussed, Alden discloses reducing light emitted from selected LEDs, which direct light to sectors determined to contain another vehicle (*i.e.*, “first light of at least the first cluster”), to dimmed, “low beam” intensity light, so that “the driver of 41 [*i.e.*, the oncoming vehicle] has minimum glare” (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):



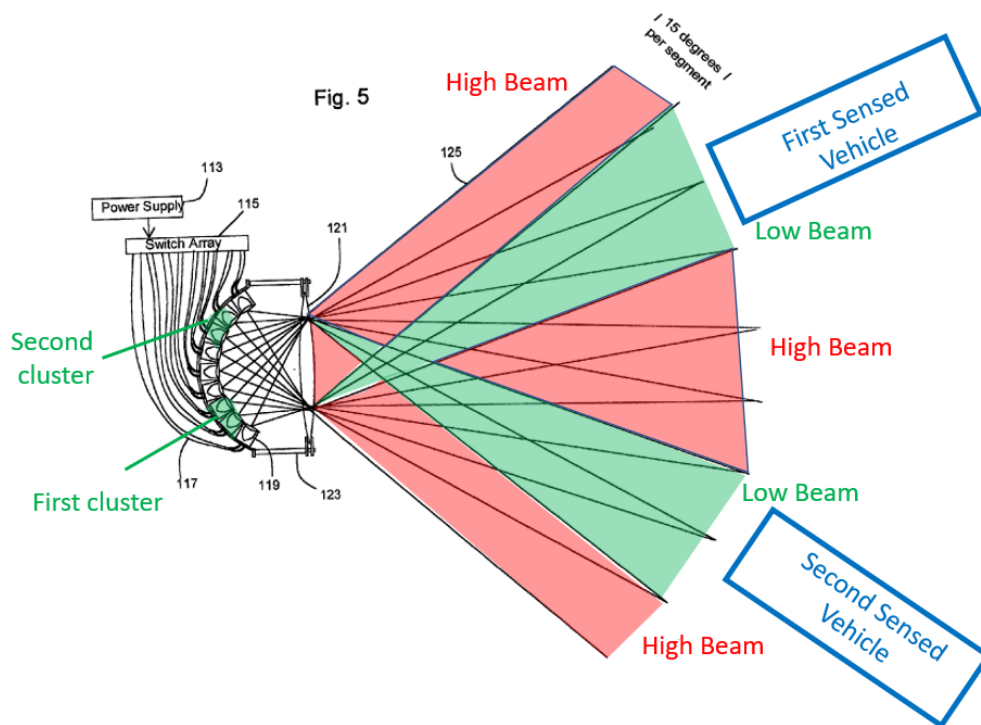
(*Id.*, Fig. 5 (annotated), [0026]-[0029].) See also *supra* ¶¶65-70 (Claim 24[g]), ¶95 (Claim 40[i]).

40[k]: *determine a second, different cluster of the LEDs illuminating at least a second portion of a second other vehicle based at least in part on data indicating a second position associated with the second other vehicle;*

97. Alden discloses or renders obvious Claim 40[k]. Alden’s system can “detect the sector *in which* [oncoming vehicle] 33 (or *any* other *vehicle*)” is present:



(Alden, Fig. 1, [2005].) That is, Alden clearly contemplates that multiple vehicles can be detected, and even shows multiple vehicles in Figure 1 above. Alden further discloses that its system provides a “specific means for *sensing locations of vehicles* and independent illumination control,” and that it can automatically provide high beams in sectors “where *no vehicle* is detected.” (*Id.*) Thus, as a POSITA would have understood, if Alden’s system detects a second vehicle (*e.g.*, after sensing light from the headlamps of a second vehicle in addition to headlamps of a first vehicle), it would determine the second vehicle position using its sensor array 51a-51b and CPU 71 and select the cluster of LEDs associated with that position that should be dimmed. *See supra* ¶¶72-74 (Claims 24[i]-24[j]). This would result in the selection of a second, different cluster of LEDs associated with the second vehicle’s position:



(Alden, Fig. 5 (annotated), [0025], [0027]-[0029].)

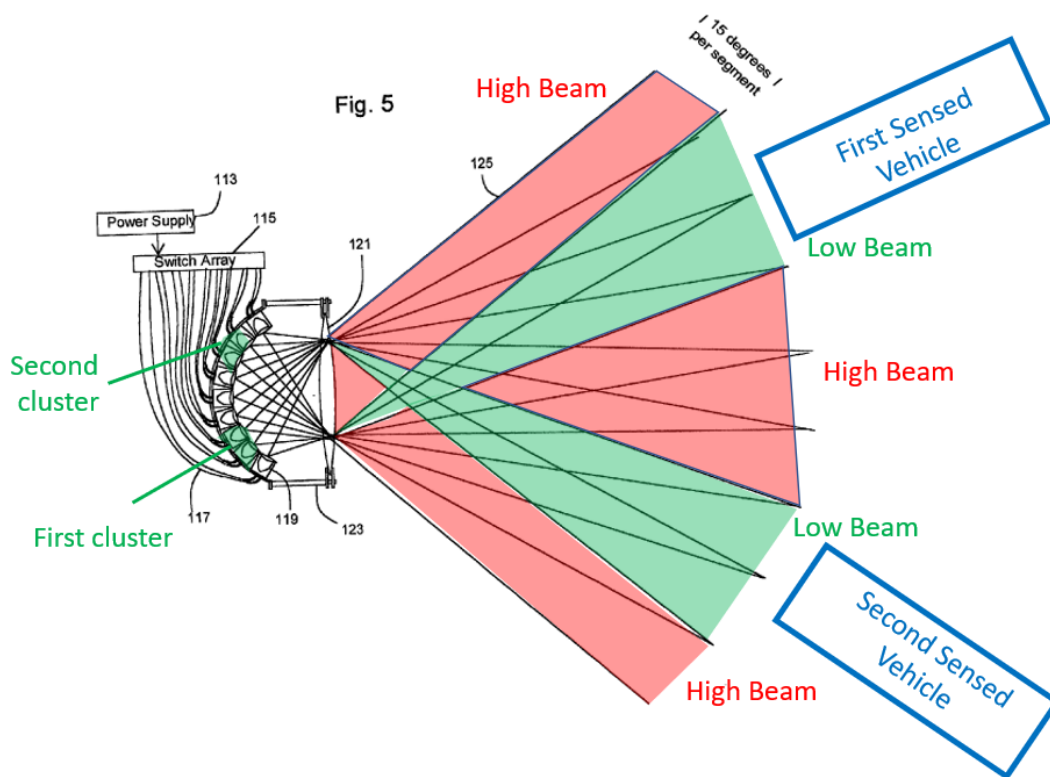
40[i]: *diminish glaring illumination of the second other vehicle by a second change to one or more characteristics of second light of at least the second, different cluster;*

98. Alden discloses or renders obvious Claim 40[i]. As discussed, Alden discloses diminishing the illumination of LEDs directing light towards sectors of the headlight distribution area where a second vehicle is sensed, by changing an intensity characteristic of the light to be dim, low beam light, so that the driver of that vehicle has “minimum glare.” (Alden, [0027]; *see also* [0025]-0026], [0028]-[0029], Figs. 1-3, 5.) *See also supra* ¶75 (Claim 24[k]), ¶96 (Claim 40[j]).

40[m]: *wherein the first and second changes decrease intensity of first emission from the first cluster and second emission from the second cluster relative to a*

third emission, from the at least one headlamp, illuminating an area between the first and second portion.

99. Alden discloses Claim 40[m]. Alden discloses that changes in characteristics of the light from the first and second clusters directing light to the first and second detected vehicles include a decrease in intensity to dim, low beam light. *See supra* ¶96 (Claim 40[j]), ¶98 (Claim 40[l]). Alden also discloses setting the light emitted from the LEDs, which direct light to sectors where no other vehicle is detected (*i.e.*, “a third emission, from the at least one headlamp” which illuminate an area between the first sensed vehicle and the second sensed vehicle) on “high beam” intensity light:



(*Id.*, Fig. 5 (annotated), [0026]-[0029].) As shown in Figure 5 above, the dim, low beam light directed at the first and second vehicles is decreased in intensity relative to the “high beam” intensity light directed to the area in between the first and second sensed vehicle where no other vehicles are present. (*Id.*) *See also supra* ¶¶65-70 (Claim 24[g]), ¶95 (Claim 40[i]), ¶97 (Claim 40[k]).

6. Dependent Claim 41

100. As viewed by a POSTIA, Alden anticipates or renders obvious Claim 41.

41[a]: *The illuminating device of claim 64, wherein: the data includes image data;*

101. Claim 41[a] is substantially identical to Claim 33[b], and is disclosed by Alden as discussed. *See supra* ¶90 (Claim 33[b]).

41[b]: *at least one of first or second change to characteristics of light associated with at least one of the first or second cluster of LEDs includes at least one of a change to color, to intensity, or a change of at least one LEDs of the respective cluster to a non-emitting state;*

102. Claim 41[b] is substantially identical to Claim 25[a], and is disclosed by Alden as discussed. *See supra* ¶77 (Claim 25[a]).

41[c]: *at least one of the first cluster or the second cluster includes a plurality of the LEDs and at least one of the first cluster or the second cluster includes non-contiguous LEDs;*

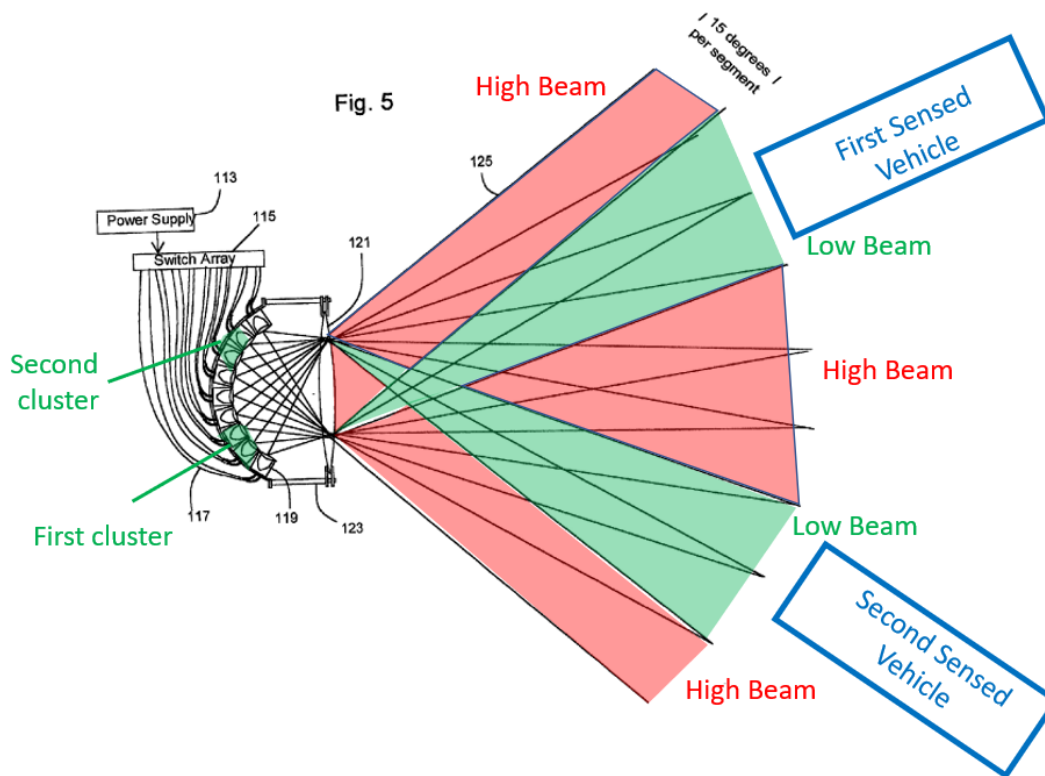
103. Claim element 41[c] is substantially identical to claim element 25[b], and is disclosed by Alden as discussed. *See supra* ¶78 (Claim 25[b]).

41[d]: the determination of the first cluster includes selection of the first cluster based at least in part on known aimings of light associated with the first cluster having a correlation to the first position, the known aimings based at least in part on at least one of known directionality of light emitted by the first cluster or known directionality of light emitted by the first cluster exiting the headlamp; and.

104. Claim element 41[d] is substantially identical to claim element 33[a], and is disclosed by Alden as discussed. *See supra* ¶90 (Claim 33[b]).

41[e]: the determination of the second cluster includes selection of the second cluster based at least in part on known aimings of light associated with the second cluster having a correlation to the second position, the known aimings based at least in part on at least one of known directionality of light emitted by the second cluster or known directionality of light emitted by the second cluster exiting the headlamp.

105. Alden discloses and renders obvious Claim 41[e]. Claim 41[e] is substantially identical to Claim 41[d], except that is directed to the “second cluster” that would be used vis-a-vis a second detected vehicle. As I discussed, Alden’s system can detect multiple vehicles, and it works the same way when detecting and adjusting illumination in the area of a “second vehicle” as it does for adjusting illumination in the area of the “first” vehicle. *See supra* ¶¶97-98 (Claims 40[k]-40[l]). As I also discussed, 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 (annotated).) Thus, when Alden illuminates an area (such as one with a “second vehicle”) with low beam light, it will select and adjust those LEDs that are directing light into that corresponding area where the second vehicle is. *See also* supra ¶¶73-74 (Claim 24[j]), ¶89 (Claim 33[a]), ¶96 (Claim 40[j]), ¶98 (Claim 40[l]).

7. Dependent Claims 26/34/42

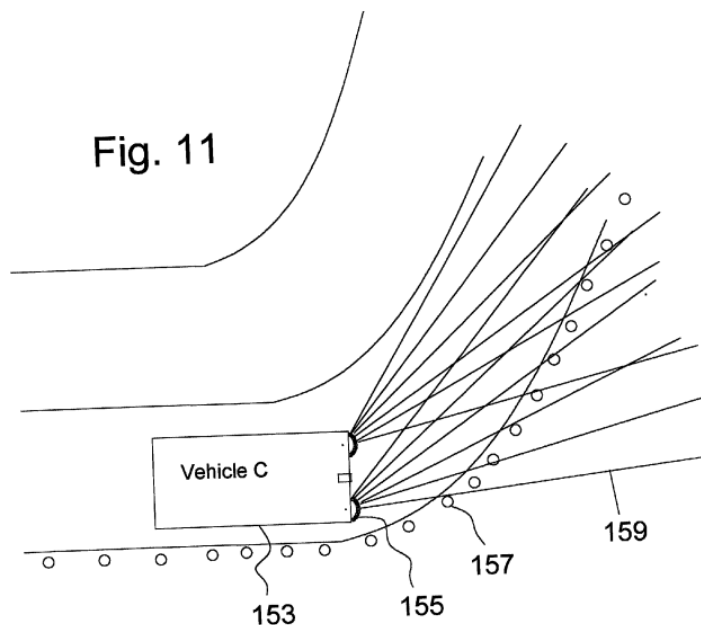
106. As viewed by a POSITA, Alden anticipates or renders obvious Claims 26/34/42.

[26/34/42]a: *The illuminating device of claim [24/32/40], wherein the memory further stores instructions that when executed by one or more processors of the controller, enable the controller to:*

107. Alden discloses Claim [26/34/42]a. *See supra* ¶71 (Claim 24[h]).

[26/34/42]b: *identify an upcoming road curvature along a road on which the motor vehicle is traveling; and*

108. Alden discloses Claim [26/34/42]b. Alden discloses that its segmented headlight system, including the CPU logic controller 71 and detector arrays 51, can be used to “concentrate light to look around corners in response to road conditions.” (Alden, [0036].) It does this by, for example sensing “that the road turns by receiving light from reflectors such as a reflector 157.” (*Id.*)



109. (*Id.*, Fig. 11.) As shown, Alden discloses that a vehicle equipped with the “segmented sensing elements and segmented light distribution elements described” therein “*sensees that the road turns* by receiving light from reflectors

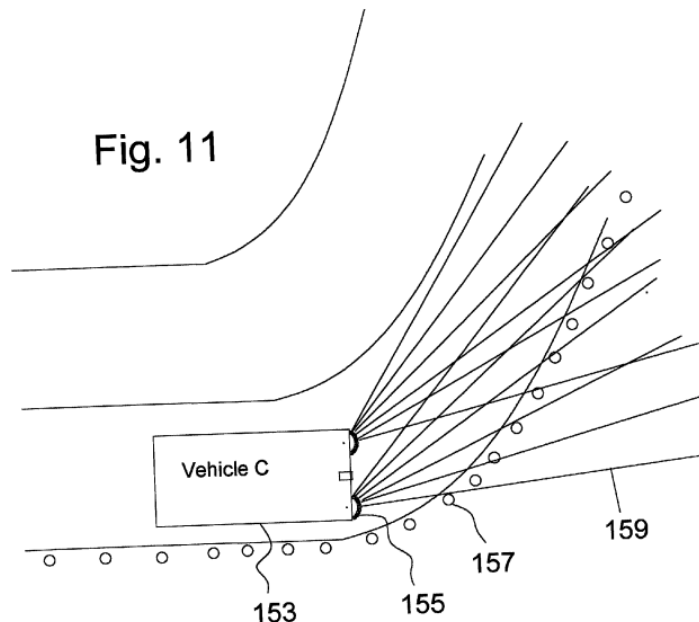
such as a reflector 157.” (*Id.*, [0036].) That is, Alden identifies an upcoming road curve by sensing the location and position of reflectors positioned along the curve. (*Id.*) Alden’s “sensing elements” include left and right sensors to detect such light and a CPU to process this data and instruct 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].) *See also supra* ¶¶56-58 (Claim 24[c]), ¶¶65-70 (Claim 24[g]).

110. Additionally, Alden discloses that its system can include a “rotation sensor” in the steering wheel that can further detect when a vehicle is planning to turn. (Alden, [0039]-[0040], Figs. 14-15.) For example, the steering wheel sensor would indicate that a driver has turned the wheel by a certain amount, indicating that the vehicle will be making a turn corresponding to the amount the wheel was turned. In particular, 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 turn, Alden’s system “increases illumination illuminating the turn.” 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 know, often times the driver will 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.

[26/34/42]c: accommodate the upcoming road curvature by adaptation of a light pattern of at least one of the at least one headlamps.

111. Alden discloses Claim [26/34/42]c. Again, Alden discloses that its segmented headlight system, including the CPU logic controller 71 and detector arrays 51, can be used to “**concentrate light to look around corners** in response to road conditions”:



(Alden, [0036], Fig. 11.) Alden does this by adapting the light pattern of the headlights to “direct light into the corner to maximize the driver’s ability to see there.” (*Id.*, [0036], [0026]-[0029].) Alden further discloses that “the directing of light can be achieved with the segmented sensing elements and segmented light distribution elements described therein.” (*Id.*, [0036], [0026]-[0029].) As discussed, this includes determining a control strategy to adapt the light output of the lighting elements, such that high intensity light is directed to segments intended to illuminate the turn. (*Id.*, [0027]-[0029], [0036]; *see also* [0039]-[0040] (discussing controlling direction of the headlight beam based on sensing steering wheel angle.) *See also supra* ¶¶65-70 (Claim 24[g]). 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. For example, Alden can recognize the curve, determine which segments of the light distribution area of the headlight lie along the curve, and then switch the lighting segments that direct light to those segments to be on high beam. This can be considered in reference to Figures 3 and 5 of Alden. The system of Alden would detect light from reflectors based on the left and right sensors. The logic CPU would then determine that this light indicates the curve of a road, much in the same it way it can detect an oncoming vehicle based on its headlights, and the location and distance of the headlights from the equipped vehicle. Once this determination is made, the CPU would instruct the

control circuitry to adjust the illumination of the LEDs accordingly. In particular, LEDs pointed in the direction of those reflectors can be switched to high beam, while other LEDs directed towards other areas can be switched to low beam. Further, a POSITA would have understood from Alden that when positioning LEDs along the curved structure in the headlamp (such as shown in Figure 5), LEDs could be positioned to ensure that the beam created by the headlamp is sufficiently wide to illuminate turns. That is, a POSITA would understand to position the LEDs on each end of the array, for example, far enough along the curve and at such an angle that their emitted light would be directed sufficiently to the sides of the vehicle. This directing of light into the corner, as shown in Figure 11 above, is an adaption of the light pattern of the headlamps. (*Id.*)

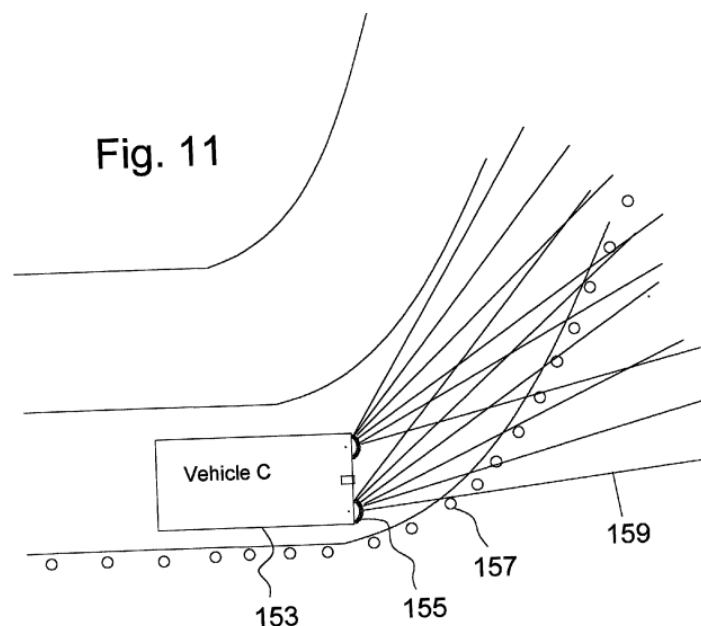
8. Dependent Claims 27/35/43

112. Alden anticipates and renders obvious Claims 27/35/43. Claims 27, 35, 43 are substantially identical to Claims 25, 33, 41, respectively, except that each additionally recites that “the memory further stores instructions that, when executed by one or more processors of the controller, enable the controller to accommodate the road curvature by changing illumination in at least a direction of the road curvature by adaptation of light pattern in at least one of color, intensity or spatial distribution by modification of light associated with one or more of the LEDs.” *See* Appendix B. Thus, the claims are anticipated and rendered obvious by

Alden for the reasons given above for the common elements. *See supra* ¶¶76-78 (Claim 25), ¶¶88-92 (Claim 33), ¶¶100-105 (Claim 41). Moreover, Alden discloses the additional limitation, since all instructions are stored in this memory element (including the instructions associated with the handling of an upcoming road curvature).

27c/35c/43e: the memory further stores instructions that, when executed by one or more processors of the controller, enable the controller to accommodate the road curvature by changing illumination in at least a direction of the road curvature by adaptation of light pattern in at least one of color, intensity or spatial distribution by modification of light associated with one or more of the LEDs.

113. Alden discloses Claim 27c/35c/43e. Alden's system, including the processor executing stored instructions, accommodates road curvature by adapting the light pattern in intensity to "***concentrate light to look around corners*** in response to road conditions":



(Alden, [0036], Fig. 11.) Alden does this by adapting the light pattern of the headlights 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 sensing steering wheel angle). *See also supra* ¶¶106-111 (Claims 26/34/42).

9. Dependent Claims 29/37/45

The illuminating device of claim [26/34/42], wherein the identification of the upcoming road curvature is based at least in part on sensor data provided by one or more of the sensors of the vehicle and wherein the adaptation of the light pattern is based at least in part on the sensor data.

114. Alden discloses Claim [29/37/45]. *See supra* ¶¶106-111 (Claims 26/34/42). As discussed, Alden’s system can sense when a road curves in front of a vehicle based on sensor data detecting reflectors 157 along the road. (Alden, [0036], Fig. 11.) Alden further discloses adapting the emitted light pattern from the headlights based on the sensor data to increase the illumination illuminating the turn, by directing light “into the corner to maximize the driver’s ability to see there.” (*Id.*)

115. 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 road curve. (Alden, [0039]-[0040], Figs. 14-15.) For example, the steering wheel sensor would indicate that a driver has turned the wheel by a certain amount, indicating that the vehicle will be making a turn corresponding to the

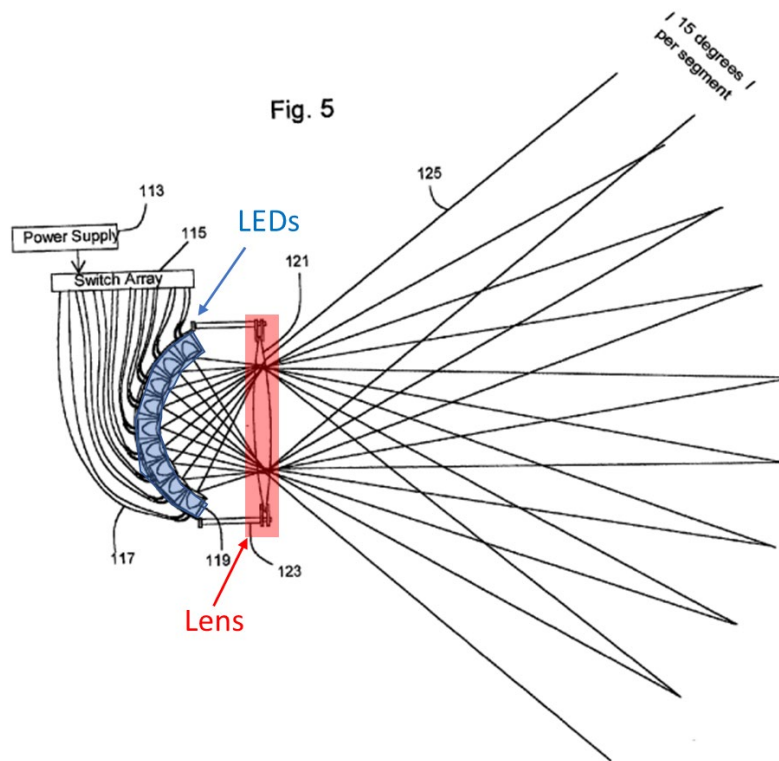
amount the wheel was turned. In particular, as the steering wheel “rotates ‘x’ degrees,” the system calculates the new planned direction of the vehicle and “changes the direction of the headlight output 197 a corresponding ‘f(x)’ degrees.” (*Id.*) Thus, when a driver turns her steering wheel before moving, in anticipation of an upcoming curve, Alden’s system adapts the light pattern to illuminate the curve. *See supra* ¶¶108-110 (Claim [26/34/42]b).

10. Dependent Claims 30/38/46 and Dependent Claims 31/39/47

[30/38/46]: *The illuminating device of claim [24/32/40], further including one or more optical control elements to control light emitted from one or more of the LEDs.*

[31/39/47]: *The illuminating device of claim [30/38/46], wherein the optical control elements include at least one of one or more reflectors, refractors or lenses.*

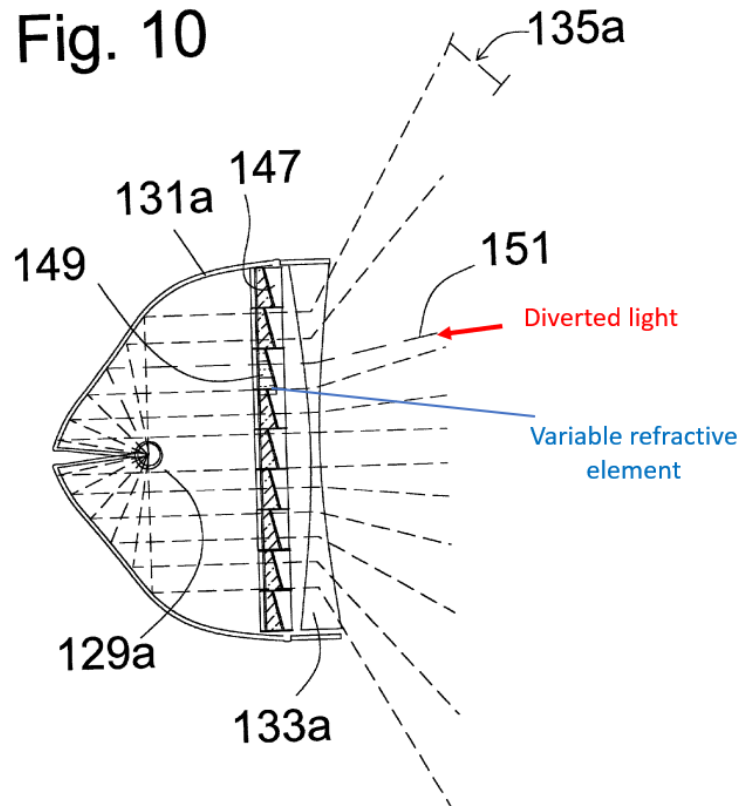
116. Alden discloses Claim [30/38/46] and Claim [31/39/47]. As shown in Figure 5 of Alden (below), each headlamp comprises of an array of lighting elements, *e.g.*, LEDs. (Alden, [0029], Fig. 5.) As I have mentioned several times, Alden discloses that these lighting elements “are on a curve along the 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 the illuminating device 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).) This lens controls a characteristic of the light emitted from the lighting elements 119, as it focuses the light from each lighting element into particular portions of the light distribution area. (*Id.*, [0029].) As shown above, lens 121 focuses the light from the lighting element labeled with reference numeral 119 in the “15 degrees” segment designated 125.

117. 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 variable 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).)

118. 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].) By selectively closing the circuit, light for a particular sector can be “bent” to redirect the light to a different area. A POSITA would have known that factors such as pressure, the presence of an electric field, temperature, and chemical composition

can have an impact on the refractive state of a liquid crystal. This is associated with the fact that liquid crystals have anisotropic properties. In other words, their molecular structure and alignment change the direction and polarization of light passing through them. For example, an electric field can change the molecular alignment of the liquid crystals, thereby changing the refractive indices and having a profound impact on the passage of light. A well-known example of these characteristics is the Liquid Crystal Display (LCD).

119. 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 such 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, including one or more variable refractive elements in the system of Figure 5 would be the use of a known optical element (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 they have one refractive state, and bending light when the circuit is closed and the crystal has a different refractive state. And a POSITA would have been motivated to add this

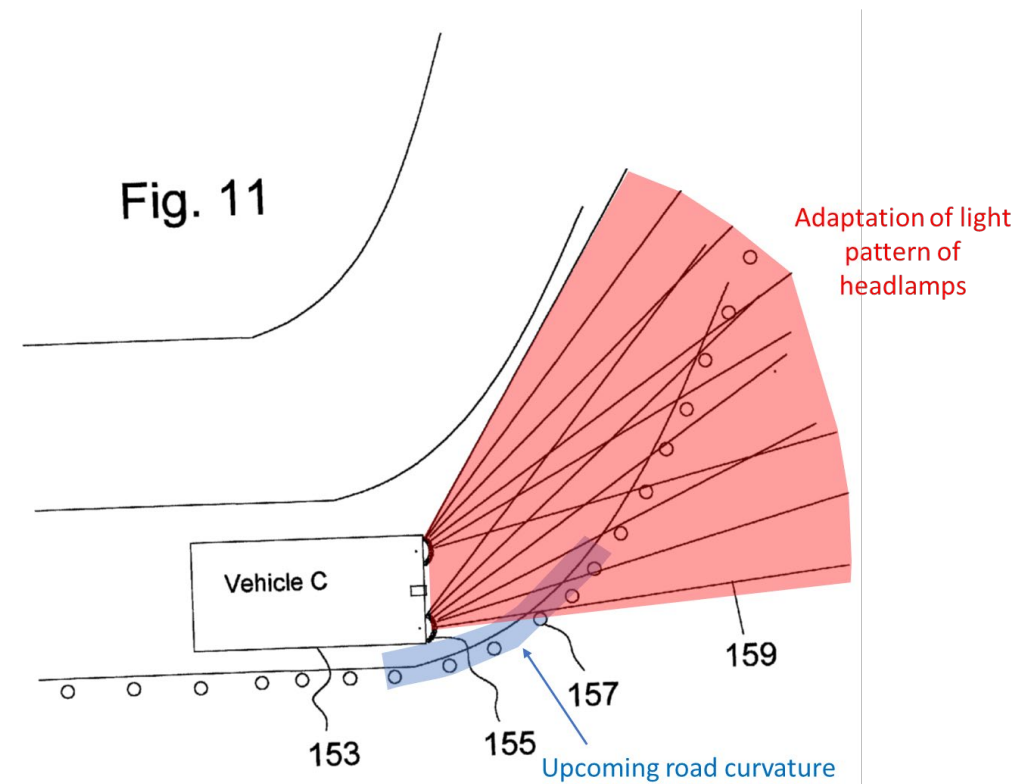
refractor element to the system in Figure 5 of Alden, so as to provide multiple means of modifying the direction or intensity of individual lighting sectors, including bending the light output in certain desired portions, allowing more variable control of lighting of subsections of a headlight beam. For example, as disclosed in Alden, the inclusion of variable refractor 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, including the refractor 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 Combined with Kobayashi Renders Obvious Claims 28, 36, 44

The illuminating device of claim [26/34/42], wherein identification of the upcoming road curvature is based at least in part on map data and wherein the adaptation of the light pattern is based at least in part on the map data.

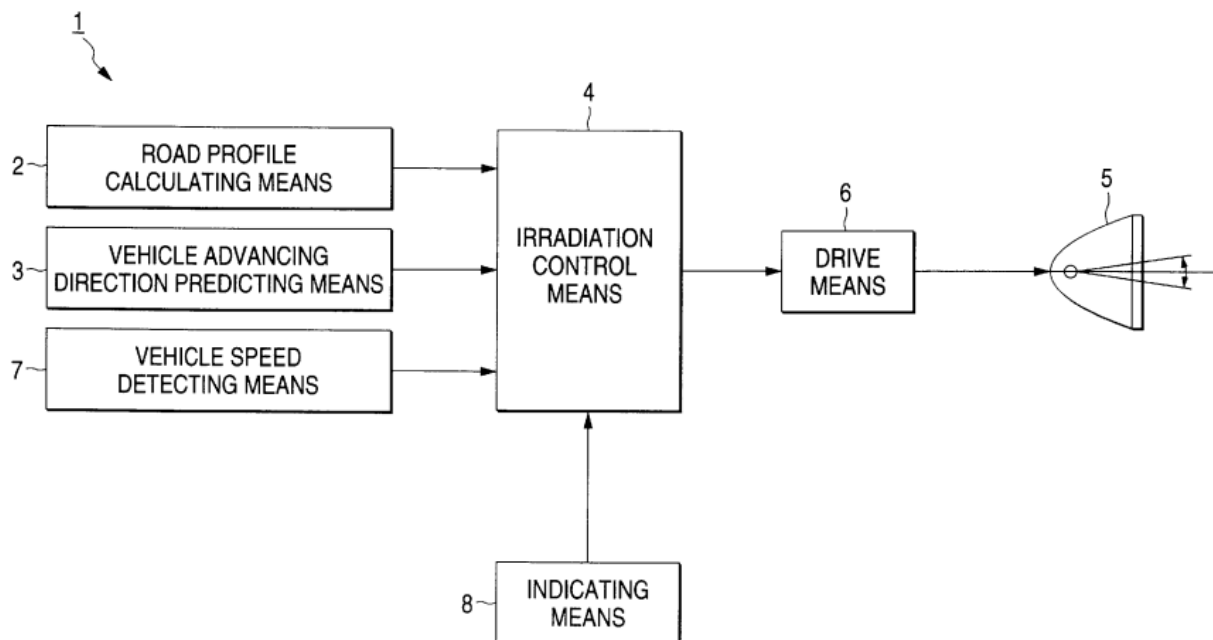
120. As viewed by a POSITA, Alden in view of US6,049,749 (EX1006) (“**Kobayashi**”) renders obvious Claim [28/36/44]. I have reviewed Kobayashi. Kobayashi issued on April 11, 2000, and is prior art under §102(b). For example, Alden discloses with respect to Figure 11 that an equipped vehicle 153 may sense upcoming road curvature and upon sensing the road curvature, the segmented headlights 155 will direct light into the corner to maximize the driver’s ability to see there. (Alden, Fig. 11 and [0036].) As shown, when an upcoming road

curvature is detected and the vehicle is about to turn left, light is directed to the left shoulder:



(*Id.*, Fig. 11 (annotated).)

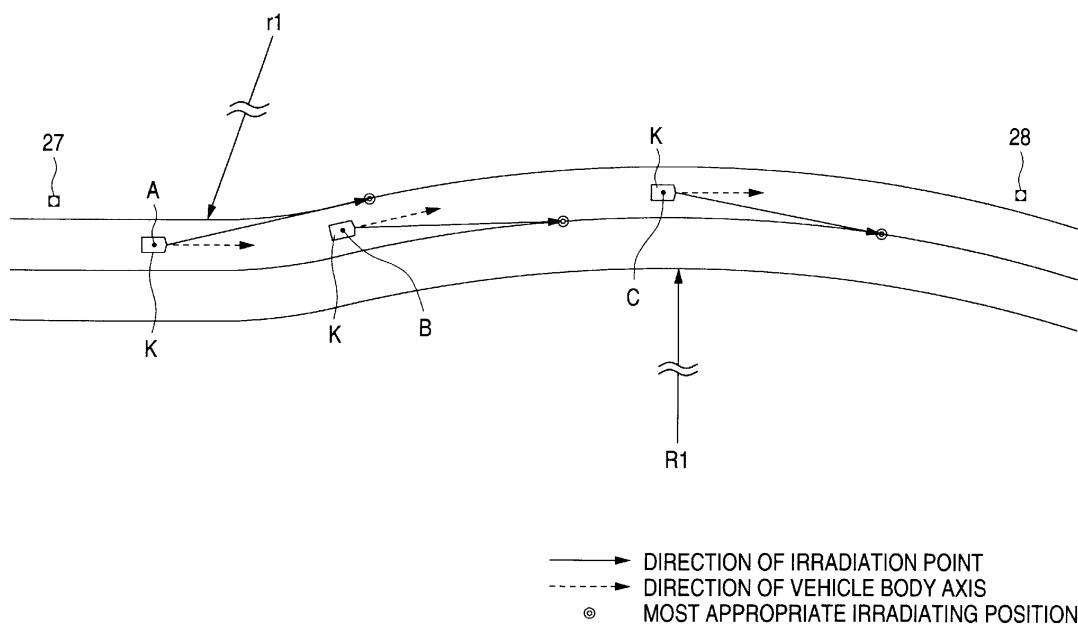
121. Alden does not disclose using map data to identify the upcoming road curvature and adapt the light pattern. Like Alden, Kobayashi titled “Lighting device for a vehicle” is directed to vehicle headlamp systems including detection of positioning along a road. (Kobayashi, Abstract, 1:5-8.) Similar 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, 17:3-47, 2:28-50.) Kobayashi further discloses that as a vehicle moves along roads in a travel route, including, for example, traveling along straight roads or bending roads, 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.)

122. It would have been obvious to a POSITA to apply these teachings to Alden to use map data to identify road curvature when adapting the LEDs of Alden to “direct light into the corner.” Both Alden and Kobayashi are directed to vehicle controlled headlamp systems, both can re-direct light based on detecting an upcoming road curve to help increase visibility for the driver, and both can use data from various sensors to do so. Further, 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: map data. A POSITA would have thus understood the systems to be complementary, and would have had a reasonable expectation of success, 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.

123. 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 and 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. Installation of such reflectors on all roads could be costly, and may not be feasible or practical in many areas. And in an urban environment, where map data may have been less reliable, light or steering wheel sensors may have been preferred.

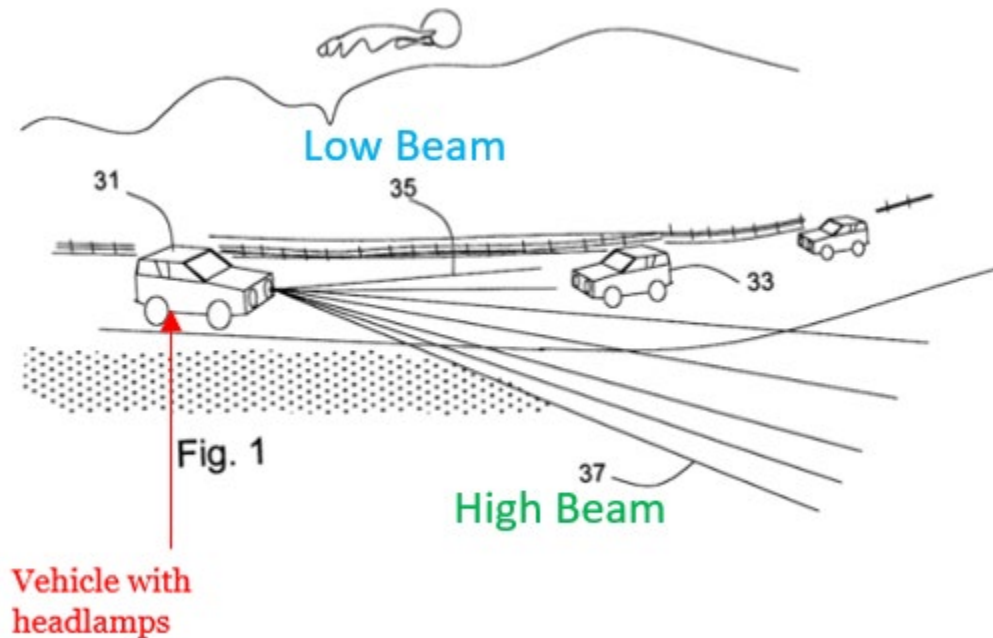
C. **Ground 3 – Alden Combined with Kondo Renders Obvious Claims 8, 10-14**

1. **Independent Claim 8**

124. As viewed by a POSITA, Alden in view of US20020057572 (EX1008) (“**Kondo**”) renders obvious Claim 8. I have reviewed Kondo. Kondo published on May 16, 2002, and is prior art under at least pre-AIA 35 U.S.C. § 102(a).

8[pre]: *An illuminating device which provides light to meet an illumination requirement of an illuminated area in which visual activities are performed, where different sub-areas of the illuminated area need to be illuminated at a different intensity and/or at a different spectrum than another sub-area of the illuminated area, comprising:*

125. Alden discloses Claim 8[pre] to the extent the preamble limits the scope of the claim. Alden recognizes that in an illuminated area, such as a vehicle’s field-of-view, different sectors (“sub-areas”) have different illumination requirements; for example, areas where there is no oncoming vehicle should have “maximum light” while areas where there is a “driver of an oncoming vehicle” should have “minimum glare.” (Alden, Abstract, [0005], [0029].) Alden thus discloses an “automatic segmented illumination” headlight system (“illuminating device”) that can emit different illumination in different sectors in its field-of-view, such as emitting “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”:

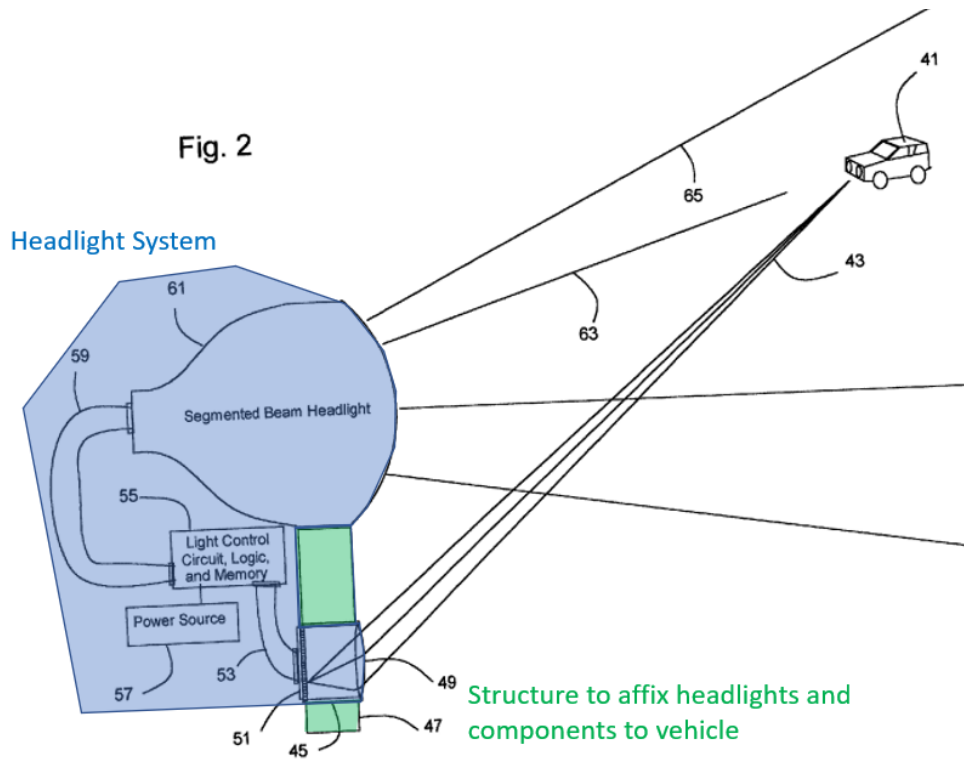


(Alden, [0025], Fig. 1 (annotated); *see also* [0026], [0029].) *See also supra* ¶51

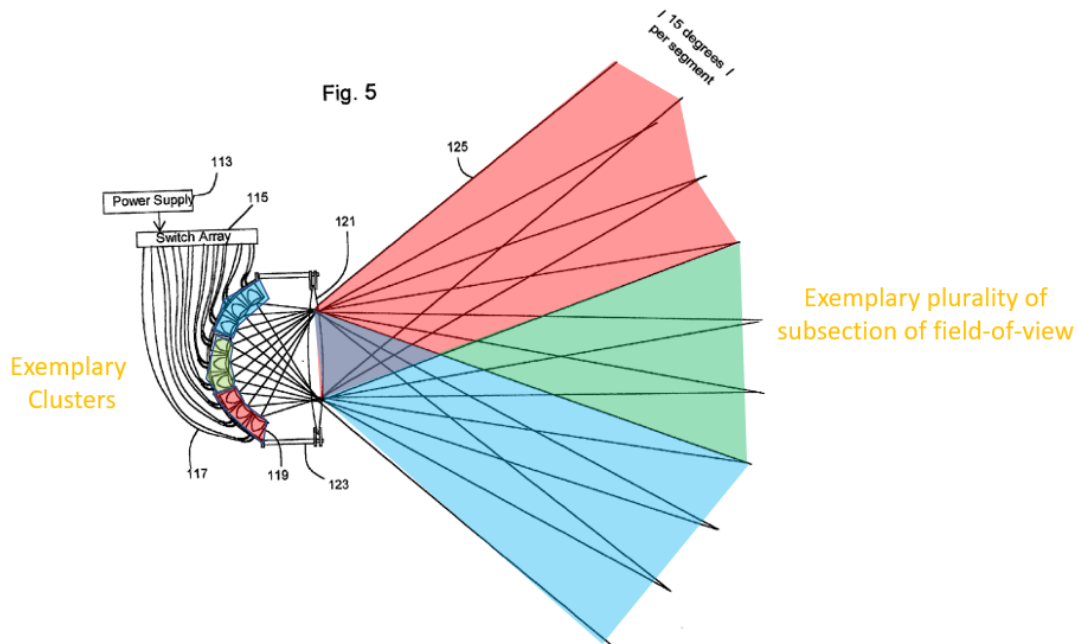
(Claim 24[pre]).

8[a]: *a light fixture including a multiplicity of directional light sources including at least two directional light sources pointing in different directions thereby illuminating different sub-areas of the illuminated area,*

126. Alden discloses Claim 8[a]. Alden’s system includes a “light fixture” in the form of “segmented beam headlight” (61) mounted in a vehicle:



(Alden, [0026], Fig. 2 (annotated).) Each “segmented beam headlamp” has “a multiplicity of directional light sources including at least two directional light sources pointing in different directions,” as each includes an “array” of “white LEDs” or “alternate light mechanisms” “on a curve along the focal point of a headlight lens 121, such that the light from each lighting element (or group thereof) goes into *a specified portion (or portions) of the headlight distribution area*” (as shown again in the representative figure below demonstrating this concept):

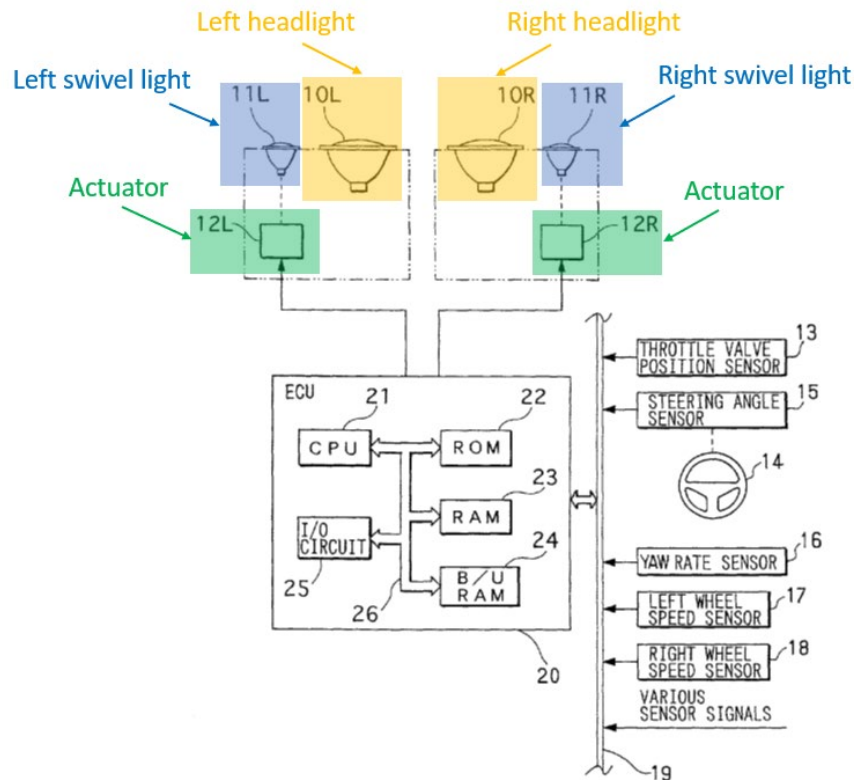


(*Id.*, Fig. 5 (annotated), [0029].) These lighting elements can also be individually controlled, and thereby arranged in additional groupings, to project different illuminations in different areas in front of the vehicle, such as dimmed, low beam light in the area of an oncoming vehicle and high beam light in other areas. (*Id.*, [0026]-[0029].) As shown, this can result in a first group of LEDs in blue illuminating a sub-area to the left of a vehicle, a second group of LEDs in green illuminating a second sub-area in the front of the vehicle, and a third group of LEDs in red illuminating a third sub-area to the right of the vehicle. *See also supra* ¶¶54-55 (Claim 24[b]), ¶¶73-74 (Claim 24[j]).

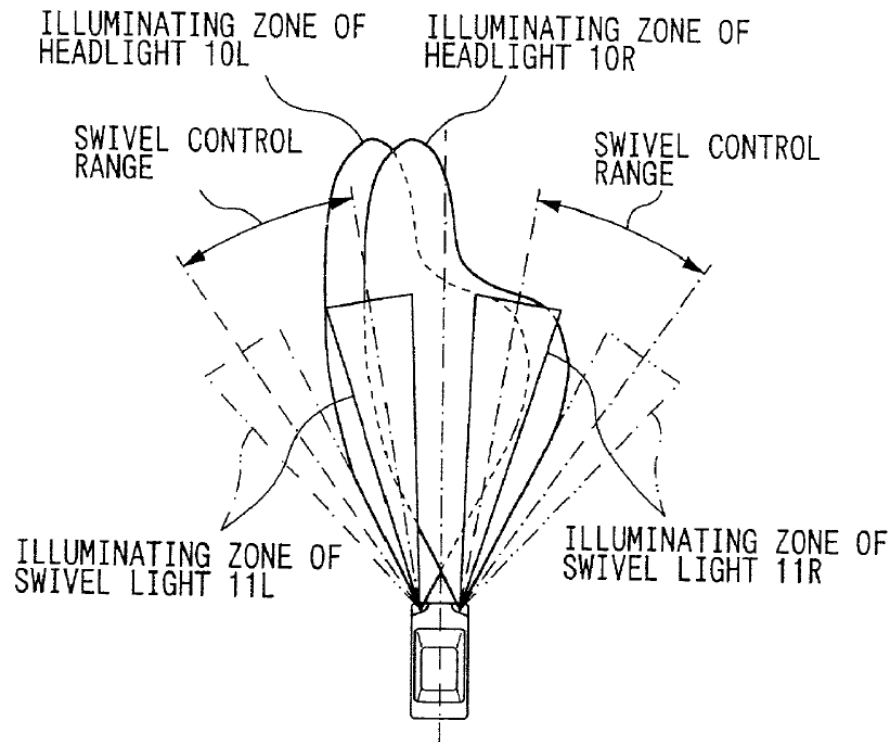
8[b]: the light fixture having movable structure for aiming the directional light sources mounted thereon in a defined direction;

127. Alden is directed to a headlight system mounted on a vehicle, with LEDs in the headlamps aimed in various directions. *See supra* ¶126 (Claim 8[a]). Alden discloses that this vehicle can be moved to aim the directional light sources in different directions. (Alden, Fig. 1, [0005], [0025].) For example, as the vehicle is driven and travels along a road, the headlights are aimed in the direction of travel and their direction changes as the vehicle direction changes. Alden further discloses that its system can re-direct light around corners and up and down hills, and that it can use various mechanisms (including a lens and a variable refractor) to redirect or bend light. (*Id.*, Figs. 5, [0029], Figs. 10-15, [0035]-[0040].)

128. Further, Alden in view of Kondo renders obvious Claim 8[b]. Kondo is titled “Automatic Optical-Axis Adjusting Device for Automatically Adjusting Directions of Optical Axes of from Lights,” and like Alden, is directed to vehicle headlamp systems that adjust the direction of “the front lights with respect to a turning direction or traveling direction of the vehicle to improve visibility to a driver.” (Kondo, Abstract, [0005], [0008].) Kondo discloses vehicle front lights comprised of swivel lights 11L-11R and left and right headlights 10L-10R. (Kondo, [0016].)



(*Id.*, Fig. 1, [0016].) The optical axes of swivel lights 11L-11R “can be **turned** horizontally in a left or right direction separately from or **integrally with** optical axes of the headlight 10L, 10R **through a swivel control.**” (*Id.*) As an example, Kondo discloses that “illuminating zones of the swivel lights 11L-11R can be adjusted within its swivel control range” that allows the vehicle to increase the area to either side of the vehicle that the lights can illuminate, as shown in Figure 2:



(*Id.*, Fig. 2, [0018].)

129. Kondo's device also includes actuators 12L-12R, which are driven to adjust the directions of the optical axes of swivel lights 11L-11R, based on the swivel control angle computed by ECU 20. (*Id.*, [0030]-[0031]; *see also* Fig. 1, [0016]-[0018].) Kondo further discloses that this angle is determined at least partly based on the turning radius of the vehicle. (*Id.*, [0030], Fig. 3.) Thus, the directions of the optical axes of the front lights can be adjusted “with respect to a turning direction or travelling direction of the vehicle to improve visibility of a driver.” (*Id.*, [0005]-[0008].) In sum, Kondo discloses a headlight fixture (*i.e.*, swivel light) having a “movable structure” (*i.e.*, swivel structure) for “aiming the directional

light sources in a defined direction.” (*see also* Kondo, Fig. 3, [0020]-[0025], Fig. 4, [0027]-[0032].)

130. It would have been obvious to apply these teachings and include LEDs of Alden on a moveable structure as taught by Kondo. Alden and Kondo are both directed vehicle headlight systems, both disclose adjusting headlight directionality using a controller taking into account various sensor data, and both disclose focusing light in the direction of a curve or turn to improve driver visibility. Alden also already contemplates that the directionality of light from its headlamps can be adjusted in numerous ways, including via a lens and a variable refractive element, and Kondo simply provides a known alternative for re-directing such light.

131. Further, a POSITA would have had a reasonable expectation of success in using the swivel structure (and associated actuator) taught by Kondo to mount certain LEDs to in the system of Alden. For example, LEDs in Alden (such as those in Figure 5) could be mounted to the moveable structure and controlled using the same controller (Alden’s CPU 71) that is already assessing how and in what directions light should be projected—something that Kondo similarly uses a CPU to assess.

132. A POSITA would have also been motivated to mount LEDs of Alden on the swivel structure of Kondo. Again, Alden discloses that its system can be

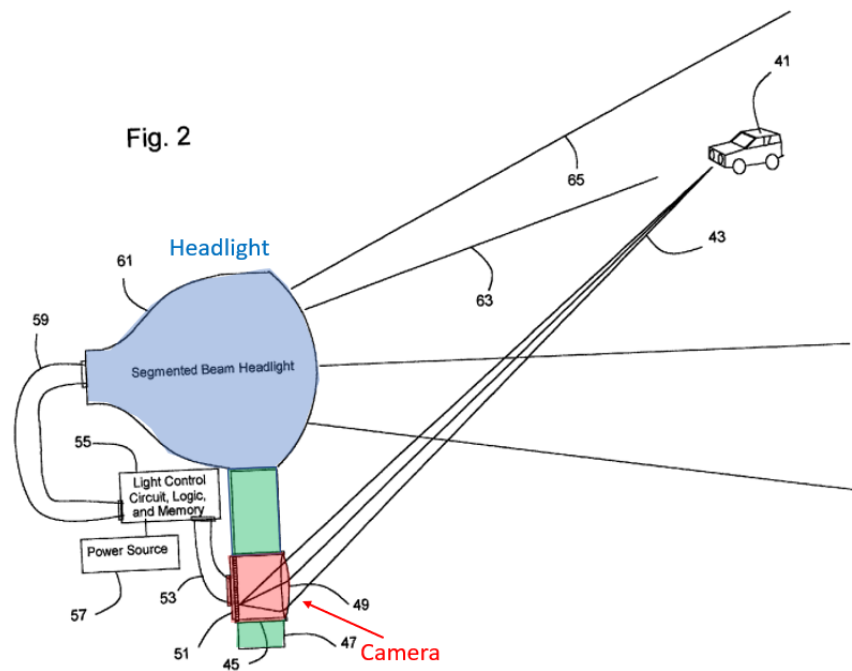
used to “direct light into the corner to maximize light there.” (Alden, Fig. 11, [0036].) Kondo provides a specific solution to address this; it can accommodate sharp turns by using a swivel structure to adjust the physical direction of lights. Accordingly, using such a structure in the system of Alden would have given Alden greater flexibility in controlling the directionality of emitted beams. By adding the swivel structure, for example, the headlights could be made to sweep across a greater range in front of the vehicle than by using the fixed lighting elements and optical members disclosed in Alden.

8[c]: a camera for obtaining images of the illuminated area functioning as a detector for at least one of (i) a light detector (ii) a spectrum detector, (iii) a motion detector, (iv) a measuring detector for sensing a geometry of the illuminated area, and (v) a detector for sensing at least one of work surfaces and road objects and at least one of vehicles and people;

133. Alden discloses Claim 8[c]. As discussed, Alden discloses a “camera” for obtaining images of the illuminated area. *See supra* ¶¶60-62 (Claim 24[e]), ¶80 (Claim 32[e]). Specifically, Alden’s system includes a lens along with photodiodes arrays or CCD detectors, which detect and image lights of oncoming vehicles of other drivers. (Alden, [0026]-0028], Figs. 2-3.) It can also detect and image roadside objects such as reflectors. (Alden, [0036], Fig. 11.) Thus, this camera functions as a “light detector” and a “detector” for sensing road objects, vehicles, and people, among other things. A POSITA would also have viewed Alden’s

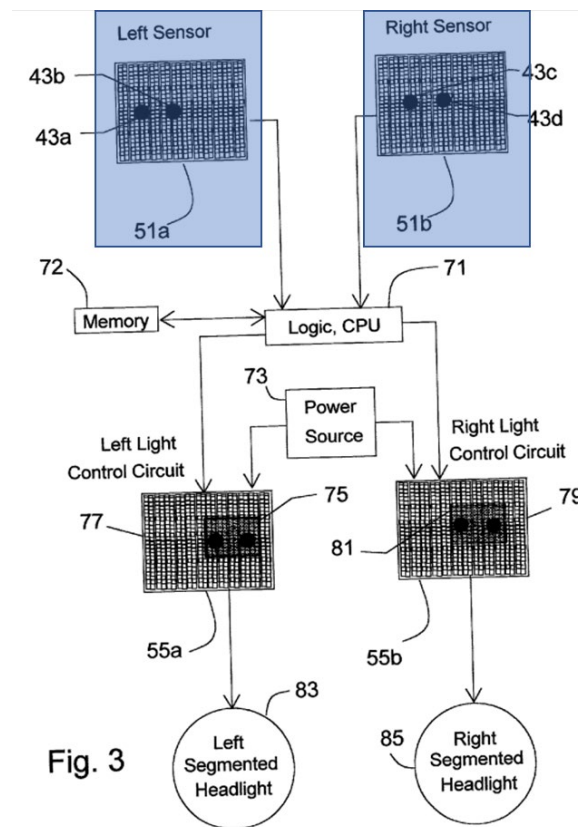
disclosure about triangulation (Alden, [0028]) as a way to recover essential components of geometry of the illuminated area.

134. Alden discloses one or more “sensors” including “cameras.” Alden discloses that each headlight includes a “sensor unit 45” mounted on “vehicle 47” that functions as a light detector to detect the presence of other vehicles:



(Alden, [0026], Fig. 2 (annotated).) 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. (*Id.*, [0026]-[0027].)

135. Alden discloses that the camera sensors include a “left sensor 51a” and a “right sensor 51b” which are used concurrently. (*Id.*, [0027].) The left sensor 51a detects the “position and intensity” of two headlights of an oncoming vehicle “at a first illuminated spot 43a and a second illuminated spot 43b respectively,” *i.e.*, coordinate specific information about the illuminated area. (*Id.*) Similarly, the right sensor 51b detects position and intensity of the headlights of the oncoming vehicle as a first spot 43c and a second spot 43d respectively. (*Id.*)



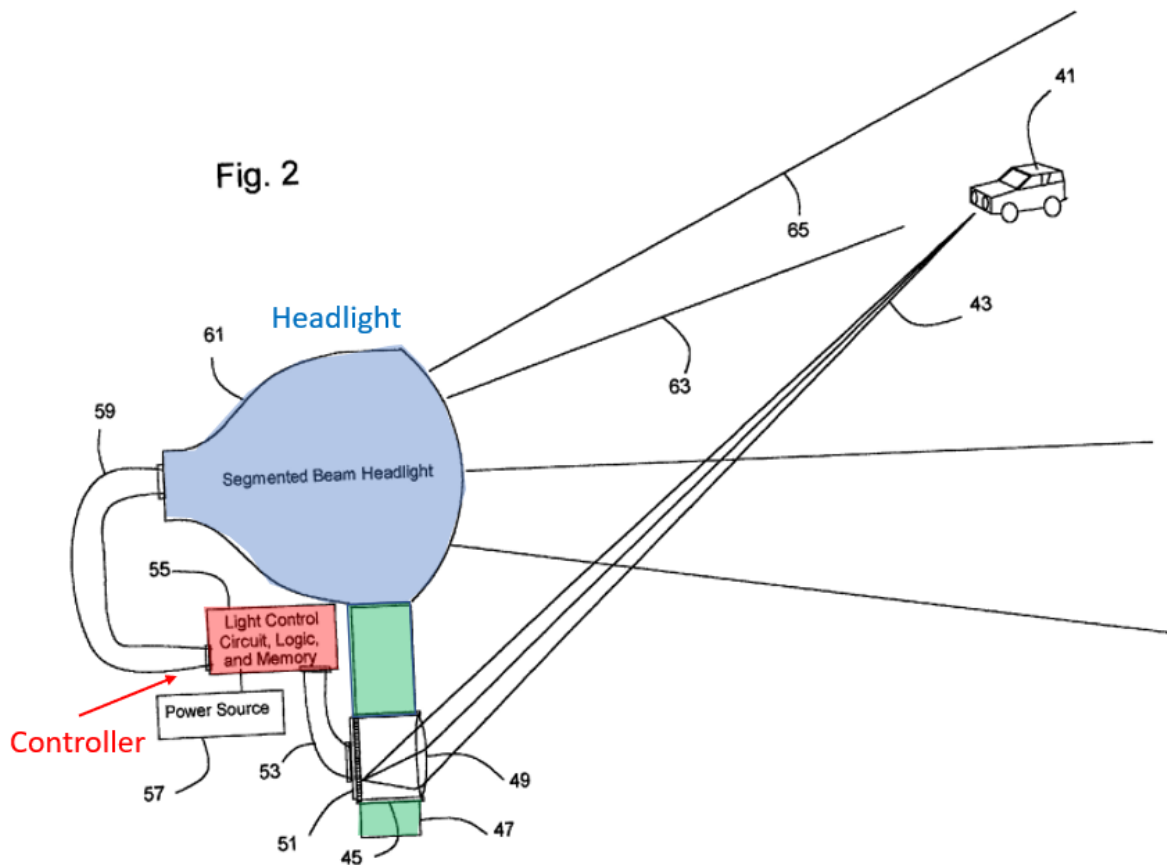
(*Id.*, Fig.3 (annotated).) Alden discloses that the position of each light spot (*i.e.*, “coordinate specific information”) is determined by checking the status of respective “sensor sectors” of each light sensor in an iterative process. (*Id.*, [0028],

Fig. 4.) Thus, the camera-sensors in Alden function as light detectors, and in particular detectors to sense the headlights of other vehicles.

136. Alden also discloses that the camera-sensor functions as a detector for sensing “road objects”, as it can sense that “the road turns by receiving light from reflectors such as a reflector 157.” (Alden, [0036], Fig. 11.) The roadside reflectors 157 are road objects, and are sensed based on detected received light above threshold limits at a plurality of sensor positions. (*Id.*, [0027]-[0028], Figs. 3-4.)

8[d]: a controller for adjusting a light intensity and a direction of each of the directional light sources;

137. Alden discloses Claim 8[d]. Alden’s system includes “light control circuit, logic, and memory 55” for controlling its headlamp and light sources therein:



(Alden, Fig. 2 (annotated), [0026].) This includes a CPU and left and right light control circuits. *See supra* ¶¶56-58 (Claim 24[c]), ¶¶63-64 (Claim 24[f]). Further, the CPU and left and right control circuits can adjust the intensity of light (e.g., switching some LEDs to dim and others to high), as well as its direction (e.g., based on combining different groups of LEDs). *See supra* ¶¶65-70 (Claim 24[g]), ¶75 (Claim 24[k]). (Alden, Figs. 10, [0033-0036] (discussing refractive element), Figs. 11-15, [0037]-[0040] (discussing system project light around curves and up and down hills).) Alden further discloses in Figure 11 that its headlight system can sense road curvature, and the headlights will “direct light into the corner to maximize the

driver's ability to see there." Alden also discloses in Figure 12 and Figure 13 that its headlight system can be used to "concentrate light to look up [or down] a hill in response to road conditions." (*Id.*, [0037]-[0038].) Thus, Alden discloses that the same controller also adjusts the direction of each of the directional light sources.

138. Further, Alden in view of Kondo renders obvious Claim 8[d]. As discussed, Kondo discloses a lighting device that can adjust the direction of swivel lights via a corresponding actuator, based on a swivel control angle computed by the ECU 20. (Kondo, [0008]-[0009], [0030]-[0031], Figs. 3-4.) *See also supra* ¶¶127-132 (Claim 8[b]). Kondo discloses that the ECU 20 "is formed as a logical operation circuit that includes a CPU 21, a ROM 22, a RAM 23...", "[t]he CPU 21... carries out various known arithmetic operations," and "[t]he ROM 22 stores control programs." (*Id.*, [0016].) Kondo further discloses that ECU 20 receives sensor signals and generates output signals based on sensor data, and the output signals are sent to actuators of the swivel lights so as to adjust the direction of each of the swivel light. (*Id.*, [0017]; *see also* [0030].)

139. It would have been obvious to combine Alden and Kondo for the reasons discussed above. *See supra* ¶¶127-132 (Claim 8[b]). As discussed, Alden's system discloses re-directing light around a curve or turn, Kondo provides a known solution for accomplishing this, and a POSITA would have had a reasonable expectation of success and would have been motivated to mount LEDs of Alden on

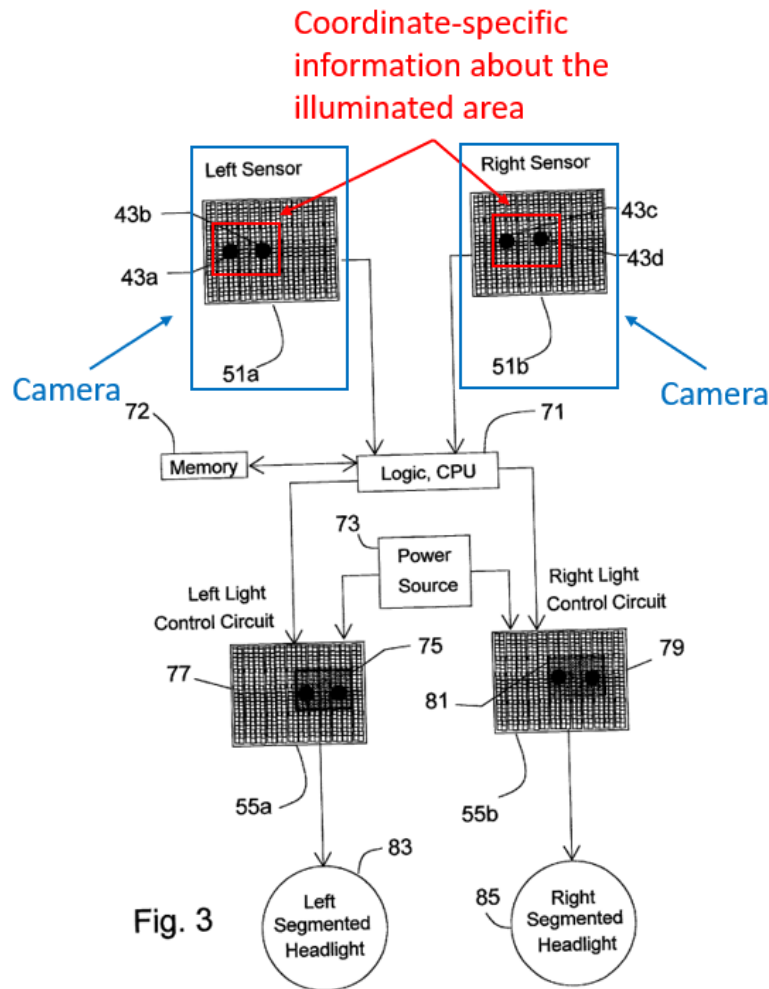
a swivel structure as taught by Kondo (*e.g.*, for greater flexibility in light projection). *See supra* ¶¶127-132 (Claim 8[b]). Further, a POSITA would have understood that once the swivel structure is included in Alden's system, and LEDs are mounted thereon, there would need to be a mechanism ("controller") to control its swivel. A POSITA would have understood that the swivel structure in Kondo could be controlled in the same way when used in Alden—for example, through the use of a processor (CPU 71) that can take into account sensor data and instruct actuators to swivel the lights accordingly.

8[e]: [1] a processor with stored algorithms and data for identifying at least one of (i) tasks being carried out by people, (ii) location of people, (iii) frequency of area usage by people, (iv) traffic density in the illuminated area from the sensed geometry, (v) work surfaces, (vi) road objects, people and/or vehicles, and (vii) roadway surface luminance [2] any of which is used by said processor for determining illumination within the illuminated area using at least one of artificial intelligence, pattern recognition, video analytics, and look-up tables [3] wherein said processor, upon calculating the required illumination parameters according to best practice standards, directs the controller to adjust the directional light sources that illuminates the specific sub-areas to meet the illumination requirements of the visual activities.

140. Alden discloses Claim 8[e]. First, Alden discloses a processor with stored algorithms and data for identifying "at least one of ... (iv) road objects and/or vehicles." *See supra* ¶59 (Claim 24[d]), ¶¶63-71 (Claims 24[f]-24[h]). In addition, a POSITA would have also understood that the processor can identify, among other things, (i) tasks being carried out by people as it can detect in real time the headlights of oncoming vehicles indicating someone is driving in another car, (ii) location of

people as these vehicles would have drivers at the time of the patent, and (iv) traffic density in the illuminated area from how many headlight “dots” are detected.

141. Second, Alden’s processor determines illumination within the illuminated area using at least “pattern recognition.” For example, Alden’s logic CPU 71 is connected to sensors 51a-51b and receives information from the sensors regarding patterns of sensed light. (Alden, [0027].) When there is an oncoming vehicle, light from it “passes through [the] primary lens 49” in sensor unit 45, converges, and “fall[s] upon one or more sectors [] within the detector array 51 where it is detected”:



(Alden, Fig. 3, [0026]-[0027].) As shown, each sensor “detects the two headlights of [oncoming vehicle] 41” at first and second illuminated spots 43a-43d, 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.*, [0027]-[0028], Figs. 3-4.) *See also supra* ¶¶60-62 (Claim 24[e]).

142. CPU then compares these maps and assesses whether they appear to be oncoming vehicles, including based on the “intensity” and “distance” of the light patterns. (*Id.*, [0028], Fig. 4.) If the light patterns are determined to be a vehicle, then

CPU 71 will adjust the illumination of light in the sector(s) containing those patterns, instructing the control circuitry to, for example, power the lighting elements to switch to low beam light or to high beam light, depending on whether they direct light to the sectors where the other vehicle is located. (Alden, [0027]-[0029].) *See also supra* ¶¶65-70 (Claim 24[g]). A POSITA would have understood pattern recognition to have the objective of analyzing and interpreting data in order to recognize and categorize underlying patterns or structures. Moreover, a POSITA would have understood pattern recognition to include among other steps, data acquisition, preprocessing, feature extraction, pattern representation, and pattern classification. Alden discloses pattern recognition since Alden discloses the detection of headlights along with methods such as triangulation to refine the results. (Alden, [0027]-[0028].) For example, in Alden, the headlights of the other vehicle are detected when two dots of light at certain positions are detected.

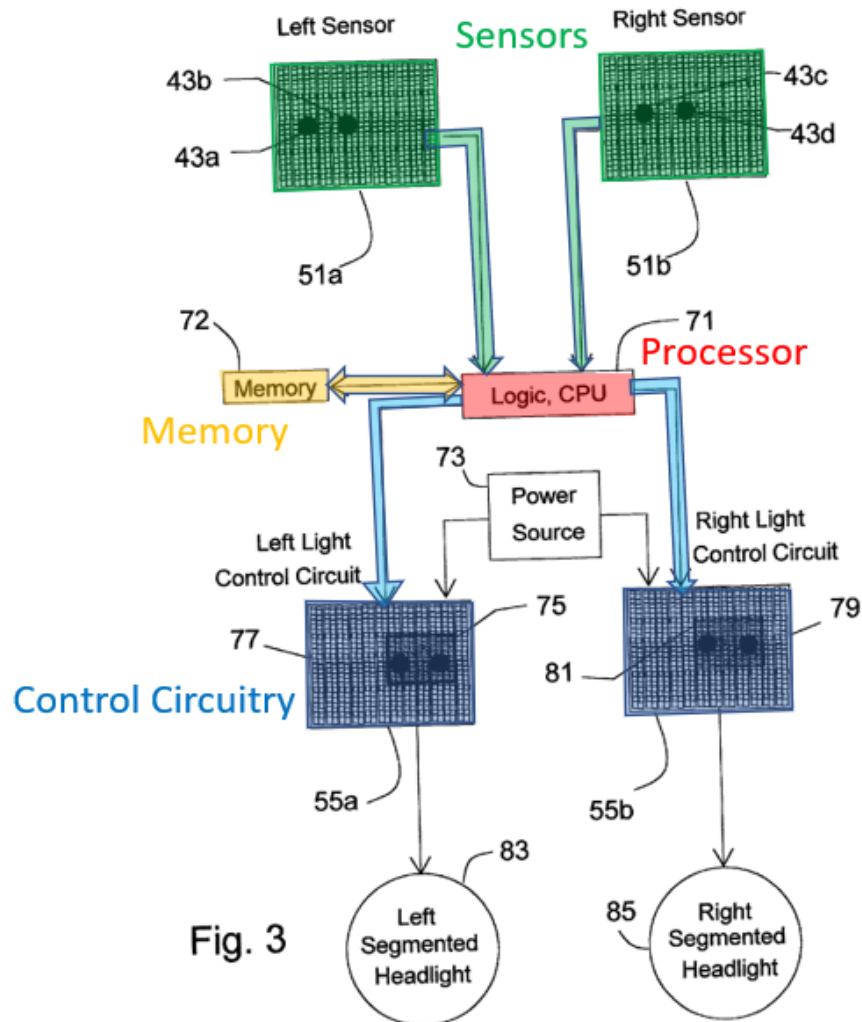
143. Third, Alden discloses after determining which lighting elements to dim and which to set to high beam, the processor sends signals to the control circuits to switch some sectors to dim, low beam light, and others to high beam. (*Id.*, Fig. 4, [0027]-[0028]; see also Fig. 3, [0025]-[0026].) *See also supra* ¶¶65-70 (Claim 24[g]). Thus, once Alden determines that the “light for both drivers is concurrently optimized,” CPU 71 directs the control circuitry to adjust the directional light sources that illuminates the specific sub-areas to meet the illumination requirements

of the visual activities, such as to dim the space containing another vehicle to minimize glare. (Alden, [0006], [0026]-[0027], Fig. 2.)

2. Dependent Claim 10

The illumination device of claim 8, [1] wherein the controller receives real time information from the camera and [2] wherein the processor, using image recognition capability, directs the controller to adjust at least one of (i) the intensity, (ii) the spectral light distribution and, (iii) the direction of the light sources based on at least one of (i) where people requiring illumination are located, (ii) what object the person is viewing and (iii) what visual task the person needs to perform.

144. As viewed by a POSITA, Alden in view of Kondo renders obvious Claim 10. First, Alden discloses that its “controller” (e.g., logic CPU 71) receives data from left and right camera sensors 51a-51b:



(Alden, Fig. 3 (annotated), [0027]; *see also* [0026], Fig. 2.) *See also supra* ¶¶65-70 (Claim 24[g]). Alden also discloses that CPU 71 processes this sensor data to determine how to adjust the headlights and instruct the control circuitry “so as to be responsive to changing environmental conditions *in real time*.” (*Id.*, [0028].) Thus, Alden discloses that the sensor data is real-time information. *See also supra* ¶¶65-70 (Claim 24[g]).

145. Second, Alden discloses that its processor, using its image recognition capability, directs the control circuitry to adjust the intensity and direction of light

sources based on (a) where someone requiring illumination (the driver) is located, (b) what objects the driver is viewing (*e.g.*, oncoming vehicles), and (c) what task the driver needs to perform (*i.e.*, driving in traffic). (Alden, [0027]-[0028].) As discussed, when the CPU detects an oncoming vehicle in a particular sector based on sensor data, it will instruct the control circuitry to cause a group of LEDs pointing in the direction of that sector to dim, while instructing the controller to cause other LEDs (*e.g.*, those not pointing at that sector) to switch to high beam. *See supra* ¶¶65-70 (Claim 24[g]). As a result, “the light sent to the sensed vehicle location is dimmer than the light sent to all other areas of the headlight distribution area.” (Alden, [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.*; *see also* Abstract, [0005].)

146. Alden can similarly adjust the direction of the beam emitted from the headlamps. For example, Alden discloses emitting a low beam light at an oncoming vehicle. As that vehicle continues to get closer, the direction of the beam of dim light will change (*e.g.*, shift), with different LEDs being used to project light dim beam light projected at a different angle relative to the equipped vehicle. (*See* Alden, [0036], Fig. 11 (re-directing light around corner based on light from roadside signs).)

3. Dependent Claim 11

The illumination device of claim 8, further comprising at least one of the directional light sources mounted on the movable structure where the movement of the light source direction is automatically controlled by the controller.

147. As viewed by a POSITA, Alden in view of Kondo renders obvious Claim 11. As discussed, it would have been obvious to a POSITA to apply the teachings of Kondo to mount Alden's LEDs to a movable structure and use the same controller that automatically controls the intensity of the lighting elements to control the direction of the light sources. *See supra* ¶¶127-132 (Claim 8[b]), ¶¶137-139 (Claim 8[d]). For example, a POSITA would have been motivated to apply such teachings of Kondo to Alden, given that the references are in the same field, that Alden already contemplates re-directing lighting in various ways, and that using the swivel of Kondo as controlled by a controller would have simply been a known method in a similar system that would have provided greater flexibility.

4. Dependent Claim 12

The illumination device of claim 11, providing a different illumination to a sub-area based on usage wherein the controller interpreting images from the camera adjusts the moveable light sources such that they provide the required illumination in a sub-area proximate to the individuals as they move around in the illuminated area.

148. As viewed by a POSITA, Alden in view of Kondo renders obvious Claim 12. As discussed, Alden discloses that the CPU repeatedly checks the status of the sensor unit, calculates the location of the oncoming vehicle from the

information collected by the sensor unit, and determines which headlights need to be dimmed or switched to high beam in an iterative process, “so as to be responsive to changing environmental conditions in real time.” *See supra* ¶¶65-70 (Claim 24[g]), ¶¶140-143 (Claim 8[e]). This includes continuously adjusting the lighting elements so that they provide dim, low beam light to areas proximate to both drivers of equipped and oncoming vehicles as they move. *Id.* That is, if a sensed other vehicle is moving relative to the vehicle equipped with Alden’s system, then each time the process repeats in real time, the new location of the vehicle will be determined. Lighting elements that illuminate sectors corresponding to this new vehicle position will be switched to dim light. And any lighting elements directing light to a sector where the other vehicle was previously located, but is no longer located, will be switched from dim, low beam light to high beam light. A POSITA would have viewed this as a continuous adaptation of the headlights beam in view of changing conditions on the road and the vehicles present in the vicinity of the equipped vehicle.

149. Further, Kondo discloses that the direction of the light source can be adjusting using a swivel mount and that this can be automatically controlled by a controller. *See supra* ¶¶127-132 (Claim 8[b]), ¶¶137-139 (Claim 8[d]), ¶147 (Claim 11). For the same reasons as above, it would have been obvious to a POSITA to apply these teachings and mount Alden’s LEDs to a movable structure and use the

same controller that automatically controls the intensity of the lighting elements to control the direction of the light sources. *Id.* A POSITA would have understood that applying this teaching would have enabled Alden to continue to illuminate areas proximate to vehicle drivers as they move, but would have added greater flexibility to the system (*e.g.*, in the range of light). A POSITA would have viewed this as increasing the capabilities and performance of the LEDs, as it would have given them flexibility to direct light in a broader area.

5. Dependent Claim 13

The illumination device of claim 8, wherein the illuminated area is a road and the objects include road signs.

150. As viewed by a POSITA, Alden in view of Kondo renders obvious Claim 13. For example, Alden's headlight system can be used "to concentrate light to look around corners in response to road conditions," thereby illuminating the road. (Alden, Fig. 11, [0036].) Alden can also detect road "signs," as it can sense "that the road turns by receiving light from reflectors such as a reflector 157," and, accordingly, light emitted from the headlights is "directed into the corner to maximize the driver's ability to see there." (*Id.*) The roadside reflectors 157 would be detected using the same process described with respect to Figures 3-4, where "objects" are sensed based on detected received light above threshold limits at a plurality of sensor positions. (*Id.*, [0027]-[0028], Figs. 3-4.) If anything, the threshold level and distance of the detected light would simply be adjusted to

consider something a road sign or reflector as opposed to headlights of an oncoming vehicle (which Alden discloses appear as two dots of light). A POSITA would understand that a roadside reflector is a type of traffic sign, as it signals to the driver that the road is curving. *See also supra* ¶¶106-111 (Claims 26/34/42).

6. Dependent Claim 14

The illumination device of claim 8, further comprising at least one of the directional light sources on an automatic swivel joint and providing spot lights of limited beam angle for task lighting while other light source provide general illumination to the illuminated area.

151. As viewed by a POSITA, Alden in view of Kondo renders obvious Claim 14. As discussed, Kondo discloses at least one of the directional light sources on an automatic swivel joint, *i.e.*, swivel lights 11L-11R, which provide spot lights of limited beam angle for task lighting, such as illuminating at the turning direction of the vehicle, while other light sources, such as the headlights 10L-10R provide general illumination to the illuminated area. *See supra* ¶¶127-132 (Claim 8[b]), ¶¶137-139 (Claim 8[d]), ¶147 (Claim 11).

152. For the same reasons as above, it would have been obvious to a POSITA to apply these teachings and mount Alden's LEDs to the automatic swivel and use the same controller that automatically controls the intensity of the lighting elements to control the direction of the light sources. *Id.* A POSITA would have understood that after applying this teaching Alden would continue to be able to illuminate discrete areas with one light level (such in the area of a turn or a nearby,

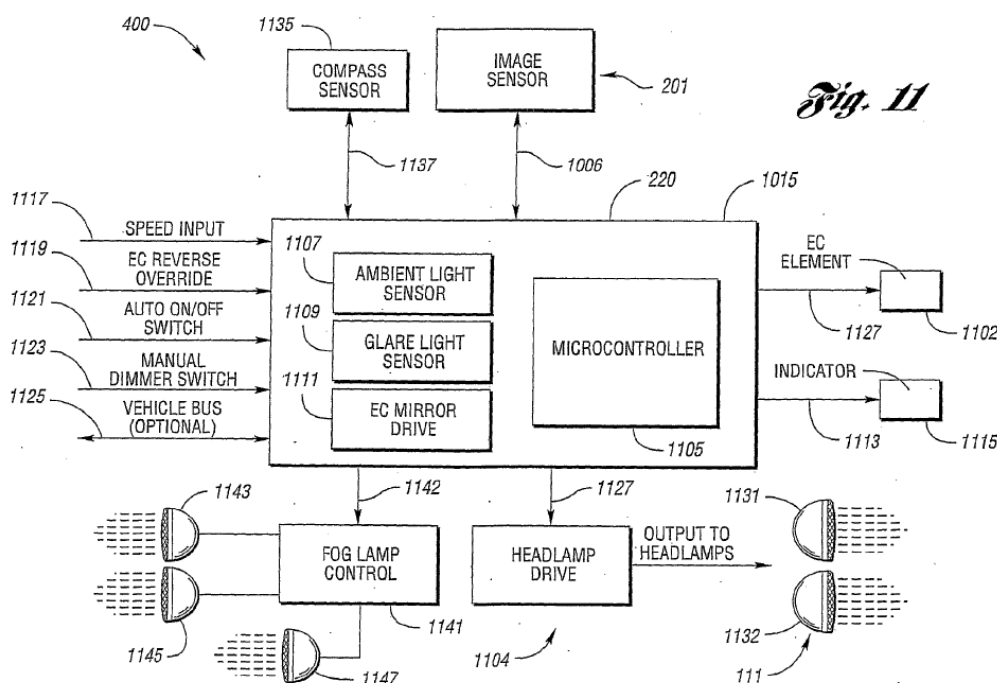
oncoming vehicle), while illuminating other areas with another, only now it would have greater flexibility (e.g., in its angle and range of light).

D. Ground 4 – Alden Combined with Kondo and Stam Renders Obvious Claims 15-18

1. Dependent Claim 15

The illumination device of claim 8, further comprising a controller with communication capability to other devices, where the camera in one location obtains information and the controller process the information and communicates the camera obtained information to a second device.

153. As viewed by a POSITA, Alden in view of Kondo further in view of Stam renders obvious Claim 15. I have reviewed Stam. Stam published on September 27, 2001, and is prior art under at least pre-AIA 35 U.S.C. §102(a). Stam disclose “a control system for controlling the exterior lights of a vehicle,” as shown in Figure 11 below:



(Stam, 9:8-9.) The exterior lights include headlights and other vehicle lights such as tail lights, fog lights, brake lights, etc.. (*Id.*, 9:9-12). Stam discloses that its control system includes an image sensor 201 and a microcontroller 1105 which “receives image signals from the image sensor 201, processes the images, and generates output signals.” (*Id.*, 25:4-5.) Stam discloses that the image sensor is a camera. (*Id.*, 14:23-30.) Stam also discloses that its control system includes a fog lamp control 1141, which receives fog light control output 112 generated by the microcontroller 1105 and “controls front fog lamps 1143 and rear fog light 1145 to turn ON and OFF.” (*Id.*, 27:14-17.) Stam further discloses that “[f]og may be detected by using the image sensor and optical system.” (*Id.*, 63:15-16.) Thus, Stam discloses that the microcontroller 1105 processes the information obtained by the image sensor 201 which is a camera, and communicates the camera obtained information to a second device, such as to the fog lights.

154. A POSITA would have been motivated to implement the teachings in Stam to the Alden-Kondo system. Stam is in the same field as Alden, similarly discloses vehicles with headlamps that can be controlled to change brightness and beam patterns so as to “maximize the illuminated area in front of the vehicle without causing excessive glare in the eyes of other drivers.” (Stam, Abstract.) Like Alden, Stam also receives data from sensors, and controls the headlights to “control their beam patterns in response to objects detected” in the vicinity of the vehicle. (Stam,

2:28-5:23.) Stam merely adds that the same image sensor and optical system “for the headlamp ON/OFF and headlamp dimmer control” could also be used to detect other conditions such as fog, and other exterior lights on the vehicle like fog lights could be controlled based on the sensed information. A POSITA would have had a reasonable expectation of success in implementing Stam’s teaching in Alden’s system, i.e., using the same sensor to collect data for controlling other exterior lights on the vehicle. The headlights in Alden would continue to operate the same way, and no substantial changes to any hardware or components would be necessary. And, a POSITA would have been motivated to use the same image sensor for control of different exterior lights on the vehicle.

2. Dependent Claim 16

The illumination device of claim 15, where the illuminated area is a road and the second device to where the camera obtained information is communicated to is a lighting fixture.

155. As viewed by a POSITA, Alden in view of Kondo further in view of Stam renders obvious Claim 16 obvious. As discussed, Stam discloses the microcontroller 1105 communicates the camera-obtained information to the fog lights on the vehicle, and the illuminated area of the fog lights is a road, and it would have been obvious to apply these teachings to the Alden system for the reasons explained above. *See supra* ¶¶153-154 (Claim 15).

3. Dependent Claim 17

The illumination device of claim 16, where the processor uses information obtained from the cameras and exchanged between fixtures for identifying traffic requirements in the illuminated area and from the vehicles locations and geometry determining the illumination requirements of the illumination area thereby directing the controller to adjust the directional light sources to meet the illumination requirements.

156. As viewed by a POSITA, Alden in view of Kondo further in view of Stam renders obvious Claim 17. As discussed, Alden discloses CPU 71 (1) identifying changing “environmental conditions,” such as an oncoming vehicle (“traffic”) in the area illuminated by vehicle headlights based on camera data; (2) calculating the location and geometry of the sensed vehicle; (3) determining which portions of the headlights to be dimmed or switched to high beam based on the calculation (“illumination requirements”); and (4) directing the control circuitry to reduce or switch the intensity of light emitted from the selected light sources in the headlights, such as LEDs so as to reduce glare to the driver of the sensed vehicle. *See supra* ¶¶65-70 (Claim 24[g]).

4. Dependent Claim 18

The illumination device of claim 17, wherein the controller is programmed to adjust at least one of (i) increase illumination with an approach of a vehicle, and (ii) change beam cut-off levels as the vehicle advances toward the lighting fixture to eliminate glare.

157. As viewed by a POSITA, Alden in view of Kondo further in view of Stam renders obvious Claim 18. As discussed, Alden discloses changing beam cut-

off levels as the sensed oncoming vehicle advances towards the equipped vehicle to eliminate glare. *See supra* ¶¶65-70 (Claim 24[g]). That is, when the vehicle approaches and gets close enough, Alden changes the beam cut-off levels in the sector where the vehicle is located so that the beam is reduced to dim, low beam light.

VI. CERTIFICATION

158. 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 7, 2023

APPENDIX C

Materials Considered

Exhibit No.	Description
1001	U.S. Patent No. 9,955,551 (“ ’551 ”)
1002	Original File History for the ’551 Patent
1003	
1004	Curriculum Vitae of Dr. Nikolaos Papanikolopoulos
1005	U.S. Patent Publication No. 2003/0,137,849 (“ Alden ”)
1006	U.S. Patent No. 6,049,749 to Kobayashi (“ Kobayashi ”)
1007	U.S. Patent Application No. 2002/0057572 (“ Kondo ”)
1008	WIPO Patent Publication No. 2001/070538 (“ Stam ”)
1009	
1010	Reexamination File History for the ’551 Patent
1011	Patent Owner Disclaimer under 37 CFR 1.321(a)
1012	Reissue File History for the ’551 Patent