

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 10,894,503

**DECLARATION OF DR. NIKOLAOS PAPANIKOLOPOULOS
IN SUPPORT OF MERCEDES' PETITION FOR *INTER PARTES* REVIEW
OF CLAIMS 37-70 OF U.S. PATENT NO. 10,894,503**

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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. 10,894,503 (EX1001) (the “**503 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.

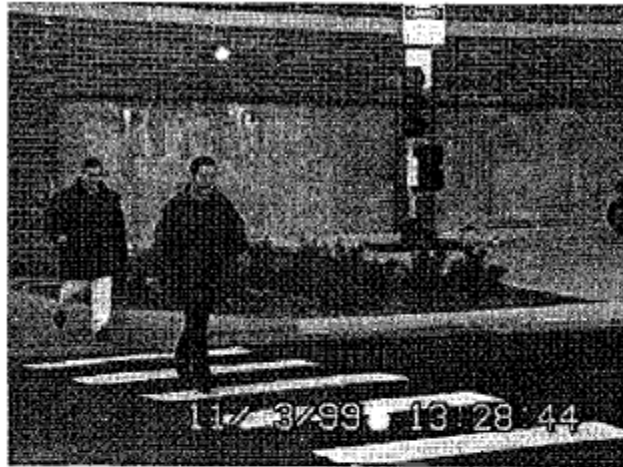


Figure 6.3 The traffic light is flashing red when there are pedestrians at the intersection.



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.

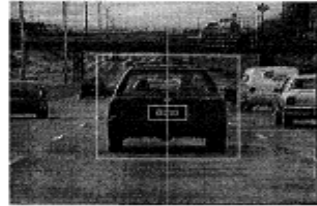
18. For more than a decade, I have been developing computer vision-based systems to assess truck parking availability at truck rest areas. The funding

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 '503 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 '503 Patent and its prosecution history, as well as the other materials referenced in Appendix A. Counsel has informed me that I should consider these materials through the lens of one of ordinary skill in the art related to the '503 Patent, at the time of the earliest purported priority date of the '503 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 '503 Patent has a priority date of July 12, 2002 (the “**Critical Date**”).

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

26. I may rely on these and additional materials to respond to arguments raised by the Patent Owner. I may also consider additional documents and

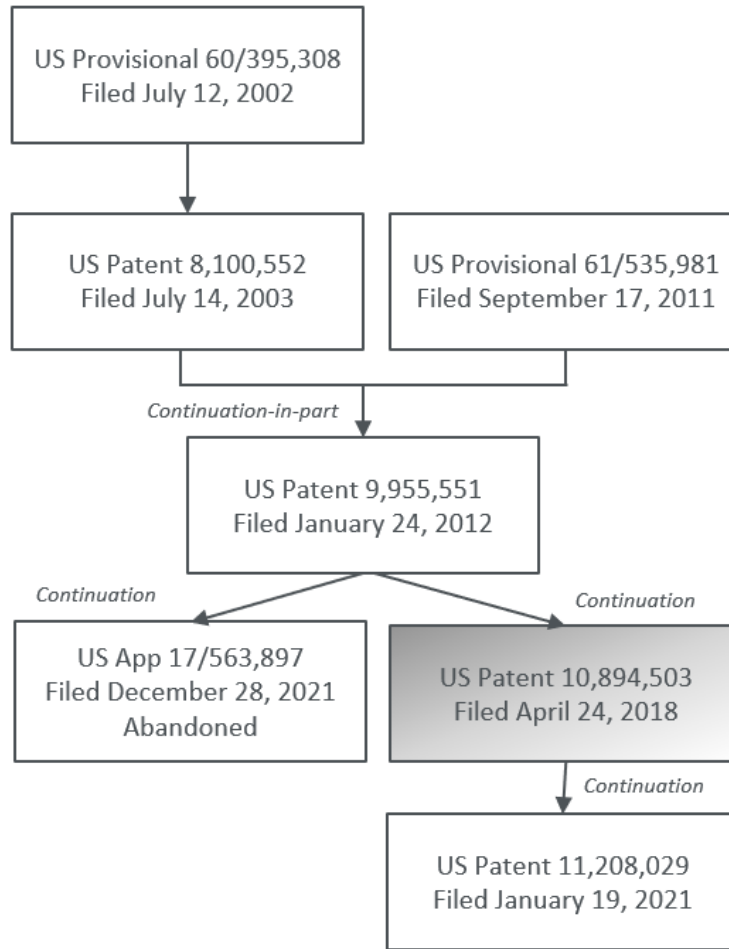
information in further analyses—including documents that may not yet have been provided to me.

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

II. BACKGROUND OF THE '503 PATENT

A. The '503 Patent

28. I understand the '503 Patent was filed on April 24, 2018, and issued on January 19, 2021. I also understand that the '503 Patent is part of the following patent family:

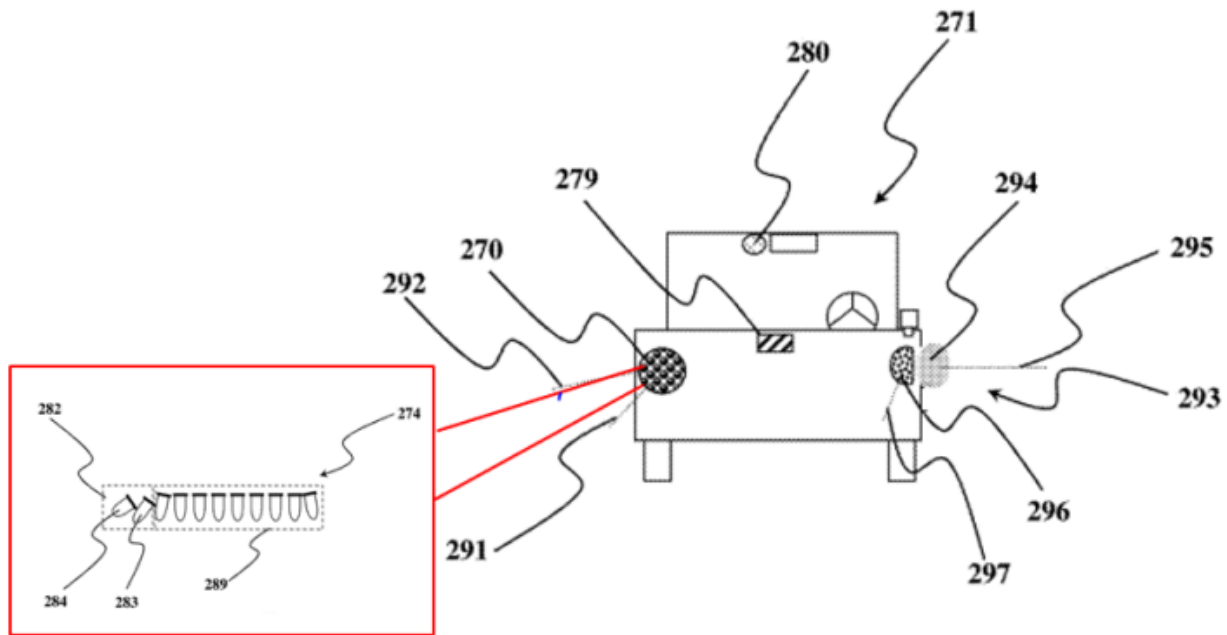


29. I have assumed, for purpose of this declaration, that the '503 Patent is entitled to this Critical Date of July 12, 2002.

30. The '503 Patent alleges that in the “prior art,” lighting fixtures were often single, large lights that were “generic” and “universal.” ('503 Patent, 5:39-49, 11:4-8, 11:50-51.) The '503 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 '503 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 '503 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.*, 11:11-16.) The '503 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.*, 11:60-67.)

31. The '503 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 37, 59, 65; *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 '503:



(*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 37, 50:40-52:57; 53:17-55:47.) 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 '503 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 '503 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 37-70 OF THE '503 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 37-70 of the '503 (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 PCT Patent Publication WO2001070538 (“**Stam**”) (EX1010), WO2001/001038A1 (“**Harbers**”) (EX1006), U.S. Patent No. 4,970,628 (“**Bergkvist**”) (EX1007), U.S. Patent No. 6,144,158 to Beam (“**Beam**”) (EX1008), U.S. Patent No. 6,049,749 to Kobayashi (“**Kobayashi**”) (EX1009), and PCT Patent Publication WO2002004247A1 (“**Braun**”) (EX1011).

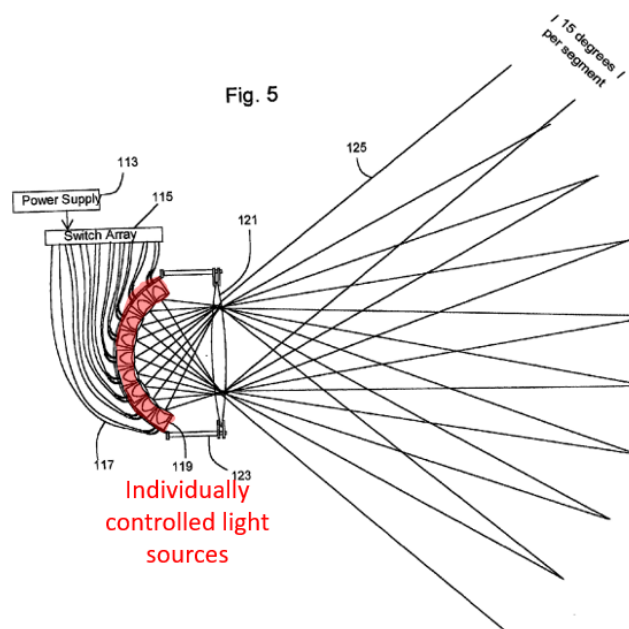
45. My analysis of these prior art references relative to the elements of the Challenged Claims—specifically, how and where the prior art references disclose the limitations of the challenged claims—is provided below. The citations that I have included are not intended to provide an exhaustive list,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

46. I have reviewed Alden. Alden describes 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).

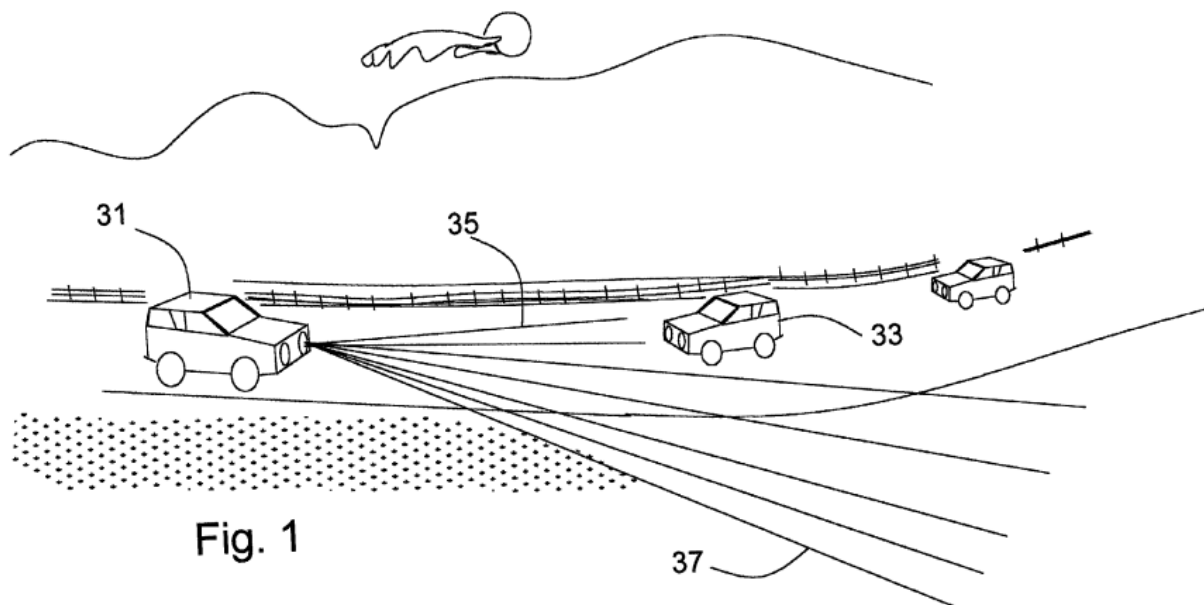
47. My review of the '503 Patent file history shows that Alden was not considered during prosecution of the '503 Patent.

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 (Alone or in Combination with Stam) Anticipates and Renders Obvious Claims 37-44, 47, 50-56, 58-59, 60-62, 64-65, and 70

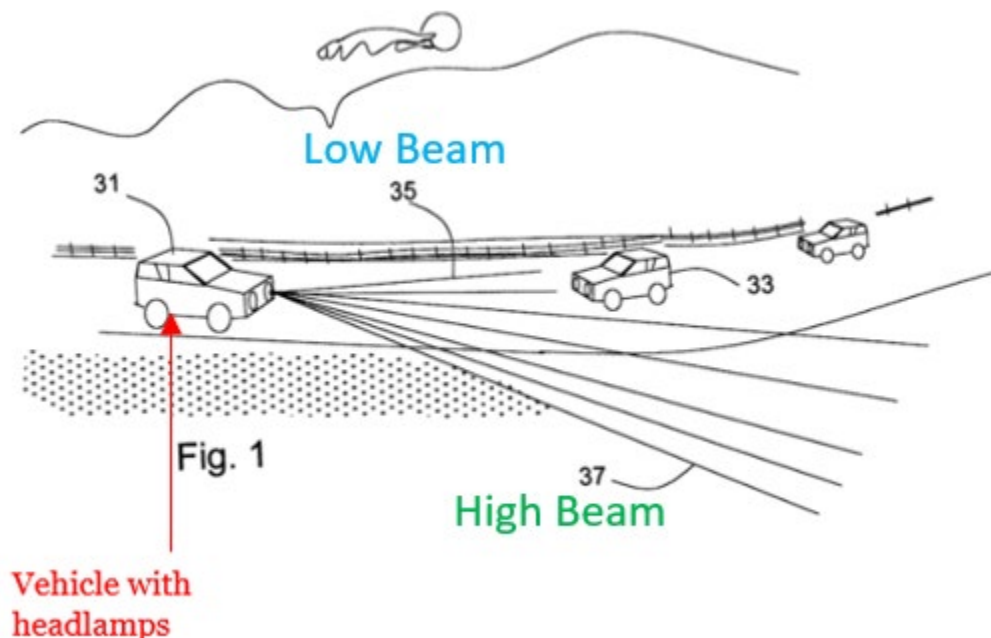
1. Independent Claim 37

50. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) Claim 37.

37[Pre]: A vehicle headlight system comprising:

51. Alden discloses Claim 37[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." (*Id.*, [0006]; *see also* Abstract.) In Alden, a "first vehicle 31" includes an "automatic segmented illumination" headlight system, allowing the vehicle to emit different light illuminations in different areas in its field-of-view. (*Id.*, [0025], Fig. 1 (annotated); *see also* [0026], [0029].) That is, the segmented headlight system can provide

different lighting illumination to different sectors of the headlight distribution area in front of the vehicle. The illumination in each sector can be controlled as to intensity and direction based on sensed information about the environment around the vehicle. For example, Alden discloses that the system can emit “a low beam illumination 35 in a first headlight distribution sector while concurrently emitting a high beam, illumination 37 in a second headlight distribution sector”:



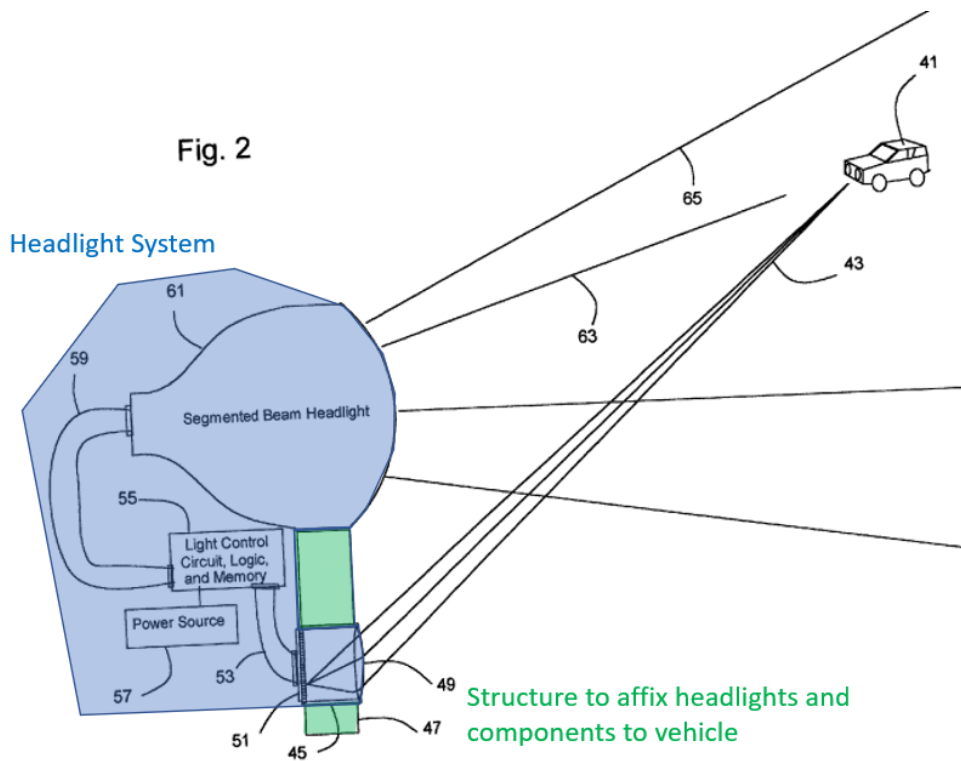
(*Id.*, [0025], Fig. 1 (annotated); *see also* [0026], [0029].)

37[A]: one or more headlamps affixable to a first vehicle;

52. Alden discloses Claim 37[A]. Alden discloses that its system is for “one or more headlamps,” or headlights, on a vehicle. (*See, e.g.*, Alden, Figs. 1-2, Fig. 11, [0025].) 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 affixable to the vehicle, including “segmented beam headlight” (61), “sensor unit” (45) that allows for the detection of the lights of other vehicles, and “light control circuit, logic, and memory” (55):

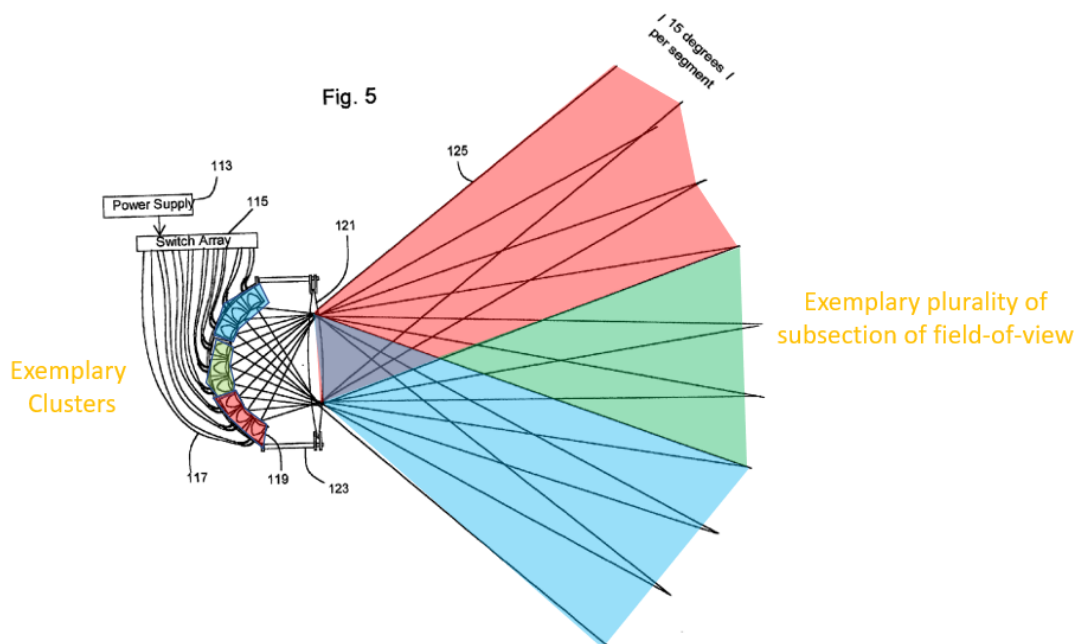


(*Id.*, [0026], Fig. 2 (annotated).) Alden explains these are “mounted on an equipped automobile 47 (47 being a part of the automobile—the [full] automobile is not shown).” (*Id.*, [0026].) As can be seen from this Figure, the Alden system components are connected together in such a way that they can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

37[B]: a plurality of light clusters arranged in each of the one or more of the headlamps and capable of illuminating sub-sections of a field-of-view with

different illumination characteristics, wherein at least two of the light clusters operate to create a headlight beam;

54. Alden discloses Claim 37[B]. First, “light clusters” can comprise “one or more light emitting sources,” such as one or more LED(s). The patent specifically says this in dependent claims, where it confirms the term “light cluster” need only include one LED. (*See, e.g.,* ’503, Claim 42.) Alden’s system includes a “plurality of light clusters” in the headlamps, as it includes a plurality of lighting elements (*e.g.,* LEDs) arranged in the headlamps. (Alden, [0029], Fig. 5.) Further, these lighting elements are “on a curve along the focal point of a headlight lens 121,” with different groups projecting light into different areas, which may be made up of one or more sectors, in front of the vehicle, *e.g.,* left, center, right:



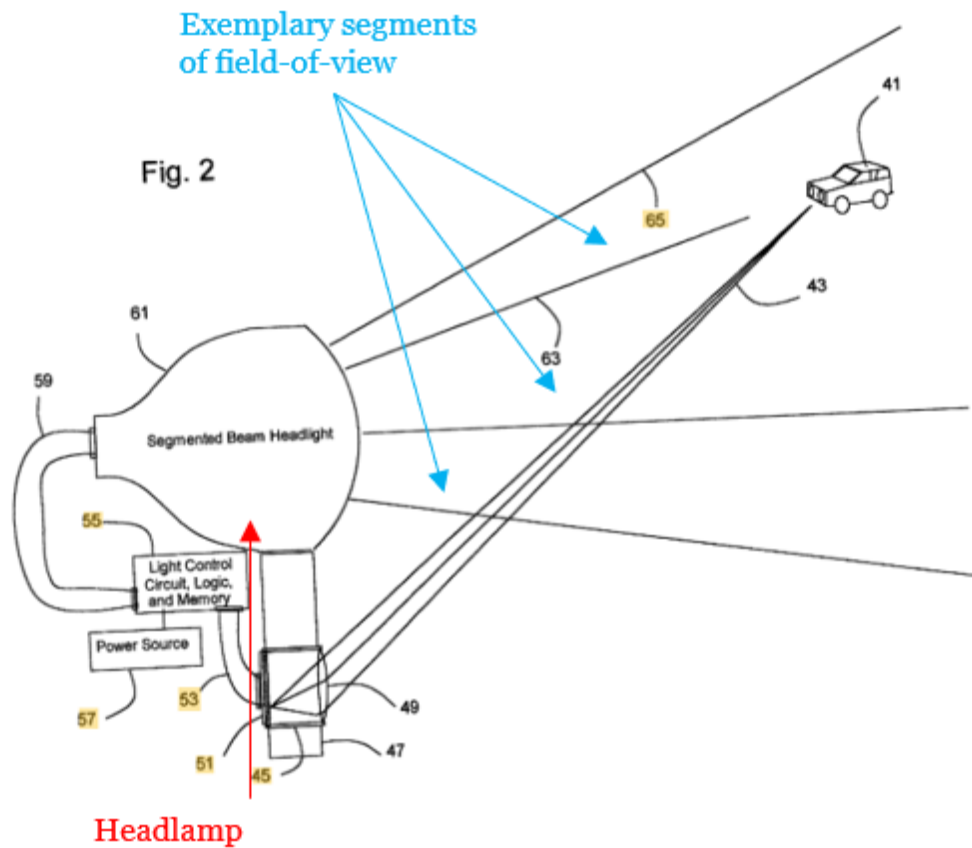
(*Id.*, Fig. 5 (annotated), [0029].) Alden also discloses that these lighting elements can be individually controlled, and thereby arranged in additional groupings, to project different illumination levels in different areas in front of the vehicle, such as low beam light in the area of a detected oncoming vehicle and high beam light in other areas. (*Id.*, [0026]-[0029].) For example, Alden discloses that certain of the lighting elements can be selected and switched to produce dimmed, low beam light in the area of a detected oncoming vehicle, while other of the lighting elements can be selected and switched to produce high beam light in other areas where no vehicles are detected. (*Id.*) That is, the lighting elements selected and switched to produce low beam light would be a “low beam” cluster, and the lighting elements selected and switched to produce high beam light would be a “high beam” cluster.

55. Second, Alden discloses that its headlamps project light into different areas in front of the vehicle (*e.g.*, “a plurality of sub-sections of a field-of-view”) with “different illumination characteristics.” Again, lighting elements are individually-controllable and located on a curve along the headlight lens, “such that the light from each lighting element goes into ***a specified portion (or portions) of a headlight distribution area.***” (*Id.*, [0025], [0029], Fig. 5.) As shown in Figure 5 above, this results in a first group of LEDs (shown in blue) illuminating one area (such as to the left of the vehicle), a second group of LEDs (shown in green) illuminating a second area (such as in the front of the vehicle), and a third group of

LEDs (shown in red) illuminating a third area (such as to the right of the vehicle).

Each of these groups would be a different cluster, as each group can be operated to emit light in a particular direction to illuminate different areas in front of the vehicle.

56. Further, each of these areas can have different illumination characteristics. For example, if an oncoming vehicle is detected, thereby requiring different illumination characteristics (*e.g.*, lower light in the form of the dimmed low beams) in that particular area (“sub-section”), Alden will produce “a high beam in a ***first sector 65*** [where no other vehicles are detected] while concurrently producing a low beam in a ***second respective sector 63*** (or dim beam) where the 41 [other vehicle] is sensed”:

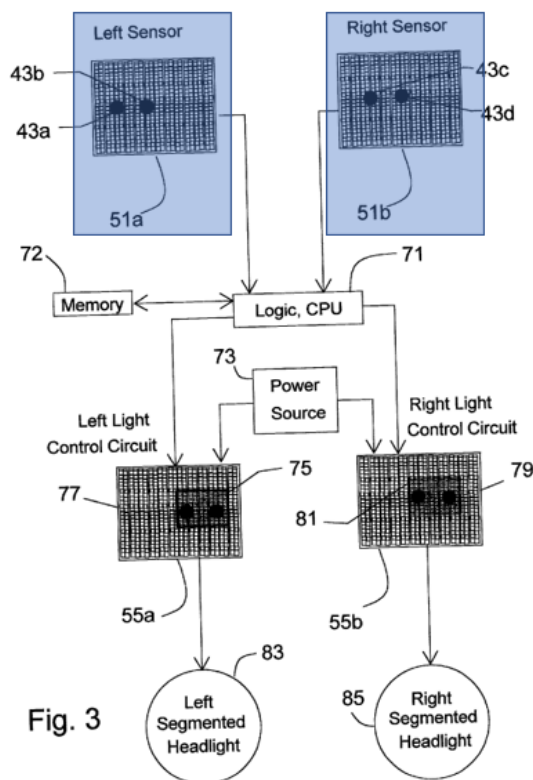


(Alden, Fig. 2 (annotated), [0026]; *see also* [0027]-[0028] (noting that “[s]ignals are sent to each of the headlight control circuit zones that need to be dimmed to restrict the amount of current to the corresponding headlight zones such that they are dimmed in a dimming process 109” and that “zones which are not dimmed remain on high beam”), Figs. 11-13, [0036]-[0038] (describing changing projection of light in areas in front of vehicle based on road conditions such as curves, corners, and hills).)

37[C]: one or more sensors configured to obtain and provide sensor data, at least a portion of the sensor data indicating a second vehicle within the field-of-view; and

57. Alden discloses Claim 37[C]. Alden discloses that the headlight system includes one or more sensors to “detect” or “sense” “locations of vehicles” such as “oncoming vehicles” within the light distribution area (e.g., field of view). (Alden, [0025]-[0026], Figs. 1-2). Alden describes that its headlight system “emits a low beam illumination 35 in a first headlight distribution sector while concurrently emitting a high beam illumination 37 in a second headlight distribution sector. The low beam illumination in 35 being emitted in response to the detection of an oncoming vehicle 33 (the 33 emitting light which has been omitted for drawing clarity).” (*Id.*, [0025]; *see also id.*, [0026]-[0029].)

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

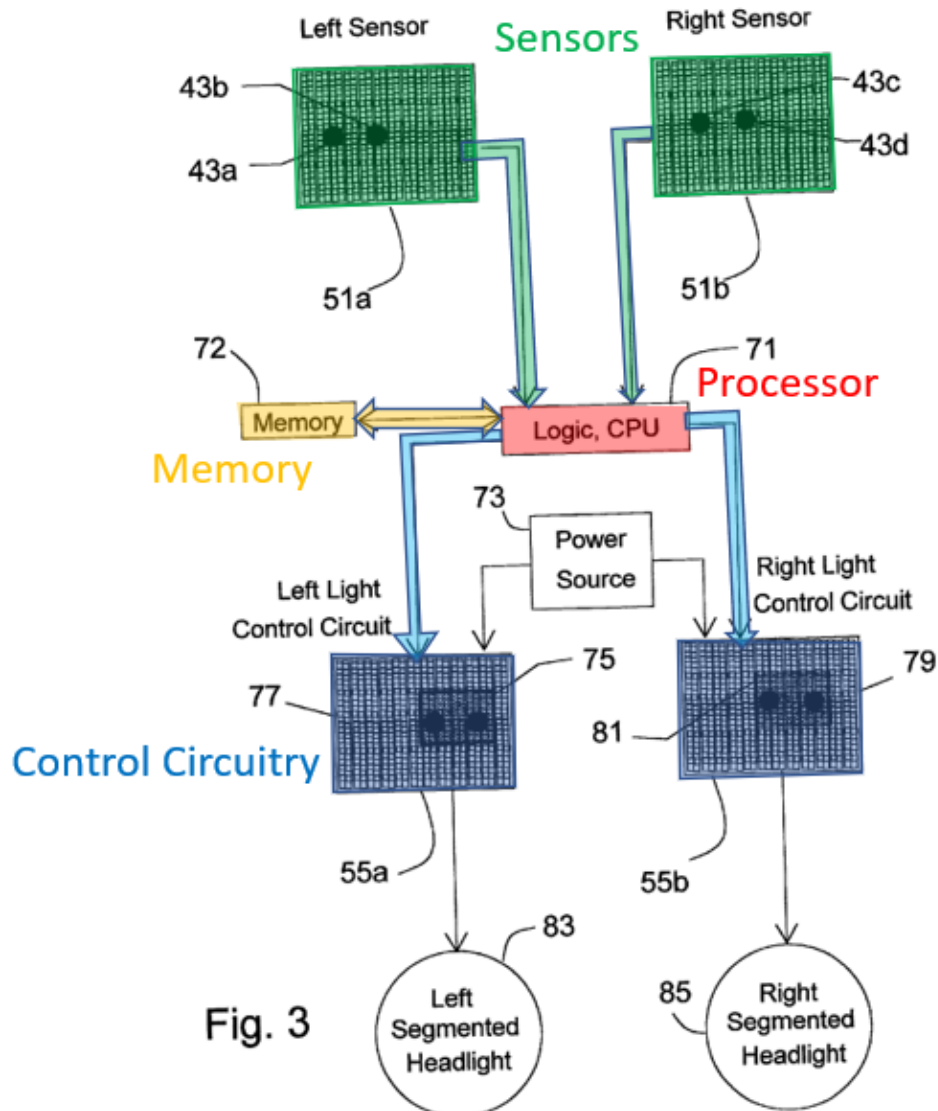


(Alden, Fig. 3, [0027]-[0028]; *see also* [0026].) The sensors are also shown in Figure 2, where the sensor unit 45 is shown as having a lens element 49 that converges light, such as from the headlights of another vehicle, onto a detector array which may be a photodiode array or CCD. (*Id.*, [0026], Fig. 2.) 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 as detecting headlights of an oncoming vehicle, and Alden’s CPU logic flow selects portions of the segmented headlight system to be dimmed based on this sensor data. (*Id.*, [0026]-[0028]; *see also id.*, Figs. 2-4.) For

example, Alden explains that the “right sensor and the left sensor will receive spots of nearly identical intensity and size representative of the 41 headlights but the positions on the 51a will be different relative to 51b. The less the difference between these relative positions, the greater the distance [the vehicle is from an oncoming vehicle].” (*Id.*) This sensor data is then used to reduce illumination in lighting areas where the oncoming vehicle is sensed. (*Id.*; *see also id.*, Figs. 2-4.)

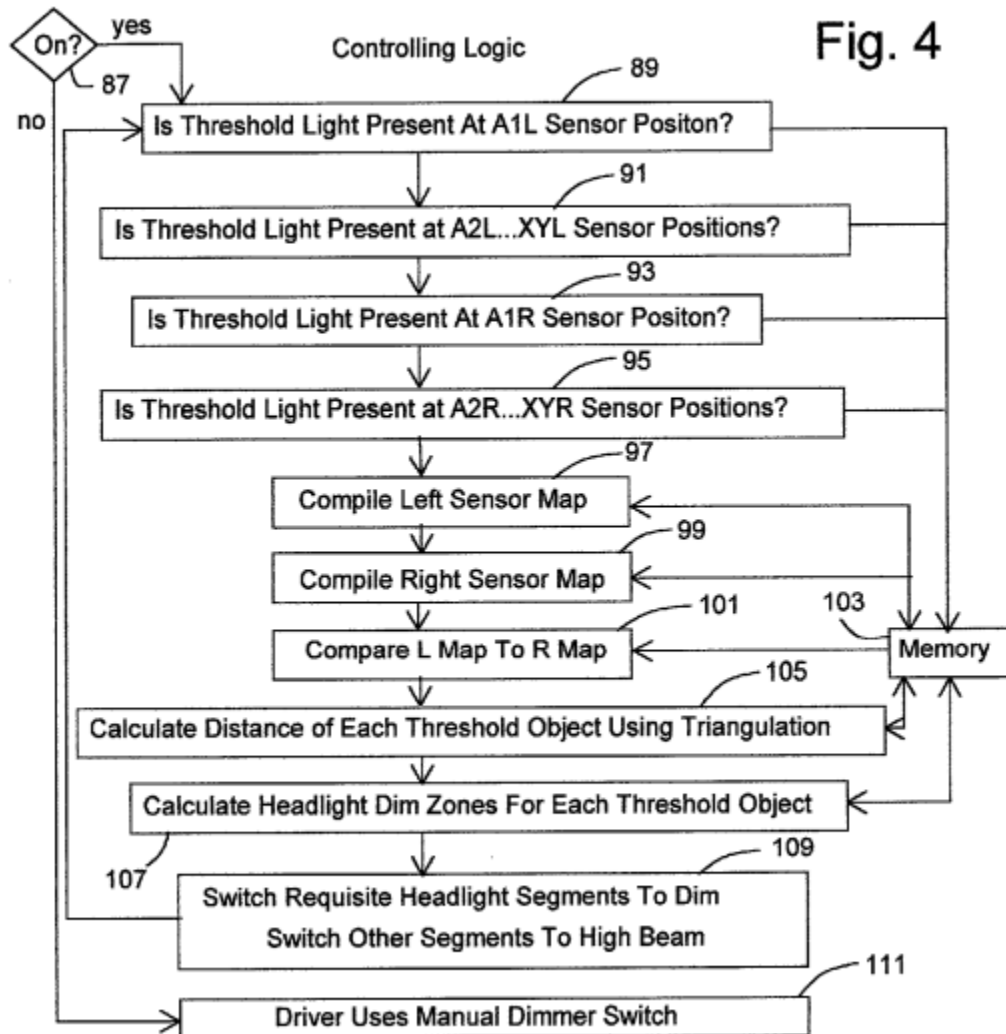
37[D]: at least one processor configured to: receive the sensor data; process the sensor data to determine a light distribution pattern for an adaptive headlight beam,

59. Alden discloses Claim 37[D]. First, Alden discloses a “logical controller including a processor” that receives data from the sensors:



(Alden, Fig. 3 (annotated), [0027]; *see also* [0026].) As shown in Figure 3, left and right sensors 51a-51b are connected to the processor (CPU 71), which receives information from the sensors regarding sensed light. (*Id.*, [0027].) In particular, each of the sensors 51a-b “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.*)

60. Second, Alden discloses that the processor (logic CPU 71) is configured to “process the sensor data” to determine a light distribution pattern for an adaptive headlight beam:



(*Id.*, Fig. 4; *see also* Fig. 3, [0026]-[0028].) As shown in Figure 4, the logic process implemented by the CPU can include: processing sensor data (steps 89, 91, 93, 95) to check whether light above a certain threshold is present at a plurality of sensor

positions; compiling sensor maps for the left sensor and right sensor, and comparing them to each other (steps 97, 99); determining the “distance and intensity of each object sensed in a calculating process 101” that, as I mentioned earlier, includes comparing the left and right sensor maps; and calculating distances to objects using a “triangulation process 105.” (*Id.*, Fig. 4, [0028]; *see also* Fig. 3, [0026]-[0027].) The distance data is then used to “determine the intensity of light that will be produced by the 61 [headlight] in the corresponding headlight sectors,” as shown in step 107, and signals are then sent to the control circuits to switch some zones to dim and others to high beam, as shown in step 109. (*Id.*, Fig. 4, [0027]-[0028]; *see also* Fig. 3, [0026]-[0027].)

61. Alden further explains that this is a real-time process that is continuously repeated. (*Id.*, [0028] (stating that the “process then begins again so as to be responsive to changing environmental conditions in real time.”).) Thus, if environmental conditions, including the location of other vehicles, change, the determined light distribution pattern for headlights will also change. For example, Alden explains that if threshold light is detected at certain sensor positions such that another vehicle is present, a determination is made that the intensity of light for the headlight sectors corresponding to those sensor positions should be switched to 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. In sum, as part of the real-time process, Alden is continuously determining whether each sector should be low beam or high beam.

62. In addition, Alden mentions that the headlights can be operated to produce not only low and high beam light, but also “a range of intensities between the high beam and the low beam state.” (Alden, [0061].) Where Alden wants a sector of the headlight beam to low or high, a determination is made to power the lighting elements for those sectors to produce low beam intensity light or high beam intensity light, as opposed to light at an intensity in the range between low and high. For example, a POSITA would understand that if the vehicle were traveling fast on a highway, it may be desirable to have some areas illuminated with a “medium” light intensity that is lower than the maximum high beam light so as not to cause to cause glare for drivers rapidly approaching in the opposite lanes. As a second example, a POSITA would have understood that high beams with a higher intensity could be used when the detected objects, such as the oncoming vehicles, are determined to be farther away through the triangular process in Alden. (Alden, [0027]-[0028].) When an oncoming vehicle is determined to be closer, the high beam light may be reduced in intensity so as not to be distracting or inadvertently cause glare to the driver of the oncoming vehicle. Stated

differently, Alden is not simply keeping LEDs on low or high, but rather teaching that multiple illumination levels can be used and that the system must determine which illumination level to use and switch to and from, for example, low and high beam.

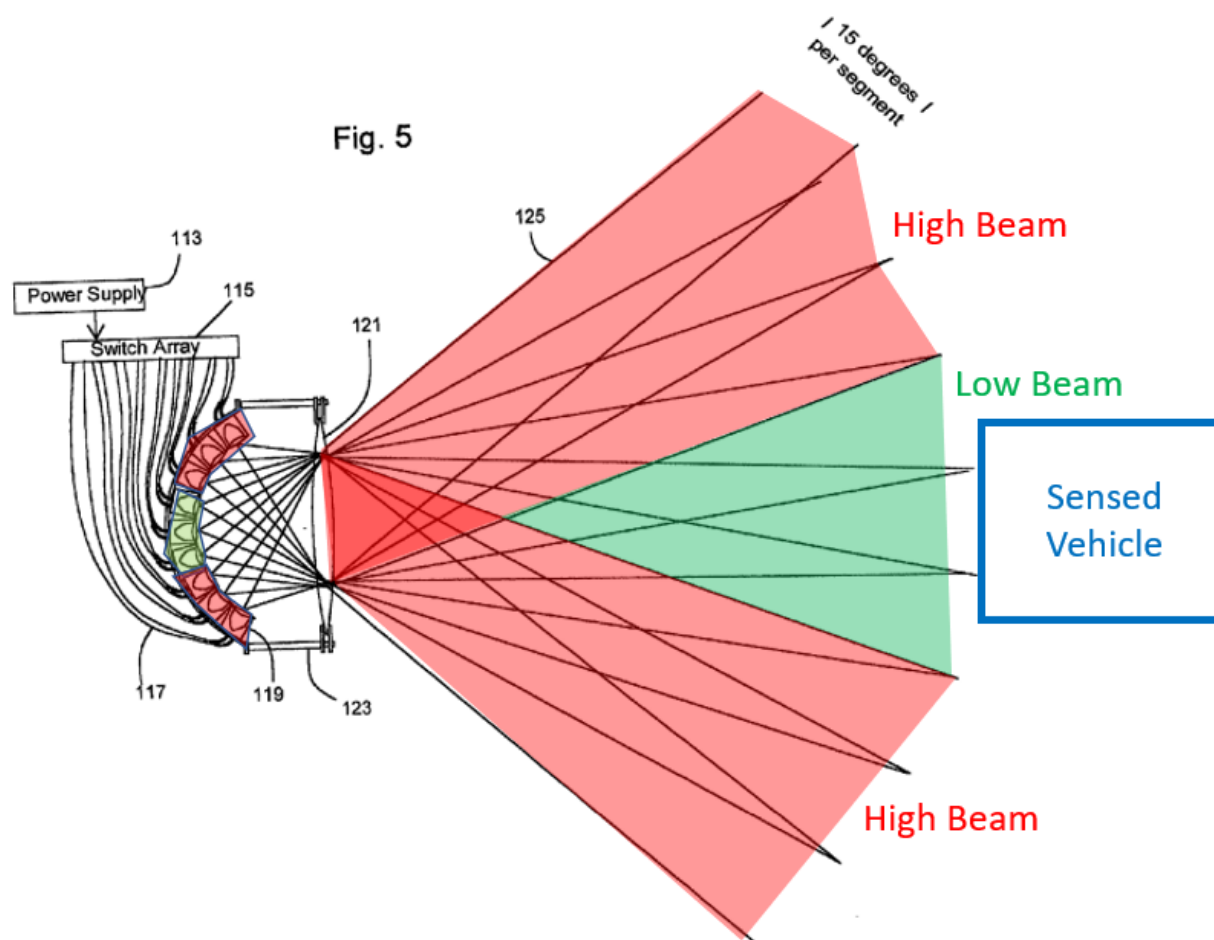
63. As another example, a POSITA would have known to determine different intensity levels for the headlight distribution patterns depending on the type of road the vehicle is traveling on—rural roads with less traffic, pedestrians, and buildings could be illuminated with higher intensity light than city streets where there is more ambient light, vehicles, pedestrians, and buildings that could be disturbed by higher intensity light. In these situations, a POSITA would have understood the processor in Alden could determine that the power flow for “high beam” can be higher in a rural setting and lower for an urban setting.

37[E]: at least one processor configured to: [1] receive the sensor data; [2] process the sensor data to determine a light distribution pattern for an adaptive headlight beam, such that a headlight beam adapted to the pattern substantially illuminates a first subsection of the field-of-view including at least a portion of the second vehicle with an illuminance below a predefined threshold value, while the beam substantially illuminates at least the one or more second subsections of the field-of-view to either side of the first subsection with an illuminance above the predefined threshold value; and

64. Alden alone discloses and renders obvious Claim 37[E]. Alden discloses that its headlamps provide the determined illumination levels and that it uses different illuminations levels in different sectors to reduce glare where another

vehicle is present (*i.e.*, in “a first of the at least two subsections”). That is, Alden discloses its adaptive headlight beam provides different illumination levels in different sectors to reduce glare where another vehicle is present (*i.e.*, in “a first subsection of the field-of-view including at least a portion of the second vehicle”), while switching other sectors to “high beam” (*i.e.*, in “at least the one or more second subsections of the field-of-view.”) Alden describes, in reference to steps 107 and 109 of Figure 4, that “[t]he location of objects is used to calculate which zones of each headlight need to be dimmed in a calculate headlight dim zones process 107. Signals are sent to each of the headlight control circuit zones that need to be dimmed to restrict the amount of current to the corresponding headlight zones such that they are dimmed in a dimming process 109. Zones which are not dimmed remain on high beam. Thus the light sent to the sensed vehicle location is dimmer than the light sent to all other areas of the headlight distribution area.” (*Id.*, [0028], Fig. 4; *see also* [0026]-[0027], [0029], Fig. 5.)

65. Where another vehicle is detected, for example, in a middle zone or sector, that sector will be dimmed while the light directed to the zones or sectors on either side will be switched to high beam intensity:



(*Id.*, Fig. 5 (annotated), [0026]-[0029].) Alden discloses that this reduces glare for oncoming vehicles: “the driver of 41 [*i.e.*, the oncoming vehicle] has minimum glare while the driver of 47 [*i.e.*, the vehicle implementing the Alden system] has maximum light.” (*Id.*; *see also* Abstract, [0005].) That is, based on the sensor data, an adaptive headlight beam is generated that is dimmer in a first subsection where another vehicle is sensed to reduce glare to the driver of that vehicle, while other subsections to either side of the sensed vehicle are switched to high beam.

66. With respect to illuminance being below (or above) a “predefined threshold value,”¹ Alden discloses that its system can “provide illumination to independently controlled segments [*e.g.*, “subsections”] each operable within a **range of intensities between the high and the low beam** state.” (Alden, [0061].) Alden’s system can thus operate not only at high beam and low beam but also at intensities in between, *e.g.*, medium low, medium, medium high. That is, Alden recognizes that the low beam light is “low” compared to the other intensities in the range, and that high beam light is “high” as compared to the other intensities in the range. As viewed by a POSITA, these intensities in between high beam and low beam (*e.g.*, medium) are a “predefined threshold value” for which the low beam would be below and for which the high beam would be above.

67. Further, a POSITA would have understood from Alden that for a low beam to have “minimum glare,” the low beam’s intensity would need to be below a particular threshold—*e.g.*, below a level such that the “driver of [vehicle] 41 sees only a dim or low beam light from [vehicle] 47.” (Alden, [0026]-[0027], Figs. 1-2.) High beam light would be above this threshold, so that, as Alden, teaches visibility in high beam areas is maximized. (Alden [0026]-[0027].) Stated differently, because Alden is concerned with minimizing glare to other drivers, it would have a

¹ The ’503 does not use this phrase outside of the claims.

certain threshold of intensity below which it knows glare is reduced or eliminated. The low beam lights would be set below this limit. Conversely, because Alden wants to have high beam lights that “maximize” visibility in sectors where, for example, no other vehicles are detected, the system in Alden would power the lighting elements directing light into these sectors such that they produce an intensity greater than the “reduced glare” intensity threshold. (*Id.*, [0025]-0027].)

68. A POSITA would further understand that for Alden to produce light with different illuminance levels (dim or low beam as compared to high beam) in different sectors, there must be a predefined threshold value that separates the two—that is, that low beam is below and high beam is above. (*Id.*, [0026]; *see also* [0027]-[0029].) In particular, to create distinct low beam and high beam light, and to ensure the low beam is dim enough to not induce glare, one would need to select a predefined threshold illuminance that the low beam light must be below and that the high beam would be above. Without such a separation, there would be little distinction between the intensities of the high and low beams.

69. Moreover, Alden in view of Stam renders Claim 37[E] obvious with respect to the “predefined threshold value” element. I have reviewed Stam. Stam was published on September 27, 2001, and is prior art under at least § 102(a). Stam, in the same field as Alden, similarly discloses vehicles with headlamps containing individual light sources that can be controlled to change brightness and

beam patterns based on detected objects, 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.) Moreover, Stam discloses that the light output of the headlights “may be varied by changing the illumination output of one or more lights forming the headlights, ... activating or deactivating some or all of the lights, altering the illumination pattern forward of the vehicle, or a combination of the above” in order to reduce or eliminate glare in the eyes of drivers and passengers of detected other vehicles. (Stam, 9:8-10:19; *see also* 10:20-25 (“A controlled vehicle 100 (Fig. 1) having an automatic headlamp dimmer includes an optical sensor system 102 for detecting the headlamps 104 of an oncoming vehicle 105 and the tail lights 108 of a preceding vehicle 110. The headlamps 111 of the controlled vehicle 100 are controlled automatically to avoid shining the high beams, or bright lights, directly into the eyes of a driver of oncoming vehicle 105 or by reflection into the eyes of the driver of the preceding vehicle 110.”).)

70. Stam further discloses that predefined illuminance threshold values can be considered in setting the illuminance of low and high beams. (*Id.*, 1:16-2:5.) Stam notes that, in fact, governments have laws and regulations that limit the

intensity of vehicle headlamps, including to control the amount of glare experienced by drivers of other vehicles. (*Id.*) Stam gives an example limiting headlight illuminance to below a threshold of “0.1 foot candles (fc)” incident on other vehicles, in order to avoid causing them glare and to comply with Department of Transportation regulations. (*Id.*) Stam notes that when no other vehicles are present, the lights can be on high beam, and above the 0.1 foot candles threshold. (*Id.*) A POSITA would have known that the foot candle is a unit of measurement of the amount of light impacting a surface. The unit foot candle is equal to the illuminance created by one lumen distributed over a square foot. To understand the threshold of 0.1 foot candles a POSITA would have considered that the moonlight has an illuminance between 0.1 and 0.5 foot candles while a typical room in a house has an illuminance between 10 and 20 foot candles. A sunny day can produce at least 10,000 foot candles. A POSITA would have known that the lux unit is also used to quantify illuminance with one lux being equivalent to one lumen per square meter.

71. It would have been obvious to include such a predefined illuminance threshold value, such as of 0.1 foot candles, in the system of Alden. Including such a threshold level would have required nothing more than setting a predetermined illuminance level to “control the amount of glare experienced by drivers” as taught by Stam—an issue already focused on by Alden. A POSITA would have also had a

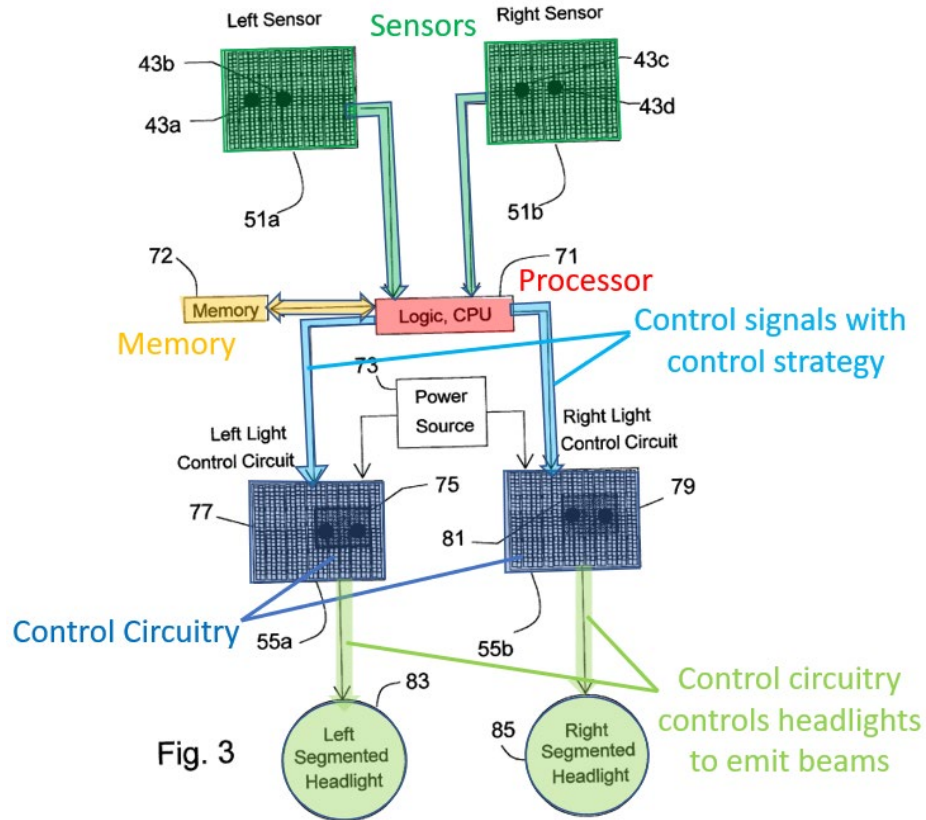
reasonable expectation of success and been motivated to use such a predetermined value as taught by Stam, since Alden and Stam are in the same field, Alden already contemplates using a range of intensities and desires to minimize glare, and using a predefined threshold as taught by Stam would be an easy, known way to ensure the appropriate light levels within this range are being used at all times. In particular, the controllers in Stam would be able to apply appropriate power to the lighting elements for sectors of the headlight distribution area where other vehicles are present with “low beam” light that would not cause glare, while powering lighting elements illuminating sectors with no other vehicles to emit light with an intensity higher than the predetermined threshold to maximize visibility.

72. A POSITA would have had a reasonable expectation of success in using a predetermined value, as taught by Stam. Both Stam and Alden have the same purpose – controlling headlights to maximize visibility in areas where no other vehicles are present, while dimming headlights in areas where other vehicles are present to reduce glare. The headlights in Alden would continue to operate the same way, and no changes to any hardware or components would be necessary. Using the predefined illuminance threshold value would simply be a known way of setting the power levels for the dimmed low beam and maximized high beam lights in Alden. Moreover, a POSITA would have understood that using a predetermined value would be an easy way to ensure low beam lights are below a certain level so

as to not cause glare, while allowing high beam lights to be above the level to maximize visibility. And, a POSITA would have been motivated to use such a predetermined illuminance threshold value so as to comply with government regulations.

37[F]: at least one processor configured to: instruct operation of at least two of the light clusters to create the adapted headlight beam.

73. Alden discloses Claim 37[F]. As I explained earlier, the CPU 71 (“processor”) receives data from left and right sensors 51a-51b, processes that data, and “determines the intensity of light” to be produced in each sector of the headlight distribution area. *See supra* ¶¶64-72 (Claim 37[E]); *see also supra* ¶¶54-56 (Claim 37[B]), ¶¶59-63 (Claim 37[D]). This includes determining which sectors should be illuminated with high beam light where there are no detected other vehicles, and which sectors should be illuminated with low beam where there are other vehicles. *Id.* Alden further discloses that once the CPU makes these determinations, it then sends this “[i]nformation” to the left and right control circuits “to control the power flow” to the lighting elements (or LEDs) to set the determined intensities of light to be used:



(Alden, [0026]-[0029], Fig. 3 (annotated); *see also* Figs. 4-5.) The determined power flow sets the intensity, with a higher power flow creating a higher intensity light output, and a lower power flow creating a lower intensity. This creates the adapted headlight beam, with certain lighting elements directing light to certain areas (*e.g.*, where there is an oncoming vehicle) providing different illumination than other lighting elements directing light to other areas (*e.g.*, where there is no oncoming vehicle). (*Id.*, Figs. 1-2, [0025]-[0026], Fig. 5, [0029], Figs. 11-13, [0036]-[0038].)

2. Independent Claim 59

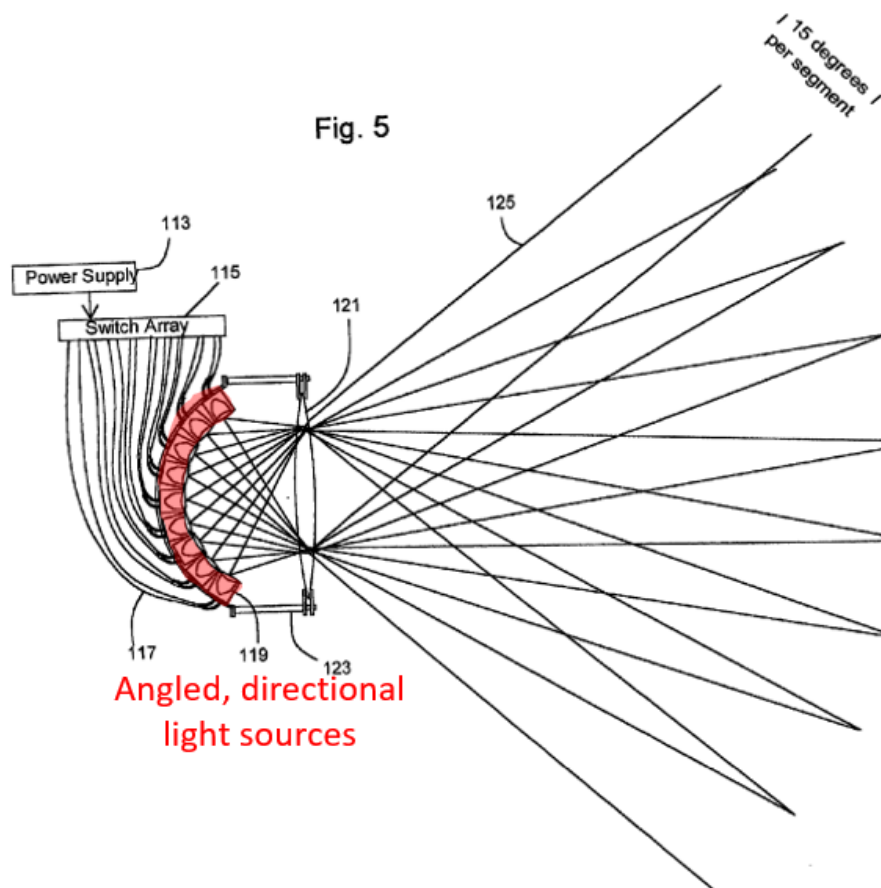
74. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) Claim 59.

59[Pre]: *A vehicle headlight system comprising:*

75. Alden discloses Claim 59[Pre] to the extent the preamble is limiting to the claim. *See supra* ¶51 (Claim 37[Pre]).

59[A]: *one or more headlamps affixed to a first vehicle, each headlamp including at least three directional light sources having different aimings relative to the first vehicle, the light sources having one or more controllable illumination characteristics;*

76. Alden discloses Claim 59[A]. First, Alden discloses “one or more headlamps affixed to a first vehicle.” *See supra* ¶¶52-53 (Claim 37[A]). Second, the headlights in the vehicle system of Alden each have “at least three directional light sources having different aimings relative to the first vehicle,” as they include an “array” of lighting elements “on a curve along the focal point of a headlight lens 121, such that the light from each lighting element goes into a specified portion (or portions) of the headlight distribution area”:



(Alden, Fig. 5 (annotated), [0029].) As shown in annotated Figure 5 above, each lighting element is directed at a different angle, and thus direction, relative to the front of the first vehicle, based on its position along the curve of the headlight unit. The light is emitted from each element at an angle, where it is incident upon lens 121. (*Id.*, Fig. 5, [0029].) The lens then focuses the light into the different illumination sectors. (*Id.*) Based on each lighting elements position along the curve, and angle with respect to the vehicle, each lighting element directs light to different sectors or segments of the overall headlight distribution area. For example, as shown in Fig. 5 above, the lighting element labeled with reference numeral 119 directs light into segment 125 based on its position along the curve

and angle. Each other lighting element similarly directs light to the other segments, based on its angle and position on the curve.

77. Third, Alden further discloses that its lighting elements (e.g., “light sources”) are configured to have one or more controllable “illumination characteristics,” as it teaches that each lighting elements is “independently controllable as to intensity and direction.” (*Id.*, [0008]; *see also* Abstract, [0026]-[0029], Figs. 2-4.) To adjust intensity, for example, the power to each individual lighting element is CPU-controlled, such that “the light sent to the area of 41 [an oncoming vehicle] is dimmed using a headlight with segmented lighting means” (i.e., the light elements have independently-controllable light characteristics). (*Id.*, [0029]; *see also* [0026]-[0028].) Again, Alden explains that information from CPU 71 controls switch characteristics of left and right light control circuits, such that the power from the power supply to each lighting element is controlled based on the sensed environmental conditions (e.g., whether or not another vehicle is present in each sector of the headlight distribution area). (Alden, [0027]-[0029].) This controlled power supply controls the intensity of the light that will be emitted by each lighting element. Moreover, Alden also discloses that one or more light modifying elements, such as lens 121 or variable refractors, can be included and controlled to adjust the direction or the light or even “bend” the light from certain lighting elements—direction is another “light characteristic.” *See infra* ¶¶103-108

(Claims 42[B]-42[C]). And, Alden discloses that the direction of light emitted from the lighting elements can be controlled when, for example, information from sensed roadside reflectors of the angle of the steering wheel indicates the vehicle is going around a curve or turn, or when the vehicle is going uphill or downhill. (Alden, Figs. 11-15, [0036]-[0040], [0061].)

59[B]: one or more sensors configured to sense information, at least a portion of the sensed information indicating a second vehicle, and communicate sensor data reflecting the sensed information to at least one processor,

78. Alden discloses Claim 59[B]. As described above with respect to Claim 37[C], Alden discloses sensors that sense light indicative of other vehicles (as the sensors detect light and that light is compared to a threshold to determine if it may be headlights of an oncoming vehicle). *See supra* ¶¶57-58 (Claim 37[C]). The sensors communicate information regarding the sensed light to a processor, logic CPU 71, as sensor data and the processor uses that information to configure the lighting characteristics of (that is, adjust the light being illuminated from) headlamps. *Id.*, *see also supra* ¶¶59-72 (Claims 37[D]-37[E]). For example, Alden discloses that sensed information regarding “emitted light 43” from other vehicles is communicated to a processor, logic CPU 71, as sensor data:

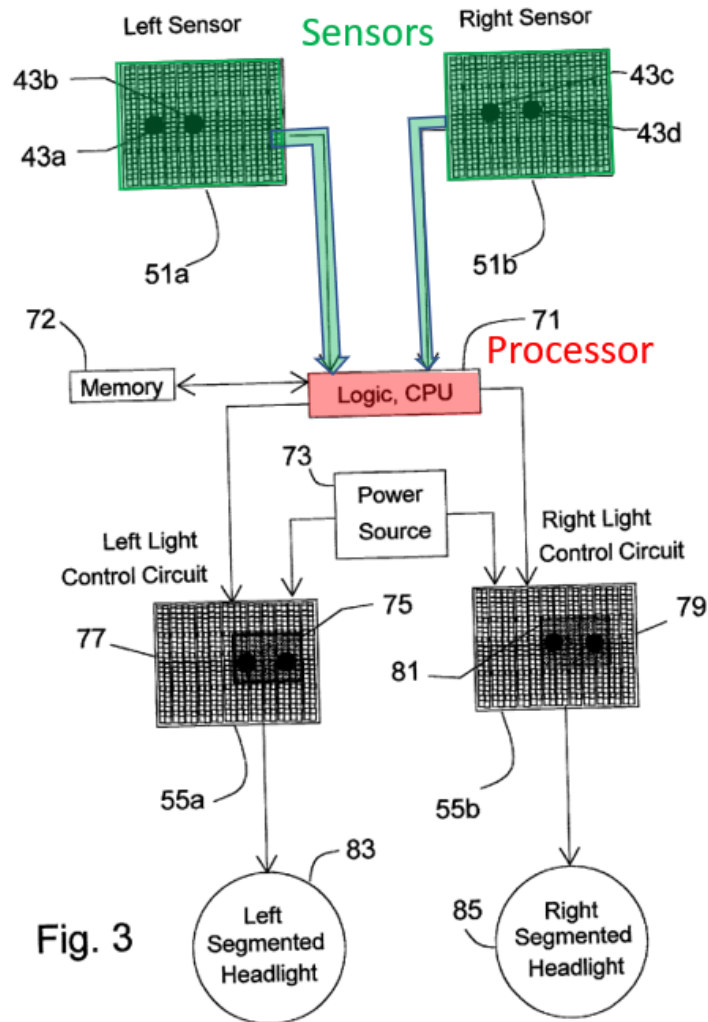


Fig. 3

(Alden, Fig. 3 (annotated).)

59[C]: *wherein the at least one processor is configured to: process the sensor data to identify a first subsection, of a field of view, that includes at least a portion of the second vehicle;*

79. Alden discloses Claim 59[C]. Alden discloses that the processor, logic CPU 71, processes the sensor data to identify sectors, or zones, of the headlight distribution area where other vehicles are present (*i.e.*, “first subsection of a field of view”). *See supra* ¶¶57-72 (Claims 37[C]-37[E]). Again, Alden discloses that

data from left and right sensors 51a, 51b is used to “determine the intensity of light that will be produced by the [headlight] 61 in the corresponding headlight sectors. ... Note that a left shaded circuit area 75 [where another vehicle is detected] indicates the areas of a segmented headlight control switch array switches which will cause portions of the left headlight to be dim while a non-shaded left circuit area 77 represents the portions of the segmented headlight which will be on high beam.” (Alden, [0027]; *see also* [0028]-[0029].) The headlight thus “produces a high beam in a first sector 65 while concurrently producing a low beam in a second respective sector 63 (or dim beam) where the 41 [other vehicle] is sensed.” (*Id.*, [0026].)

59[D]: wherein the at least one processor is configured to: determine light output for the headlight system that aims illumination at the first subsection, the illumination aimed at the first subsection substantially resulting in light below a first predefined illuminance in the first subsection, and that aims illumination at one or more second subsections of the field of view to either side of the first subsection, the illumination aimed at the one or more second subsections substantially resulting in light above the first predefined illuminance in the one or more second subsections; and

80. Alden alone discloses and renders obvious Claim 59[D]. Alden discloses that the logic CPU processor 71 determines the light output for the lighting elements of its headlight system that aim illumination at the sector containing the sensed other vehicle (“first subsection”). *See supra* ¶¶59-72 (Claims 37[D]-37[E]). Alden discloses that the light aimed at the sector where another

vehicle is sensed is dimmed, or low beam, light. *Id.* And, Alden discloses that the lighting elements that aim light to sectors of the headlight distribution area that do not contain other vehicles (“second subsections”) are illuminated with high beam light. *Id.* Again, where a vehicle is detected in a middle sector, that middle sector will be a low beam sector, and the high beam sectors will be located to either side of the dimmed, low beam sector. *Id.*

81. Alden further discloses that the illumination aimed at the first subsection is “below a first predefined illuminance” and light aimed at the second subsections is “above” the predefined illuminance. *See supra* ¶¶64-72 (Claim 37[E]). As discussed above, Alden further discloses that the lighting elements in the headlights can produce not only low and high beam light, but also “a range of intensities between the high beam and the low beam state.” (Alden, [0061]; *see also supra* ¶¶59-72 (Claim 37[D]-37[E]).) These intensities in between high and low beam are a “predefined illuminance” which the low beam is below and high beam is above. *See supra* ¶¶64-72 (Claim 37[E]). In addition, as I explained in detail above, a POSITA would have understood that for the low beam light to have “minimum glare,” it would need to be below a threshold illuminance, and for the high beam light to provide “maximized” visibility, it would need to be above the threshold. *Id.*

82. Additionally, Alden in view of Stam renders obvious Claim 59[D]. In as I discussed above with respect to Claim 37[E], it would have been obvious to a POSITA to modify Alden to include such a predefined illuminance level as taught by Stam. *Id.*

59[E]: wherein the at least one processor is configured to: instruct adjustment of one or more of the light sources to achieve the determined output.

83. Alden discloses Claim 59[E]. Alden discloses that the processor instructs adjustment of its lighting elements to produce “a high beam in a first sector 65 [no other vehicles] while concurrently producing a low beam in a second respective sector 63 (or dim beam) where the 41 [other vehicle] is sensed. ... Thus the driver of 47 can see everything illuminated to the maximum except the area where 41 is. Meanwhile, the driver of 41 sees only a dim or low beam light from 47. Thus the light for both drivers is concurrently optimized by segmented the light distribution into independently controlled sectors.” (Alden, [0026], [0027] (noting that CPU 71 determines the light to be produced so the headlight “distributes high beams throughout its distribution areas except in a box in the direction of the 41 [other vehicle]. Thus the driver of 41 has minimum glare while the driver of 47 has maximum light.”).) *See also supra* ¶73 (Claim 37[F]).

3. Independent Claim 65

84. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) Claim 65.

65[Pre]: *A method for generating a headlight beam in an adaptive headlight system that provides illumination to at least a portion of a field-of-view, comprising*

85. Alden discloses Claim 65[Pre]. Alden discloses “automatic segmented illumination” headlights on a vehicle that provide “low beam illumination” and “high beam illumination” in different headlight distribution sectors in the field-of-view of a vehicle. (Alden, Abstract, [0025]; *see also* [0026]-[0029], Figs. 2, 4-5, 11.) *See also supra* ¶51 (Claim 37[Pre]), ¶¶54-56 (Claim 37[B]).

65[A]: *utilizing one or more sensors of a first vehicle to obtain and provide data, the data including data indicating at least a second vehicle;*

86. Alden discloses Claim 65[A]. Alden discloses a vehicle using sensors, including left and right light sensors, to obtain and provide “data indicating at least a second vehicle.” *See supra* ¶¶57-58 (Claim 37[C]). As explained above, Alden discloses that the sensed data indicates the presence of an “oncoming vehicle” or “any other vehicle.” (Alden, [0025]; *see also id.*, Figs. 2-4, [0026]-[0027] (describing that the sensor data “detects the two headlights of” an oncoming vehicle, and that the data is used to sense such other vehicles), [0028]-[0029].) Thus, Alden discloses that the sensor data is indicative of whether there are other vehicles in the headlight distribution area of a vehicle equipped with its headlight system.

65[B]: *determining illumination for at least a first subsection including the second vehicle and at least one or more second subsections, to either side of the first subsection, including determining an illumination level for the first*

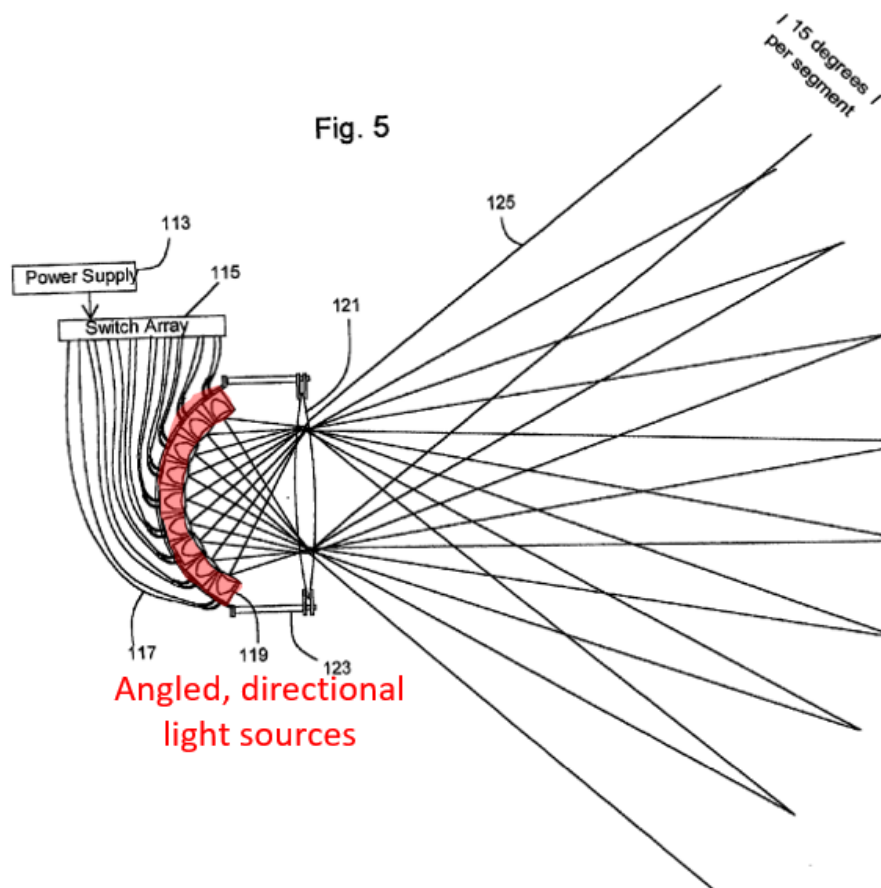
subsection that substantially illuminates the first subsection below a predefined illuminance, and determining an illumination level for the one or more second subsections that substantially illuminates the one or more second subsections above the predefined illuminance;

87. Alden discloses and renders obvious (alone or in view of Stam) Claim 65[B]. *See supra* ¶¶59-72 (Claims 37[D]-37[E]), ¶¶80-82 (Claim 59[D]).

65[C]: determining control instructions for controlling one or more directional light sources included in the adaptive headlight system to achieve the determined illumination levels for at least the first and one or more second subsections; and

88. Alden discloses Claim 65[C]. As discussed, Alden discloses a logic processor, logic CPU 71, that determines “control instructions” for controlling the lighting elements of its segmented headlight system—*i.e.*, the processing steps for determining whether each portion of the headlight distribution area should be dimmed or on high beam. *See supra* ¶¶59-72 (Claims 37[D]-37[E]), ¶¶80-82 (Claim 59[D]).

89. Further, Alden’s headlamps each have “one or more directional light sources,” as they include an “array” of lighting elements “on a curve along the focal point of a headlight lens 121, such that the light from each lighting element goes into a specified portion (or portions) of the headlight distribution area”:

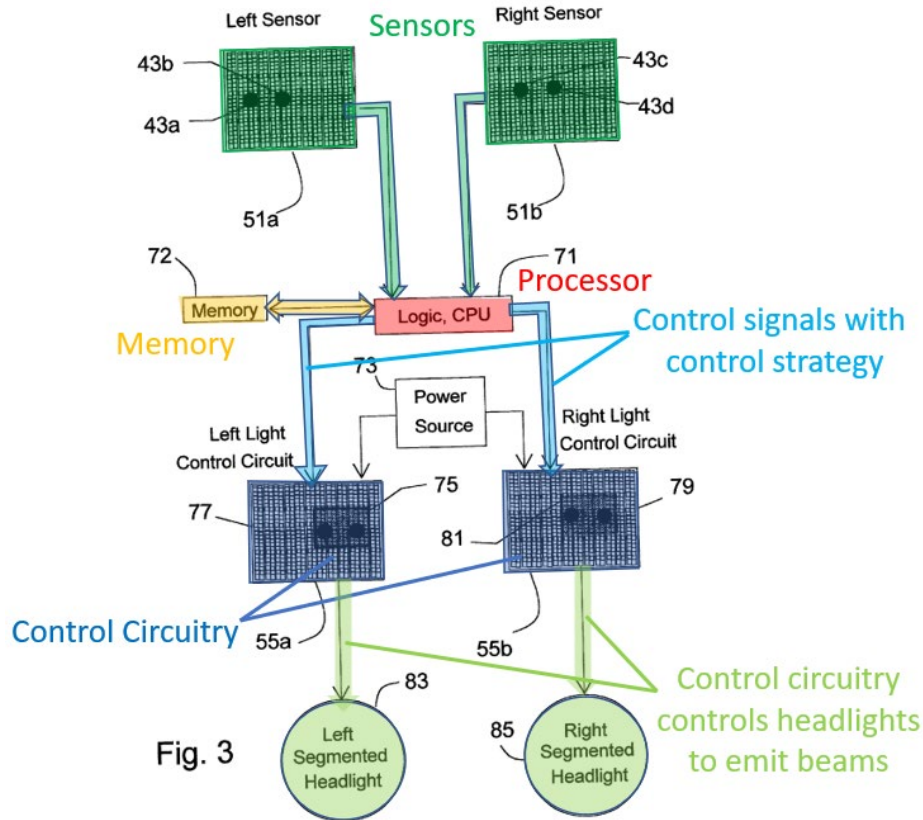


(Alden, Fig. 5 (annotated), [0029].) As shown in annotated Figure 5 above, each lighting element is directed at a different angle relative to the front of the first vehicle based on its position along the curve of the headlight unit. The light is emitted from each element at an angle, where it is incident upon lens 121. (*Id.*, Fig. 5, [0029].) The lens then focuses the light into the different illumination sectors. (*Id.*) Based on each lighting element's position along the curve, and angle with respect to the vehicle, each lighting element directs light to different sectors or segments of the overall headlight distribution area. For example, as shown in Fig. 5 above, the lighting element labeled with reference numeral 119 directs light into segment 125 based on its position along the curve and angle. Each other lighting

element similarly directs light to the other segments, based on its angle and position on the curve. Alden's logic CPU processor sets the control instructions for these lighting elements so as to create light output in a "headlight distribution area" such that portions, or sectors, including a detected vehicle ("first subsection") are illuminated with dimmed, low beam light to reduce glare for the driver of the other vehicle, while portions, or sectors, with no detected vehicles ("second subsection") are illuminated with high beam light to maximize visibility in those areas. (Alden, [0027]-[0029].) *See also supra* ¶¶59-72 (Claims 37[D]-37[E]), ¶¶80-82 (Claim 59[D]).

65[D]: controlling the light sources to emit the headlight beam in accordance with the control instructions.

90. Alden discloses Claim 65[D]. As I explained above with respect to Claim 37, Alden's left and right control circuits control the lighting elements in the segmented left and right headlights, respectively, to emit a headlight beam in accordance with the control instructions from the logic CPU 71. *See supra* ¶¶64-73 (Claims 37[E]-37[F]); *see also supra* ¶¶80-83 (Claims 59[D]-59[E]).



(Alden, Fig. 3 (annotated); see also Figs. 1-2, 5, 11-13.)

4. Dependent Claims 38-41

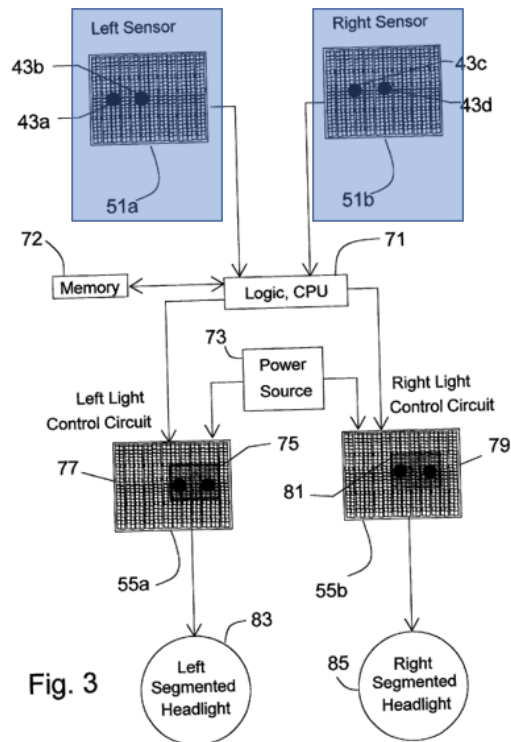
91. As viewed by a POSITA, Alden anticipates or renders obvious (alone or in view of Stam) Claims 38-41.

38: *The headlight system of Claim 37, wherein at least one of the at least one processors is further configured to process the sensor data to determine illumination for at least one first subsection of the field-of-view, determined to include at least a portion of the second vehicle, based on the sensor data, and for at least one second subsection determined not to include the second vehicle, based on the sensor data.*

92. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) Claim 38. Alden discloses that its logic CPU 71

(“processor”) processes the sensor data to determine illumination for subsections in the field-of-view that include detected vehicles (“first subsections”), and other subsections that do not include a detected vehicle (“second subsections”). *See supra* ¶¶59-72 (Claims 37[D]-37[E]). The illumination requirements for Alden’s “headlight distribution sectors” (or “subsections of the field-of-view”) are determined in response to sensor data. (Alden, [0026]-[0028].) Alden describes, for example, that the headlight system on a vehicle “emits a low beam illumination 35 in a first headlight distribution sector while concurrently emitting a high beam, illumination 37 in a second headlight distribution sector. The low beam illumination in 35 being emitted *in response to the detection of an oncoming vehicle 33* (the 33 emitting light which has been omitted for drawing clarity).” (*Id.*, [0025]; *see also id.*, [0026]-[0029].)

93. 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]; *see also id.*, [0026], Fig. 2 (depicting sensor unit 45 with detector array 51).) The information from these sensors is used to “determine the intensity of light that will be produced by the 61 [vehicle] in the corresponding headlight sectors. ... Note that a left shaded circuit area 75 indicates the areas of a segmented headlight control switch array switches which will cause portions of the left headlight to be dim while a non-shaded left circuit area 77 represents the portions of the segmented headlight which will be on high beam.” (*Id.*, [0027].)

94. Alden specifies that the logic flow implemented by the processor uses data from the sensors regarding the location of vehicles to “calculate which zones of each headlight need to be dimmed in a calculate headlight dim zones process

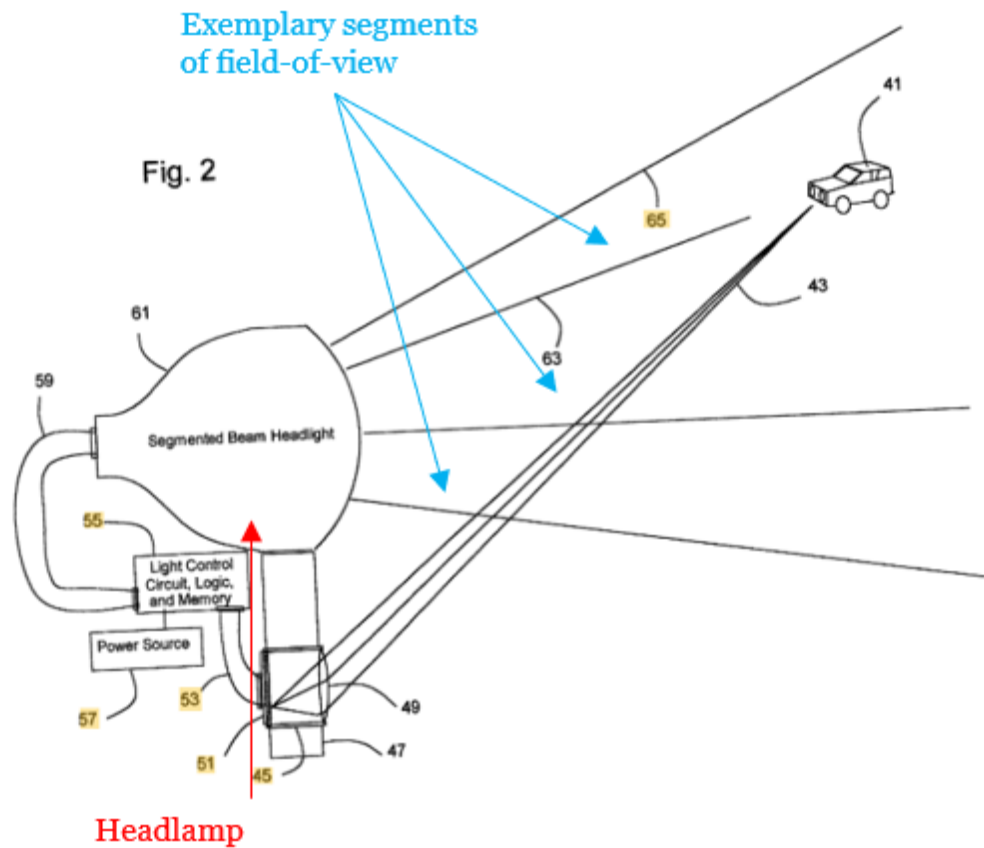
107. Signals are sent to each of the headlight control circuit zones that need to be dimmed to restrict the amount of current to the corresponding headlight zones such that they are dimmed in a dimming process 109. Zones which are not dimmed remain on high beam. Thus (assuming the sensed light is above a threshold intensity or distance) the light sent to the sensed vehicle location is dimmer than the light sent to all other areas of the headlight distribution area.” (*Id.*, [0028], *see also* [0029] (noting that “[t]he 119 and other 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. ... Thus the light sent to the area of 41 [detected other vehicle] is dimmed using a headlight with segmented lighting means.”), Fig. 5.)

39: The headlight system of Claim 37, wherein the plurality of light clusters are further capable of illuminating at least two of the sub-sections with different illumination characteristics based on the at least one processor determining specific, different illumination characteristics for each of the at least two sub-sections.

95. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) Claim 39. As discussed above, Alden discloses that its plurality of light clusters, namely the lighting elements 119, are capable of illuminating different sub-sections of the headlight distribution area with different illumination characteristics based on the processor determining specific, different

illumination characteristics for each sub-section. *See supra* ¶¶54-56 (Claim 37[B]), ¶¶59-72 (37[D]-37[E]).

96. In particular, Alden discloses that the light clusters in its headlamps project light into different areas in front of the vehicle (*e.g.*, at least first and second “sub-sections”) with different illumination characteristics. Again, each individual lighting element is individually-controllable and located on a curve along the headlight lens, “such that the light from each lighting element goes into a specified portion (or portions) of a headlight distribution area.” (*Id.*, [0025], [0029], Figs. 1-2, 5.) And, if an oncoming vehicle is detected, thereby requiring different illumination characteristics (*e.g.*, lower light) in that particular area (*e.g.*, “sub-section”), Alden will produce “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”:



(Alden, Fig.2 (annotated), [0026]; *see also* [0027]-[0028] (noting that “[s]ignals are sent to each of the headlight control circuit zones that need to be dimmed to restrict the amount of current to the corresponding headlight zones such that they are dimmed in a dimming process 109. Zones which are not dimmed remain on high beam.”), Figs. 11-13, [0036]-[0038] (changing projection of light in certain areas in front of vehicle based on road conditions such as corners and hills).)

40: *The headlight system of Claim 37, wherein the light distribution pattern defines illumination for at least the first and the one or more second sub-sections of the field of view.*

97. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) Claim 40. The “light distribution pattern” in Alden is the differing illumination levels being output from the lighting elements in the segmented headlamps, and in Alden that pattern defines the light to be produced in “the first and the one or more second sub-sections,” e.g., with light in some sectors where a vehicle is detected being dimmed and light in other sectors being high beam. *See supra* ¶¶59-72 (Claims 37[D]-37[E]). That is, the “distribution pattern” is the pattern of low beam sectors and high beam sectors that make up the overall headlight distribution in front of the vehicle.

41: *The headlight system of Claim 37, wherein the light distribution patterns defines illumination for the first subsection designed to result in an illuminance below the predefined threshold value, and defines illumination for the one or more second subsections designed to result in an illuminance above the predefined threshold value.*

98. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) Claim 41. *See supra* ¶¶59-72 (Claims 37[D]-37[E]).

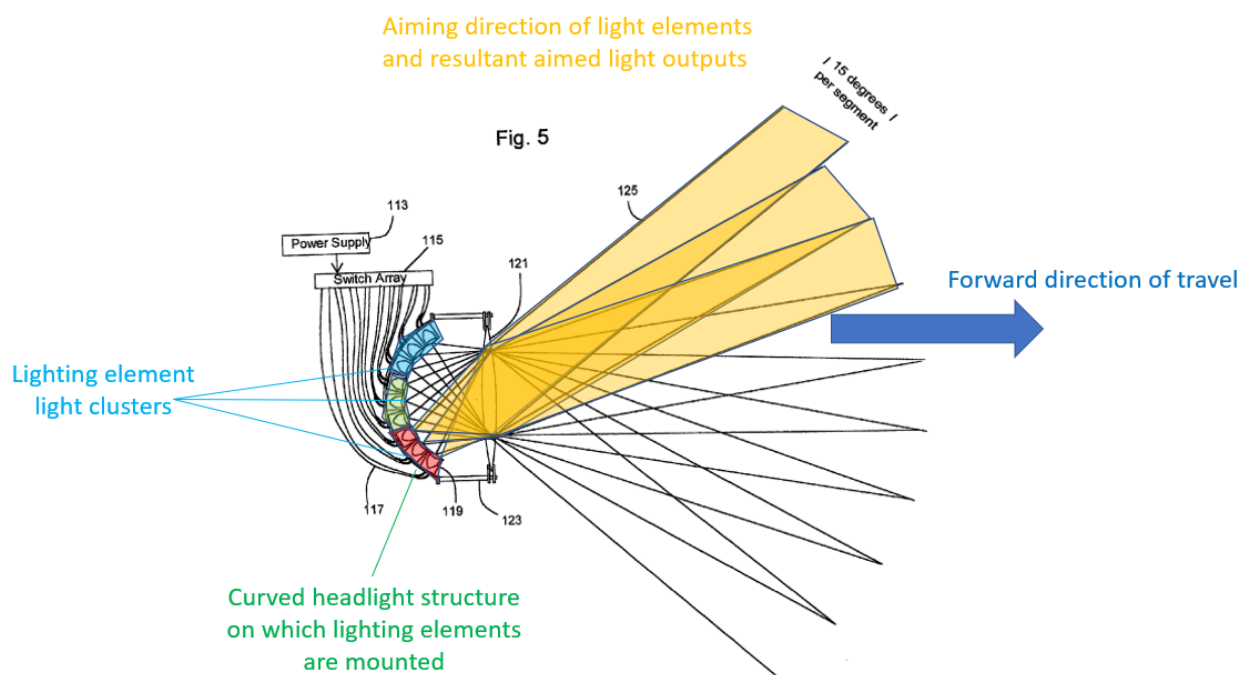
5. Dependent Claim 42

99. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) Claim 42.

42[A]: *The headlight system of Claim 37, wherein at least one of the light clusters comprises: one or more light sources, each having a variable light-source light*

characteristic dependent on power and alterable, at least responsive to instructions from at least one of the at least one processors, via power control; and

100. Alden discloses Claim 42[A]. Alden discloses that the light elements 119 forming the “light clusters” are in a “segmented headlight 123” structure that includes a curved portion on which the light elements are mounted:



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

101. As shown, each light cluster has one or more light sources (individual or groups of elements 119). (Alden, Fig. 5, [0029].) Alden discloses that the light elements 119 have a variable light source light characteristic that is dependent on power. (Alden, Abstract, [0026]-[0029].) For example, Alden discloses that the intensity of each light element is alterable, as it can be either a “high” or “low” (dim) beam, depending on the power supplied via power control responsive to

instructions from a processor. (*Id.*, [0026]-[0029].) The power to each element is controlled by “electronic control unit circuitry, namely a “left light control circuit 55a” and a “right light control circuit 55b.” (*Id.*, [0026]-[0027], Figs. 2-4.) These control circuits include switch arrays for respective left and right headlights that “control[] which segments of a segmented beam headlight 61 are on low and which are on high by controlling the power flow to each respective sector from a power source 57.” (*Id.*)

102. Looking at Figure 5, for example, Alden discloses that the individual lighting elements making up the segmented headlights of Figure 5 are 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. ... Thus the light sent to the area of 41 (where another vehicle is sensed) is dimmed using a headlight with segmented lighting means.” (*Id.*, [0029].)

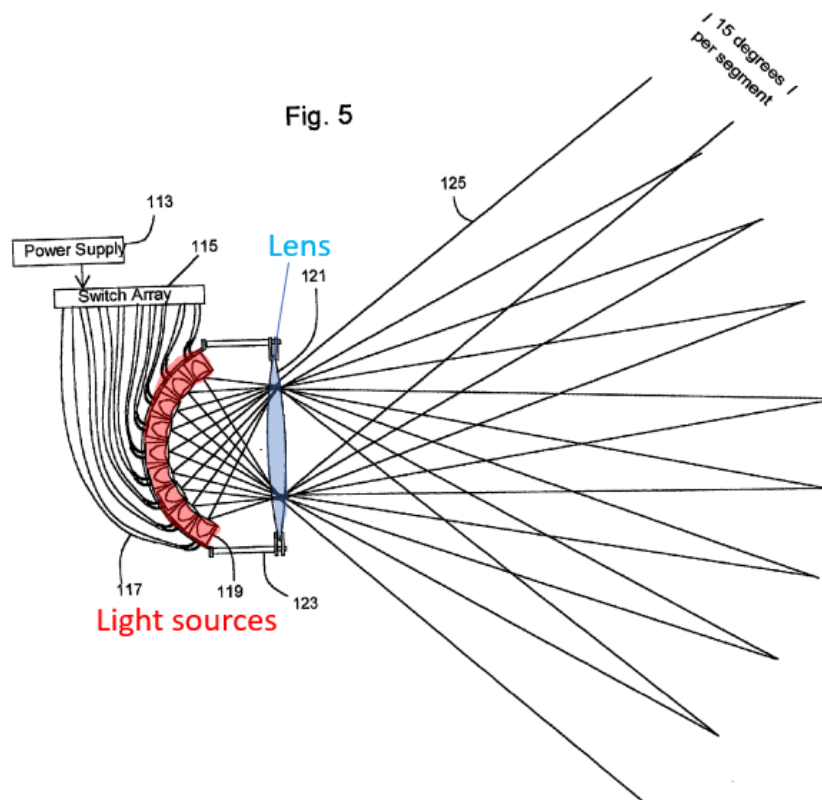
42[B]: one or more light modifying elements provided in a path of light emitted from at least one of the light sources, further controlling at least one light characteristic of the at least one of the light source;

103. Alden discloses and renders obvious claim 42[B]. I note that the ’503 discloses that “light modifying elements” can include “lenses” and “refractors,”

each of which “controls” light by directing it to or focusing it on specific areas.

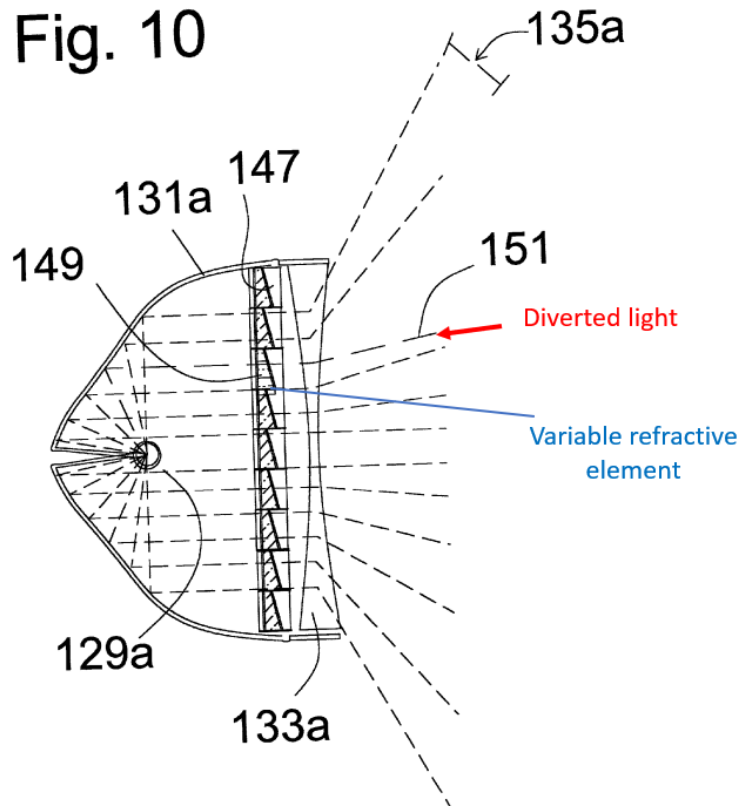
(’503, Claim 43.) The ’503 further discloses that “light-source characteristics” can include not only intensity, but also things like direction of the light. (’503, Claim 42[C].)

104. Alden discloses such a light modifying element, as it discloses a “lens 121” in the path of light emitted of lighting elements 119. (Alden, Fig. 5, [0029].) Alden discloses that this lens causes “the light from each lighting element [to go] into a specified portion (or portions) of the headlight distribution area” as shown below:



(Alden, [0029], 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. Thus, Alden discloses Claim 42[B] for this reason alone.

105. In addition, Alden discloses that other “light modifying elements” can be included in its system, including a “variable refractive element” in the form of a liquid crystal. (Alden, [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).)

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

107. Alden discloses that its use of refractive elements to “bend” light can be included in its headlight system, such as that of Figure 5, and a POSITA would have readily understood how to implement the variable refractive elements in the system of Figure 5. In fact, Alden specifically 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 (a variable refractive liquid crystal) in a system having different light distribution sectors that Alden describes the liquid crystal as acting upon.

Moreover, a POSITA would have had 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 depicted in Figure 5 of Alden, so as to provide multiple means of modifying the direction or intensity of the individual lighting sectors. This would include, for example, allowing for selective and controllable bending of the light output in certain desired portions, allowing more variable control of lighting of various 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].) This diversion of light could also be used to bend or direct the light of certain segments of the headlight beam in the direction of a curve in the road, as is shown in Figure 11 of Alden. (*Id.*, Fig. 11, [0036], *see also id.*, Figs. 14-15, [0039]-[0040].)

42[C]: wherein control of the light sources and light modifying elements results in a specified emitted light-source light characteristic, where said emitted light-source light characteristic includes at least one of direction, intensity, beam spread, spatial light distribution or spectral light distribution.

108. Alden discloses claim 42[C]. Alden discloses that control of the light elements 119 located on the curved surface and the lens 121 results in emitted light with particular intensity, direction, beam spread, and spatial light distribution. (Alden, [0026]-[0029], Fig. 5.) In particular, Alden notes that the control of the lighting elements by the power supply and control circuitry causes the different intensity in different portions of the light distribution area. (*Id.*) That is, the

intensity of each lighting element is dependent upon the power provided to that particular lighting element. Alden explains that with the lighting elements being “on a curve along the focal point of a headlight lens 121,” the “light from each lighting element goes into a specified portion (or portions) [*i.e.*, direction] of the headlight distribution area.” (*Id.*, [0029].) Again, the control of the lighting elements by the control circuitry enables causes different intensities of light in different portions of the headlight distribution area. (Alden, [0026]-[0029], Fig. 5.) Moreover, the inclusion of refractive liquid crystal elements, as disclosed in Alden, further alters the direction, beam spread, and spatial light distribution. (*Id.*, [0033]-[0035].)

6. Dependent Claim 43

The headlight system of Claim 42, wherein the one or more light modifying elements comprises at least one of reflectors or refractors, and wherein at least one of the at least one processors is configured to instruct control of at least one light modifying element resulting in a change to the light-source light characteristic.

109. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) Claim 43. As discussed above, Alden discloses use of a “variable refractive element.” *See supra* ¶¶103-107 (Claim 42[B]). This “variable **refractive** element,” which Alden describes as a variable refractive liquid crystal element, is a “refractor.” *Id.* Further, Alden discloses a processor configured to instruct control of the variable refractive element, as it includes a control circuit

controlled to be “open” or “closed” to change the direction and distribution of light passing through the refractive element. (Alden, [0033]-[0035], Figs. 8-10.) That is, the controlled circuit which can be open or closed is “variable light modifier control circuitry.” Opening or closing the circuitry for the liquid crystal element alters the variable refractive liquid crystal, causing the light to either pass straight through or be “bent” and redistributed to a different portion of the headlight distribution area. (*Id.*) See also *supra* ¶¶103-108 (Claims 42[B]-42[C]).

7. Dependent Claim 44

The headlight system of Claim 42, wherein the light modifying element further comprises at least one of lenses, diffractors, optical devices, a light guide, filters, phosphors, optical coatings, prisms, controllable piezoelectric light guides, MEMS devices, light valves or optical switches and wherein at least one of the at least one processors is configured to instruct control of at least one light modifying element resulting in a change to the light-source light characteristic.

110. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) Claim 44. Alden discloses that its “light modifying element” can be “lens 121.” (Alden, [0029].) See also *supra* ¶¶103-107 (Claim 42[B]). Such a lens also a common type of “optical device.” Alden further discloses that other optical devices, such as its variable refractive element, can be used as a light modifying element. See *supra* ¶¶103-107 (Claim 42[B]).

111. With respect to Alden’s “variable refractive elements,” as I explained above with respect to Claim 43, Alden discloses that these are “individually controlled” using control circuits which open or close to change the direction and

distribution of light passing through the refractive element. (Alden, [0033]-[0035], Figs. 8-10.) *See also supra* ¶109 (Claim 43). Again, Alden explains, for example, that controlling opening and closing of the control circuit causes the light to either pass straight through the liquid crystal elements or be “bent” and redistributed to a different portion of the headlight distribution area. (*Id.*) *See also supra* ¶¶103-107 (Claim 42[B]).

8. Dependent Claim 47

The headlight system of Claim 37, wherein at least one of the sensors is a camera-sensor configured to image at least lights indicative of an oncoming vehicle.

112. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) Claim 44. 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 having drivers whose vision could be disturbed by the glare of the headlight beam. (Alden, [0026]-[0027], Figs. 2-3.) *See also supra* ¶¶57-58 (Claim 37[C]). 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. 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.

9. Dependent Claim 50

The headlight system of Claim 37, further including a computer vision processing unit configured to use the sensor data to identify entities including at least one of beings, vehicles, roadway, or street signs, and wherein the processor is further configured to determine modification of the headlight beam to change illumination of the identified entity.

113. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) Claim 50. The '503 Patent discloses that the headlight system includes a “computer vision processing unit,” which according to the claim is a computing unit that uses sensor data and algorithms to identify objects like vehicles. Alden discloses that its headlight system includes a “computer vision processing unit,” which is part of logic CPU 71 and control circuitry 55. (Alden, [0027], Fig. 3; *see also* Figs. 11-13.) The logic CPU 71 and control circuitry 55 receive data from photodiode or CCD detector arrays 51, and use this data with algorithms (such as shown in Figure 4) to identify vehicles in the light distribution area in front of a vehicle. (*Id.*, [0027]-[0028], Figs. 3-4.) Alden further discloses that the logic CPU 71 and control circuitry 55 are configured to modify the output of the segmented headlight beam such that any detected vehicles in the light distribution area are illuminated with dimmed beams. (*Id.*, [0027]-[0028]; *see also* [0025]-[0026], [0029].) *See also supra* ¶112 (Claim 47), ¶¶59-72 (Claims 37[D]-37[E]). A POSITA would understand that a “computer vision processing unit” in the context of the '503 Patent includes hardware, such as, among other things, at

least one camera sensor, converters, communication, and a processor module. The data from the at least one camera sensor is converted to a signal that it is communicated the processor. The processor includes instructions and logic programming to detect objects of interest from the sensor data, such as headlights, taillights, and vehicles, among other things. That is, a “computer vision processing unit” is a processor that receives data from at least a camera sensor, and processes that data to detect objects of interest. Using computer vision, a system can detect and potentially track objects of interest.

10. Dependent Claim 51

The headlight system of Claim 37, where the illumination created by the headlight beam results in illumination both providing a driver of the first vehicle with preserved illumination in the one or more second subsections and mitigating glare projected to reach the eyes of a driver of the second vehicle.

114. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) discloses Claim 51. As discussed above, Alden discloses that a headlight beam is created that provides the driver of the vehicle with preserved, high illumination in portions of the headlight distribution area where no other vehicles are detected (“second subsections”), while mitigating glaring illumination projected to reach the eyes of another driver by having dimmed, low beams in portions of the headlight distribution area where the other vehicle was detected (“first subsection”). *See supra* ¶¶59-72 (Claims 37[D]-37E)). By controlling the illumination to sectors where no vehicles are detected to remain

on high beam and “maximize” driver visibility in those areas, the illumination in those areas is preserved. (*See also* Alden, [0027] (“The 55 a controls the power flow from 73 to a left segmented headlight 83 which distributes high beams throughout its distribution areas except in a box in the direction of the 41 [other vehicle]. Similarly, the 55 b controls the power flow from 73 to a right segmented headlight 83 which distributes high beams throughout its distribution areas except in a box in the direction of the 41. Thus the driver of 41 has minimum glare while the driver of 47 has maximum light.”), [0025]-[0026], [0028]-[0029].)

11. Dependent Claim 52

The headlight system of Claim 37, wherein the adapted headlight beam continues to provide high-beam illumination in the one or more second of the subsections without diminishing a range of the high-beam illumination.

115. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) Claim 52. As discussed above, Alden discloses that it detects light from oncoming vehicles. *See supra* ¶¶57-72 (Claims 37[C]-37[E]). The headlight beam of Alden is modified to reduce glare to the oncoming vehicle, while maintaining high-beam illumination in other portions of the light distribution area. (*See, e.g.*, Alden, [0027].) Because the high-beam illumination is maintained in the other portions of the light distribution area, the range of this high-beam illumination is not diminished. That is, by individually controlling the lighting elements and illumination in the individual sectors, Alden can change one or more

sectors from high beam to low beam, without changing the output, including the range, of other lighting elements that are controlled to continue to emit high beam light.

12. Dependent Claim 53

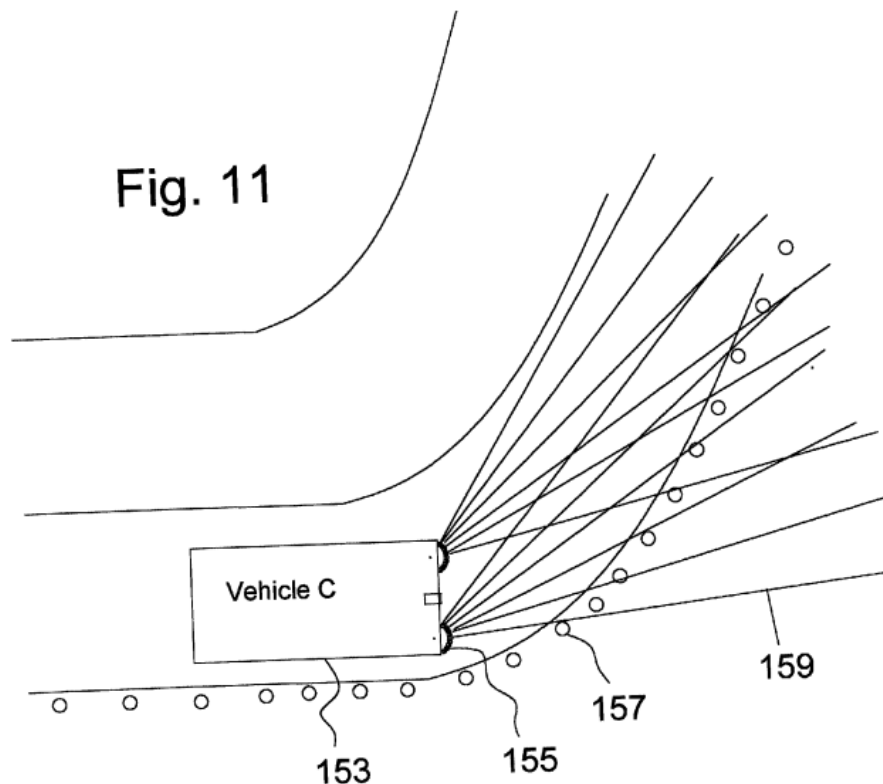
The headlight system of Claim 37, wherein the one or more sensors further includes at least one of a camera, a microphone, an ultrasonic transducer and receiver, or an electromagnetic radiation source and detector including any of IR, UV, laser, or light.

116. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) Claim 53. Alden discloses that the sensors include a camera (lens along with a detector, such as a photodiode array or CCD, to detect light that was focused or converged by the lens on the detector) and also notes that these sensors detect electromagnetic radiation (photons) of visible light from other vehicles. (Alden, [0026]-[0027].) In particular, Alden discloses a “sensor unit 45” including a “lens 49” and “detector array 51” that may be a photodiode array or CCD, sensing information regarding “emitted light 43” from other vehicles. (*Id.*, [0026].) *See also supra* ¶¶57-58 (Claim 37[C]). Alden additionally notes that “[m]any light detector (wherein electromagnetic radiation is converted to an electric signal) techniques can be used herein as sensors, for example, photodiode, CCD etc.” (*Id.*, [0061].)

13. Dependent Claims 54, 60

54 / 60: The [headlight] system of claim [37 / 59], wherein at least one of the at least one processors is further configured to determine at least a road curvature, indicated by the sensor data, ahead of the first vehicle and to determine [a second illumination pattern defining increased illumination / light output that aims illumination] in a direction of the road curvature.

117. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) Claims 54 and 60. 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.*)



(*Id.*, Fig. 11.) As illustrated in Figure 11 above, Alden discloses that a vehicle equipped with the “segmented sensing elements and segmented light distribution elements described” therein “senses that the road turns by receiving light from reflectors such as a reflector 157.” (*Id.*, [0036].) This sensor information is used by the controller such that the “responding headlights 155 direct light into the corner to maximize the driver's ability to see there.” (*Id.*, [0036], [0026]-[0029].) *See also supra* ¶¶59-72 (Claims 37[D]-37[E]). 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 (or adjusting the directional light sources) in the direction of the road 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. It should also be noted that Alden can further control the direction of the light in those sectors containing the road curve, such as by using a variable refractive element to bend or shift the light of the sectors into the direction of the curve. As can be seen from Figure 10, the variable refractive element enables light to be bent to divert it to other areas. *See supra* ¶¶103-108 (Claims 42[B]-42[C]).

118. 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 intended 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.

14. Dependent Claims 55-56, 61-62, 70

55 / 56: The headlight system of claim [54 / 37], wherein at least one of the at least one processors is further configured to determine at least a planned upcoming turn, indicated by the sensor data, and to determine a third illumination pattern defining increased illumination illuminating the turn.

119. As viewed by a POSITA, Alden anticipates or renders obvious (alone or in view of Stam) Claims 55-56. As discussed above, Alden discloses that the system can sense when a road curves in front of the vehicle, such that the vehicle must turn, based on sensor data detecting reflectors 157 along the road. (Alden, [0036], Fig. 11.) *See also supra* ¶¶117-118 (Claims 54, 60). I should note that with the system of Alden, the reflectors would be ahead of the vehicle, much like when one is driving down a road and sees reflectors ahead of her car to warn that there is a curve ahead. Thus, the detection of light off of the reflectors would indicate to Alden's system that there is a "planned upcoming turn." Alden further discloses

then creating a third illumination pattern increasing the illumination illuminating the turn, by directing light “into the corner to maximize the driver’s ability to see there.” (Alden, [0036], Fig. 11.) *See also supra* ¶¶117-118 (Claims 54, 60).

120. 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 intended 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.

61 / 62: The system of claim [60 / 59], wherein at least one of the at least one processors is further configured to determine at least a planned upcoming turn,

indicated by the sensor data, and to determine light output that illuminates the turn.

121. As viewed by a POSITA, Alden anticipates or renders obvious (alone or in view of Stam) Claims 61-62. *See supra* ¶¶117-120 (Claims 54-56, 60).

Again, Alden discloses that the illumination is increased in the direction of the curve using the segmented headlight systems described therein. (Alden, [0036], [0039]-[0040].) As I detailed above, Alden discloses that control circuitry, and in particular the left control circuit and right control circuit, are directed by the processor to create the desired illumination in each sector or segment of the headlight distribution area. (*Id.*, [0026]-[0029], Figs. 3-4.) Thus, in illuminating the turn, the processor in Alden would instruct the control circuits to create implement high beam light in the segments and sectors along the turn. *See supra* ¶73 (Claim 37[F]), ¶83 (Claim 59[E]).

70: The method of claim 65, wherein the determining illumination further includes determining illumination that increases illumination of an upcoming curve indicated by the data, wherein the determining the control instructions further comprises determining the control instructions for controlling one or more of the directional light sources to achieve illumination around the curve.

122. As viewed by a POSITA, Alden anticipates or renders obvious (alone or in view of Stam) Claim 70. *See supra* ¶¶117-121 (Claims 54-56, 60-62).

15. Dependent Claims 58, 64

58 / 64: The [headlight] system of claim [37 / 59], wherein at least one of the one or more headlamps further includes at least one of reflectors, refractors, or lenses

usable to alter emitted light from at least one of the light [clusters/sources] as part of the instructed operation.

123. As viewed by a POSITA, Alden anticipates and renders obvious (alone or in view of Stam) Claims 58 and 64. *See supra* ¶¶103-108 (Claim 42[B]-42[C]) (discussing Alden using lenses and variable refractors to alter emitted light as part of the instructed operation of the lighting elements).

B. Ground 2 – Alden, or, Alternatively, Alden in view of Stam, in view of Harbers Renders Obvious Claims 45, 68 and 69

124. I have reviewed Harbers. Harbers, titled “Vehicle Headlamp and a Vehicle,” was published on January 4, 2001, and is prior art to the ’503 Patent at least under at least § 102(b). Harbers, like Alden, is directed to improvements in vehicle headlamp systems to selectively control illumination of different areas in front of the vehicle to maximize driver visibility. (Harbers, Abstract, 5:14-7:19). Similar to Alden, Harbers describes vehicle headlights made up of a plurality of controllable LEDs, and note that the LEDs can be controlled to generate different colors (“spectral characteristics”) and spatial distributions of light in response to sensed conditions around the vehicle. (*Id.*, 2, Figs. 1B-4B, Claims 1, 9.)

125. My review of the ’503 file history shows that Harbers was not considered during prosecution of the ’503.

1. Dependent Claim 45

The headlight system of claim 37, wherein at least one of the light-clusters includes: [a] a plurality of light sources, wherein one or more of the plurality of

light sources comprises at least one of multiple light-emitting-diodes (LEDs) or organic light-emitting-diodes, [b] each light source having a spectral power distribution characteristic alterable, at least responsive to instructions from at least one of the at least one processors, by modifying power to the one or more light sources of the plurality of light sources, resulting in a color change to projected light from the at least one light-cluster illuminating at least one sub-section of the field-of-view.

126. As viewed by a POSITA, Alden (alone or as modified by Stam) in view of Harbers renders obvious Claim 45. Alden discloses that at least one of the light clusters includes a plurality of LEDs. (Alden, Fig.5, [0029].) *See supra* ¶¶54-56 (Claim 37[B]). Alden further discloses that each LED has power distribution characteristics, and that control circuitry is configured to alter these characteristics (e.g., overall light-cluster power distribution) to illuminate different portions of the headlight distribution area with different light intensities. (Alden, [0029].) *See also supra* ¶¶54-63 Claims 37[B]-37[D]. Alden does not explicitly disclose, however, that the “spectral” power of its LEDs can be controlled to change the color of projected light from at least one of the lighting elements illuminating a portion of the headlight distribution area (*i.e.*, a “sub-section of the field-of-view”)—that is, while Alden specifically mentions that its system can include “white LEDs” and “*alternate lighting mechanisms*,” it does not expressly say these “alternate lighting mechanisms” include *colored* LEDs that would allow for the color of light directed at specific portions to change. (Alden, [0029].)

127. Harbers, in the same field as Alden, similarly discloses vehicles with headlamps comprised of a plurality of controllable LEDs. (Harbers, 2:1-32, Figs. 1B-2.) Each headlamp has light sources (4, 5) that emit beams “subdivided into four beam segments 6, 6’, 6’’, 6’’’, 7, 7’, 7’’, 7’’’.” (*Id.*, 6:28-7:19, Fig. 1B.) The light sources producing the beams may comprise “a plurality of light-emitting-diodes (LEDs),” such as “an array of 8x3 LEDs.” (*Id.*, 8:10-20.) This LED array may include red, green, blue, and yellow LEDs, which can be controlled such that the different beam segments have different “spectral characteristics,” *i.e.*, colors. (*Id.*, 8:21-10:20, Figs. 1B, 2, 3A-4B.) Although LEDs produce light at a specific wavelength (mainly based on the construction material), there are methods that can slightly change this wavelength (e.g., temperature control) or most often use several LEDs of different material to produce the desired wavelength by selectively turning on/off subsets of them.

128. Harbers explains that the spectral characteristics of each beam segment can be controlled to improve visibility. (*Id.*) For example, “to improve the visibility of the surroundings of the vehicle 1, a substantially different spectral characteristic of the light beam is brought about between the on-axis parts [*e.g.*, in front of the driver] and the off-axis parts [*e.g.*, to the side of the driver] of the light beam. In particular, in the off-axis beam segment 6’, 7’ of the light beam, the spectral characteristic of the light is adapted to a light intensity which is relatively

low. ... This can be achieved by providing the *first beam segment 6; 7 and the third and fourth beam segments 6'', 6''' ; 7'', 7'''* with a spectral characteristic which is rich in white or yellow-orange light and by providing the *second beam segment 6', 7'* with a spectral characteristic which is rich in blue-green light. By thus rendering the spectral characteristic of the light beam generated by the light source dependent upon the position in the light beam, objects situated outside the center of the light beam are better observed.” (*Id.*, 9:28-10:5; *see also* 2:33-3:10, 4:33-5:26, 6:1-7, 9:1-27, 5:21-26.)

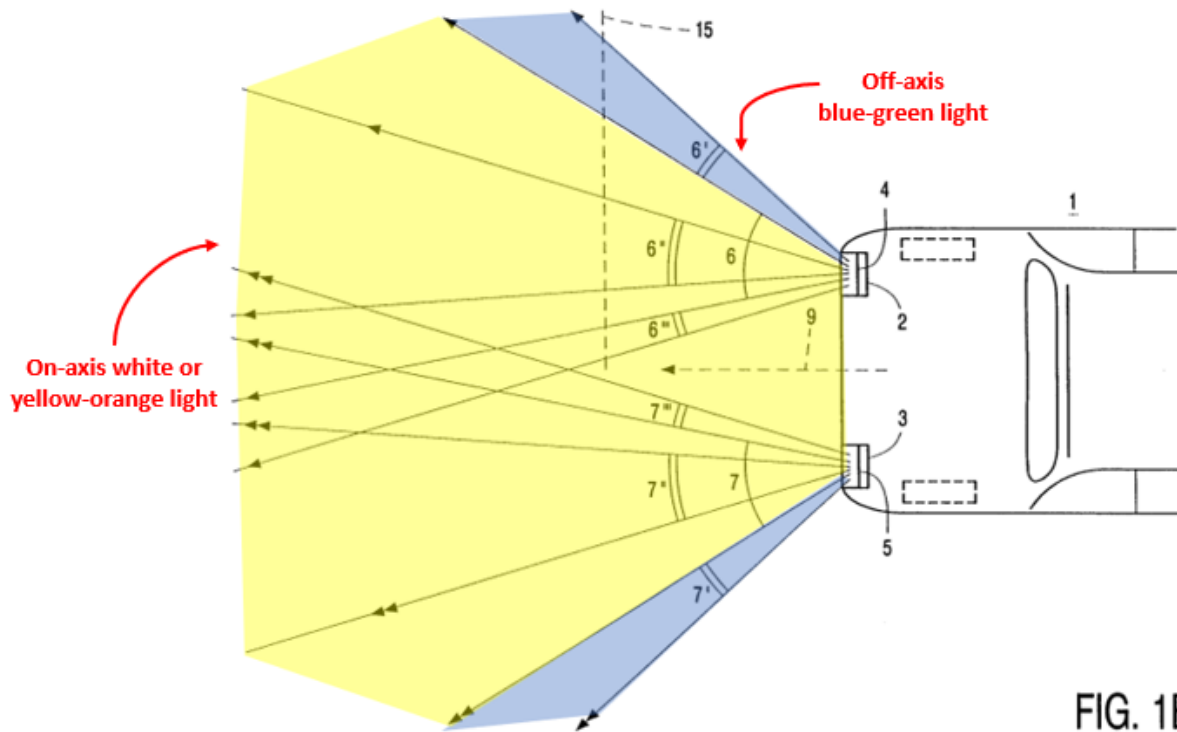


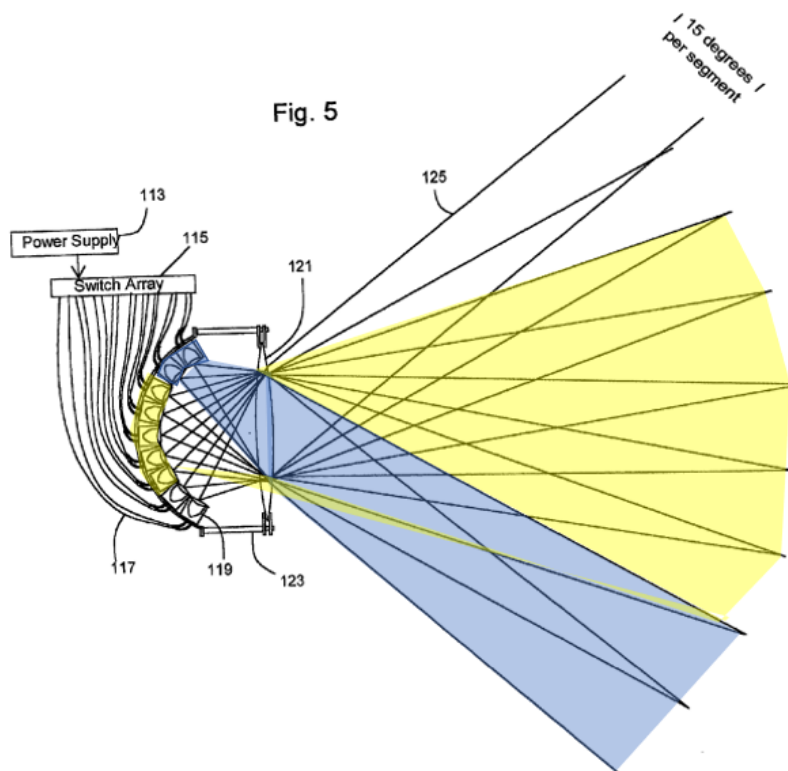
FIG. 1B

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

129. It would have been obvious to modify Alden to include color LEDs which are selectively controlled to create beam segments with different spectral intensities (different colors) in different portions of the headlight distribution area, as taught by Harbers. Both Alden and Harbers are directed to headlamp systems that include LED arrays configured to direct beams of light having different characteristics into different areas in front of the vehicle. (*See, e.g.*, Alden, Figs. 2, 5; Harbers, Figs. 1B, 2.) Moreover, both Alden and Harbers disclose control circuitry to adjust the power distribution of individual LEDs to change output characteristics of the light from those LEDs. Therefore, modifying the LED array and control system in Alden to include multiple different color LEDs as described in Harbers would have merely been the implementation of a known device (color LED arrays) for its intended purpose in a similar system already designed for use with “white LEDs” and “alternate lighting mechanisms.” In fact, both Harbers and Alden disclose LED arrays with individual LEDs mounted on a surface in a vehicle headlight to form the array. (*Compare* Alden, Fig. 5 *with* Harbers, Fig. 2.) As such, the use of Harber’s color LEDs in the LED array of Alden would have been the simple substitution of one known element (color LEDs) for another (generically-recited LEDs).

130. Moreover, the color LEDs from Harbers would perform their same function if implemented in the system of Alden, and the system of Alden would

likewise perform its same function of adjusting illumination of different portions of a headlight distribution area. However, Alden would now provide the ability to control not just the intensity and direction of light from the LED array in different areas or portions, but also color as well (that is, an additional “lighting characteristic”). Thus, a POSITA would have had a reasonable expectation of success in incorporating the color LEDs and control functions from Harbers into the system of Alden, which, again, already includes LED arrays and corresponding control circuitry. A POSITA would have been motivated to include color LEDs in the system of Alden so that, for example and as taught by Harbers, off-axis and on-axis beam segments have different spectral characteristics so that objects “situated outside the center of the light beam are better observed.” (*Id.*, 9:28-10:5; *see also* 2:33-3:10, 4:33-5:26, 6:1-7, 9:1-27, 5:21-26.) Again, the on-axis beam segments are beams projected along the road in front of the driver, while the off-axis beams are directed towards the sides of the road. Indeed, a POSITA would have understood that this could be easily achieved by including particular color LEDs, as taught by Harbers, at the particular locations along the curve in Alden’s Figure 5 headlight to produce “blue” light in portions of the beam that are off-axis and directed toward the side of the road, while including yellow light in the main, on-axis portions of the headlight distribution area:



(Alden, Fig. 5 (annotated).)

2. Dependent Claim 68

The method of Claim 65, wherein the determining illumination further includes determining a yellowish illumination color for illumination illuminating a road within the field-of-view and a blueish illumination color for illumination illuminating areas off-road within the field-of-view.

131. As viewed by a POSITA, Alden anticipates and renders obvious (alone or as modified by Stam) in view of Harbers Claim 68. Harbers discloses providing different segments of illumination, in order to improve the driver's view of the road and vehicle surroundings. (Harbers, 2:1-32, Figs. 1B-2.) As discussed above, Harbers discloses providing yellow-tinted light on-axis that will illuminate a road, and blue, low intensity light off-axis along the side of a road. *See supra*

¶¶126-130 (Claim 45). Harbers further discloses that the driver’s “off-axis” viewing, or peripheral vision, of “objects situated at or near the edge of the field of vision of driver,” such as the shoulder of the road or objects on the edge of the road, can be enhanced by providing headlight distribution with blue color beams along the side of road while providing yellow color beams along the road itself. (*Id.*, 2:33-3:10, 4:33-5:26, 6:1-7.) In particular, Harbers discloses that providing “yellow” light in the on-axis beam segments illuminating along the road, while providing “blue-green” light in off-axis beam segments “objects situated outside the center of the beam are better observed.” (*Id.*, 9:28-10:5; *see also* 2:33-3:10, 4:33-5:26, 6:1-7, 9:1-27, 5:21-26.)

132. As discussed above regarding Claim 45, it would have been obvious to apply these teachings to Alden’s system to include color LEDs and produce blue light in off-axis areas along the side of the road and yellower light in the center portion of the headlight distribution area. *See supra* ¶¶126-130 (Claim 45). The rationale for this is the same as I already discussed above; after all, we are once again discussing the simple inclusion and use of color LEDs in Alden’s system, which already contemplates using “alternate lighting mechanisms” beyond simple “white LEDs.” But, for example, a POSITA would have been motivated to use blue and yellow beam segments to improve driver vision in all areas, including along the side of the road where objects such as road signs, road lines, and

pedestrians may be located. (Harbers, 10:6-14.) Such would ensure that objects along the road can be better observed. Moreover, such use of color LEDs would have been the simple substitution of one known element (color LEDs) for another (Alden's generically-recited LEDs) in a similar system, which system would now have the ability to control an additional lighting characteristic to further improve driver visibility.

3. Dependent Claim 69

The method of Claim 65, wherein the data includes data indicating fog or snow environmental conditions and the determining illumination includes determining a shift of at least a portion of the light output from the headlight system towards yellow.

133. As viewed by a POSITA, Alden (alone or as modified by Stam) in view of Harbers renders obvious Claim 69. Harbers discloses providing different segments of illumination, in order to improve the driver's view of the road and vehicle surroundings. (Harbers, 2:1-32, Figs. 1B-2) *See also supra* ¶¶126-130 (Claim 45). Harbers discloses altering its lighting based on whether there is fog or snow: "Under unfavorable weather conditions, in particular fog and snow, when visibility is reduced by backscattering caused by fog or snow particles, both the **configuration and the spectral composition** of the light beams generated by the light source 4; 5 **can be adapted** by activating different combinations of LEDs and by changing the output levels of the various LEDs. As a result of these adaptations, the spatial and/or spectral distribution of the light is changed. **An example of such**

an adaptation is shown in Fig. 4A, wherein a relatively *wide beam 16* is obtained which is *substantially composed of yellow light*. The absence of the blue component in the visible light causes the effect of backscattering to be substantially reduced.” (Harbers, 10:6-14.)

134. It would have been obvious to a POSITA to apply these teachings to the system of Alden, and thereby use colored LEDs and adjust the color of those LEDs in areas in the field-of-view, for the reasons discussed above regarding Claim 45. *See supra* ¶¶126-130 (Claim 45). For example, applying these teachings to the lighting elements shown in Figure 5 of Alden would enable Alden to produce yellower light in the area in front of the driver when rain or snow are sensed, as taught by Harbers. A POSITA would have been motivated to change this portion of the light distribution to yellower light in order to increase visibility and avoid backscatter under these conditions. (Harbers, 10:6-14.) As Harbers explains, blue light has greater backscattering from fog and snow particles than yellow light. By changing the spectral characteristics of the light emitted by the LEDs, such that they produce more yellow light without the blue components, the backscattering effect can be reduced and driver vision improved. One of the factors that impact backscattering of the light is its wavelength. Blue light has a shorter wavelength than yellow light and thus for small particles (smaller than the light

wavelength) the backscattering will be more pronounced for the blue light than the yellow light.

C. Ground 3 – Alden (Alone or as Modified by Stam) in View of Bergkvist Renders Obvious Claim 46

The headlight system of claim 37, wherein the light output from at least one headlamp further comprises at least one of infrared or ultraviolet wavelengths.

135. As viewed by a POSITA, Alden (alone or as modified by Stam) in view of Bergkvist renders obvious Claim 46. I have reviewed Bergkvist. Bergkvist issued on November 13, 1990, and is prior art under at least § 102(b). Bergkvist discloses a vehicle having a headlamp beam with different lobes, including a “full beam lobe” and a “dipped lobe.” (*Id.*, Abstract, 2:7-23, 2:40-60, 3:66-4:44.) Bergkvist further discloses that when a “dipped” beam is used to reduce glare (or “dazzle”) to oncoming vehicles, there may not be sufficient illumination of roadside objects like signs and pedestrians. (*Id.*, 1:5-38.) To ensure sufficient illumination of roadside objects, Bergkvist discloses a headlight that produces both visible light *and ultraviolet (UV) light*, so that roadside objects (such as signs) “glow” when illuminated with UV. (*Id.*, Abstract, 2:7-23, 2:40-60, 3:66-4:44.) A POSITA would have known that UV light is associated with a phenomenon called fluorescence. It is associated with certain materials that can absorb UV light and then re-emit it in the visible range. The visible range has a longer wavelength than the UV range. Under these circumstances the object

suddenly appears to “glow.” Bergkvist discloses that by including a UV light source in the headlight, the driver will “observe” objects like road signs and pedestrians “despite said objects being located in an area not irradiated by visible light.” (*Id.*, 4:4-44.)

136. It would have been obvious to apply Bergkvist’s teachings to include a UV light source in Alden’s system, so as to better illuminate roadside objects, like road signs in areas where there is little or no visible light projected, without causing glare to other drivers or pedestrians. Including such a UV light source would have been well within the skill of a POSITA, as it would merely require adding a known element for its intended purpose, in a headlight that is already made up of a plurality of light sources and that can already use a variety of “lighting mechanisms.” That headlight system of Alden already includes a number of disparate components that can, together, be mounted or affixed to a vehicle. Thus, a POSITA could have easily included a UV light source within the headlight system of Alden, and would have further been able to direct this UV light source towards the side of the road so that its emitted UV light would be incident upon the roadside objects, such as signs, painted lines, and pedestrians, that Bergkvist indicates should be illuminated so they are more visible to the driver. Moreover, a POSITA would have been motivated to include at least one UV light source in the array of Alden in order to have light outside the visible range, such that it is not

distracting to other drivers or pedestrians but can still illuminate reflective materials such as road signs or markings. Because UV light is outside the visible spectrum, it is not detected by the human eye.

D. Ground 4 – Alden, or, Alternatively, Alden in view of Stam, in view of Beam Renders Obvious Claims 48, 57, and 63

1. Dependent Claim 48

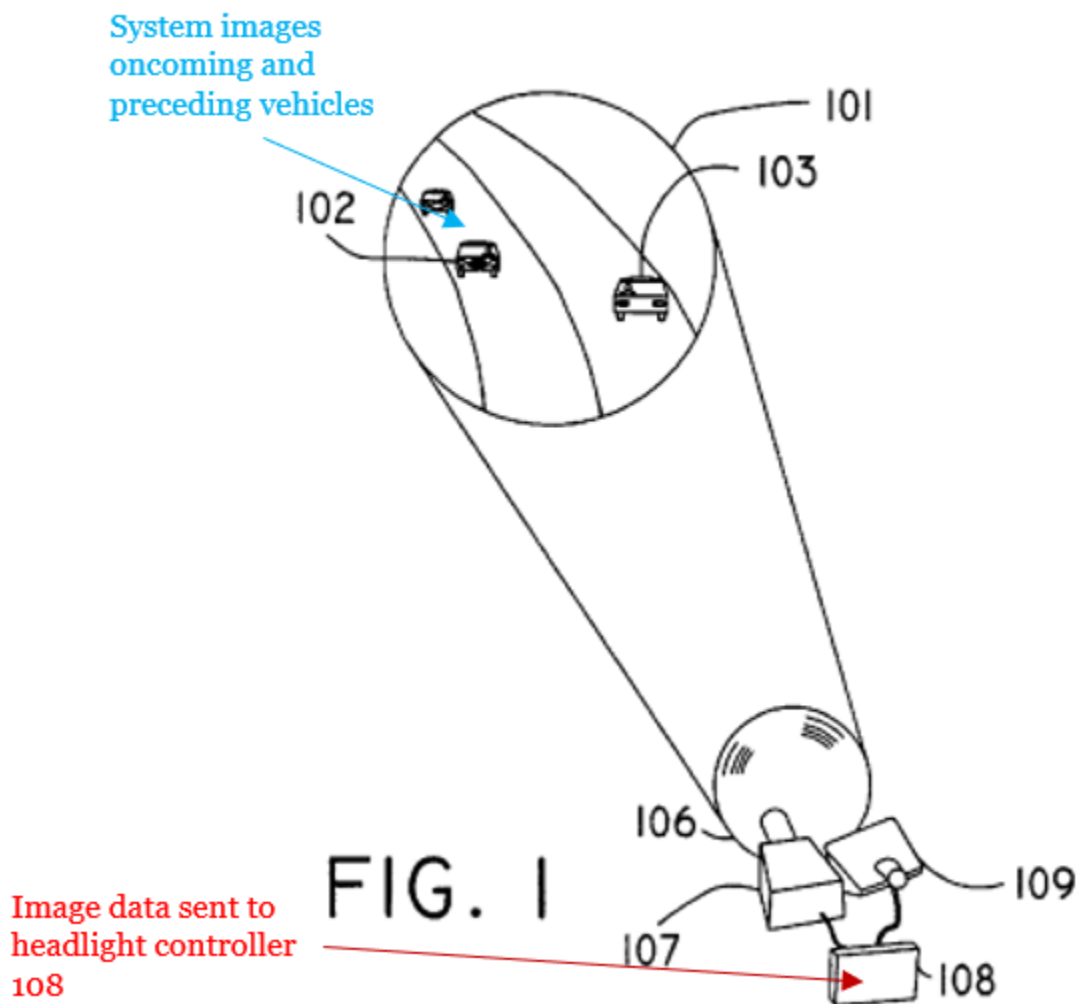
The headlight system of claim 1, wherein at least one of the sensors is a camera-sensor configured to image at least lights indicative of preceding vehicles having a driver whose vision could be disturbed by the headlight beam reflected in a mirror, and where the logical controller upon receiving data, indicating a position of the lights, from the camera-sensor, is configured to use one or more of the algorithms to determine a position of the preceding vehicle, based on the position of the lights as indicated by the data, relative to the vehicle headlight system and responsively adapt the headlight beam to decrease at least one vision-disturbing characteristic to the driver of the preceding vehicle.

137. As viewed by a POSITA, Alden (alone or as modified by Stam) in view of Beam renders obvious Claim 48. I have reviewed Beam. Beam issued on November 7, 2000, and is prior art under at least § 102(b). Dependent Claim 48 is nearly identical to dependent Claim 47, but says that instead of detecting an oncoming vehicle, the system detects lights indicative of a “preceding vehicle” and adjusts the beam to decrease at least one “vision-disturbing characteristic” to the driver of the preceding vehicle. As is known, an oncoming vehicle is one that is traveling in the opposite direction of a vehicle being driven by a driver. And, a preceding vehicle is one that is traveling in the same direction as the one driven by a driver. For example, on a two lane road, an oncoming vehicle would be a vehicle

traveling in the opposite lane and approaching the driven vehicle while traveling in the opposite direction. Thus, the headlights of the oncoming vehicle would be visible. A preceding vehicle would be one traveling in the same lane and direction as the driven vehicle. The preceding vehicle could be ahead of the driven vehicle, such that its brake or rear lights are visible. Alden discloses the elements of Claim 48 for the same reasons as discussed with respect to Claim 47, except only expressly mentions detecting lights of an oncoming vehicle and reducing glare for the driver of that vehicle. *See supra* ¶112 (Claim 47). That is, while Alden discloses detecting light from multiple objects, including oncoming vehicles, it does not explicitly mention “preceding vehicles” (it does not use those words).

138. Like Alden, Beam discloses a system for controlling vehicle headlights, in which headlight output patterns in particular areas are controlled or changed to eliminate “the blinding of a driver in an oncoming vehicle, while continuing to provide intense forward illumination.” (Beam, Abstract, 1:5-19.) That is, like Alden, Beam is also concerned with reducing or eliminating glare conditions that would impact the vision of other drivers. Beam describes a vehicle headlamp system that uses a “sensor 107” to detect light from other vehicles. (Beam, 4:9-59, 5:3-16, Claims 1-6, Figs. 1-2, 4.) The sensor data is used by a controller 108 to adjust the output of a plurality of individually-controlled light

sources, or “microbeams,” making up the headlight beam, in order to attenuate beams directed to detected vehicles. (*Id.*)



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

139. Beam recognizes that headlights can cause glare, or “dazzle,” that impacts not only drivers of oncoming vehicles, but also drivers of preceding vehicles “when reflected by a rear-view mirror.” (*Id.*, 4:9-25, 4:45-59, 6:61-7:8.) That is, glare can be caused not only by bright lights shining directly into the eyes

of another driver, but also light that is emitted from behind the other driver's car and then reflects into the eyes of that driver off the rear-view mirror. Thus, Beam discloses that lights from both the headlights of oncoming vehicles and the tail lights of preceding vehicles can be detected, and the output of the headlight controlled to darken light directed to the areas of the sensed oncoming and preceding vehicles. (*Id.*, 4:9-25, 4:45-59, 5:61-6:8, 6:61-7:8.)

140. For example, Beam discloses a system that “automatically sens[es] the presence and location of headlights *and taillights* ahead of the car on which it is mounted,” and then controls “the light output” of an overall headlight beam so that “the area of the beam that would dazzle the driver will be darkened, while maintaining full intensity elsewhere.” (*Id.*, 2:54-65.) Like Alden, Beam's system “provid[es] the driver of an automobile equipped with the instant invention with a far brighter headlight beam while simultaneously protecting the drivers of all vehicles ahead from being dazzled by the light.” (*Id.*, 3:11-15.)

141. It would have been obvious to a POSITA to modify Alden to detect headlights of oncoming vehicles and taillights of preceding vehicles, and to dim headlight beam output directed to areas of both the oncoming and preceding vehicles as taught by Beam. Both Alden and Beam are directed to controlling headlight beams to reduce glare for other drivers by dimming the headlights in areas occupied by detected vehicles. And, both Alden and Beam accomplish this

by detecting lights from other vehicles using a sensor, determining the locations of the other vehicles based on the detected lights, and controlling the output of an array of light sources so that beams directed to the other vehicles are dimmed.

142. Thus, modifying Alden to dim headlight beams directed to a portion of the headlight beam distribution area where preceding vehicles are present would have merely required the continued use of Alden's existing system components for their intended purposes. A POSITA would have recognized that tail lights can be detected in the same way the Alden system detects the headlights of oncoming vehicles—by using the left and right sensors (51a, 51b) to detect light and determine another vehicle is present at the location of the sensed light when it is “above a threshold intensity or distance.” (Alden, [0027]-[0028].) That is, modifying Alden to reduce glare for oncoming vehicles as well as preceding vehicles would require no additional equipment or changes in the processing steps—it would at most merely require adjusting of the thresholds for detected light because taillights are often dimmer than headlights. However, this would not be introducing any new processing steps, and a POSITA would readily understand how to set a threshold level such that headlights *and* taillights could be detected. A POSITA would have also readily understood that different thresholds could be set, such that light above one threshold would be detected as headlights of an

oncoming vehicle, and light above a lower threshold would be detected as taillights of a preceding vehicle.

143. Moreover, a POSITA would have a reasonable expectation of success, as the system of Alden would continue to perform the same function, using the same components, and would produce the same result, namely, using the sensors in concert with headlamps to increase illumination for a driver while reducing glare for the drivers of other vehicles nearby that driver. And a POSITA would have been motivated to check for preceding vehicles in addition to oncoming vehicles, as taught by Beam, as the purpose of Alden is to control the headlights so that the driver's vision is maximized with high beams in areas with no other vehicles, while "all areas with other drivers present receive low beams so as to minimize the glare for to betterment of other drivers." (Alden, Abstract.)

2. Dependent Claims 57, 63

57 / 63: The [headlamp] system of claim [37 / 59], wherein at least one light source provided to at least one headlamp [further] includes a laser diode.

144. As viewed by a POSITA, Alden (alone or as modified by Stam) in view of Beam renders Claims 57 and 63 obvious. Claims 57 and 63 merely add that the light source can be a laser diode, a "lighting mechanism" for headlights that was well known in the art. As explained, Beam, like Alden, discloses a system controlling headlight output patterns in particular areas to eliminate "the blinding of a driver in an oncoming vehicle, while continuing to provide intense forward

illumination,” which system can include sensors and a plurality of individually-controlled light sources. *See supra* ¶¶137-143 (Claim 48).

145. Beam further discloses that its light sources can include LEDs or an array of lasers (*i.e.*, “laser diodes”). (Beam, Claims 4-5.) Thus, Beam recognizes that LEDs and lasers, which are emitted from laser diodes, are alternative known “lighting mechanisms” that can be used in an array to generate a controllable headlight beam. A POSITA would have known that laser light in automotive headlight applications is produced by a laser diode which is a semiconductor device. The laser light is created when an electric current passes through the laser diode. Laser’s use in headlights can provide several advantages, since laser offers longer reach, energy efficiency, and improved visibility. It would have been obvious to a POSITA to modify Alden to include laser diodes instead of LEDs as the light sources.

146. As taught by Beam, laser diodes and LEDs were known alternative components, each capable of being individually controllable light source that can be used in arrays for headlight beams. Thus, using laser diodes instead of LEDs as the light sources in Alden would have simply been the replacement of one known component for another. Indeed, with reference to Figure 5, Alden specifically says that each lighting element 119 can be a “white LED (or alternate lighting mechanism).” (Alden, [0029].) Moreover, a POSITA would have a reasonable

expectation of success in using laser diodes instead of LEDs, as the system of Alden would continue to work the same if laser diodes were used. For example, the system would continue to sense the lights from other vehicles and adjust light outputs in different portions of the headlight distribution area in response, by controlling individual lighting elements as disclosed in Alden.

E. Ground 5 – Alden (Alone or as Modified by Stam) in View of Kobayashi Renders Obvious Claim 49

The headlight system of claim 1, wherein the one or more sensors includes a GPS sensor.

147. As viewed by a POSITA, Alden (alone or as modified by Stam) in view of Kobayashi renders obvious Claim 49. I have reviewed Kobayashi. Kobayashi issued on April 11, 2000, and is prior art under § 102(b). Kobayashi is titled “Lighting device for a vehicle” and, like Alden, is directed to improvements in vehicle headlamp systems including detection of positioning along a road. (Kobayashi, Abstract.) Kobayashi discloses that a “GPS navigation device 29 sends information about the road profile and the present vehicle position to ECU 10.” (*Id.*, 17:39-40.) Kobayashi further discloses that “when the vehicle advances along a scheduled course, irradiation control of the lamp is conducted in accordance with the course concerned.” (*Id.*, 17:59-61.)

148. It would have been obvious to a POSITA to apply the teachings of Kobayashi and include a GPS sensor in the system of Alden. Both are directed to

the same function and perform the same result—Alden discloses directing light based on detecting an oncoming road turn or curve (Alden, [0036], [0039]-[0040]), and Kobayashi similarly discloses controlling headlights based on the upcoming direction of the vehicle. (Kobayashi, 18:1-14.) Further, a POSITA would have been motivated to apply the teachings of Kobayashi to Alden. Alden details how a headlight system can use sensors to sense light from reflectors located along a curve in a road, to detect road curvature, and adjust the headlights in view of this. (Alden, [0036], Figs. 11].) Additionally, Alden discloses that a steering wheel sensor can be used to determine the direction the vehicle is traveling and adjust the light accordingly. (*Id.*, [0039]-[0040], Figs. 14-15.) Kobayashi makes clear that this same detection of road curvature can be performed with a GPS with the same result. (Kobayashi, 17:39-40.) A POSITA would have known that at the time of the ‘503 patent, GPS (although not as accurate as today) was used in intelligent vehicles applications including among others navigation, telematics, fleet management, emergency response, and traffic management. The need to track vehicles’ locations was at the forefront of these GPS deployments at that time.

149. A POSITA would have thus been motivated to combine Alden’s techniques with Kobayashi’s teaching of using GPS to maximize successful detection of road curvature in different environments. Alden already recognizes that different techniques, such as a light reflector along a road curve and steering

wheel sensors, can be used to sense road curvature and turns and the direction the vehicle is going to travel. (Alden, [0036], [0039]-[0040].) Thus, a POSITA would have been motivated to include additional, known, techniques for sensing the road curvature, such as Kobayashi's teachings of GPS. A POSITA would have understood that using GPS gives the same information on upcoming curves and turns ahead of a vehicle as Alden's method of using sensed roadside reflectors.

150. Moreover, it would have been obvious to modify Alden to include the use of GPS as taught by Kobayashi, so that the system could work in areas where, for example, reflectors are not included along every road curve or such reflectors would not be reliably detected by the vehicle's light sensors. Installing such road reflectors along all roads would be expensive, and it could be impractical in some areas, like urban environments, where there may not be a place for such reflectors to be installed such that they could be recognized. However, as taught by Kobayashi, using GPS information received within the vehicle itself allows the system to determine upcoming curves and turns and adjust the light accordingly, without requiring any additional infrastructure external to the vehicle. A POSITA would understand that the systems are complementary, as both Alden and Kobayashi disclose sensor data fed to a controller, which then controls lighting.

151. A POSITA would have had a reasonable expectation of success of including a GPS in the system of Alden, as Alden's system discloses the use of a

CPU to process sensor data and control vehicle lighting accordingly. A POSITA would have thus expected that Alden's CPU could synthesize multiple sources of information, such as data regarding both roadside light reflectors and oncoming vehicles. (Alden, [0025]-[0026], [0036], [0039]-[0040].) It would have thus been obvious to include the GPS sensor feeding information regarding road profile from Kobayashi into the system of Alden to further control lighting around road curvatures.

F. Ground 6 – Alden, or, Alternatively, Alden in view of Stam, in view of Braun Renders Obvious Claims 66 and 67

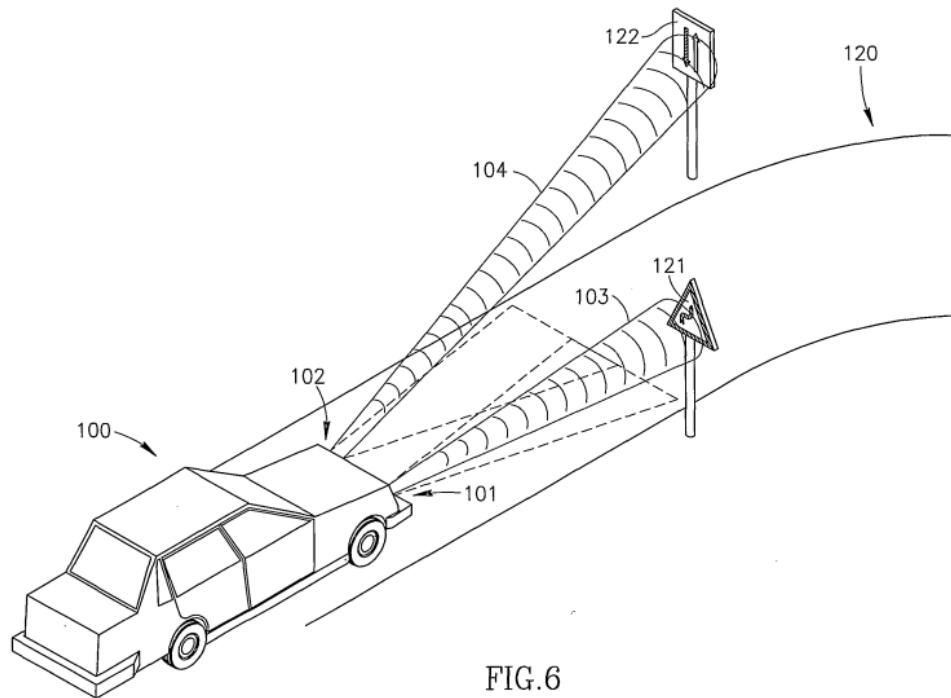
66: The method of Claim 65, wherein the data includes data indicating a pedestrian and wherein the determining illumination includes determining an illumination level, for at least a third subsection including the pedestrian.

67: The method of Claim 65, wherein the data includes data indicating a road-sign wherein the determining illumination includes determining an illumination level, for at least a third subsection including the road-sign.

152. As viewed by a POSITA, Alden (alone or in view of Stam) in view of WO2002004247A1 ("Braun") (EX1011) renders obvious Claims 66 and 67. Claims 66 and 67 are similar, and recite detecting a pedestrian and road sign, respectively, and determining an illumination level for a third subsection that includes the pedestrian or road sign.

153. I have reviewed Braun. Braun was published on January 17, 2002, and is prior art to the '503 under at least 35 U.S.C. § 102(a). Braun is titled "Method and apparatus for providing adaptive illumination," and, like Alden, is directed to a

vehicle headlight system that includes individually controllable light sources that can illuminate different regions of an area in front of the vehicle with different light characteristics based on detected objects so as to increase safety. (Braun, Abstract, 4:17-5:5, 5:21-6:7, 10:20-11:30, 12:17-20, 22:19-26:17, 26:29-27:2, Figs. 1, 5-6). For example, Braun discloses that “cameras 112 (Fig. 5) image the roadway scene and determine distances to objects and features in the scene,” that “pattern recognition” is applied to process the images and identify particular objects, such as “roadway signs” (24:2-21) or “people in a road” (26:32), and that the individual illuminator elements are controlled to illuminate the roadway based on the detected objects. (Braun, Fig. 5, 24:2-21; *see also* 22:19-23, 23:8-24:1, 24:22-25:2, 26:29-27:2.) In particular, Braun notes that roadway signs or persons in the road can be highlighted with a particular spotlight beam to alert the driver to their presence:



(*Id.*, Fig. 6, 23:8-24:1, 24:22-25:2, 26:29-27:2.)

154. It would have been obvious to a POSITA to modify Alden to include using a camera system to acquire images and apply pattern recognition to detect objects in a roadway such as road signs and pedestrians. Alden already discloses acquiring light to image a roadway scene in front of a vehicle, and using the camera system of Alden with further capabilities of detecting road signs and pedestrians from the images would have been the simple substitution of one camera sensor and processing unit (Alden's lens and photodiode array or CCD detectors and logic CPU) with another (Braun's camera and pattern recognition system). Moreover, a POSITA would have had a reasonable expectation of success in implementing Braun's detection system in Alden. The Alden system would

continue to be able to detect oncoming vehicle headlights and positions/distances (something Braun also does) and control the individual lighting elements accordingly. Moreover, a POSITA would have been motivated to apply Braun's teachings of further controlling the light output of certain individual lighting elements to create a spotlight illuminating any detected roadway signs or pedestrians ("third subsections") to the system of Alden. In fact, Alden already recognizes that other objects (like reflectors, which are similar to road-signs) can be detected, and that the individual lighting elements can be controlled based on these detected reflectors to change illumination characteristics of the headlight distribution area so as to, for example, direct light into the curve. (Alden, Fig. 11, [0036].) A POSITA would have understood that a similar process could be used to direct light towards roadway signs or pedestrians in the road, as taught by Braun. A POSITA would have been motivated to detect and illuminate roadway signs and pedestrians with a spotlight beam in the system of Alden, as taught by Braun, in order to further increase safety for the driver of the vehicle and others in the roadway.

VI. CERTIFICATION

155. 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.

A handwritten signature in black ink, appearing to be 'N. Papanikolopoulos', written over a light gray rectangular background.

Dr. Nikolaos Papanikolopoulos

Dated: June 5, 2023

APPENDIX A

Materials Considered

Exhibit No.	Description
1001	U.S. Patent No. 10,894,503 (“’503 Patent”)
1002	File History for the ’503 Patent
1003	Declaration of Dr. Nikolaos Papanikolopoulos
1004	Curriculum Vitae of Dr. Nikolaos Papanikolopoulos
1005	U.S. Patent Application Publication No. 2003/0137849 (“Alden”)
1006	WIPO Patent Publication No. 2001/001038A1 (“Harbers”)
1007	U.S. Patent No. 4,970,628 to Bergkvist (“Bergkvist”)
1008	U.S. Patent No. 6,144,158 to Beam (“Beam”)
1009	U.S. Patent No. 6,049,749 to Kobayashi (“Kobayashi”)
1010	WIPO Patent Publication No. 2001/070538 (“Stam”)
1011	WIPO Patent Publication No. 2002/004247A1 (“Braun”)