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Paper 26
Date: January 16, 2025

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MERCEDES-BENZ USA, LLC,
Petitioner

v.

YECHEZKAL EVAN SPERO,
Patent Owner.

IPR2023-01026
Patent 10,894,503 B2

Before JASON W. MELVIN, AARON W. MOORE, and
MICHAEL T. CYGAN, *Administrative Patent Judges*.

Opinion for the Board filed by *Administrative Patent Judge* MOORE

Opinion Concurring filed by *Administrative Patent Judge* CYGAN

MOORE, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)

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I. BACKGROUND

Mercedes-Benz USA, LLC (“Petitioner”) filed a Petition requesting *inter partes* review of claims 1–36 of U.S. Patent No. 10,894,503 B2 (Ex. 1001, the “’503 patent”). Paper 2 (“Pet.”). Yechezkal Evan Spero (“Patent Owner”) filed a Preliminary Response. Paper 9 (“Prelim. Resp.”).

We instituted *inter parties* review on January 17, 2024 (Paper 11, “Inst. Dec.”), Patent Owner filed a Response (Paper 15, “PO Resp.”), Petitioner filed a Reply (Paper 17, “Pet. Reply”), and Patent Owner filed a Sur-Reply (Paper 18, “PO Sur-reply”).

We held a hearing on October 16, 2024, and a transcript of the hearing is included in the record, as are the demonstratives. *See* Paper 25 (“Tr.”); Ex. 1014 (Petitioner Demonstratives); Ex. 2068 (Patent Owner Demonstratives).

We issue this Final Written Decision under 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73 and, for the reasons that follow, determine that Petitioner has shown, by a preponderance of the evidence, that claims 1–36 are unpatentable.

A. *Related Matters*

Petitioner also filed a second Petition on the ’503 patent, challenging claims 37–70. *See* IPR2023-01027, Paper 2, 1. A decision in that case issues today.

The parties identify two civil actions, *Torchlight Techs. LLC v. Daimler AG, et al.*, No. 1:22-cv-00751 (D. Del.),¹ and *Torchlight Techs. LLC v. General Motors LLC, et al.*, No. 1:22-cv-00752 (D. Del.), as related matters. *See* Pet. 3; Paper 4, 1.

The parties also identify as related IPR2023-00197 (in which ’503 patent claims 20–25 and 59–64 were found unpatentable), IPR2023-00328 (in which ’503 patent claims 26–28, 30–36, 65–68, and 70 were found unpatentable, but claims 29

¹ Daimler AG became Mercedes-Benz Group AG, a real party-in-interest, on February 1, 2022. *See* Pet. 2, 3 n.1.

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and 69 were not found to be unpatentable), IPR2023-00335 (in which '503 patent claims 1–19 and 37–58 were found to be unpatentable); and IPR2023-01231 (which was joined to IPR2023-00197). *See* Pet. 3; Paper 4, 1–2. We also note that IPR2023-01320 and IPR2023-01321 were joined to IPR2023-00328 and IPR2023-00335, respectively.

Patent Owner also identifies a number of other post-grant proceedings involving patents in the same family as the '503 patent. *See* Paper 4, 2–3.

B. The '503 Patent

The '503 patent is titled “Detector Controlled Headlight System” and is directed to “[a]n automated headlight system for vehicles [that] replaces the high and low beam with a continuum of beam patterns, with further variable spatial distribution of intensities and color spectrum.” Ex. 1001, Abstract. The embodiment that corresponds to the challenged claims is depicted in Figure 15, which is reproduced in part below:

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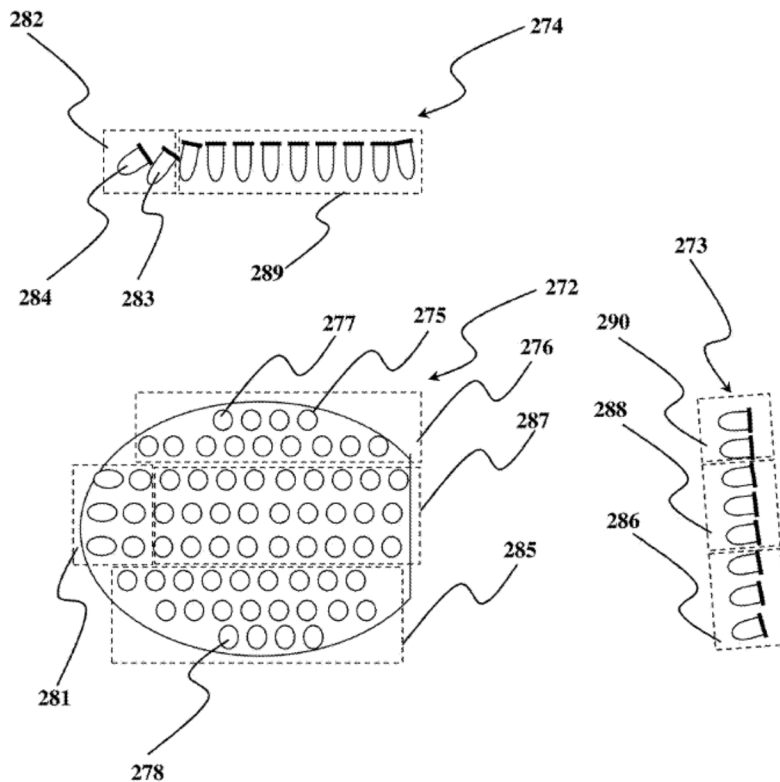


Figure 15 shows a “multiple light-source headlamp.” Ex. 1001, 15:64.

This figure depicts “a headlamp 270 of a land, sea or air vehicle . . . in front view 272, side view of a section 273 and top view of a section 274.” Ex. 1001, 53:17–19. A solid-state light source, “such as an LED 275 with [a] specific location within the cluster 276 has a specific spatial light distribution, color wavelength and aiming relative to the vehicle, such as straight ahead, and or downwards and or off towards the right or left.” Ex. 1001, 53:19–23. Different LED 277, which is “at a second location within the same cluster[,] may have a similar or dissimilar aiming, wavelength and spatial light distribution.” *Id.* at 53:29–31.

The patent explains that “headlamp control is automatic, from turning on automatically when ambient lighting levels fall to such a level where it is

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advantageous to have headlamps on, either to aid in illuminating the way ahead or facilitate being seen by others, to automatic dimming of high beam due to detection of oncoming vehicles and shut off when ambient lighting levels are sufficient.” Ex. 1001, 52:25–32. The patent further identifies “[a] possible control system for such purposes [that] is described in U.S. Pat. No. 6,281,632 by Stam, et al from Aug. 28, 2001,” in which “[i]f there is no oncoming traffic, then [the headlamp] operates as [a] high beam,” but “[i]f there is oncoming traffic, then it acts as [a] regular low beam.” *Id.* at 52:31–33, 52:55–57.

Of the challenged claims, claims 1, 20, and 26 are independent and are directed to vehicle headlight systems. Claim 1 is directed to a vehicle headlight system:

1. A vehicle headlight system comprising:
 - one or more headlamps and a vehicle structure, arranged for affixing components of the system to the vehicle;
 - a plurality of light clusters, arranged in each of the one or more of the one or more headlamps, the headlamps capable of projecting light so as to illuminate a plurality of sub-sections of a field-of-view with different illumination characteristics, the subsections determined in response to sensor data, wherein the light clusters operate to create a headlight beam;
 - electronic control circuitry configured to independently operate the light clusters;
 - one or more sensors configured to obtain and provide the sensor data predefined as pertinent to illumination requirements for the field-of-view; and
 - a logical controller including a processor, the processor in communication with a memory storing one or more algorithms, with the sensors, and with the control circuitry, wherein the processor is configured to process the one or more algorithms and the sensor data to determine an illumination for at least two of the sub-sections, that reduces illumination to reduce glare in at least a first of the at least two subsections and adapt the light emitted from one or more of the light-clusters so as to create the headlight beam that provides the determined illumination.

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Claim 20 recites a system similar to that of claim 1, except it requires that each headlamp include at least three directional light sources aimed at different angles relative to the vehicle:

20. A vehicle headlight system, comprising:

one or more headlamps affixed to a vehicle, each headlamp including at least three directional light sources aimed at different angles relative to the vehicle, the light sources configured to have one or more controllable light characteristics, wherein a first light source of the more than one light sources at a first angle is less visually disturbing to traffic than a second light source of the more than one light sources aimed at a second angle, different from the first angle;

control circuitry configured to adjust the at least one light characteristic of at least one of the directional light sources;

one or more sensors configured to sense information defined as pertinent to determining illumination output from the one or more headlamps and communicating the sensed information to a processor as sensor data;

the processor, in communication with at least the sensors and the control circuitry, configured to:

process the sensor data to determine, within a field-of-view, at least a first subsection including a detected vehicle and at least a second subsection not including the detected vehicle,

determine optimal use of the differently aimed directional light sources to maximize vehicle operator visibility in at least the second subsection, while minimizing a disturbing effect, resulting from the illumination output, on the vision of other traffic in at least the first subsection, and

direct the control circuitry to adjust the directional light sources to achieve the determined optimal use.

Claim 26 is directed to a method that generally corresponds to the subject matter of claim 1:

26. 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:

utilizing one or more sensors of a vehicle including the adaptive headlight

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system to obtain and provide data predefined as relevant to a determination of illumination requirements for the field-of-view, the data including data indicative of at least one of one or more other vehicles or a pedestrian;

determining illumination requirements for the field-of-view based on the data sensed by the sensors, including determining illumination for at least a first subsection of the field-of-view including the other vehicle or pedestrian, as indicated by the sensor data, and for at least a second subsection of the field-of-view not including the other vehicle or pedestrian;

determining a control strategy for controlling one or more directional light clusters in a headlight assembly to create an output headlight beam meeting the determined illumination requirements, the headlight beam spatial light distribution shaped to provide high beam illumination for a driver of the vehicle, in at least the second subsection, while mitigating glaring light illuminating at least the first subsection including detected other vehicles or pedestrians;

sending control signals implementing the control strategy to an electronic control circuitry configured to operate the light-clusters; and

controlling the light clusters via the electronic control circuitry to collectively emit the headlight beam meeting the determined illumination requirements.

C. Asserted Grounds

The Petition raises the following grounds:

Claims Challenged	Basis	References
1–4, 7, 10–17, 19–23, 25, 26, 27, 30–36	§ 102	Alden ²
1–4, 7, 10–17, 19–23, 25, 26, 27, 30–36	§ 103	Alden
5, 28, 29	§ 103	Alden, Harbers ³

² U.S. Patent App. Pub. No. 2003/0137849 A1 (Exhibit 1005).

³ PCT Patent App. Pub. No. WO 01/01038 (Exhibit 1006).

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6	§ 103	Alden, Bergkvist ⁴
8, 18, 24	§ 103	Alden, Beam ⁵
9	§ 103	Alden, Kobayashi ⁶

II. ANALYSIS

We discuss the appropriate level of skill in the art, claim construction, and patentability, in that order.

A. *Level of Ordinary Skill in The Art*

Petitioner contends that a person of ordinary skill in the art at the time of the alleged invention “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” and that more education could compensate for less experience and vice versa. *See* Pet. 8–9 (citing Ex. 1003 ¶ 33).

Patent Owner “does not dispute Petitioner’s proposed skill level for a person of ordinary skill in the art” (PO Resp. 4), and, as we generally agree that it is consistent with the subject matter disclosed in the ’503 patent and the prior art, we adopt it for purposes of this decision.

B. *Claim Construction*

We construe claims using the standard that would be applied in a civil action under 35 U.S.C. § 282(b), giving terms their ordinary and customary meaning to

⁴ U.S. Patent No. 4,970,628 (Exhibit 1007).

⁵ U.S. Patent No. 6,144,158 (Exhibit 1008).

⁶ U.S. Patent No. 6,049,749 (Exhibit 1009).

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one of ordinary skill in the art in view of the specification and prosecution history. *See* 37 C.F.R. § 42.100(b).

The Petition asserts that all claim terms should be given their “ordinary and customary meaning.” *See* Pet. 8. Patent Owner also proposes that the claim terms be given their ordinary meaning, and identifies the “ordinary meaning” for the terms “identify,” “turn,” and “curve,” which we discuss in our analysis below. We otherwise find that that no express claim construction is necessary. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (explaining that construction is needed only for terms that are in dispute, and only as necessary to resolve the controversy).

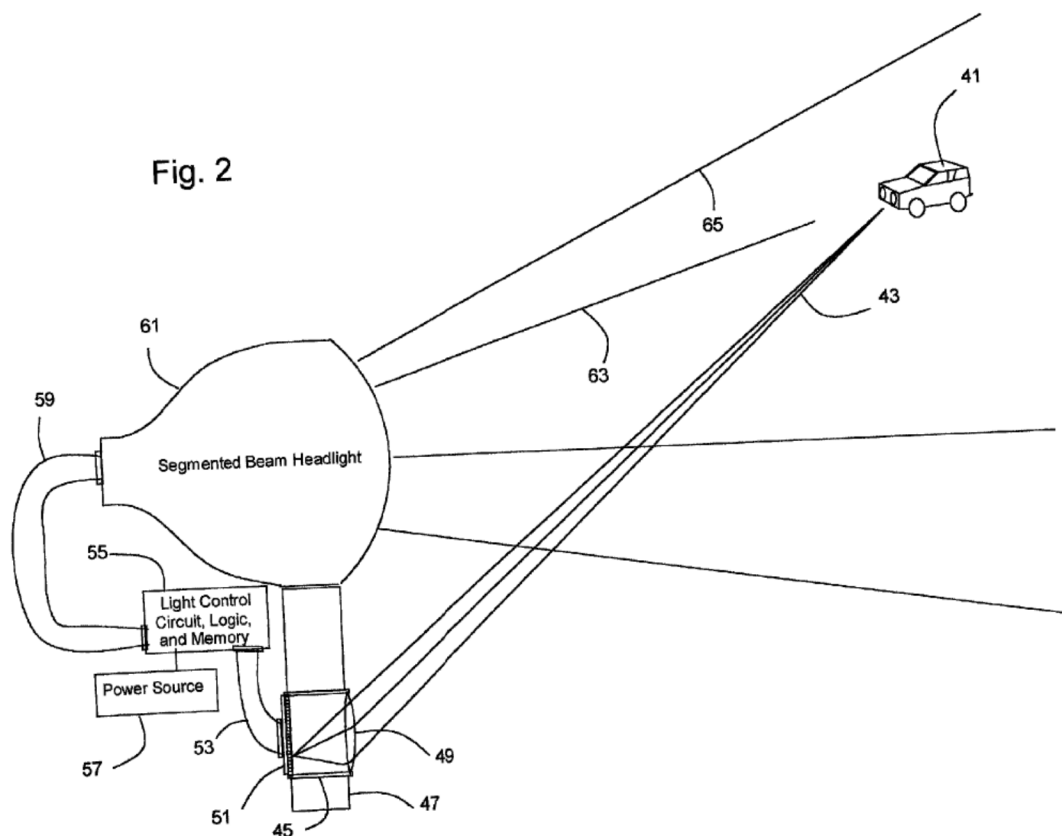
C. Anticipation by Alden

Petitioner asserts that Alden anticipates claims 1–4, 7, 10–17, 19–23, 25–27, and 30–36. *See* Pet. 11–59.

Alden is a published U.S. Patent Application describing and claiming a segmented-distribution headlight system. Ex. 1005, code (54). Alden’s Figure 2 is reproduced below:

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Alden's Figure 2 "illustrates the elements of a segmented distribution illumination process." Ex. 1005 ¶ 11.

This figure shows the elements of Alden's "segmented distribution illumination process," in which vehicle 41 emits light towards a vehicle with Alden's invention, and that light illuminates detector array 51, which is part of sensor unit 45. Signals representing the received light are then sent to light control circuit 55, which controls segmented beam headlight 61 to provide either low or high illumination in its various segments, such that light directed toward the vehicle 41 is a low beam and light directed elsewhere is a high beam. *Id.* ¶ 26, Fig. 2.

Alden's system detects spots of light, performs triangulation to calculate the distance to each, then uses the spots' intensity, size, and location information to represent "objects." *Id.* ¶ 27 ("Triangulation is thus used by the CPU to determine the distance" when detecting "spots of nearly identical intensity and size

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representative of the [oncoming vehicle's] headlights.”), 28 (explaining that “[t]he CPU compares the right map to the left map to determine the distance and intensity of each object sensed”).

Once objects have been identified, Alden’s system uses them to determine which headlight zones to dim. *Id.* ¶ 28 (“[t]he location of objects is used to calculate which zones of each headlight need to be dimmed”; “assuming the sensed light is above a threshold intensity or distance”). In that decision, the CPU identifies a corresponding pair of headlights as a vehicle, and accommodates the vehicle by defining a dimming area larger than just the headlights. *Id.* ¶ 27 (“The [dimmed] area is significantly larger than the headlight dots that were initially received by [the light-detector arrays] because, the CPU has made assumptions about the space that may potentially be occupied by the driver of the sensed vehicle.”). Finally, “[s]ignals are sent to each of the headlight control circuit zones that need to be dimmed,” whereas other zones “remain on high beam.” *Id.* ¶ 28.

With signals from the CPU, Alden’s “segmented beam headlight” projects light in the desired pattern. *E.g., id.* ¶¶ 26, 29. Alden discloses a number of embodiments for the headlamp, including one with an array of LEDs (*id.* ¶ 29, Fig. 5) and others with electro-chromatic, liquid-crystal, or variable-refraction elements (*id.* ¶¶ 30–35, Figs. 6–10).

As we did at institution, we agree with Petitioner that Alden discloses the subject matter of the challenged independent claims. Specifically, Alden describes a vehicle headlight system with two headlamps for attachment to a vehicle and pluralities of light clusters in the headlamps. *See, e.g.,* Ex. 1005, Figs. 1, 2, 3, 5. The headlamps are described as being capable of projecting light to illuminate a plurality of sub-sections of a field-of-view, determined in response to sensor data, with different illumination characteristics. *See id.* ¶¶ 25–29. Alden discloses

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control circuitry to operate the light clusters and the sensors to obtain the sensor data. *See id.* ¶¶ 25–29, Fig. 3. The reference further describes a controller with a processor in communication with the sensors, the control circuitry, and with memory storing one or more algorithms. *See id.* ¶¶ 25–29, Fig 3. Finally, the processor uses the sensor data and algorithms to determine an illumination that reduces glare in a first subsection. *See id.* ¶¶ 26–28. Alden also discloses, in Figure 5 for example, that each headlamp may include three directional light sources aimed at different angles relative to the vehicle, as recited in claim 20.

Patent Owner raises a number of arguments, some directed at Alden itself and some directed to specific claims. We address these issues in the order presented.

1. Two-Dimensional Lighting

Patent Owner first argues that Alden “lacks express details needed to implement [two-dimensional] functionality, absent modification, and Petitioner never makes such modifications or ever presents Figure 5 with an accompanying two-dimensional explanation.” PO Resp. 18. This is unpersuasive.

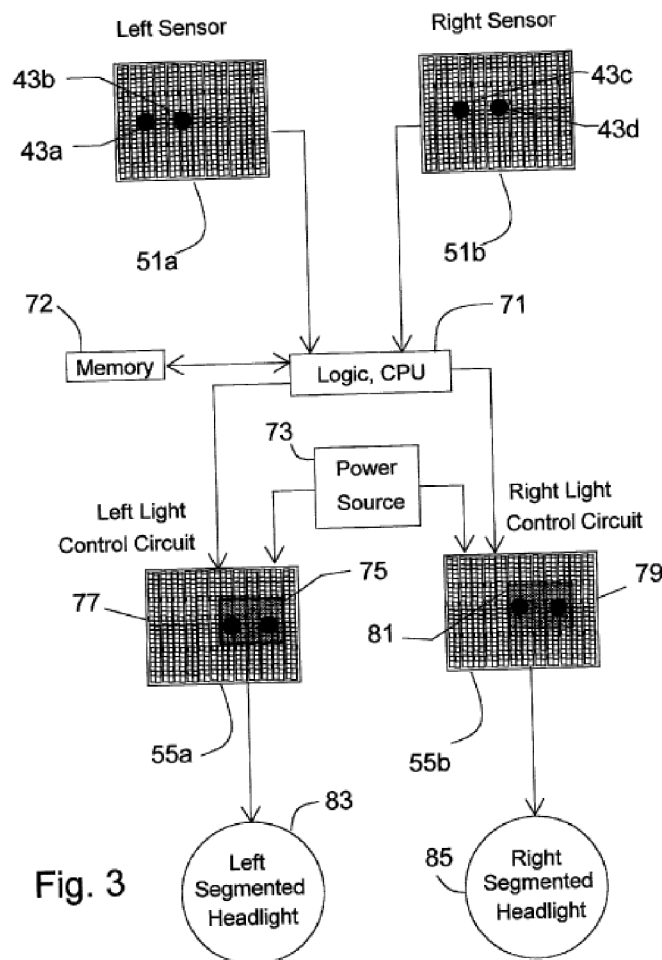
First, we do not agree with Patent Owner that Alden’s Figure 5 depicts a device with only a single row of lighting elements. Although Figure 5 shows one embodiment of Alden’s “segmented headlight means and controlling switch array” (Ex. 1005 ¶ 29), the segmented headlight is merely one aspect of Alden’s invention. The segmented headlight receives signals from a “light control circuit”—logic executing on a CPU that controls the switch array. *Id.* ¶¶ 26, 27, Figs. 2, 3. Thus, it is important to view Figure 5 and the corresponding description with an eye to the broader context in which it operates.

Alden discusses “elements of a segmented distribution illumination process” in connection with Figure 2. Ex. 1005 ¶ 26. The described process uses “a

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segmented beam headlight 61” to differentially illuminate sectors of the light distribution based on light sensed by a detector array and logic in a light-control circuit. *Id.* ¶ 26, Fig. 2. Alden’s description is generic to the specific headlight embodiment, and states that “[s]ome methods employed within [segmented beam headlight] 61 to segment light into independently controlled sectors are discussed later.” *Id.* Similarly, Figure 3 and its associated discussion provides “a more detailed illustration of the information flow, processes and architecture of the elements described in FIG. 2.” *Id.* ¶ 27, Fig. 3. Figure 3 is reproduced below:



Alden’s Figure 3 is “a more detailed illustration of the information flow, processes and architecture of [the segmented distribution illumination process] described in [Figure 2].” Ex. 1005 ¶ 12.

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This figure depicts “the information flow, processes and architecture of the elements described in FIG. 2,” including sensors 51a/b with illuminated spots 43a/b/c/d, logic and CPU 71, light control circuits 55a/b, and segmented headlights 83/85. *Id.* ¶ 27, Fig. 3.

Figure 3 depicts segmented headlights 83 and 85 generically, and the description refers to them without limiting the particular form of those headlights. *Id.* Thus, when Alden describes that Figure 5 “illustrates the segmented headlight means and controlling switch array in a first embodiment,” that does not describe an aspect disconnected from the components and operation depicted in Figures 2 or 3, but rather provides details regarding one embodiment of the segmented headlights included in Figures 2 and 3. *See id.* ¶ 29.

Importantly, Figure 3 unambiguously depicts two-dimensional sensor arrays 51a/b and two-dimensional control circuits 55a/b. *Id.*, Fig. 3. That figure and the corresponding text indicate that Alden’s process for dimming illumination sectors involves aspects in the vertical direction—the shaded boxes 75/77 representing dimmed illumination extending beyond the sensed lights 43a/b/c/d more in the vertical direction than in the horizontal direction, and “[t]he 75 area is significantly larger than the headlight dots that were initially received by 51a and 51b because, the CPU has made assumptions about the space that may potentially be occupied by the driver of the sensed vehicle.” *Id.* ¶ 27, Fig. 3.

Moreover, Alden’s description of Figure 3’s logic—though Figure 4’s flow chart and corresponding text—leaves no doubt that Alden’s process uses two-dimensional analysis. As Alden describes, the CPU checks each sector of the light sensor, for the left sensor beginning with sector A1L, proceeding to A2L and continuing through XYL. *Id.* ¶ 28, Fig. 4. The same process occurs for the right sensor, checking sectors A1R through XYR. *Id.*

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Finally, Alden describes additional applications for its invention, beyond those used to dim light sectors for oncoming vehicles. Those applications include where the invention is “used to concentrate light to look up a hill in response to road conditions” and “look down a hill in response to road conditions.” *Id.* ¶¶ 55, 56, Figs. 12, 13. From that description and the corresponding figures, it is apparent that those applications use Alden’s ability to control sectors along the vertical axis within the segmented headlight that effects illumination.

While Alden’s Figure 5 shows a sectional view of a segmented-headlight embodiment, thus depicting a single line of LEDs, that does not restrict the embodiment to a one-dimensional array. Indeed, Alden’s disclosures discussed above contradict such a view, as do the disclosures regarding Figure 5 and other segmented-headlight embodiments. We credit Petitioner’s expert’s testimony in this regard. Ex. 2041, 59:10–12 (“[I]t’s very clear we’re talking about a two-dimensional structure that is map of this set of slices in figure 5.”); *accord id.* at 56:25–60:18. The Figure 5 embodiment includes a switch array to control the individual lighting elements, with “[e]ach lighting element being independently controlled by a corresponding switch in an array of switches 115.” Ex. 1005 ¶ 29. The Figure 6 embodiment includes a face-on view of the headlight plainly showing a two-dimensional array, in addition to a sectional view similar to that of Figure 5. *Id.* at Fig. 6. And Alden describes that the Figure 6 embodiment uses a “switch array similar to 115 and the process previously described herein.” *Id.* ¶ 30.

Considering Alden’s description of its sensing-and-control circuit in connection with Figure 3, which illustrates a two-dimensional array, and its description of Figure 5’s segmented headlight as working with that approach, we find that Alden’s LED-based segmented headlight is capable of selective illumination in two dimensions. *See id.* ¶¶ 27, 29, Figs. 3, 5.

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Patent Owner argues that “Alden’s depiction of the row of LEDs being positioned along the focal point of the lens undermines a conclusion that the Figure 5 LED embodiment expressly discloses a two-dimensional array.” PO Resp. 18. It is uncontroversial that the lens has a single focal point, though there are many curves passing through that focal point, and thus many curves on which lighting elements may be arranged. While Figure 5 shows elements along one such curve, that does not preclude the existence of other elements that fall on other curves. Thus, we do not agree that Alden’s statement regarding the focal point restricts Figure 5 to depicting an embodiment with one row of lights.

Patent Owner also faults Petitioner’s expert for characterizing the figures as conceptual. *See* PO Resp. 19–20. But there is nothing problematic with conceptual figures, particularly where the corresponding description makes clear how the invention operates. For example, Patent Owner complains that Petitioner’s expert “could not explain how the switch array shown in Figure 3 controls the LED array shown in Figure 5 to create the beam spread illustrated therein.” *Id.* at 19. We would not expect Dr. Papanikolopoulos to explain that—the beam spread of any optical system will depend on the lens used and the relative position of the light sources to the lens, so it is unclear why Patent Owner expects the particular switch array to determine beam spread. When asked about beam spread (Ex. 2041, 107:11–12), Dr. Papanikolopoulos stated that it would depend on the specifics of an overall system and could not be determined by Alden’s figures (*id.* at 108, 4–10). Patent Owner finds fault in the mismatch between the number of switches in Figure 3 and Figure 5’s nine LEDs. PO Resp. 33. But that mismatch represents the conceptual nature of the figures, rather than signaling a fundamental disconnect between the two figures such that Alden’s disclosures do not enable its invention. The same problem infects Patent Owner’s complaint that

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“Alden lacks details regarding how the hypothetical structure would be put together—notable whether the two-dimensional LED structure would form a semi-cylinder, a semi-sphere or a flat plane (among other choices), which informs the control strategy and resultant beam spread.” PO Sur-reply 8. Those details are not required by Alden’s description because they do not fundamentally change Alden’s invention.

Because Alden describes its segmented headlights as implementing a process using two-dimensional signals for two-dimensional dimming functionality, we find that Figure 5 depicts a section of an embodiment that contains more than a single row of lighting elements. Stated otherwise, Alden’s disclosures are consistent with each other and are directed to a two-dimensional approach to sensing, control, and illumination.

Further, we note that Patent Owner has not addressed the legal standard for lack of enablement. To overcome the presumption that prior-art disclosures are enabled, a Patent Owner must show that ordinarily skilled artisans would require undue experimentation to practice the disclosed invention. *See Amgen Inc. v. Hoechst Marion Roussel, Inc.*, 314 F.3d 1313, 1354–55 (Fed. Cir. 2003); *In re Antor Media Corp.*, 689 F. 3d 1282, 1287–88 (Fed. Cir. 2012). But other than arguing that Figure 5 discloses a single-row embodiment that is unusable with Alden’s other disclosures, Patent Owner has made no attempt to show Alden is not enabled. Patent Owner has not addressed what experimentation skilled artisans would require to practice an invention using Alden’s Figure 5 segmented headlight with the remainder of Alden’s system as disclosed in Figures 2, 3, and 4, and Alden’s corresponding textual description.

For these reasons, we determine that Patent Owner has not shown that Alden fails to disclose and enable a two-dimensional lighting scheme.

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The concurrence is of the view that “[f]inding Alden to disclose a two-dimensional array is a position not advanced in the Petition, and is not required to resolve the patentability issues presented in the Petition.” Concur. 1. The majority disagrees on both points.

First, the Petition relies on the two-dimensional control technique of Alden’s Figure 3 for the “subsections determined in response to sensor data” of element 1[C] and the “control circuitry” of element 1[D]. *See* Pet. 17–20. Then the Petition asserts that “switch array control circuitry [of Figure 3] is *further* illustrated in Figure 5, where the lighting elements are ‘individually controlled’ by a ‘switch array,’ with each switch being “controlled by the CPU and logic previously described.” *Id.* at 20 (emphasis added). The “previous description” to which the Figure 5 description refers is the two-dimensional technique shown in Figures 3 and 4. From this we understand Petitioner to be asserting that the Figure 5 headlight produces a two-dimensional pattern.

It is true that the Petition did not explicitly say, for example, “Figure 5 is a sectional view of a two-dimensional array,” but it did not need to because it is clear from Alden that it is. Alden describes a two-dimensional technique and then three alternative headlights that may be used to implement the two-dimensional technique—that of Figure 5, which uses multiple LEDs projecting light at angles through a lens, the alternative headlamp of Figures 6 and 7, which uses a single light source reflecting light through a set of electro-chromatic cells that control the intensity and optics that control the direction, and the alternative headlamp of Figures 8, 9, and 10, which uses a single light source and electro-optic cells. *See* Ex. 1005 ¶ 29–35.

We know that Figure 5 is not meant to show a one-dimensional array because the only disclosed control scheme is two-dimensional. Notably, Figure 5

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shows only switches, not anything that determines whether they are on or off. There is no disclosure of some other control technique that operates in just one-dimension. We also know that Figure 9 is a section view from the figure itself, because all of the included parts of the headlight are shown in section. For example, the lens is shown as a section, because, if not, we would see a vertical line down the middle representing the edge of the lens. And the housing is shown as a section because, were that not the case, we would not be able to see the LEDs at all, as they are inside the housing. This explains why the figure shows just the one line of LEDs.

Nor do we agree that this issue can be avoided. Figure 5 showing a two-dimensional array may not be necessary to satisfy the claims, but, as explained above, Petitioner relied on the descriptions concerning both Figure 3 and Figure 5, and Patent Owner argues in various ways that this is problematic because the two-dimensional control system of Figure 3 would not work with the allegedly one-dimensional headlight shown in Figure 5. The concurrence contends that “Patent Owner does not dispute that the Figure 5 embodiment incorporates the logic and control described in Alden’s Figures 3 and 4.” Concur. 4 (citing Sur-reply 7). It is difficult to tell from the Sur-reply exactly what Patent Owner might “not dispute,”⁷

⁷ Patent Owner argues as follows: “What is not present is any teaching that the Figure 5 LED array is controlled by the ‘previously described’ Figure 3 switch arrays 55a and 55b. The ‘previously described’ connection between Figures 3-4 and Figure 5 is limited to CPU/logic for control of the switches and does not extend to the illustrated ‘architecture of the elements[,]’ which are called out as a separate component of Figure 3.” (citing Ex. 1005 ¶ 12).” Sur-reply 7. The “CPU/logic for control of the switches” is essentially the whole of Figures 3 and 4, which seems inconsistent with Patent Owner’s argument that the arrays are excluded. It is also unclear why or how the “architecture of the elements,” i.e., how the elements shown in the figure are connected, would be excluded.

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but Patent Owner is clear that “[w]hat is not present is any teaching that the Figure 5 LED array is controlled by the ‘previously described’ Figure 3 switch arrays 55a and 55b.” Sur-reply 7. Patent Owner therefore *does* dispute that Figure 3 and the associated description provides the two-dimensional technique that would be used to control the headlight of Figure 5.

Although we generally agree that we should avoid making determinations that are not necessary to a complete result, we could only sidestep this issue if there was agreement, or the dispute did not affect the result. As explained above, neither of those conditions is met.

2. *Speculation/Inoperability/Impermissible Modification*

Patent Owner argues that “Petitioner’s application of Alden, specifically the seminal Figure 5 LED embodiment,” impermissibly “strays beyond the ‘four corners’ of that reference.” PO Resp. 17.

For example, Patent Owner argues that “[t]hough the Petition takes definitive positions on how the Figure 5 embodiment operates — including color coding beam segments to explain their functionality and specifying the location of a vehicle in the beam pattern — the deposition of Dr. Papanikolopoulos establishes that Petitioner’s proofs are predicated on speculation and/or the need to modify Alden.” PO Resp. 17. But Patent Owner fails to explain, and we fail to see, how the colors and labels Petitioner applied to Alden’s Figure 5 to help explain its position amounts to improper speculation or modification of the reference.

Patent Owner further argues that Alden “lacks express details needed to implement [two-dimensional] functionality, absent modification,” and that Petitioner never makes such modifications or ever presents Figure 5 with an accompanying two-dimensional explanation. *Id.* at 18. We disagree. For the reasons explained above, we find Patent Owner’s argument to be based on an

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incorrect reading of Figure 5, and that, properly interpreted, Figure 5 depicts a section of a two-dimensional lighting system.

The fact that Figure 5 is “schematic” is also not a problem. The reference clearly discloses the basic concept of a two-dimensional lighting scheme that lowers light in the direction of oncoming traffic. A reference need not include a detailed engineering drawings in order to anticipate, particularly where, as here, neither the claims at issue, nor the specification of the subject patent, identify the various “parameters” that the Patent Owner claims are “missing.” Instead, the reference only needs to disclose the features that are recited in the claims.

Patent Owner further argues that “Petitioner’s expert identified . . . at least three modifications that would be required of the Figure 5 express teachings”: the number of LEDs needed to reach a desired lumen output, the exact arrangement of the LEDs, and the distance between the LEDs and the lens. *See* PO Resp. 20–22. None of those details are required by the claims, however, and, to the extent Patent Owner is arguing that Alden is not enabled, Patent Owner has not even attempted to perform the correct analysis, as noted above.

Patent Owner also argues that the Petition is deficient because a working headlight would require more LEDs than are shown in Figure 5. *See* PO Resp. 23. This is unpersuasive because, again, we find that Figure 5 is simply meant to illustrate the relationship between the various components, is a sectional view that thus only shows the LEDs existing at the given two-dimensional section (i.e., one row of LEDs), and is not meant to depict all of the LEDs that would be present in a working system that projected light in two dimensions.

We find Patent Owner’s reliance on *Apple Inc. v. Corephotonics, Ltd.*, 861 Fed. App’x 443, 450 (Fed. Cir. 2021), to the effect that “[p]rior art that must be modified to meet the disputed claim limitation does not anticipate the claim,” to

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be misplaced. In that case, the embodiment that the Petition cited could not meet the claim language “[a] lens assembly . . . [that] has an effective focal length (EFL), a total track length (TTL) of 6.5 millimeters or less” because the figures showed an overlap of the two lenses. The reference would have had to be modified by removing the overlap in order to meet the claim language. Here, on the other hand, Patent Owner does not identify modifications that would be required to *meet the claim language*; instead, Patent Owner’s allegedly missing details are what one might need to *make a working headlight* from Alden’s disclosure.

Patent Owner next finds a problem with “how each of the nine LEDs shown in the Figure 5 embodiment are powered by the switch arrays disclosed in Figure 3.” PO Resp. 24. According to Patent Owner, “[s]ince there are 576 switches in the Figure 3 switch array and 9 LEDs in the Figure 5 LED array as shown, absent some unspecified modification, it is unclear what switch or switches would be ‘a corresponding switch’ to each LED as required by Alden.” *Id.* Moreover, argues Patent Owner, “if a multitude of switches were mapped to a single LED, then unless the bounding box overlapped **all** those switches, at least one switch would still permit high-beam power to the LED — which means the LED would not be powered to the low state dictated by the low power switch(es).” *Id.* at 25.

These arguments are unpersuasive because, again, Figure 5 is not limited to one-dimension, and Alden’s figures simply illustrate the various aspects of Alden’s invention, and are not technical drawings for a specific physical embodiment. We find that a person with the agreed level of skill—a degree in electrical engineering and two years of experience working with lighting control systems—would be fully capable of adjusting the number of switches to match the number of LEDs in

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a given implementation. And we see no reason why that artisan would map multiple switches to one LED, especially given that it could prevent the system from dimming areas with oncoming vehicles as Alden describes. Indeed, the mismatch between the number of switches in Figure 3 and the number of LEDs in Figure 5 provides further evidence that Figure 5 was not intended to show all of the LEDs.

For these reasons, we conclude that Patent Owner has not shown improper speculation by Petitioner or Dr. Papanikolopoulos, that Alden's disclosure is "inoperable," or that the combination requires an "impermissible modification" of Alden.

We turn to Petitioner's arguments regarding specific claim language, in the order argued by Petitioner.

3. *Independent Claim 1*

a. *Element 1[D]: "electronic control circuitry configured to independently operate the light clusters"*

Patent Owner argues that "Petitioner has failed to address how power flows to each LED, specifically how the multiple switches of Figure 3 would be mapped to each LED of Figure 5 — necessitating a modification to the combination, as presented, that Petitioner neither identifies nor explains." PO Resp. 29–30. This argument is unpersuasive because it again relies on Patent Owner's contention that one of ordinary skill in the art would view Alden's disclosure as restricted to mapping a two-dimensional array of 576 switches to a one-dimensional row of 9 LEDs, and would be unable to make a working system with that arrangement. As explained above, we find to the contrary that Alden discloses switch arrays and LED arrays that are both two-dimensional, and that the skilled artisan would have been able to appropriately map the switches to the LEDs.

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- b. *Element 1[F]: a processor configured to “determine an illumination for at least two of the sub-sections, . . . that reduces illumination to reduce glare in at least a first of the two subsections”*

The Petition asserts that, in Alden, “distance data” is used to determine the intensity of light that will be produced in a given sector, “as shown in step 107.” Pet. 24. Patent Owner argues that the Petition misstates what occurs in step 107 because that step does not describe the use of distance information and that, although Alden does disclose that distance information is used to determine intensity, “neither Alden, nor Petitioner, explain how distance information is used in this manner.” PO Resp. 31.

This argument is unpersuasive because the claim does not implicate the use of distance data in determining the illumination for the subsections. Patent Owner does not appear to dispute that Alden reduces glare in one of the subsections, which is what the claims require.

Patent Owner also argues that the Petition fails to establish “that Alden determines illumination **for** a subsection.” PO Resp. 32. According to Patent Owner, “what Alden determines is which zones need to be dimmed, which is the same proof offered for 1[C]” and that “Ppetitioner provides no separate proof to establish that Alden determines illumination **for** a subsection--because no such proof exists.” *Id.* at 33. Patent Owner argues that “[o]nce Alden determines the subsections that require control . . . those sections are automatically set to the single, predetermined low level,” and that “the subsections that are not dimmed ‘remain on high beam . . . such that the light sent to the sensed vehicle location is dimmer than the light sent to all other areas of the headlight distribution area.” *Id.* (citing Ex. 1005 ¶¶ 26–28; Ex. 2040 ¶¶ 161–163).

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We find this line of argument unpersuasive because Alden *does* “determine an illumination for at least two of the sub-sections,” namely one subsection with an oncoming vehicle and one without an oncoming vehicle,” and “reduces illumination to reduce glare in at least a first of the two subsections,” by switching to the lower light level in the subsection with the oncoming vehicle. The claim does not require any sort of calculation or otherwise preclude the use of predetermined illumination levels.

Patent Owner also argues that “Petitioner improperly relies on a singular determination, that of 1[C], to satisfy two discrete claim determinations.” PO Resp. 34. We disagree. Petitioner describes how Alden determines the subsections using the sensor data, as in 1[C], for example when it identifies a section with an incoming vehicle. And Petitioner explains how Alden also determines the illumination for the subsection, as in 1[F], for example by lowering the level in the subsection with the vehicle and not lowering it elsewhere.

Patent Owner does not otherwise contest Petitioner’s unpatentability assertions regarding claim 1 and any further challenge has been forfeited.⁸ We have considered Petitioner’s contentions in light of the full record and conclude that Petitioner has shown claim 1 unpatentable for the reasons provided in the Petition, and as discussed above. *See* Pet. 11–26.

⁸ *See* Paper 12, 9 (“Patent Owner is cautioned that any arguments not raised in the response may be deemed waived.”).

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4. *Independent Claim 20*

- a. *Element 20[A][3]: light sources configured to have one or more controllable light characteristics*

The Petition contends that Alden’s lighting elements have “one or more controllable light characteristics,” because its lighting elements are “independently controllable as to intensity and direction.” Pet. 28 (quoting Ex. 1005 ¶¶ 8, 26–29).

Patent Owner argues that “[t]here is no ‘controllability’ of the direction of lighting elements in Figure 5, however,” and that “[w]hile intensity may be sufficient for this element, later references in the Petition, citing this element, rely on other allegedly ‘controllable’ characteristics such as direction.” PO Resp. 35.

We will address the “later references in the Petition” below, but for purposes of element 20[A][3], it is sufficient that Petitioner identifies the intensity as controllable.

Patent Owner next argues that the Petition “failed to explain how the system of Alden would determine “a second subsection not including the detected vehicle.” PO Resp. 37. We do not agree. When Alden determines a subsection that has a vehicle by identifying headlights, it is implicitly determining that the other areas do not have vehicles. Were that not the case, the system would also reduce the illumination level in those areas. We find this to be sufficient and, in fact, consistent with the disclosure of the ’503 patent which, like Alden, describes the detection of vehicles but does not describe any active steps taken to ensure that other areas are free of vehicles.

Patent Owner relatedly argues that “for referential element 1[F], there is no mention in claim 1[F] related to determining where a vehicle is, and where a vehicle is not” because “[t]here is just a determination to reduce glare in a first subsection.” PO Resp. 37. Patent Owner asserts that “[d]etermining where a portion of a vehicle is, based on the position of detected headlights, does not prove

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that the system can determine where the vehicle is not, given that vehicles are larger than their headlights and can, per Petitioner’s proofs, approach at angles where the ‘sectors’ not including the headlights may include substantial portions of the vehicle.” *Id.* This is unpersuasive because even if a portion of the vehicle lies in area away from the headlights, the system nevertheless will be not reducing illumination in other areas, which can be considered the subsection that does not include the vehicle. Again, this is generally the same as how the system of the ’503 patent works.

Patent Owner does not otherwise contest Petitioner’s unpatentability assertions regarding claim 20. We have considered Petitioner’s contentions in light of the full record and conclude that Petitioner has shown this claim unpatentable for the reasons provided in the Petition, and as discussed above. *See* Pet. 34–38.

5. *Independent Claim 26*

- a. *Element 26[B]: “determining illumination requirements . . . for at least a second subsection of the field-of-view not including the other vehicle or pedestrian”*

Patent Owner argues that “Petitioner’s proffer has three issues when it comes to this claim limitation.” PO Resp. 38.

First, with respect to claim element 26[B], Patent Owner argues that “as noted previously, Petitioner’s proof fails to establish that Alden includes determination of illumination for the subsection including the other vehicle.” PO Resp. 38. For the reasons given above, we do not agree.

Patent Owner also argues that “[t]here is also no determination of illumination for the second subsection –i.e., the subsections that remain on high beam.” PO Resp. 38. We see no reason why the system keeping subsections

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without vehicles at the high level of illumination is not determining the illumination for those subsections—it remains at the high illumination level. It is unclear what else Patent Owner believes is required to “determine” illumination,⁹ but Alden’s technique is, again, not distinguishable in this respect from what is described in the ’503 patent.

Patent Owner additionally argues that “there is no possible way for the Alden system to ‘know’ whether a subsection does ‘not include’ the other vehicle” because “[a]t best, [Alden] preserves illumination for all subsections outside the bounding box that it draws around detected light, and, as noted above, to the extent one of those subsections ‘does not include’ a vehicle, that is simply incidental.” PO Resp. 40. We also find this argument insufficient to distinguish Alden. First, we disagree that the preservation of the illumination outside the bounding box is “incidental”; Alden’s system, in the relied-on use, like the system of the ’503 patent, is designed to dim the light projected and maintain the higher level of illumination elsewhere. Patent Owner seems to be arguing that the system may not work perfectly, but we do not find that to be required for anticipation, at least in this context, where both the art in this field and the ’530 patent itself do not demand the precision Patent Owner is suggesting might be required. And, even if the system is not perfect, it nevertheless will include, at times, areas that do not include oncoming vehicles in which the higher level of illumination is preserved. That, we conclude, is sufficient to meet the claim language.

⁹ Patent Owner has not sought a construction of “determine,” so we apply its ordinary meaning.

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- b. *Element 26[C]: “determining a control strategy . . . to create an output headlight beam meeting the determined illumination requirements”*

Second, for claim element 26[C], Patent Owner argues that “[t]he ‘illumination requirements’ – i.e., illumination for the first and second subsections – are supposed to be ‘determined’ prior to the control strategy, as the control strategy is based on such determinations.” PO Resp. 40. According to Patent Owner, “the control strategy **utilizes** the determined illumination, so illumination for the two subsections must be ‘determined’ prior to the control strategy.” *Id.* at 41. Patent Owner argues that, in Alden, “the ‘control strategy’ --the decision that zones should be mapped to switches that have predefined binary control--is already part of the predefined algorithm in Fig. 4,” or “[a]lternatively, if one considers determination of the bounding box to be the determination of the control strategy . . . that box is determined *before* the application of the predefined, dim and high illumination levels.” *Id.* Patent Owner concludes that Petitioner has not shown “how a control strategy that ‘meets determined illumination requirements’ can be determined for illumination requirements that are, per the proof and Alden, at best determined after the alleged control strategy.” *Id.* at 42.

Neither party has asked us to construe “determining,” “illumination requirements,” or “control strategy,” and we find that Patent Owner’s argument is based on an improperly narrow meaning the claim language, as well as an incorrect application of the language to Alden.

Alden “determines illumination requirements” with its scheme that applies a lower level of illumination to a subsection of the field of view that includes a vehicle, and a higher level of illumination to a different subsection of the field of view that does not include a vehicle. In other words, the “illumination requirement” for subsections with vehicles is low, and the “illumination

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requirement” for subsections without vehicles is high. There is nothing in the claim requiring that the “illumination requirements” not be part of a preset scheme. Alden’s system then implements a “control strategy” when, in operation, it determines, using the sensor data, which LEDs to illuminate to implement the desired illumination scheme.

With that understanding of Alden, the determination of the illumination requirements in fact precedes the determination of a control scheme for a particular scene, which is consistent with Patent Owner’s position that the illumination requirements “are supposed to be ‘determined’ prior to the control strategy.”

Patent Owner does not otherwise contest Petitioner’s unpatentability assertions regarding claim 26. We have considered Petitioner’s contentions in light of the full record and conclude that Petitioner has shown this claim unpatentable for the reasons provided in the Petition, and as discussed above. *See* Pet. 32–36.

6. *Dependent Claims*

a. *Dependent Claim 2*

Claim 2 includes “one or more light emitting sources, each having a variable light-source characteristic dependent on power,” that “the control circuitry is arranged to alter said light-source characteristic via power control,” and “one or more light modifying elements provided in the path of light emitted from at least one of the sources, further controlling the light-source characteristics.”

Patent Owner argues that Petitioner identifies Alden’s lens 121 for the “light modifying elements” limitation and that “the lens 121 ‘adjusts’ the direction of light emitted by the light element 119, not its intensity.” PO Resp. 43. Patent Owner concludes that because Petitioner “relies on Alden’s disclosure regarding intensity for satisfying the ‘characteristic’ limitation,” Petitioner’s “identification

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of headlight lens 121 for element 2[C] fails, [because] lens 121 is not shown to ‘control’ the intensity characteristic, as required by the claim.” *Id.* We do not agree with Patent Owner’s analysis.

Notably, the control circuitry alters the light source *characteristic* (singular), but the light modifying element(s) further control the light-source *characteristics* (plural). This claim language is awkward,¹⁰ but, given that “characteristic” and “characteristics” are different terms (“characteristics” being broader), we conclude that “light source-characteristic dependent on power” does not provide a limiting antecedent basis for “light-source characteristics,” and that Petitioner thus may rely on the circuitry for controlling the intensity characteristic and the lens for controlling a directional characteristic.

Our conclusion finds further support in claim 3, which recites that the light modifying element (which controls the “light-source characteristics”) may be “static” (i.e., not variable like the “variable light-source characteristic dependent on power”), and claim 4, which recites that the light modifying element controlling one of the “light-source characteristics” may in fact be a lens.

b. Dependent Claims 3 and 4

Patent Owner argues that the Petition has not shown Alden to anticipate claim 3 because “[w]hile intensity is capable of being altered via power control,

¹⁰ The problematic language may have been a result of a claim drafting error. In the original claims copied from the parent application, what issued as 2[B] referred to “a flux characteristic,” and what issued as 2[C] referred to “illumination characteristics,” which were different things. *See* Ex. 1002, 232–233. However, the different terms “flux” and “illumination” were both changed to “light” when the continuation was filed. *See id.* This tends to confirm that “characteristic” of 2[B] should not be viewed as an antecedent to “characteristics” in 2[C]. The parties did not identify or discuss this portion of the file history, however, so we do not rely on it in reaching our decision.

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static lens 121 is incapable of controlling Petitioner’s proffered intensity characteristic,” and that “[b]ecause claim 4 inherits all of the claim limitations of claim 2, the proof deficiencies of claim 2 apply with equal measure” PO Resp. 49, 51. These arguments are unpersuasive because, as explained above, the “variable light-source characteristic” in the combination is altered by controlling the power, while the light modifying element that controls one of the “light-source characteristics” is the lens.

c. Dependent Claim 11

Claim 11 adds to claim 1 a “computer vision processing unit configured to use the sensor data and one or more of the algorithms to identify entities including at least one of beings, vehicles, roadway, or street signs.” Petitioner contends that “Alden’s headlight system includes a ‘computer vision processing unit’ with its logic CPU 71 and control circuitry 55” and that “[t]he 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.” Pet. 49 (citing Ex. 1005 ¶¶ 27–28, Fig. 3).

Patent Owner argues that “[t]he light sensors of claim 1 are at best, a very rudimentary ‘computer vision processing unit’ that is incapable of ‘identifying’ a vehicle (or anything else).” PO Resp. 52. According to Patent Owner, “the ordinary meaning of ‘identify’ is to ‘show to be a certain person or thing; to fix the identity of,’” and “[a]t no point does Alden provide an algorithm or any other teaching that allows Alden to ‘show or fix the identity of’ the detected light as a vehicle, as compared to a myriad of other potential light sources.” *Id.* (citing Ex. 2069, 902; Ex. 2040 ¶ 244).

The problem with Patent Owner’s position is that neither the dictionary definition nor the ’503 patent’s specification establish any degree of proof,

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verification, or confirmation that an object has been correctly identified. The specification discloses that “techniques known in the art” may be used “to classify, identify or locate the contents” visible to a camera sensor. Ex. 1001, 45:1–5. That does not establish any certainty obtained by the preexisting techniques. The specification states that the system can “illuminate distant overhead and roadside signs” and can use “[i]mage recognition via a camera” so that the illumination beam may “follow the retroreflective sign as the vehicle moves.” *Id.* at 51:63–67.

That disclosure does not speak to any degree of confirmation or certainty. The specification’s other disclosures are no different. *Id.* at 52:25–31 (disclosing automated control over lighting and referencing “automatic dimming of high beam due to detection of oncoming vehicles”), 53:3–4 (“Using color and pattern recognition techniques it is possible to determine what is a sign.”), 63:15–18 (“Using real time image processing methodologies with image and scene recognition technology known in the art, room or outdoor area elements, objects and people are identified.”), 64:52–55 (“Using machine vision technology known in the art such as neural networks training and other pattern recognition techniques the vision system has sensor, algorithmic and computation means for identifying devices or objects.”), 69:61–64 (“In a preferred embodiment of the invention the logical controller 454 receiving image input from the camera 453 and running pattern recognition software will identify what is the visual task a person is trying to perform.”), 75:65–76:4 (“Using programmed scene recognition algorithms, the luminaire’s computer vision system comprised of the camera sensor 496 and logical controller 494 identifies the food on the plate, looks-up in storage the recommended CCT and powers each of the different colored LED chips aimed thereon at the correct power level in order to provide the optimal color illumination.”). None of those disclosures addresses a requirement for confirming

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or verifying an identification that the system makes; nor does any address a particular accuracy requirement in identifying an object.

Based on the specification using “identify” without any requirement that identifying an object requires confirmation or verification of the object’s true identity, we do not adopt Patent Owner’s proposed construction. Although the construction itself similarly does not expressly require the confirmation or verification that Patent Owner seeks to impose, we understand that to be Patent Owner’s intent, and accordingly do not adopt the proposed construction. The parties dispute no other aspect of “identify,” and we therefore need not expressly construe the term.

Because Patent Owner acknowledges that Alden discloses a computer vision processing unit, and because Alden “identifies” vehicles with the same level of certainty as embodiments described in the ’503 patent, we find Patent Owner’s arguments regarding claim 11 unpersuasive.

d. Dependent Claims 15, 16, 17, 21, 22, 23, 32, and 33

Claim 15 adds to claim 1 that the controller is configured to determine road curvature, “indicated by the sensor data,” and increase illumination in the direction of the curvature. Claim 21 makes a similar addition to claim 20.

Patent Owner first argues that, because “Petitioner’s proffer for ‘*sensor data*’ in claim 1 was ‘detected light,’” “the road curvature ‘*indicated by the sensor data*’ must be also based on detected light – or, alternatively, different sensor data must be shown to meet the “*predefined as pertinent to illumination requirements*” limitation of 1[E].” PO Resp. 53. Patent Owner then cites deposition testimony from Dr. Papanikolopoulos and argues that “[w]ithout knowing the difference between vehicles and reflectors, and absent a teaching to help differentiate between the two, Alden has no way of determining whether it should dim in response to

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detected light per the Figure 5 embodiment or perform some curve-accommodation per Figure 11, to form ‘concentrated’ high-beam emission.” PO Resp. 54–56.

Patent Owner’s argument, which amounts to a claim that Alden’s system cannot do what Alden says it can do, is unpersuasive. We do not agree that the cited testimony supports the idea that Alden cannot differentiate between headlights and the road reflectors. Instead, Dr. Papanikolopoulos explained that Alden describes “two main use cases,” one in which the light is dimmed in the direction of headlights, and one in which the detection of the road markers causes the system to direct light into a corner. Patent Owner also has not attempted to show that Alden does not enable the ability to use markers to direct light into a corner that it describes.

Based on Alden’s disclosures, we credit Petitioner’s expert’s testimony that Alden’s system adequately describes detecting and accommodating road curvatures as claimed by the ’503 patent. *See* Ex. 1003 ¶¶ 113–114.

Patent Owner also argues that it is not clear that Alden’s headlight could direct more light into a corner because “[t]he lamp already emits high beams everywhere there is not glare reduction and it lacks optical steering capability.” PO Resp. 57.

Patent Owner’s position conflates Alden’s embodiments with their uses. While Alden describes operation where non-dimmed areas are illuminated with the high beam (Ex. 1005 ¶ 27), that relates to preventing glare to oncoming vehicles. Skilled artisans would understand that Alden’s description of directing light into corners is a different use with different requirements. *See* Ex. 2041, 50:9–51:1. Petitioner’s expert explains that the segmented headlight shown in Alden’s Figure 5 can function in both uses by identifying both oncoming vehicles and roadside reflectors. *Id.* at 78:22–80:24. As Petitioner points out, even when

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preventing glare to oncoming vehicles, Alden teaches switching certain headlight segments to dim and switching other segments to the high beam. *See* Ex. 1005, Fig. 4. By including a decision about each headlight segment, Alden’s system is thus configured to implement the road-curvature use. And Alden teaches that its invention may be used such that each segment is “within a range of intensities between the high beam and the low beam state.” *Id.* ¶ 61. That supports that Alden’s invention is not limited to a binary choice between dimming for oncoming vehicles or providing high-beam illumination.

As to the specific hardware configuration, we credit the testimony of Petitioner’s expert that, in the road-curvature use, skilled artisans would position the device’s LEDs “to ensure that the beam created by the headlamp is sufficiently wide to illuminate turns.” Ex. 1003 ¶ 113. That explanation is consistent with Alden’s Figure 11, which contradicts Patent Owner’s view that all segments would be illuminated, as Figure 11 depicts an asymmetric beam projection. *See* Ex. 1005, Fig. 11. Thus, Figure 11 itself shows “how fixed, unsteerable LEDs can be used to ‘concentrate’ light” (PO Sur-reply 11)—certain LEDs are used for wide illumination, and only activated when the system desires to “concentrate light to look around corners in response to road conditions” (Ex. 1005 ¶ 36, Fig. 11).

Based on the foregoing evidence, we find that Alden’s invention is not limited to uses where it only dims in response to oncoming vehicles. Further, we find that Alden’s invention may perform the variety of uses that Alden discloses, which include both dimming for oncoming vehicles and increasing light in the direction of detected road curvature.

For claim 21, Patent Owner argues that Petitioner “fail[s] to show what control adjustment achieves the claimed increase of illumination in a direction of the road curvature.” PO Resp. 60. We fail to see why Petitioner would need to

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make such a showing given that the claims contain no limitations relating to the nature of the “control adjustment” and, again, Patent Owner has not argued that Alden is not enabled.

For claims 15, 16, 17, 21, 22, 23, 32, 33, and 34–36, Patent Owner argues that Petitioner “conflates *curves* and *turns*, even though both claim terms have different plain meanings and the doctrine of claim differentiation militates against such a conflated construction.” PO Resp. 61. According to Patent Owner, the plain meaning of “turn” is a “change of direction when moving,”¹¹ while the plain meaning of a “curve” is a “continuously bending line, without angles. *Id.*

Applying Patent Owner’s definitions to this context, the “upcoming curve” is the upcoming bend in the road, while the “upcoming turn” would be the upcoming change in direction of the vehicle in response to the bend in the road. There is no claim differentiation problem because, as Patent Owner itself argues, these terms have different meanings, and the claims thus have different scopes. *See Google LLC v. EcoFactor, Inc.*, 92 F.4th 1049, 1059 (Fed. Cir. 2024) (explaining that “the doctrine of claim differentiation only creates a rebuttable presumption that each claim in a patent has a different scope,” and also noting that “it is a guide, not a rigid rule of claim construction”).

The next question is whether these different claims can all read on Alden. We find that they can. Alden discloses use of sensor data (e.g., the sensed road markers) for the purpose of “concentrating light to look around corners,” as shown in its Figure 11, which is an overhead view of a vehicle approaching an upcoming bend in the road. This is sufficient to disclose a system determining illumination

¹¹ The link given in Patent Owner’s Response for the definition of “turn”—“www.google.com/turn”—returns a 404 error. We assume Petitioner intended to refer us to dictionary.com, which was the source of the definition for “curve.”

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for “road curvature,” as in claims 15 and 21, and “an upcoming curve,” as in claim 32. The “curve” (i.e., bend) is clearly shown in Figure 11. In addition, because the vehicle will necessarily be changing direction due to the curve, it is also sufficient to disclose a system determining illumination for “a planned upcoming turn” (i.e., change of direction when moving) as in claims 16, 17, 22, 23, and 33–36.

7. *Conclusion on Alden*

For the reasons provided in the Petition, and as explained above, we agree with Petitioner that independent claims 1, 20, and 26, and dependent claims 2, 3, 4, 11, 15, 16, 17, 21, 22, 23, 24, 28, 32, and 33, are anticipated by Alden. Patent Owner did not separately argue claims 7, 10, 12–14, 19, 20, 25–27, 30, 31, or 34–36, and any such arguments are waived.

D. *Alden in View of Harbers: Claims 5, 8, 29*

Claim 5 recites “illuminat[ing] at least one of the at least two sub-sections of the field-of-view with a different color of light from another of the at least two sub-sections.” Petitioner relies on Harbers for the different colors, citing the following passage from the reference:

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,

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objects situated outside the center of the light beam are better observed.

Pet. 61–62 (quoting Ex. 1006, 9:28–10:5).

Patent Owner contends that Petitioner “shows neither a single light source that comprises multiple LEDs, nor a single light source that comprises an organic LED” because “the proof is about light clusters, not light sources.” PO Resp. 64. This is not persuasive because Harbers clearly describes subsections with different colors of light. There necessarily would be at least one light cluster with light sources that create a subsection with a different color.

Patent Owner also argues that “Petitioner has not explained . . . how including such colored LEDs into the system of, for example, [Alden’s] Fig. 5 embodiment will not create color changing issues with emission.” PO Resp. 65. Patent Owner contends that “each replacement of a colored LED from Harbers into the Alden array, replaces 1/9 of the emission output with a different color.” *Id.* This is unpersuasive because, as explained above, Alden’s Figure 5 is a sectional view that one of ordinary skill in the art would understand does not depict all of the light sources. Alden instead describes a two-dimensional array, and we agree with Petitioner and its expert that one of ordinary skill would be able to use some colored light sources, as Harbers does, in view of Harber’s teachings. *See* Ex. 1003 ¶¶ 127–131.

Patent Owner also argues that “in Alden, each beam segment has defined responsibility for a portion of the field of view—a factor Petitioner’s proofs fail to address” and that “[a] driver of [an] oncoming vehicle [may] see red, or yellow, or blue emission beams.” PO Resp. 65. We conclude that Patent Owner is overcomplicating the situation by requiring that the selective dimming of Alden and different colors of Harbers both be employed in the same areas at the same time. Alden specifically lowers the illumination in the direction of an oncoming

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vehicle, which would appear to minimize any color changing issues and, if not, the off-axis differently colored light could be not used when a vehicle is approaching that region were that a problem. We note that the '503 patent, despite claiming the combination of selective dimming and different colored light, also does not provide details about how to manage the combination of those two features, suggesting that the inventors viewed such implementation details as falling within the level of ordinary skill.

We agree with Dr. Papanikolopoulos that this combination “would have merely included the implementation of a known device (color LED arrays) for its intended purpose in a system already designed for use with LEDs,” that “the use of Harber’s color LED array in the LED array of Alden would have been the simple substitution of one known element (color LEDs) for another (generically recited LEDs),” and that one of ordinary skill “would have had a reasonable expectation of success in incorporating the color LEDs and control functions from Harbers into the system of Alden.” Ex. 1003 ¶¶ 127–131. We also agree that the ordinary artisan would “have been motivated to include color LEDs in the system of Alden so that . . . 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.* ¶ 131 (quoting Ex. 1006, 9:28–10:5).

Patent Owner also argues that “Petitioner has never explained, for example, what color effect would be achieved by dimming a single (or group of) color LEDs, or replacing white LEDs, having exclusive responsibility for a sector, with colored ones, rendering the combination unpredictable at best and unsafe at worst.” PO Resp. 66. We disagree. The Petition describes how the proposed combination would, for example, use bluish light for better off-axis illumination, as taught by Harbers. *See* Pet. 60–65.

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Regarding claim 28, Patent Owner argues that “Petitioner never addresses any of the unpredictability selective dimming would have on such a combined Alden-Harbers system, and/or the issues occurring from not following Harbers’s strict LED ordering to ‘substantially reduce possible color effects.’” PO Resp. 66–67. This argument is unpersuasive for the reasons described above. Such details are not required for the combination to meet the claim language.

Regarding claim 29, Patent Owner contends that “changing output levels of LEDs and ‘activating different LEDs,’ to deal with the creation of function-specific beams per Harbers, is not compatible with Alden’s system” and that “in a one-dimensional array, it is not even clear how such changing would occur.” PO Resp. 67. These arguments are unpersuasive because, as explained above, we do not agree that the systems are incompatible, and because, as also explained above, we do not agree that Alden is limited to a one-dimensional array.

For the reasons provided in the Petition, and as explained above, we agree with Petitioner that claims 5, 8, and 29 would have been obvious in view of Alden and Harbers.

E. Alden in View of Bergkvist: Claim 6

Claim 6 recites that “the headlight beam further comprises light in at least one of infra-red (IR) or ultra-violet (UV) wavelengths” and Petitioner relies on Bergkvist’s disclosure that the use of UV light will aid the driver by causing objects like road signs to be more visible. *See* Pet. 68–69.

Patent Owner asserts that “Bergkvist uses a single light source that emits in both visible and UV spectrums and relies on a filter to block visible light,” that “Bergkvist has no LEDs, nor does it mention UV LEDs,” and that “[t]he suggestion to ‘include at least one UV light **source** in the array of Alden” has no motivation in Bergkvist, as there is no filter element imported – i.e., incorporating

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the source of Bergkvist will simply also produce visible light.” PO Resp. 68.

These arguments are unpersuasive because the claims require “light clusters,” not LEDs, because the combination contemplates the use of UV light generally, not Bergkvist’s specific light source, and because, even if the combination did require use of Bergkvist’s specific light source, it would include the filtering that Bergkvist uses to limit the emission to the UV spectrum, because that is what Bergkvist teaches.

Patent Owner also argues that “[s]ince the motivation to combine was ‘in order to have light outside the visible range, such that it is not distracting to other drivers or pedestrians’ it is unclear how such distraction would not occur when visible light is not filtered.” PO Resp. 68. This argument is unpersuasive because it assumes the visible light would be not filtered, which is the opposite of what Bergkvist teaches.

For the reasons provided in the Petition, and as explained above, we agree with Petitioner that claim 6 would have been obvious in view of Alden and Bergkvist.

F. Alden in View of Beam: Claim 8

Claim 8 recites that “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.” For this feature, the Petition relies on Beam, which, according to Petitioner, “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.” Pet. 71–72 (citing Ex. 1008, 4:9–25, 4:45–59, 5:61–6:8, 6:61–7:8; emphasis omitted).

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Patent Owner again searches for technical problems with the combination, asserting that Beam does not provide “tuning” to distinguish taillights from headlights, that turning the threshold down to include taillights would “increase the level of illumination detected for an oncoming headlight,” and that “a traveling vehicle on a crowded highway would see countless preceding taillights, yet Petitioner’s combination provides no explanation of how Alden would ‘match’ such taillights across two sensors, especially as the taillights would appear much dimmer than headlights” and “Beam is of no assistance, as it does not attempt sensor-to-sensor matching and Alden never explains such matching for anything more than a single vehicle scenario.” PO Resp. 69.

We find these arguments unpersuasive because claim 8 does not require distinguishing between headlight and taillights—it simply requires a sensor “configured to image at least lights indicative of preceding vehicles,” which is what Beam teaches. It may be that the threshold would need to be lowered to capture pairs of taillights in addition to pairs of headlights, but in view of Beam’s teachings, we find that adjustment would fall within the level of ordinary skill, as evidenced by the depth of the disclosures of both the prior art and the ’503 patent, which itself does not explain how one might distinguish headlights and taillights.

For the reasons provided in the Petition, and as explained above, we agree with Petitioner that claim 8 would have been obvious in view of Alden and Beam.

G. Alden in View of Kobayashi: Claim 9

Claim 9 recites that “the one or more sensors includes a GPS sensor.” Petitioner relies on Kobayashi, which discloses that “GPS navigation device 29 sends information about the road profile and the present vehicle position to ECU 10” and that “when the vehicle advances along a scheduled course, irradiation control of the lamp is conducted in accordance with the course concerned.” Pet. 76

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(citing Ex. 1009, 1, 2:28–50, 3:9–5:28, 11:34–14:52, 15:6–28, 17:3–67, Fig. 9, Fig. 10, Fig. 12).

Patent Owner argues that the combination “seems to be an either/or type of combination, without explanation as to which system controls when both signals are useful.” PO Resp. 70. This is not persuasive because the fact that either Alden’s reflectors or Kobayashi’s GPS could be used to control the lighting into a curve does not make it non-obvious to use one or the other. This again appears to be an implementation level detail that would be within the level of ordinary skill.

Patent Owner also identifies a “larger issue,” which is that “Alden’s system is already inclusive of a significant beam-spread, more than sufficient to accommodate curves” and that “Alden lacks any control over its LEDs for curve purposes – they emit, per Alden, at high-beam all the time.” PO Resp. 70. This is unpersuasive because, as explained above, we find that Alden discloses increasing light in the direction of detected road curvature and is not limited to an embodiment in which all light sources are always at maximum illumination.

For the reasons provided in the Petition, and as explained above, we agree with Petitioner that claim 9 would have been obvious in view of Alden and Kobayashi.

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III. CONCLUSION

For the reasons given, Petitioner has met its burden of showing that claims 1–36 of U.S. Patent 10,894,503 B2 are unpatentable.¹² The results are summarized below:

Claim(s)	35 U.S.C. §	Reference(s)	Claim(s) Shown Unpatentable	Claim(s) Not Shown Unpatentable
1–4, 7, 10–17, 19, 20, 21–23, 25–27, 30–36	102	Alden	1–4, 7, 10–17, 19, 20, 21–23, 25–27, 30–36	
1–4, 7, 10–17, 19, 20, 21–23, 25–27, 30–36	103	Alden ¹³	1–4, 7, 10–17, 19, 20, 21–23, 25–27, 30–36	
5, 28, 29	103	Alden, Harbers	5, 28, 29	
6	103	Alden, Bergkvist	6	
8, 18, 24	103	Alden, Beam	8, 18, 24	
9	103	Alden, Kobayashi	9	
Overall Outcome			1–36	

¹² Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. § 42.8(a)(3), (b)(2).

¹³ We do not address obviousness in view of Alden alone because we determine the claims challenged in this ground are anticipated by Alden.

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IV. ORDER

Accordingly, it is

ORDERED that Petitioner has shown by a preponderance of the evidence that claims 1–36 of the '503 patent are unpatentable; and

FURTHER ORDERED that, because this is a Final Written Decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MERCEDES-BENZ USA, LLC,
Petitioner

v.

YECHEZKAL EVAN SPERO,
Patent Owner.

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CYGAN, *Administrative Patent Judge*, concurring.

I respectfully concur in the determination of unpatentability of the challenged claims. However, I do not base such a determination on the Alden reference describing a two-dimensional LED array as found by the majority opinion. Finding Alden to disclose a two-dimensional LED array is a position not advanced in the Petition, and is not required to resolve the patentability issues presented in the Petition.

As an initial matter, the Petition does not base its anticipation or obviousness grounds for the independent claims (1, 20, and 26) on a two-dimensional LED array. Focusing on claim 1, the Petition explains how Alden discloses each

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element, including through Alden's lighting element clusters 119 controlled by switch array 115, illustrated in Figure 5, guided by input from sensors and control logic as illustrated in Figures 3 and 4. Pet. 13–26. At no point does the Petition assert that Alden's Figure 5 represents more than a single, 9-element LED array illuminating the road in left-to-right segments. *See, e.g.*, Pet. 12 (citing Alden's Figure 1 (illustrating left-to-right headlight beam sectors)), 14–15 (annotating Alden's Figure 5 as three groups of three LEDs illuminating the “area to the left of the vehicle,” a “second area in front of the vehicle,” and a “third area to the right of the vehicle”).

For certain dependent claims, Petitioner relies upon certain features from two-dimensional embodiments of Alden, such as Alden's variable refractive element for claims 2, 3, 19 and 25. However, for those claims the Petition did not rely on a two-dimensional LED array, but instead, on Alden's statement that “[o]ne or methods employed herein may be used in combination to vary illumination in a segmented system” to show the obviousness of those claims. Pet. 40–42 (providing motivation to combine such elements in Alden) (emphases omitted), 56.

Patent Owner argues that the two-dimensional LED array theory of Alden's Figure 5 was not advanced in the Petition, but instead, presented for the first time in the Institution Decision and subsequently copied by Petitioner in its Reply. PO Resp. 17–18; Sur-reply 1–11. Although the Petition relies on Alden's two-dimensional sensor (51) and dimming control (71, 55), which determine the location of a vehicle and the corresponding area in which headlights should be dimmed, the Petition relies solely on a one-dimensional switch array (115) controlling power (113) to each element of a one-dimensional LED array (119), in which left-to-right elements are dimmed to reduce emitted light in the sector determined by the dimming control occupied by the sensed vehicle. Pet. 11–26.

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The Petition relies solely on the Figure 5 embodiment's LED array as describing the claimed "plurality of light clusters," and does not rely on a reading of Figure 3 in which each dimming control element of Figure 5 represents a lighting cluster. Pet. 13–15.¹ Patent Owner's Preliminary Response argued that the Petition's use of Alden's two-dimensional light circuit controls (55) with Alden's one-dimensional LED array (119) is ambiguous. PO Prelim. Resp. 21–22.

The Institution Decision resolved the ambiguity raised by Patent Owner, not by explaining how the Petition's reliance on Figure 5's one-dimensional LED array is consistent with Figure 3's two-dimensional sensor and control, but instead, by providing a new interpretation in which Alden's Figure 5 is sub silentio a two-dimensional LED array. Dec. on Inst. 10 (based on a "find[ing]" that "the skilled artisan would recognize" that "a headlamp" designed in accordance with Figure 3 "would include additional rows of LEDs passing through the center of the lens"). Thus, I agree with Patent Owner that the Petition did not set forth its unpatentability grounds based upon a two-dimensional LED array in Alden, and that this unpatentability ground was first set forth in the Institution Decision.²

¹ Alden's other embodiments have two-dimensional light emitters but only a single light element, and Petitioner does not assert that these describe the "plurality of light clusters" claim limitation. Ex. 1005 ¶¶ 30–35; Pet. 13–16, 20, 37–42. Alden's Figure 3 is broad enough to encompass control of the one-dimensional LED array of Figure 5 and the two-dimensional electro-chromatic, electro-optic, and liquid crystal arrays of Figures 6–10. See Ex. 2001 ¶¶ 33–36.

² Although a decision may be based upon "arguments that were advanced by a party and to which the opposing party was given a chance to respond," "it is the petition, not the Board's discretion, that defines the metes and bounds of an [IPR]," and the Board must "reject any 'entirely new theory of prima facie obviousness absent from the petition.'" *VLSI Technology LLC v. Intel Corp.*, 53 F.4th 646, 653–54 (Fed. Cir. 2022); *Corephotonics, Ltd. v. Apple, Inc.*, 84 F.4th 990, 1002 (Fed. Cir. 2023).

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However, for purposes of this Decision, it is unnecessary to address a two-dimensional array interpretation of Alden’s Figure 5 because the Petition’s one-dimensional array assertions are sufficient to resolve the patentability dispute. *See* Pet. Reply 1. Patent Owner does not dispute that the Figure 5 embodiment incorporates the logic and control described in Alden’s Figures 3 and 4, only that the Figure 5 embodiment uses switch array 115, not switch arrays 55a and 55b, for the direct control of the LEDs. Sur-Reply 6–7. Patent Owner’s primary argument³ against the asserted anticipation of claim 1 by Alden is that “Petitioner has failed to address how power flows to each LED, specifically how the multiple switches of Figure 3 would be mapped to each LED of Figure 5.” PO Resp. 29–30 (addressing limitation 1[D]), 25–26. During oral argument, Patent Owner agreed that their position is “that it’s not Alden itself that is inoperative. . . . [but] Petitioner’s problem is that they . . . specifically tried to combine [control circuits] 55a and 55b in lieu of switch array 115.” Tr. 69:4–9; see also Tr. 47:8–24. Patent Owner further agreed that “if Petitioner had relied on 115 instead, for example, at Page 20 of their Petition, there wouldn’t have been a[n inoperability] problem.” Tr. 69:11–15.

However, Patent Owner’s statements do not accurately characterize the Petition, which clearly relies on the 9-switch array element 115 to control the 9-LED array. The Petition addresses limitation 1[D] as being described by Alden’s

Figure 5, where the lighting elements are “individually controlled” by a “switch array,” with each switch being “controlled by the CPU and logic previously described. For example the power to 119 is controlled by the CPU which dictates its respective switch characteristics at 115 such that the power from a power supply 113

³ Patent Owner makes additional arguments with respect to limitation 1[F] and the other independent claims that do not raise any such two-dimensional array issue, which the majority opinion appropriately addresses. Maj. Op. §§ II(C)(3)(b), (4)–(5).

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carried via segment wire 117 is controlled in response to the sensed environmental conditions.”

Pet. 20 (citing Ex. 1005 ¶ 29 (“Each lighting element being independently controlled by a corresponding switch in an array of switches 115”)). Patent Owner expressly states that reliance on switch array 115 to control the one-dimensional LED array of Figure 5 does not cause an inoperability problem. Tr. 69:11–15. Because the Petition asserts a corresponding number of switches and LEDs, none of the operability issues that Patent Owner argues would result from different numbers of switches and LEDs are present in the Petition’s assertions of unpatentability.

Because Alden’s one-dimensional array is sufficient to show unpatentability, Patent Owner’s arguments based upon lack of express description of, need for modification or speculation to find, or whether a person of ordinary skill in the art would envisage a two-dimensional LED array in Alden’s Figure 5 embodiment, and the issue of what positioning of additional LED rows would satisfy Alden’s statement that such LEDs are “on a curve along the focal point of a headlight lens,” are moot. *See* PO Resp. 14–27; Sur-reply 7–10. Additionally, Patent Owner’s clarification that that Alden is not itself inoperative moots the factual issue, raised by Dr. Papanikolopoulos, regarding whether Alden’s Figure 5 has sufficient lumen output (which is an unclaimed feature) to be operative. Tr. 69:4–9; PO Resp. 23–24.

The majority opinion’s determination for the remaining patentability issues can be applied without the need for a two-dimensional LED array. For example, the analysis of claim 5 is partly grounded on additional light sources from a two-dimensional LED array. Maj. Op. §(II)(D). However, that portion of the analysis is not necessary because Petitioner’s combination modifies Alden to include multiple different color LEDs as described by Harbers, and Dr. Papanikolopoulos

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explains that in such a combination, Alden would “be improved by providing the ability to control not just the intensity and direction of the light output from the LED array in the different portions or areas, but also to adjust the color as well” in a one-dimensional LED array. Pet. Reply 21–22; Ex. 1003 ¶¶ 130–131. Although Dr. Turk states that such substitution would “replace 1/9 of the emission with a different color,” that appears to be the point of the combination, providing the advantage identified by Dr. Papanikolopoulos. Similarly with respect to claim 29, Dr. Papanikolopoulos explains that Harbers teaches changing the configuration and spectral composition of the light beams, and that by removing the blue component of the light, backscattering of the headlight beams due to fog and snow would be substantially reduced. Ex. 1003 ¶ 134. Such explanation adequately addresses the concerns stated by Dr. Turk that the systems would be incompatible. Ex. 2040 ¶ 280. The remainder of the majority opinion’s analysis applies to explain why such combinations would be desirable, even in view of Patent Owner’s arguments to the contrary.

For the above reasons, Alden’s Figure 5, as a one-dimensional array having a one-dimensional control switch, provides sufficient description, and where relied upon for its teachings, sufficient teaching, to support the anticipation and obviousness contentions set forth in the Petition.⁴ Therefore, I concur in the determinations of unpatentability set forth in the majority opinion based upon a one-dimensional array interpretation.

⁴ Thus, I need not evaluate the strength of the evidentiary support for the majority opinion’s two-dimensional LED array interpretation.

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Paper 26
Date: January 16, 2025

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MERCEDES-BENZ USA, LLC,
Petitioner

v.

YECHEZKAL EVAN SPERO,
Patent Owner.

IPR2023-01027
Patent 10,894,503 B2

Before JASON W. MELVIN, AARON W. MOORE, and
MICHAEL T. CYGAN, *Administrative Patent Judges*.

Opinion for the Board filed by *Administrative Patent Judge* MOORE

Opinion Concurring filed by *Administrative Patent Judge* CYGAN

MOORE, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)

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I. BACKGROUND

Mercedes-Benz USA, LLC (“Petitioner”) filed a Petition requesting *inter partes* review of claims 37–70 of U.S. Patent No. 10,894,503 B2 (Ex. 1001, the “’503 patent”). Paper 2 (“Pet.”). Yechezkal Evan Spero (“Patent Owner”) filed a Preliminary Response. Paper 9 (“Prelim. Resp.”).

We instituted *inter parties* review on January 17, 2024 (Paper 11, “Inst. Dec.”), Patent Owner filed a Response (Paper 15, “PO Resp.”), Petitioner filed a Reply (Paper 17, “Pet. Reply”), and Patent Owner filed a Sur-Reply (Paper 18, “PO Sur-reply”).

We held a hearing on October 16, 2024, and a transcript of the hearing is included in the record, as are the demonstratives. *See* Paper 25 (“Tr.”); Ex. 1016 (Petitioner Demonstratives); Ex. 2068 (Patent Owner Demonstratives).

We issue this Final Written Decision under 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73 and, for the reasons that follow, determine that Petitioner has shown, by a preponderance of the evidence, that claims 37–70 are unpatentable.

A. *Related Matters*

Petitioner also filed a second Petition on the ’503 patent, challenging claims 1–36. *See* IPR2023-01026, Paper 2, 1. A decision in that case issues today.

The parties identify two civil actions, *Torchlight Techs. LLC v. Daimler AG, et al.*, No. 1:22-cv-00751 (D. Del.),¹ and *Torchlight Techs. LLC v. General Motors LLC, et al.*, No. 1:22-cv-00752 (D. Del.), as related matters. *See* Pet. 3; Paper 4, 1.

The parties also identify as related IPR2023-00197 (in which ’503 patent claims 20–25 and 59–64 were found unpatentable), IPR2023-00328 (in which ’503 patent claims 26–28, 30–36, 65–68, and 70 were found unpatentable, but claims 29

¹ Daimler AG became Mercedes-Benz Group AG, a real party-in-interest, on February 1, 2022. *See* Pet. 2, 3 n.1.

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and 69 were not found to be unpatentable), IPR2023-00335 (in which '503 patent claims 1–19 and 37–58 were found to be unpatentable); and IPR2023-01231 (which was joined to IPR2023-00197). *See* Pet. 3; Paper 4, 1–2. We also note that IPR2023-01320 and IPR2023-01321 were joined to IPR2023-00328 and IPR2023-00335, respectively.

Patent Owner also identifies a number of other post-grant proceedings involving patents in the same family as the '503 patent. *See* Paper 4, 2–3.

B. The '503 Patent

The '503 patent is titled “Detector Controlled Headlight System” and is directed to “[a]n automated headlight system for vehicles [that] replaces the high and low beam with a continuum of beam patterns, with further variable spatial distribution of intensities and color spectrum.” Ex. 1001, Abstract. The embodiment that corresponds to the challenged claims is depicted in Figure 15, which is reproduced in part below:

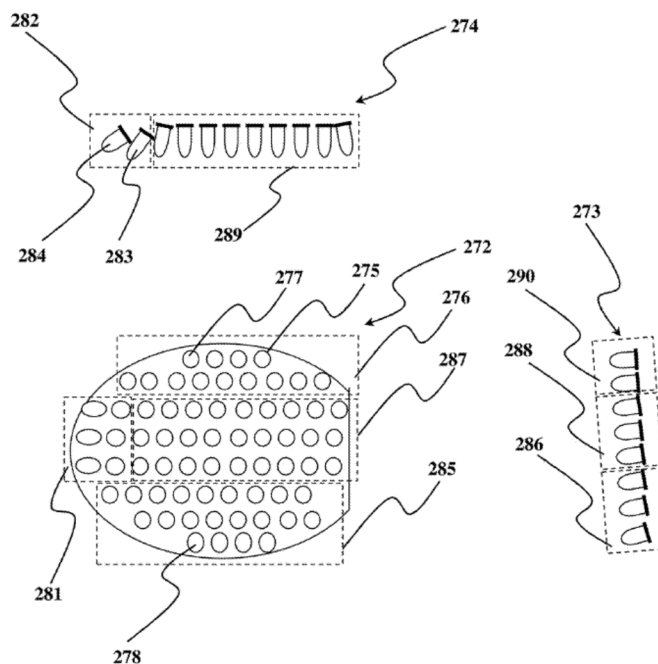


Figure 15 shows a “multiple light-source headlamp.” Ex. 1001, 15:64.

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This figure depicts “a headlamp 270 of a land, sea or air vehicle . . . in front view 272, side view of a section 273 and top view of a section 274.” Ex. 1001, 53:17–19. A solid-state light source, “such as an LED 275 with [a] specific location within the cluster 276 has a specific spatial light distribution, color wavelength and aiming relative to the vehicle, such as straight ahead, and or downwards and or off towards the right or left.” Ex. 1001, 53:19–23. Different LED 277, which is “at a second location within the same cluster[,] may have a similar or dissimilar aiming, wavelength and spatial light distribution.” *Id.* at 53:29–31.

The patent explains that “headlamp control is automatic, from turning on automatically when ambient lighting levels fall to such a level where it is advantageous to have headlamps on, either to aid in illuminating the way ahead or facilitate being seen by others, to automatic dimming of high beam due to detection of oncoming vehicles and shut off when ambient lighting levels are sufficient.” Ex. 1001, 52:25–32. The patent further identifies “[a] possible control system for such purposes [that] is described in U.S. Pat. No. 6,281,632 by Stam, et al from Aug. 28, 2001,” in which “[i]f there is no oncoming traffic, then [the headlamp] operates as [a] high beam,” but “[i]f there is oncoming traffic, then it acts as [a] regular low beam.” *Id.* at 52:31–33, 52:55–57.

Of the challenged claims, claims 37, 59, and 65 are independent and are directed to vehicle headlight systems. Claim 37 is reproduced in full below:

37. A vehicle headlight system comprising:
one or more headlamps affixable to a first vehicle;
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;

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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

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, 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

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

Claim 59 recites a system similar to that of claim 37, except that it requires that each headlamp include at least three directional light sources having different aimings relative to the vehicle:

59. A vehicle headlight system, comprising:

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;

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, 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;

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

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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

instruct adjustment of one or more of the light sources to achieve the determined output.

Claim 65 is a method claim that generally corresponds to the subject matter of claim 37:

65. 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:

utilizing one or more sensors of a first vehicle to obtain and provide data, the data including data indicating at least a second vehicle;

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;

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

controlling the light sources to emit the headlight beam in accordance with the control instructions.

C. Asserted Grounds

The Petition raises the following grounds:

Claims Challenged	Basis	References
37–44, 47, 50–56, 58, 59, 60–62, 64, 65, 70	§ 102	Alden ²

² U.S. Patent App. Pub. No. 2003/0137849 A1 (Exhibit 1005).

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37–44, 47, 50–56, 58, 59, 60–62, 64, 65, 70	§ 103	Alden, Stam ³
45, 68, 69	§ 103	Alden[/Stam], Harbers ⁴
46	§ 103	Alden[/Stam], Bergkvist ⁵
48, 57, 63	§ 103	Alden[/Stam], Beam ⁶
49	§ 103	Alden[/Stam], Kobayashi ⁷
66, 67	§ 103	Alden[/Stam], Braun ⁸

II. ANALYSIS

We discuss the appropriate level of skill in the art, claim construction, and patentability, in that order.

A. *Level of Ordinary Skill in The Art*

Petitioner contends that a person of ordinary skill in the art at the time of the alleged invention “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” and that more education could compensate for less experience and vice versa. *See* Pet. 8–9 (citing Ex. 1003 ¶ 33).

³ PCT Patent App. Pub. No. WO 01/70538 A2 (Exhibit 1010).

⁴ PCT Patent App. Pub. No. WO 01/01038 (Exhibit 1006).

⁵ U.S. Patent No. 4,970,628 (Exhibit 1007).

⁶ U.S. Patent No. 6,144,158 (Exhibit 1008).

⁷ U.S. Patent No. 6,049,749 (Exhibit 1009).

⁸ PCT Patent App. Pub. No. WO 02/04247 A1 (Exhibit 1011).

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Patent Owner “does not dispute Petitioner’s proposed skill level for a person of ordinary skill in the art” (PO Resp. 4), and, as we generally agree that it is consistent with the subject matter disclosed in the ’503 patent and the prior art, we adopt it for purposes of this decision.

B. Claim Construction

We construe claims using the standard that would be applied in a civil action under 35 U.S.C. § 282(b), giving terms their ordinary and customary meaning to one of ordinary skill in the art in view of the specification and prosecution history. *See* 37 C.F.R. § 42.100(b).

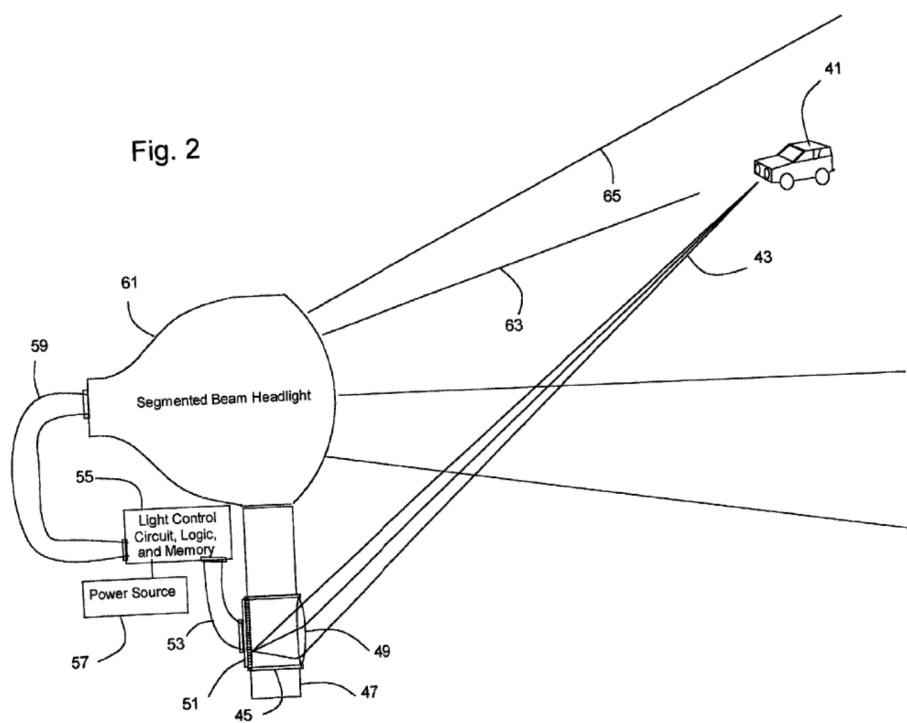
The Petition asserts that all claim terms should be given their “ordinary and customary meaning.” *See* Pet. 8. Patent Owner also proposes that the claim terms be given their ordinary meaning, and identifies the “ordinary meaning” for the terms “identify,” “turn,” and “curve,” which we discuss in our analysis below. We otherwise find that that no express claim construction is necessary. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (explaining that construction is needed only for terms that are in dispute, and only as necessary to resolve the controversy).

C. Alden

Alden is a published U.S. Patent Application describing and claiming a segmented-distribution headlight system. Ex. 1005, code (54). Alden’s Figure 2 is reproduced below:

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Alden's Figure 2 "illustrates the elements of a segmented distribution illumination process." Ex. 1005 ¶ 11.

This figure shows the elements of Alden's "segmented distribution illumination process," in which vehicle 41 emits light towards a vehicle with Alden's invention, and that light illuminates detector array 51, which is part of sensor unit 45. Signals representing the received light are then sent to light control circuit 55, which controls segmented beam headlight 61 to provide either low or high illumination in its various segments, such that light directed toward the vehicle 41 is a low beam and light directed elsewhere is a high beam. *Id.* ¶ 26, Fig. 2.

Alden's system detects spots of light, performs triangulation to calculate the distance to each, then uses the spots' intensity, size, and location information to represent "objects." *Id.* ¶ 27 ("Triangulation is thus used by the CPU to determine the distance" when detecting "spots of nearly identical intensity and size representative of the [oncoming vehicle's] headlights."), 28 (explaining that "[t]he

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CPU compares the right map to the left map to determine the distance and intensity of each object sensed”).

Once objects have been identified, Alden’s system uses them to determine which headlight zones to dim. *Id.* ¶ 28 (“[t]he location of objects is used to calculate which zones of each headlight need to be dimmed”; “assuming the sensed light is above a threshold intensity or distance”). In that decision, the CPU identifies a corresponding pair of headlights as a vehicle, and accommodates the vehicle by defining a dimming area larger than just the headlights. *Id.* ¶ 27 (“The [dimmed] area is significantly larger than the headlight dots that were initially received by [the light-detector arrays] because, the CPU has made assumptions about the space that may potentially be occupied by the driver of the sensed vehicle.”). Finally, “[s]ignals are sent to each of the headlight control circuit zones that need to be dimmed,” whereas other zones “remain on high beam.” *Id.* ¶ 28.

With signals from the CPU, Alden’s “segmented beam headlight” projects light in the desired pattern. *E.g., id.* ¶¶ 26, 29. Alden discloses a number of embodiments for the headlight, including one with an array of LEDs (*id.* ¶ 29, Fig. 5) and others with electro-chromatic, liquid-crystal, or variable-refraction elements (*id.* ¶¶ 30–35, Figs. 6–10).

D. Patentability

Petitioner asserts that Alden anticipates claims 37–44, 47, 50–56, 58–59, 60–62, 64–65, and 70. *See* Pet. 5. Petitioner alternately argues that these claims would have been obvious in view of Alden and Stam, with Stam added if needed to provide the claimed “predefined threshold value.”

Patent Owner raises numerous arguments, some directed at Alden itself and some directed to specific dependent claims. We address these issues in the order presented.

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1. Two-Dimensional Lighting

Patent Owner first argues that Alden “lacks express details needed to implement [two-dimensional] functionality, absent modification.” PO Resp. 17. This is unpersuasive.

First, we do not agree with Patent Owner that Alden’s Figure 5 depicts a device with only a single row of lighting elements. Although Figure 5 shows one embodiment of Alden’s “segmented headlight means and controlling switch array” (Ex. 1005 ¶ 29), the segmented headlight is merely one aspect of Alden’s invention. The segmented headlight receives signals from a “light control circuit”—logic executing on a CPU that controls the switch array. *Id.* ¶¶ 26, 27, Figs. 2, 3. Thus, it is important to view Figure 5 and the corresponding description with an eye to the broader context in which it operates.

Alden discusses “elements of a segmented distribution illumination process” in connection with Figure 2. Ex. 1005 ¶ 26. The described process uses “a segmented beam headlight 61” to differentially illuminate sectors of the light distribution based on light sensed by a detector array and logic in a light-control circuit. *Id.* ¶ 26, Fig. 2. Alden’s description is generic to the specific headlight embodiment, and states that “[s]ome methods employed within [segmented beam headlight] 61 to segment light into independently controlled sectors are discussed later.” *Id.* Similarly, Figure 3 and its associated discussion provides “a more detailed illustration of the information flow, processes and architecture of the elements described in FIG. 2.” *Id.* ¶ 27, Fig. 3. Figure 3 is reproduced below:

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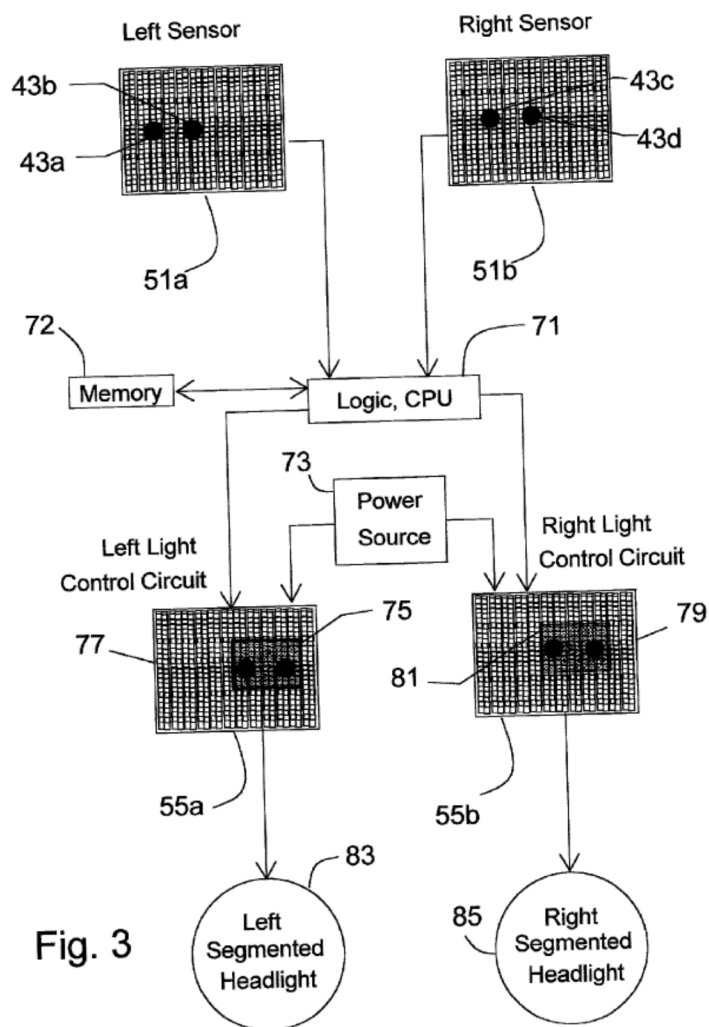


Fig. 3

Alden's Figure 3 is "a more detailed illustration of the information flow, processes and architecture of [the segmented distribution illumination process] described in [Figure 2]." Ex. 1005 ¶ 12.

This figure depicts "the information flow, processes and architecture of the elements described in FIG. 2," including sensors 51 a/b with illuminated spots 43a/b/c/d, logic and CPU 71, light control circuits 55a/b, and segmented headlights 83/85. *Id.* ¶ 27, Fig. 3.

Figure 3 depicts segmented headlights 83 and 85 generically, and the description refers to them without limiting the particular form of those headlights. *Id.* Thus, when Alden describes that Figure 5 "illustrates the segmented headlight

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means and controlling switch array in a first embodiment,” that does not describe an aspect disconnected from the components and operation depicted in Figures 2 or 3, but rather provides details regarding one embodiment of the segmented headlights included in Figures 2 and 3. *See id.* ¶ 29.

Importantly, Figure 3 unambiguously depicts two-dimensional sensor arrays 51a/b and two-dimensional control circuits 55a/b. *Id.*, Fig. 3. That figure and the corresponding text indicate that Alden’s process for dimming illumination sectors involves aspects in the vertical direction—the shaded boxes 75/77 representing dimmed illumination extending beyond the sensed lights 43a/b/c/d more in the vertical direction than in the horizontal direction, and “[t]he 75 area is significantly larger than the headlight dots that were initially received by 51a and 51b because, the CPU has made assumptions about the space that may potentially be occupied by the driver of the sensed vehicle.” *Id.* ¶ 27, Fig. 3.

Moreover, Alden’s description of Figure 3’s logic—though Figure 4’s flow chart and corresponding text—leaves no doubt that Alden’s process uses two-dimensional analysis. As Alden describes, the CPU checks each sector of the light sensor, for the left sensor beginning with sector A1L, proceeding to A2L and continuing through XYL. *Id.* ¶ 28, Fig. 4. The same process occurs for the right sensor, checking sectors A1R through XYR. *Id.*

Finally, Alden describes additional applications for its invention, beyond those used to dim light sectors for oncoming vehicles. Those applications include where the invention is “used to concentrate light to look up a hill in response to road conditions” and “look down a hill in response to road conditions.” *Id.* ¶¶ 55, 56, Figs. 12, 13. From that description and the corresponding figures, it is apparent that those applications use Alden’s ability to control sectors along the vertical axis within the segmented headlight that effects illumination.

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While Alden’s Figure 5 shows a sectional view of a segmented-headlight embodiment, thus depicting a single line of LEDs, that does not restrict the embodiment to a one-dimensional array. Indeed, Alden’s disclosures discussed above contradict such a view, as do the disclosures regarding Figure 5 and other segmented-headlight embodiments. We credit Petitioner’s expert’s testimony in this regard. Ex. 2041, 59:10–12 (“[I]t’s very clear we’re talking about a two-dimensional structure that is map of this set of slices in figure 5.”); *accord id.* at 56:25–60:18. The Figure 5 embodiment includes a switch array to control the individual lighting elements, with “[e]ach lighting element being independently controlled by a corresponding switch in an array of switches 115.” Ex. 1005 ¶ 29. The Figure 6 embodiment includes a face-on view of the headlight plainly showing a two-dimensional array, in addition to a sectional view similar to that of Figure 5. *Id.* at Fig. 6. And Alden describes that the Figure 6 embodiment uses a “switch array similar to 115 and the process previously described herein.” *Id.* ¶ 30.

Considering Alden’s description of its sensing-and-control circuit in connection with Figure 3, which illustrates a two-dimensional array, and its description of Figure 5’s segmented headlight as working with that approach, we find that Alden’s LED-based segmented headlight is capable of selective illumination in two dimensions. *See id.* ¶¶ 27, 29, Figs. 3, 5.

Patent Owner argues that “Alden’s depiction of the row of LEDs being positioned along the focal point of the lens undermines a conclusion that the Figure 5 LED embodiment expressly discloses a two-dimensional array.” PO Resp. 17–18. It is uncontroversial that the lens has a single focal point, though there are many curves passing through that focal point, and thus many curves on which lighting elements may be arranged. While Figure 5 shows elements along one such curve, that does not preclude the existence of other elements that fall on

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other curves. Thus, we do not agree that Alden's statement regarding the focal point restricts Figure 5 to depicting an embodiment with one row of lights.

Patent Owner also faults Petitioner's expert for characterizing the figures as conceptual. *See* PO Resp. 18–19. But there is nothing problematic with conceptual figures, particularly where the corresponding description makes clear how the invention operates. For example, Patent Owner complains that Petitioner's expert “could not explain how the switch array shown in Figure 3 controls the LED array shown in Figure 5 to create the beam spread illustrated therein.” *Id.* at 18. We would not expect Dr. Papanikolopoulos to explain that—the beam spread of any optical system will depend on the lens used and the relative position of the light sources to the lens, so it is unclear why Patent Owner expects the particular switch array to determine beam spread. When asked about beam spread (Ex. 2041, 107:11–12), Dr. Papanikolopoulos stated that it would depend on the specifics of an overall system and could not be determined by Alden's figures (*id.* at 108, 4–10). The same problem infects Patent Owner's complaint that “Alden lacks details regarding how the hypothetical structure would be put together—notable whether the two-dimensional LED structure would form a semi-cylinder, a semi-sphere or a flat plane (among other choices), which informs the control strategy and resultant beam spread.” PO Sur-reply 8. Those details are not required by Alden's description because they do not fundamentally change Alden's invention.

Because Alden describes its segmented headlights as implementing a process using two-dimensional signals for two-dimensional dimming functionality, we find that Figure 5 depicts a section of an embodiment that contains more than a single row of lighting elements. Stated otherwise, Alden's disclosures are

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consistent with each other and are directed to a two-dimensional approach to sensing, control, and illumination.

Further, Patent Owner has not addressed the legal standard for lack of enablement. In particular, to overcome the presumption that prior-art disclosures are enabled, Patent Owner must show ordinarily skilled artisans would require undue experimentation to practice the disclosed invention. *See Amgen Inc. v. Hoechst Marion Roussel, Inc.*, 314 F.3d 1313, 1354–55 (Fed. Cir. 2003); *In re Antor Media Corp.*, 689 F. 3d 1282, 1287–88 (Fed. Cir. 2012). Other than arguing that Figure 5 discloses a single-row embodiment that is unusable with Alden’s other disclosures, Patent Owner has made no attempt to show Alden is not enabled. Patent Owner has not addressed what experimentation skilled artisans would require to practice an invention using Alden’s Figure 5 segmented headlight with the remainder of Alden’s system as disclosed in Figures 2, 3, and 4, and Alden’s corresponding textual description.

For these reasons, we determine that Patent Owner has not shown that Alden fails to disclose and enable a two-dimensional lighting scheme.

The concurrence is of the view that “[f]inding Alden to disclose a two-dimensional array is a position not advanced in the Petition, and is not required to resolve the patentability issues presented in the Petition.” Concur. 1. The majority disagrees on both points.

First, the Petition relies on the two-dimensional control technique of Alden’s Figure 3 for the “subsections determined in response to sensor data” of element 1[C] and the “control circuitry” of element 1[D]. *See* Pet. 17–20. Then the Petition asserts that “switch array control circuitry [of Figure 3] is *further* illustrated in Figure 5, where the lighting elements are ‘individually controlled’ by a ‘switch array,’ with each switch being “controlled by the CPU and logic previously

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described.” *Id.* at 20 (emphasis added). The “previous description” to which the Figure 5 description refers is the two-dimensional technique shown in Figures 3 and 4. From this we understand Petitioner to be asserting that the Figure 5 headlight produces a two-dimensional pattern.

It is true that the Petition did not explicitly say, for example, “Figure 5 is a sectional view of a two-dimensional array,” but it did not need to because it is clear from Alden that it is. Alden describes a two-dimensional technique and then three alternative headlights that may be used to implement the two-dimensional technique—that of Figure 5, which uses multiple LEDs projecting light at angles through a lens, the alternative headlamp of Figures 6 and 7, which uses a single light source reflecting light through a set of electro-chromatic cells that control the intensity and optics that control the direction, and the alternative headlamp of Figures 8, 9, and 10, which uses a single light source and electro-optic cells. *See* Ex. 1005 ¶ 29–35.

We know that Figure 5 is not meant to show a one-dimensional array because the only disclosed control scheme is two-dimensional. Notably, Figure 5 shows only switches, not anything that determines whether they are on or off. There is no disclosure of some other control technique that operates in just one-dimension. We also know that Figure 9 is a section view from the figure itself, because all of the included parts of the headlight are shown in section. For example, the lens is shown as a section, because, if not, we would see a vertical line down the middle representing the edge of the lens. And the housing is shown as a section because, were that not the case, we would not be able to see the LEDs at all, as they are inside the housing. This explains why the figure shows just the one line of LEDs.

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Nor do we agree that this issue can be avoided. Figure 5 showing a two-dimensional array may not be necessary to satisfy the claims, but, as explained above, Petitioner relied on the descriptions concerning both Figure 3 and Figure 5, and Patent Owner argues in various ways that this is problematic because the two-dimensional control system of Figure 3 would not work with the allegedly one-dimensional headlight shown in Figure 5. The concurrence contends that “Patent Owner does not dispute that the Figure 5 embodiment incorporates the logic and control described in Alden’s Figures 3 and 4.” Concur. 4 (citing Sur-reply 7). It is difficult to tell from the Sur-reply exactly what Patent Owner might “not dispute,”⁹ but Patent Owner is clear that “[w]hat is not present is any teaching that the Figure 5 LED array is controlled by the ‘previously described’ Figure 3 switch arrays 55a and 55b.” Sur-reply 7. Patent Owner therefore *does* dispute that Figure 3 and the associated description provides the two-dimensional technique that would be used to control the headlight of Figure 5.

Although we generally agree that we should avoid making determinations that are not necessary to a complete result, we could only sidestep this issue if there was agreement, or the dispute did not affect the result. As explained above, neither of those conditions is met.

⁹ Patent Owner argues as follows: “What is not present is any teaching that the Figure 5 LED array is controlled by the ‘previously described’ Figure 3 switch arrays 55a and 55b. The ‘previously described’ connection between Figures 3-4 and Figure 5 is limited to CPU/logic for control of the switches and does not extend to the illustrated ‘architecture of the elements[,]’ which are called out as a separate component of Figure 3.” (citing Ex. 1005 ¶ 12).” Sur-reply 7. The “CPU/logic for control of the switches” is essentially the whole of Figures 3 and 4, which seems inconsistent with Patent Owner’s argument that the arrays are excluded. It is also unclear why or how the “architecture of the elements,” i.e., how the elements shown in the figure are connected, would be excluded.

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2. *Speculation/Inoperability/Impermissible Modification*

Patent Owner argues that “Petitioner’s application of Alden, specifically the seminal Figure 5 LED embodiment,” impermissibly “strays beyond the ‘four corners’ of that reference.” PO Resp. 17.

For example, Patent Owner argues that “[t]hough the Petition takes definitive positions on how the Figure 5 embodiment operates — including color coding beam segments to explain their functionality and specifying the location of a vehicle in the beam pattern — the deposition of Dr. Papanikolopoulos establishes that Petitioner’s proofs are predicated on speculation and/or the need to modify Alden.” PO Resp. 17. But Patent Owner fails to explain, and we fail to see, how the colors and labels Petitioner applied to Alden’s Figure 5 to help explain its position amounts to improper speculation or modification of the reference.

Patent Owner further argues that Alden “lacks express details needed to implement [two-dimensional] functionality, absent modification,” and that Petitioner never makes such modifications or ever presents Figure 5 with an accompanying two-dimensional explanation. *Id.* at 17. We disagree. For the reasons explained above, we find Patent Owner’s argument to be based on an incorrect reading of Figure 5, and that, properly interpreted, Figure 5 depicts a section of a two-dimensional lighting system.

The fact that Figure 5 is “schematic” is also not a problem. The reference clearly discloses the basic concept of a two-dimensional lighting scheme that lowers light in the direction of oncoming traffic. A reference need not include a detailed engineering drawings in order to anticipate, particularly where, as here, neither the claims at issue, nor the specification of the subject patent, identify the various “parameters” that the Patent Owner claims are “missing.” Instead, the reference only needs to disclose the features that are recited in the claims.

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Patent Owner further argues that “Petitioner’s expert identified . . . at least three modifications that would be required of the Figure 5 express teachings”: the number of LEDs needed to reach a desired lumen output, the exact arrangement of the LEDs, and the distance between the LEDs and the lens. *See* PO Resp. 19–20. None of those details are required by the claims, however, and, to the extent Patent Owner is arguing that Alden is not enabled, Patent Owner has not even attempted to perform the correct analysis, as noted above.

Patent Owner also argues that the Petition is deficient because a working headlight would require more LEDs than are shown in Figure 5. *See* PO Resp. 22. This is unpersuasive because, again, we find that Figure 5 is simply meant to illustrate the relationship between the various components, is a sectional view that thus only shows the LEDs existing at the given two-dimensional section (i.e., one row of LEDs), and is not meant to depict all of the LEDs that would be present in a working system that projected light in two dimensions.

We find Patent Owner’s reliance on *Apple Inc. v. Corephotonics, Ltd.*, 861 Fed. App’x 443, 450 (Fed. Cir. 2021), to the effect that “[p]rior art that must be modified to meet the disputed claim limitation does not anticipate the claim,” to be misplaced. In that case, the embodiment that the Petition cited could not meet the claim language “[a] lens assembly . . . [that] has an effective focal length (EFL), a total track length (TTL) of 6.5 millimeters or less” because the figures showed an overlap of the two lenses. The reference would have had to be modified by removing the overlap in order to meet the claim language. Here, on the other hand, Patent Owner does not identify modifications that would be required to *meet the claim language*; instead, Patent Owner’s allegedly missing details are what one might need to *make a working headlight* from Alden’s disclosure.

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Patent Owner next finds a problem with “how each of the nine LEDs shown in the Figure 5 embodiment are powered by the switch arrays disclosed in Figure 3.” PO Resp. 23. According to Patent Owner, “[s]ince there are 576 switches in the Figure 3 switch array and 9 LEDs in the Figure 5 LED array as shown, absent some unspecified modification, it is unclear what switch or switches would be ‘a corresponding switch’ to each LED as required by Alden.” *Id.* at 24. Moreover, argues Patent Owner, “if a multitude of switches were mapped to a single LED, then unless the bounding box overlapped **all** those switches, at least one switch would still permit high-beam power to the LED — which means the LED would not be powered to the low state diunctated by the low power switch(es).” *Id.*

These arguments are unpersuasive because, again, Figure 5 is not limited to one-dimension, and Alden’s figures simply illustrate the various aspects of Alden’s invention, and are not technical drawings for a specific physical embodiment. We find that a person with the agreed level of skill—a degree in electrical engineering and two years of experience working with lighting control systems—would be fully capable of adjusting the number of switches to match the number of LEDs in a given implementation. And we see no reason why that artisan would map multiple switches to one LED, especially given that it could prevent the system from dimming areas with oncoming vehicles as Alden describes. Indeed, the mismatch between the number of switches in Figure 3 and the number of LEDs in Figure 5 provides further evidence that Figure 5 was not intended to show all of the LEDs.

For these reasons, we conclude that Patent Owner has not shown improper speculation by Petitioner or Dr. Papanikolopoulos, that Alden’s disclosure is

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“inoperable,” or that the combination requires an “impermissible modification” of Alden.

We turn to Petitioner’s arguments regarding specific claim language, in the order argued by Petitioner.

3. *Anticipation by Alden and Obviousness in View of Alden and Stam*

a. *Independent Claim 37*

For the “predefined threshold value,” Petitioner argues that “Alden’s system can operate not only at high beam and low beam but also at intensities in between, e.g., medium low, medium, medium high” and that “[t]hese intensities in between high beam and low beam (e.g., medium) are a ‘predefined threshold value’ which the low beam would be below and the high beam would be above.” Pet. 25 (citing Ex. 1003 ¶ 66).

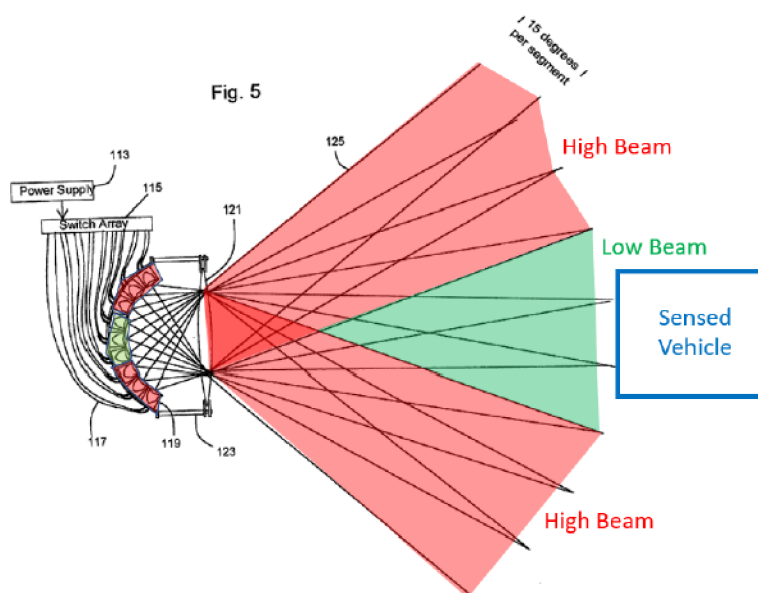
Petitioner alternately argues that “a POSITA would have understood that for [the] low beam to have ‘minimum glare,’ the low beam’s intensity would need to be below a particular threshold—e.g., below a level such that the ‘driver of 41 sees only a dim or low beam light from 47,” and that “[h]igh beam light would be above this threshold, so that, as Alden teaches, visibility in high beam areas is maximized. Pet. 25 (citing Ex. 1005, 26–27, Figs. 1–2; Ex. 1003 ¶ 67).

Patent Owner responds that there would be locations “where beams of ‘low beam’ light overlapped,” and “there would be increased (above low beam) light in those locations, because of the additive nature of light.” PO Resp. 29. Patent Owner asserts that “[t]hese overlapping light locations would also be above the low beam level, and thus definitionally no longer below the proffered ‘threshold,’ which was . . . all ranges of illumination between low and high.” *Id.* Patent Owner continues that “[t]his is relevant because Petitioner relies on Figure 5 to prove illumination ‘to either side of the first subsection,’ but portions of the beams

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created by the lamp create substantial overlap in the portions shown.” Referring to Petitioner’s annotated version of Figure 5 (reproduced below), Patent Owner asserts that “[t]he light from each of those three beams shown expands as it travels further from the vehicle, and so, for example, the outer two green beams would experience at least some additive overlap from both the adjacent high beam illumination ‘above’ or ‘below’ the green triangle, as well as additive overlap from the central beam.” *Id.*



Petitioner’s Annotated Version of Alden’s Figure 5

Patent Owner contends that “[g]iven the additive light overlap that would result, it is not possible to conclude, for example, that the region shown for the proof is ‘substantially illuminated . . . below a . . . threshold value’ over the entire region colored in green” and that “[i]f there is a lesser, more central portion that meets the limitation, then the sections ‘to either side’ of that portion would not be ‘above the . . . threshold value,’ they would simply be above the low beam state and within the ‘range’ that Petitioner defined as ‘the threshold.’” PO Resp. 30.

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There are a number of problems with this analysis. First, we do not think Petitioner defined a range as the threshold. Instead, Petitioner asserts that there is a range between low and high and that range would include, for example, medium, to which “predetermined threshold” could be mapped.

Second, Patent Owner seems to think the Alden’s system would set the brightness of the projected light to one level or the other without regard to the level of light that was being *received*, for example at the oncoming vehicle. This is not consistent with the teachings of Alden, which describe system that is specifically concerned with the level of light that would be received by an oncoming vehicle. *See, e.g.*, Ex. 1005 ¶ 26 (“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.”). Because Alden specifically describes how it controls the transmitted light such that a sector with an oncoming vehicle would receive only dim or low beam light, Patent Owner’s argument amounts to a claim that Alden would not work as described, but Patent Owner does not argue that Alden is not enabled. We conclude that, to the extent there is “additive light overlap,” one of ordinary skill in the art would understand that Alden accounts for that in determining how to illuminate the sectors.

Third, we conclude that, even if there were some additive light overlap, Alden’s teachings regarding high and low sectors would still be sufficient to disclose the claimed first subsection below a predefined threshold (e.g., medium), e.g., the center of the low beam region containing the oncoming vehicle, and the claimed second subsection above the predefined threshold (e.g., medium), e.g., the high beam at the outer edges of the illuminated scene. We note that although the claim requires that the high beam section be “to either side” of the low beam section, it does not require that they be adjacent. So, a medium region between the

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center of the low beam region and the outside of the high beam region would not prevent the claim from reading on Alden.

Patent Owner does not otherwise contest Petitioner's unpatentability assertions regarding claim 37, and any further challenge has been forfeited. We have considered Petitioner's contentions in light of the full record and conclude that Petitioner has shown claim 37 unpatentable for the reasons provided in the Petition, and as discussed above. *See* Pet. 11–28.

b. Independent Claim 59

Regarding independent claim 59, Patent Owner contends that “[a]ccording to Petitioner, ‘Alden’s CPU determines light output for the lighting elements of its system,’” but “[t]his is not a function of Alden’s processor.” PO Resp. 35 (citing Pet. 32). Patent Owner argues that “[n]othing in Alden ‘establishes how or where’ Alden’s CPU determines light output for the lighting elements of its system and that “[t]he system quite literally just ‘switches’ the determined sector to the single, predefined low value.” PO Resp. 37.

We find this line of argument unpersuasive because Alden does “determine light output,” namely one level that is used for a subsection with an oncoming vehicle and one level that is used for a subsection without an oncoming vehicle. The claim does not require any sort of calculation or otherwise preclude the use of predetermined illumination levels in deciding what light to output.¹⁰

Patent Owner also argues that “to the extent that Petitioner [relies] on the application of Alden’s predefined levels to demonstrate element 59[E], the argument fails, as the determined output is something that must have been determined, by the processor, before step 59[E].” PO Resp. 37. This is not

¹⁰ Patent Owner has not sought a construction of “determine,” so we apply its ordinary meaning.

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persuasive. Alden (necessarily) determines what the light output should be (step 59[D]) before instructing the adjustment of the light sources to achieve that light output (step 59[E]).

Patent Owner also argues that the “predefined illuminance” cannot be a “range of intensities.” *See* PO Resp. 37. We tend to agree, but, as explained above, Petitioner is not pointing to a “range of intensities” to satisfy the “predefined illuminance” claim language. It could be “medium,” for example, or some other level between the low and high beam.

Patent Owner does not otherwise contest Petitioner’s unpatentability assertions regarding claim 59, and any further challenge has been forfeited. We have considered Petitioner’s contentions in light of the full record and conclude that Petitioner has shown claim 59 unpatentable for the reasons provided in the Petition, and as discussed above. *See* Pet. 28–34.

c. Independent Claim 65

For independent claim 65, Patent Owner asserts that the “proof is exclusively by analogy to arguments regarding claim language that is fundamentally different,” that “Petitioner’s twelve pages of referential proofs thus lack particularity,” and that “[n]othing in the twelve pages of referential arguments is directed to anything about “determining illumination levels.” PO Resp. 38. We disagree. As explained above, Alden determines an illumination level (e.g., low) for a first subsection (e.g., with an oncoming vehicle) and substantially illuminates that subsection below a predefined illuminance (e.g., medium), and determines an illumination level (e.g., high) for a different subsection (e.g., with no oncoming vehicle) and substantially illuminates that subsection above a predefined illuminance (e.g., medium).

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Patent Owner does not otherwise contest Petitioner's unpatentability assertions regarding claim 65, and any further challenge has been forfeited. We have considered Petitioner's contentions in light of the full record and conclude that Petitioner has shown claim 65 unpatentable for the reasons provided in the Petition, and as discussed above. *See* Pet. 34–36.

d. Dependent Claim 38

In addition to citing its argument for 65[B], which we find unpersuasive, Patent Owner argues that the Petition does not explain “whether or how the system actually ‘determines illumination’ **for** any subsection – it merely determines the subsection and then applies predefined illumination to those subsections.” PO Resp. 40. To the extent this is understood, we find it unpersuasive. In the case of a subsection with a vehicle, Alden determines that the appropriate illumination level for that subsection is the low beam.

Patent Owner next argues that “there is no teaching or suggestion in Alden as to how [the sensor] data would be used to ‘determine intensity’” because “what is shown is that Alden determines a bounding box and then applies predefined low-beam illumination to that region.” PO Resp. 40. This is not a persuasive argument. Alden explains that the data from the two sensors is used to locate the headlights, the CPU then makes assumptions about the space that may potentially be occupied by the driver of the sensed vehicle, and corresponding headlight control array switches cause portions of the headlights to be dim (i.e., less intense) in those areas. *See* Ex. 1005 ¶ 27. The sensor data thus determines the intensity.

Patent Owner also argues that “Alden is not capable of ‘determining’ whether a section ‘does not’ include a vehicle.” PO Resp. 40. Patent Owner contends that “[b]ecause a vehicle can overlap multiple sections and the system of Alden has no way of knowing whether non-emitting portions of that vehicle exist,

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or where they exist, Alden lacks this second determination.” *Id.* We are unpersuaded. Patent Owner seems to be arguing that the system may not work perfectly, but we do not find that to be required for anticipation, at least in this context, where both the art in this field and the ’530 patent itself do not demand the accuracy Patent Owner is suggesting might be required. And, even if the system is not perfect, it nevertheless will include, at times, areas that do not include oncoming vehicles in which the higher level of illumination is preserved. That, we conclude, is sufficient to meet the claim language.

We also disagree with Patent Owner’s argument that “Petitioner improperly relies exclusively on analogy to arguments for 37[D] and 37[E] to prove “determined not to include the second vehicle.” PO Resp. 40. Addressing claim 38, the Petition accurately describes how “Alden’s CPU 71 processes the sensor data to determine illumination for subsections in the field-of-view that include detected vehicles (‘first subsections’) and that do not include other vehicles (‘second subsections’).” Pet. 36.

e. Dependent Claim 39

Patent Owner argues that “[t]he entirety of the claim 39 proof is directed at the fact that Alden ‘can’ illuminate different sectors with different illumination,” that “[w]hile the explanation about what Alden ‘can’ do may cover the ‘capable of’ language generally, it fails to offer any explanation for the claimed ‘specific, different illumination characteristics for each of the at least two sub-sections’ element other than providing an argument-by-analogy to claims 37[B] and 37[D]-37[E],” which “leaves Petitioner’s proof deficient . . . as there is no mention, in the claim language of 37[D] or 37[E] of a second subsection ‘determined not to include a second vehicle.’” PO Resp. 40–41. We are again unpersuaded because

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the Petition is abundantly clear about which are the first subsection (with vehicle, low beam) and second subsection (no vehicle, high beam) in Alden.

f. Dependent Claim 40

Claim 40 recites that “the light distribution pattern defines illumination for at least the first and the one or more second sub-sections of the field of view.”

Patent Owner argues that, according to Petitioner, the “‘light distribution pattern’ is differing illumination levels output from the lighting elements,” which “defines the light to be produced in ‘the first and one or more second subsections.’” PO Resp. 41–42. This is a problem, says Patent Owner, because “[t]he pattern, per the claims . . . is something determined before emission occurs” because the claim reads “process the sensor data to determine a light distribution pattern for an adaptive headlight beam.” *Id.* citing (Ex.2040 ¶ 190).

We do not agree with Patent Owner that the pattern “is something determined before emission occurs.” “Light distribution pattern” first appears in claim 37, which recites “process the sensor data to determine a light distribution pattern for an adaptive headlight beam.” We see nothing in the ’503 patent describing the “light distribution pattern” being determined (e.g., calculated and/or stored somewhere), before it is implemented, and we conclude that the “light distribution pattern,” in context, is simply the lighting scheme that ultimately illuminates the field-of-view. As used in claim 37, the term is broad enough to describe the lighting scheme before it is emitted, or the physical scheme that is ultimately emitted.

g. Dependent Claim 41

This claim recites that “the light distribution patterns [*sic*] 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

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subsections designed to result in an illuminance above the predefined threshold value.”

Focusing on the phrase “defining illumination,” Patent Owner argues that the Petition lacks particularity. *See* PO Resp. 42. We fail to see a problem, however, because we do not discern any meaningful distinction between the “light pattern” of claim 37, which is the set of subsections, and the “light patterns” of claim 41, which is also the set of subsections. If there is a difference between claim 37 and 41 that has a material impact on patentability, Patent Owner should have identified it.

h. Dependent Claims 42 and 43

Claim 42 recites “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.”

The Petition argues that “Alden discloses such a light modifying element, as it uses ‘lens 121’ in the path of light emitted from lighting elements 119” that “controls a ‘characteristic’ of the emitted light, as it focuses the light from each element into particular portions of the light distribution area.” Pet. 41–42 (citing Ex. 1005 ¶ 29).¹¹

Patent Owner argues that the claim “requires, among other things, ‘control of the . . . light modifying elements,’ but “[t]he Petition does not show how the lens 121 is controlled in any manner, perhaps because lens 121 is not controllable in any manner.” PO Resp. 44 (citing Ex. 2040 ¶ 199).

¹¹ Petitioner also cites the “variable refractive element” of Alden’s Figure 6 embodiment, but we agree with Patent Owner that the two embodiments are not combinable, at least as argued in the Petition, because the variable refractive element operates on collimated light, while the light sources of the Figure 5 embodiment are directed at different angles through the lens.

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We conclude that Patent Owner’s argument is based on an implicit construction of claim 42 that would require active control of a reflector, refractors, or lens that we find insufficiently supported.¹² We agree with Petitioner that the claim “recites that the light sources are controlled (via power),” but “recites only light modifying elements being present, but not controlled,” and that it is directed to a situation in which control of the light source and the inclusion of the light modifying element results in the specified light characteristics. *See* Reply 14. As Petitioner observes, this interpretation is consistent with claim 44, which recites that the light modifying elements comprise, among other things “lenses,” as disclosed in Alden.

i. Dependent Claim 50

Patent Owner argues that “[t]he light sensors of claim 1 are at best, a very rudimentary ‘computer vision processing unit’ that is incapable of ‘identifying’ a vehicle (or anything else)” and that “[a]t no point does Alden provide an algorithm or any other teaching that allows Alden to ‘show or fix the identity of’ the detected light as a vehicle, as compared to a myriad of other potential light sources.” PO Resp. 46 (citing Ex. 2040 ¶ 207).

The problem with Patent Owner’s position is that neither the dictionary definition nor the ’503 patent’s specification establish any degree of proof, verification, or confirmation that an object has been correctly identified. The specification discloses that “techniques known in the art” may be used “to classify, identify or locate the contents” visible to a camera sensor. Ex. 1001, 45:1–5. That does not establish any certainty obtained by the preexisting techniques. The

¹² We note that claim 42 was added by amendment (*see* Ex. 1002, 188), possibly to correspond to claim 2, which may have been erroneously amended, as noted in our Final Written Decision in the companion IPR2023-01026.

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specification states that the system can “illuminate distant overhead and roadside signs” and can use “[i]mage recognition via a camera” so that the illumination beam may “follow the retroreflective sign as the vehicle moves.” *Id.* at 51:63–67.

That disclosure does not speak to any degree of confirmation or certainty. The specification’s other disclosures are no different. *Id.* at 52:25–31 (disclosing automated control over lighting and referencing “automatic dimming of high beam due to detection of oncoming vehicles”), 53:3–4 (“Using color and pattern recognition techniques it is possible to determine what is a sign.”), 63:15–18 (“Using real time image processing methodologies with image and scene recognition technology known in the art, room or outdoor area elements, objects and people are identified.”), 64:52–55 (“Using machine vision technology known in the art such as neural networks training and other pattern recognition techniques the vision system has sensor, algorithmic and computation means for identifying devices or objects.”), 69:61–64 (“In a preferred embodiment of the invention the logical controller 454 receiving image input from the camera 453 and running pattern recognition software will identify what is the visual task a person is trying to perform.”), 75:65–76:4 (“Using programmed scene recognition algorithms, the luminaire’s computer vision system comprised of the camera sensor 496 and logical controller 494 identifies the food on the plate, looks-up in storage the recommended CCT and powers each of the different colored LED chips aimed thereon at the correct power level in order to provide the optimal color illumination.”). None of those disclosures addresses a requirement for confirming or verifying an identification that the system makes; nor does any address a particular accuracy requirement in identifying an object.

Based on the specification using “identify” without any requirement that identifying an object requires confirmation or verification of the object’s true

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identify, we do not adopt Patent Owner’s proposed construction. Although the construction itself similarly does not expressly require the confirmation or verification that Patent Owner seeks to impose, we understand that to be Patent Owner’s intent, and accordingly do not adopt the proposed construction. The parties dispute no other aspect of “identify,” and we therefore need not expressly construe the term.

Because Patent Owner acknowledges that Alden discloses a computer vision processing unit, and because Alden “identifies” vehicles with the same level of certainty as the system described in the ’503 patent, we find Patent Owner’s arguments regarding claim 11 unpersuasive.

j. Dependent Claim 54

Claim 54 recites that the system is “configured to determine at least a road curvature, indicated by the sensor data, ahead of the first vehicle and to determine a second illumination pattern defining increased illumination in a direction of the road curvature.”

Patent Owner first argues that, because “Petitioner’s proffer for ‘sensor data’ in claim 1 was ‘detected light,’” “the road curvature ‘indicated by the sensor data’ must be also based on detected light – or, alternatively, different sensor data must be shown to meet the “predefined as pertinent to illumination requirements” limitation of 1[E].” PO Resp. 49. Patent Owner then cites deposition testimony from Dr. Papanikolopoulos and argues that “[w]ithout knowing the difference between vehicles and reflectors, and absent a teaching to help differentiate between the two, Alden has no way of determining whether it should dim in response to detected light per the Figure 5 embodiment or perform some curve-accommodation per Figure 11, to form ‘concentrated’ high-beam emission.” PO Resp. 54–56.

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Patent Owner's argument, which amounts to a claim that Alden's system cannot do what Alden says it can do, is unpersuasive. We do not agree that the cited testimony supports the idea that Alden cannot differentiate between headlights and the road reflectors. Instead, Dr. Papanikolopoulos explained that Alden describes "two main use cases," one in which the light is dimmed in the direction of headlights, and one in which the detection of the road markers causes the system to direct light into a corner. Patent Owner also has not attempted to show that Alden does not enable the ability to use markers to direct light into a corner that it describes.

Based on Alden's disclosures, we credit Petitioner's expert's testimony that Alden's system adequately describes detecting and accommodating road curvatures as claimed by the '503 patent. *See* Ex. 1003 ¶¶ 113–114.

Patent Owner also argues that it is not clear that Alden's headlight could direct more light into a corner because "[t]he lamp already emits high beams everywhere there is not glare reduction and it lacks optical steering" capability. PO Resp. 51.

Patent Owner's position conflates Alden's embodiments with their uses. While Alden describes operation where non-dimmed areas are illuminated with the high beam (Ex. 1005 ¶ 27), that relates to preventing glare to oncoming vehicles. Skilled artisans would understand that Alden's description of directing light into corners is a different use with different requirements. *See* Ex. 2041, 50:9–51:1. Petitioner's expert explains that the segmented headlight shown in Alden's Figure 5 can function in both uses by identifying both oncoming vehicles and roadside reflectors. *Id.* at 78:22–80:24. As Petitioner points out, even when preventing glare to oncoming vehicles, Alden teaches switching certain headlight segments to dim and switching other segments to the high beam. *See* Ex. 1005, Fig. 4. By

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including a decision about each headlight segment, Alden’s system is thus configured to implement the road-curvature use. And Alden teaches that its invention may be used such that each segment is “within a range of intensities between the high beam and the low beam state.” *Id.* ¶ 61. That supports that Alden’s invention is not limited to a binary choice between dimming for oncoming vehicles or providing high-beam illumination.

As to the specific hardware configuration, we credit the testimony of Petitioner’s expert that, in the road-curvature use, skilled artisans would position the device’s LEDs “to ensure that the beam created by the headlamp is sufficiently wide to illuminate turns.” Ex. 1003 ¶ 117. That explanation is consistent with Alden’s Figure 11, which contradicts Patent Owner’s view that all segments would be illuminated, as Figure 11 depicts an asymmetric beam projection. *See* Ex. 1005, Fig. 11. Thus, Figure 11 itself shows “how fixed, unsteerable LEDs can be used to ‘concentrate’ light” (PO Sur-reply 11)—certain LEDs are used for wide illumination, and only activated when the system desires to “concentrate light to look around corners in response to road conditions” (Ex. 1005 ¶ 36, Fig. 11).

Based on the foregoing evidence, we find that Alden’s invention is not limited to uses where it only dims in response to oncoming vehicles. Further, we find that Alden’s invention may perform the variety of uses that Alden discloses, which include both dimming for oncoming vehicles and increasing light in the direction of detected road curvature.

k. Dependent Claim 60

Claim 60 recites “determin[ing] light output that aims illumination in a direction of the road curvature.”

Patent Owner argues that “it is unclear how the output of Fig. 5 would ‘aim’ illumination anywhere” because “the LEDs are emitting at high/maximum

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illumination, and further, they are not controllable in Figure 5 with regards to anything other than intensity.” PO Resp. 53–54.

We find this argument unpersuasive because, as explained above, we do not agree that Alden is limited to maximum intensity everywhere and because we find that Alden’s description of “concentrat[ing] light to look around corners in response to road conditions” (Ex. 1005 ¶ 36), is sufficient to disclose “aim[ing] illumination in a direction of the road curvature,” as claimed.

l. Dependent Claims 55, 56, 61, and 62

The claims recite “a planned upcoming turn,” and Patent Owner argues that “[i]nstead of choosing a different proof for turn vs. curve, since the claim uses different language and clearly requires a different pattern, Petitioner simply reargues curve illumination.” PO Resp. 54. Patent Owner also argues that “Petitioner never explains how there is a third pattern (different from the second pattern of claim 54, for example) or how the system of Figure 5 can be controlled, pursuant to such a pattern or otherwise, to provide increased illumination illuminating a turn.” *Id.* According to Patent Owner, “[p]er the ordinary meaning of both terms, turns are different from curves, as they typically involve the possibility of cross-traffic.” PO Resp. 55.

We first note that Patent Owner does not offer, as it did for the turn/curve dispute in related IPR2023-1026, its proposed “plain meanings” of the terms “turn” and “curve.” *See* IR2023–1026, Paper 15, 61 (“The plain meaning of a ‘turn’ is a ‘change of direction when moving’ . . . while the plain meaning of a ‘curve’ is a ‘continuously bending line, without angles.’”). For consistency, we apply the plain meanings that Patent Owner presented in the other case. Those definitions do not reflect that “turns are different from curves, as they typically involve the possibility

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of cross-traffic and would thus be illuminated differently” (PO Resp. 55), and Patent Owner does not explain why a “turn” typically includes cross-traffic.

We do not agree that Petitioner is “simply reargue[ing] curve illumination” or “never explains how there is a third pattern or how the system of Figure 5 can be controlled.” The Petition explains that “Alden’s system can sense when a road curves in front of a vehicle, such that the vehicle must turn, based on sensor data detecting reflectors 157 along the road” and “further discloses 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.’” Pet. 52. Petitioner asserts that “Alden also discloses that its system can include a ‘rotation sensor’ in the steering wheel that can further detect when a vehicle is planning to turn. *Id.* (citing Ex. 1005 ¶¶ 39–40; Figs. 14–15).

We find this description sufficient to disclose “determin[ing] at least a planned upcoming turn” and “determin[ing] a third illumination pattern defining increased illumination illuminating the turn,” as claimed. The “first pattern” would be high beams everywhere, the “second pattern” would add a dimmed area for an oncoming vehicle, and the “third pattern” would add light directed around the corner.

Patent Owner also argues that Alden’s “system calculates the new direction of the vehicle (i.e., where it is now heading, not where it is planning to head) and bases the adjustment on that present heading.” PO Resp. 55. We do not agree that Alden’s method of operation is a problem. Alden states that “[a]s the steering wheel 191 rotates ‘X’ degrees, rotation sensor 193 detects the rotation” and “[t]he system calculates the new direction of the vehicle and changes the direction of the headlight output 197 a corresponding ‘f(x)’ degrees.” Ex. 1005 ¶ 40. The vehicle itself will not start turning until after the wheel is moved and, in any event, as the

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vehicle moves through the turn the system would be continuously determining that there is additional upcoming turning, and directing illumination in that direction, because the wheel remains in a rotated position.

m. Dependent Claim 70

For claim 70, Petitioner argues that the Petition “suffers from all the shortcomings of the referenced portions of the Petition, including, for example, failure to show how the system of Figure 5 can increase illumination, failure to show how the system determines that there is an upcoming curve, and failure to show derivation of control instructions for controlling Figure 5 elements in the manner claimed.” PO Resp. 56–57. These arguments are unpersuasive for the reasons provided above. Alden does not require maximum illumination at all times, it handles upcoming curves as described above in connection with claims 55, 56, 61, and 62, and we find that Alden need not provide more details about the control scheme, as the degree of detail in Alden’s disclosure is consistent with the art in this field and the ’503 patent itself.

n. Dependent Claims 58 and 64

These claims recite that “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.”

Patent Owner argues that “there is insufficient explanation [in the Petition] of how bi-refractive elements requiring collimated light input could be used with the noncollimated system of Figure 5.” PO Resp. 57.

This is not persuasive. Claims 37 and 59, from which these claims depend, recite “instruct[ing] operation of at least two of the light clusters to create the adapted headlight beam.” Alden’s lens, which is what Petitioner relies on for these claims, alters (bends) the light that is emitted when the clusters are instructed to

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operate. These claims do not require active control of the reflector, refractor, or lens.

o. Conclusion on Alden/Stam

For the reasons provided in the Petition, and as explained above, we agree with Petitioner that independent claims 37, 59, and 65, and dependent claims 38–44, 47, 50–56, 58, 60–62, 64, and 70 would have been obvious in view of Alden. Because we find that Alden discloses the claimed “threshold,” we need not, and therefore do not, reach Petitioner’s alternative arguments based on Stam.

4. Alden in View of Harbers: Claims 45, 68, and 69

For claim 45, Patent Owner argues that “Petitioner’s 5[a] proof shows neither a single light source that comprises multiple LEDs, nor a single light source that comprises an organic LED” and that “the proof is about light clusters, not light sources.” PO Resp. 58 (citing Pet. 54).

This is not persuasive because the combination clearly discloses subsections with different colors of light, meaning that there necessarily would be at least one “light cluster” with light sources that create a subsection with a different color. The Petition explains that “Alden’s light clusters can include a plurality of LEDs.” PO Resp. 54.

For claim 45, Patent Owner also argues that Petitioner has not explained “how including . . . colored LEDs into the system of, for example, [Alden’s] Fig. 5 embodiment will not create color changing issues with emission.” PO Resp. 58. Petitioner contends that “each replacement of a colored LED from Harbers into the Alden array, replaces 1/9 of the emission output with a different color.” *Id.* This is unpersuasive because, as explained above, Alden’s Figure 5 is a sectional view that one of ordinary skill in the art would understand does not depict all of the light sources. Alden instead describes a two-dimensional array, and we agree with

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Petitioner and its expert that one of ordinary skill would be able to use some colored light sources, as Harbers does, in view of Harbers’ teachings. *See* Ex. 1003 ¶¶ 127–131.

Patent Owner also argues that “in Alden, each beam segment has defined responsibility for a portion of the field of view—a factor Petitioner’s proofs fail to address” and that “[a] driver of [an] oncoming vehicle [may] see red, or yellow, or blue emission beams.” PO Resp. 59. For claim 68, Petitioner similarly argues that “Petitioner never addresses any of the unpredictability selective dimming would have on such a combined Alden-Harbers system, and/or the issues occurring from not following Harbers’s strict LED ordering to ‘substantial[ly] reduc[e] . . . possible color effects.’” PO Resp. 60.

We conclude that Patent Owner is overcomplicating the situation by requiring that the selective dimming of Alden and different colors of Harbers both be employed in the same areas at the same time. Alden specifically lowers the illumination in the direction of an oncoming vehicle, which would appear to minimize any color changing issues and, if not, the off-axis differently colored light could be not used when a vehicle is approaching that region were that a problem. We note that the ’503 patent, despite claiming the combination of selective dimming and different colored light, also does not provide details about how to manage the combination of those two features, suggesting that the inventors viewed such implementation details as falling within the level of ordinary skill.

We agree with Dr. Papanikolopoulos that this combination “would have merely included the implementation of a known device (color LED arrays) for its intended purpose in a system already designed for use with LEDs,” that “the use of Harbers’ color LED array in the LED array of Alden would have been the simple substitution of one known element (color LEDs) for another (generically recited

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LEDs),” and that one of ordinary skill “would have had a reasonable expectation of success in incorporating the color LEDs and control functions from Harbers into the system of Alden.” Ex. 1003 ¶¶ 127–131. We also agree that the ordinary artisan would “have been motivated to include color LEDs in the system of Alden so that . . . 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.* ¶ 131 (quoting Ex. 1006, 9:28–10:5).

For claim 69, Petitioner argues that “[i]n a one-dimensional array, it is not even clear how such output changing would occur – where each element is singularly responsible for a given segment of the scene.” PO Resp. 61. This is unpersuasive because, as explained above, we do not agree that Alden is limited to a one-dimensional array.

For the reasons provided in the Petition, and as explained above, we agree with Petitioner that claims 45, 68, and 69 would have been obvious in view of Alden and Harbers.

5. *Alden in View of Bergkvist: Claim 46*

Claim 46 recites that “the light output from at least one headlamp further comprises at least one of infrared or ultraviolet wavelengths” and Petitioner relies on Bergkvist’s disclosure that the use of UV light will aid the driver by causing objects like road signs to be more visible. *See* Pet. 61–62.

Patent Owner asserts that “Bergkvist uses a single light source that emits in both visible and UV spectrums and relies on a filter to block visible light,” that “Bergkvist has no LEDs, nor does it mention UV LEDs,” and that “[t]he suggestion to ‘include at least one UV light source in the array of Alden’ has no motivation in Bergkvist, as there is no filter element imported – i.e., incorporating the source of Bergkvist will simply also produce visible light.” PO Resp. 61–62.

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These arguments are unpersuasive because the claims require “light clusters,” not LEDs, because the combination contemplates the use of UV light generally, not Bergkvist’s specific light source, and because, even if the combination did require use of Bergkvist’s specific light source, the combination would include the filtering that Bergkvist uses to limit the emission to the UV spectrum, because that is what Bergkvist teaches.

Patent Owner also argues that “[s]ince the motivation to combine was ‘in order to have light outside the visible range, such that it is not distracting to other drivers or pedestrians’ it is unclear how such distraction would not occur when visible light is not filtered.” PO Resp. 62. This argument is unpersuasive because it assumes the visible light would be not filtered, which is the opposite of what Bergkvist teaches.

For the reasons provided in the Petition, and as explained above, we agree with Petitioner that claim 46 would have been obvious in view of Alden and Bergkvist.

6. *Alden in View of Beam: Claims 48, 57, and 63*

Claim 48 recites that “at least one of the sensors is a camera-sensor configured to image at least lights indicative of a preceding vehicle.” For this feature, the Petition relies on Beam, which, according to Petitioner, “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.” Pet. 64–65 (citing Ex. 1008, 4:9–25, 4:45–59, 5:61–6:8, 6:61–7:8).

Petitioner again searches for technical problems with the combination, asserting that Beam does not provide “tuning” to distinguish taillights from headlights, that turning the threshold down to include taillights would “increase the

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level of illumination detected for an oncoming headlight,” and that “a traveling vehicle on a crowded highway would see countless preceding taillights, yet Petitioner’s combination provides no explanation of how Alden would ‘match’ such taillights across two sensors, especially as the taillights would appear much dimmer than headlights” and “Beam is of no assistance, as it does not attempt sensor-to-sensor matching and Alden never explains such matching for anything more than a single vehicle scenario.” PO Resp. 62–63.

We find these arguments unpersuasive because claim 48 does not require distinguishing between headlight and taillights—it simply requires a sensor “configured to image at least lights indicative of preceding vehicles,” which is what Beam teaches. It may be that the threshold would need to be lowered to capture pairs of taillights in addition to pairs of headlights, but in view of Beam’s teachings, we find that adjustment would fall within the level of ordinary skill, as evidenced by the depth of the disclosures of both the prior art and the ’503 patent, which itself does not explain how one might distinguish headlights and taillights.

Patent Owner also argues that “a great deal of additional modification and/or experimentation would be needed for the proposed combination to accommodate headlights and preceding taillights.” PO Resp. 63. Again, however, Petitioner does not argue that Beam is not enabled, and we conclude that any necessary modifications would be within the level of ordinary skill.

For the reasons provided in the Petition, and as explained above, we agree with Petitioner that claims 48, 57, and 63 would have been obvious in view of Alden and Beam.

7. *Alden in View of Kobayashi: Claim 49*

Claim 9 recites that “the one or more sensors further includes a GPS sensor.” Petitioner relies on Kobayashi, which discloses that “GPS navigation device 29

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sends information about the road profile and the present vehicle position to ECU 10” and that “when the vehicle advances along a scheduled course, irradiation control of the lamp is conducted in accordance with the course concerned.” Pet. 68 (citing Ex. 1009, 1, 2:28–50, 3:9–5:28, 11:34–14:52, 15:6–28, 17:3–67, Fig. 9, Fig. 10, Fig. 12).

Patent Owner argues that the combination “seems to be an either/or type of combination, without explanation as to which system controls when both signals are useful.” PO Resp. 63–64. This is not persuasive because the fact that either Alden’s reflectors or Kobayashi’s GPS could be used to control the lighting into a curve does not make it non-obvious to use one or the other. This again appears to be an implementation level detail that would be within the level of ordinary skill.

Patent Owner also identifies a “larger issue,” which is that “Alden’s system is already inclusive of a significant beam-spread, more than sufficient to accommodate curves” and that “Alden lacks any control over its LEDs for curve purposes – they emit, per Alden, at high-beam all the time.” PO Resp. 64. This is unpersuasive because, as explained above, we find that Alden discloses increasing light in the direction of detected road curvature and is not limited to an embodiment in which all light sources are always at maximum illumination.

For the reasons provided in the Petition, and as explained above, we agree with Petitioner that claim 49 would have been obvious in view of Alden and Kobayashi.

8. *Alden in View of Braun: Claims 66 and 67*

Claims 66 and 67 recite that “the data includes data indicating a [pedestrian / road-sign] [and] wherein the determining illumination includes determining an illumination level, for at least a third subsection including the [pedestrian / road-sign].”

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Patent Owner argues that “Petitioner proposes to replace Alden’s lens and photodiode array with Braun’s camera and pattern recognition system” and that “[t]here are several issues with this proposed combination.” PO Resp. 64.

Patent Owner first argues that “the photodiodes in the array of Alden are mapped to corresponding sensor elements, so it is unclear how that mapping would be converted from Braun’s camera to Alden’s control circuitry.” PO Resp. 64–65. This argument is unpersuasive because we find that one of ordinary skill would be capable of mapping features detected by Braun’s camera facing the direction of travel to Alden’s similar sensors and/or light sources facing the same direction.

Patent Owner next argues that “Braun does not ‘make assumptions’ about where the oncoming driver is located, and so, losing the processor of Alden, the system loses this capability.” PO Resp. 65. This argument is unpersuasive because the combination does not “los[e] the processor of Alden.” Instead, the combination contemplates the use of Alden’s control system augmented with concept of highlighting signs or people to alert the driver to their presence as disclosed in Braun.

Finally, Patent Owner argues that “the ‘maximum illumination’ goal of Alden” would be lost and “there is nothing to use to ‘spotlight’ pedestrians or signs, since the LEDs are not aimable.” PO Resp. 65. This too is unpersuasive because, as explained above, we do not agree that Alden requires maximum illumination everywhere at all times, and because, as explained above, Alden’s illumination is “aimable” in that the light sources can be turned on or off to control the degree of illumination applied to each portion of the overall field.

For the reasons provided in the Petition, and as explained above, we agree with Petitioner that claims 66 and 67 would have been obvious in view of Alden and Braun.

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III. CONCLUSION

For the reasons given, Petitioner has met its burden of showing that claims 37–41, 47, 50–56, 58–59, 60–62, 64–65, and 70 of U.S. Patent 10,894,503 B2 are unpatentable, but has not met its burden on showing that claims 42–44 are unpatentable.¹³ The results are summarized below:

Claim(s)	35 U.S.C. §	Reference(s)	Claim(s) Shown Unpatentable	Claim(s) Not Shown Unpatentable
37–44, 47, 50–56, 58–59, 60–62, 64–65, 70	102	Alden	37–44, 47, 50–56, 58–59, 60–62, 64–65, 70	
37–44, 47, 50–56, 58–59, 60–62, 64–65, 70	103	Alden, Stam [†]		
45, 68–69	103	Alden, Harbers	45, 68–69	
45, 68–69	103	Alden, Stam, Harbers [†]		
46	103	Alden, Bergkvist	46	
46		Alden, Stam, Bergkvist [†]		

¹³ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding, we draw Patent Owner’s attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. § 42.8(a)(3), (b)(2).

¹⁴ We do not address obviousness using Stam because we determine Alden is sufficient without Stam.

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48, 57, 63	103	Alden, Beam	48, 57, 63	
48, 57, 63	103	Alden, Stam, Beam [†]		
49	103	Alden, Kobayashi	49	
49		Alden, Stam, Kobayashi [†]		
66, 67	103	Alden, Braun	66, 67	
66, 67	103	Alden, Stam, Braun [†]		
Overall Outcome			37–70	

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IV. ORDER

Accordingly, it is

ORDERED that Petitioner has shown by a preponderance of the evidence that claims 37–70 of the '503 patent are unpatentable; and

FURTHER ORDERED that, because this is a Final Written Decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MERCEDES-BENZ USA, LLC,
Petitioner

v.

YECHEZKAL EVAN SPERO,
Patent Owner.

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CYGAN, *Administrative Patent Judge*, concurring.

I respectfully concur in the determination of unpatentability of the challenged claims. However, I do not base such a determination on the Alden reference describing a two-dimensional LED array as found by the majority opinion. Finding Alden to disclose a two-dimensional LED array is a position not advanced in the Petition, and is not required to resolve the patentability issues presented in the Petition.

As an initial matter, the Petition does not base its anticipation or obviousness grounds on a two-dimensional LED array. For example, in its assertions for claim 42, the Petition explains how Alden discloses each element, including through Alden's lighting element clusters 119 controlled by switch array 115, illustrated in Figure 5, guided by input from sensors and control logic as illustrated in Figures 3

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and 4. Pet. 39–41. At no point does the Petition assert that Alden’s Figure 5 represents more than a single, 9-element LED array illuminating the road in left-to-right segments. *See, e.g.*, Pet. 12 (citing Alden’s Figure 1 (illustrating left-to-right headlight beam sectors)), 14–15 (annotating Alden’s Figure 5 as three groups of three LEDs illuminating the “area to the left of the vehicle,” a “second area in front of the vehicle,” and a “third area to the right of the vehicle”).

Although Petitioner relies upon Alden’s two-dimensional variable refractive element for claim 42, the Petition does not rely on a two-dimensional LED array, but instead, on Alden’s statement that “[o]ne or methods employed herein may be used in combination to vary illumination in a segmented system” to show the obviousness of those claims. Pet. 41–44 (providing motivation to combine such elements in Alden) (emphases omitted).

Patent Owner argues that the two-dimensional LED array theory of Alden’s Figure 5 was not advanced in the Petition, but instead, presented for the first time in the Institution Decision and subsequently copied by Petitioner in its Reply. PO Resp. 1–3; Sur-reply 1–11. Although the Petition relies on Alden’s two-dimensional *sensor* (51) and *dimming control* (71, 55), which determine the location of a vehicle and the corresponding area in which headlights should be dimmed, the Petition relies solely on a one-dimensional *switch array* (115) controlling power (113) to each element of a one-dimensional *LED array* (119), in which left-to-right elements are dimmed to reduce emitted light in the sector determined by the dimming control occupied by the sensed vehicle. Pet. 40–41. The Petition relies solely on the Figure 5 embodiment’s LED array as describing the claimed “plurality of light clusters,” and does not rely on a reading of Figure 3 in which each dimming control element of Figure 5 represents a lighting cluster.

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*Id.*¹ Patent Owner’s Preliminary Response argued that the Petition’s use of Alden’s two-dimensional light circuit controls (55) with Alden’s one-dimensional LED array (119) is ambiguous. PO Prelim. Resp. 21–22.

The Institution Decision resolved the ambiguity raised by Patent Owner by explaining how the Petition’s reliance on Figure 5’s one-dimensional LED array is consistent with Figure 3’s two-dimensional sensor and control because “one of ordinary skill . . . would understand that the sensor and/or control circuitry would need to be tailored.” Dec. on Inst. 12. The Institution further providing a new interpretation in which Alden’s Figure 5 is *sub silentio* a two-dimensional LED array. *Id.* at 11 (“conclud[ing]” that “the skilled artisan would recognize” that “a headlamp” designed in accordance with Figure 3 “would include additional rows of LEDs passing through the center of the lens”). Thus, I agree with Patent Owner that the Petition did not set forth its unpatentability grounds based upon a two-dimensional LED array in Alden, and that this unpatentability ground was first set forth in the Institution Decision.²

¹ Alden’s other embodiments have two-dimensional light emitters but only a single light element, and Petitioner does not assert that these describe the “plurality of light clusters” claim limitation. Ex. 1005 ¶¶ 30–35; Pet. 43–45. Alden’s Figure 3 is broad enough to encompass control of the one-dimensional LED array of Figure 5 and the two-dimensional electro-chromatic, electro-optic, and liquid crystal arrays of Figures 6–10. See Ex. 2001 ¶¶ 33–36.

² Although a decision may be based upon “arguments that were advanced by a party and to which the opposing party was given a chance to respond,” “it is the petition, not the Board’s discretion, that defines the metes and bounds of an [IPR],” and the Board must “reject any ‘entirely new theory of *prima facie* obviousness absent from the petition.’” *VLSI Technology LLC v. Intel Corp.*, 53 F.4th 646, 653–54 (Fed. Cir. 2022); *Corephotonics, Ltd. v. Apple, Inc.*, 84 F.4th 990, 1002 (Fed. Cir. 2023).

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However, for purposes of this Decision, it is unnecessary to address a two-dimensional array interpretation of Alden’s Figure 5 because the Petition’s one-dimensional array assertions are sufficient to resolve the patentability dispute. *See* Pet. Reply 1. Patent Owner does not dispute that the Figure 5 embodiment incorporates the logic and control described in Alden’s Figures 3 and 4, only that the Figure 5 embodiment uses switch array 115, not switch arrays 55a and 55b, for the direct control of the LEDs. Sur-Reply 6–7. Patent Owner’s arguments³ against the asserted anticipation of claims by Alden are not based upon Alden lacking an operatively controlled LED array. PO Resp. 27–57. During oral argument, Patent Owner agreed that their position is “that it’s not Alden itself that inoperative. . . . [but] Petitioner’s problem is that they . . . specifically tried to combine [control circuits] 55a and 55b in lieu of switch array 115.” Tr. 69:4–9; *see also* Tr. 47:8–24; PO Resp. 23–26. Patent Owner further agreed that “if Petitioner had relied on 115 instead . . . there wouldn’t have been a[n inoperability] problem.” Tr. 69:11–15.

However, Patent Owner’s statements do not accurately characterize the Petition, which clearly relies on the 9-switch array element 115 to control the 9-LED array. The Petition describes Alden’s Figure 5 as illustrating elements that

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.”

³ Patent Owner makes additional arguments with respect to limitation 1[F] and the other independent claims that do not raise any such two-dimensional array issue, which the majority opinion appropriately addresses. Maj. Op. §§ II(C)(3)(b), (4)–(5).

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Pet. 41 (citing Ex. 1005 ¶ 29 (“Each lighting element being independently controlled by a corresponding switch in an array of switches 115”)). Patent Owner expressly states that reliance on switch array 115 to control the one-dimensional LED array of Figure 5 does not cause an inoperability problem. Tr. 69:11–15. Because the Petition asserts a corresponding number of switches and LEDs, none of the operability issues that Patent Owner argues would result from different numbers of switches and LEDs are present in the Petition’s assertions of unpatentability.

Because Alden’s one-dimensional array is sufficient to show unpatentability, Patent Owner’s arguments based upon lack of express description of, need for modification or speculation to find, or whether a person of ordinary skill in the art would envisage a two-dimensional LED array in Alden’s Figure 5 embodiment, and the issue of what positioning of additional LED rows would satisfy Alden’s statement that such LEDs are “on a curve along the focal point of a headlight lens,” are moot. *See* PO Resp. 16–26; Sur-reply 7–10. Additionally, Patent Owner’s clarification that that Alden is not itself inoperative moots the factual issue, raised by Dr. Papanikolopoulos, regarding whether Alden’s Figure 5 has sufficient lumen output (which is an unclaimed feature) to be operative. Tr. 69:4–9; PO Resp. 22–23.

The majority opinion’s determination for the remaining patentability issues can be applied without the need for a two-dimensional LED array. For example, the analysis of claim 45 is partly grounded on additional light sources from a two-dimensional LED array. Maj. Op. §(II)(D)(4). However, that portion of the analysis is not necessary because Petitioner’s combination modifies Alden to include multiple different color LEDs as described by Harbers, and Dr. Papanikolopoulos explains that in such a combination, Alden would “be improved

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by providing the ability to control not just the intensity and direction of the light output from the LED array in the different portions or areas, but also to adjust the color as well” in a one-dimensional LED array. Pet. Reply 22–23; Ex. 1003

¶¶ 129–130. Although Dr. Turk states that such substitution would “replace 1/9 of the emission with a different color,” that appears to be the point of the combination, providing the advantage identified by Dr. Papanikolopoulos. Similarly with respect to claim 69, Dr. Papanikolopoulos explains that Harbers teaches changing the configuration and spectral composition of the light beams, and that by removing the blue component of the light, backscattering of the headlight beams due to fog and snow would be substantially reduced. Ex. 1003 ¶ 133. Such explanation adequately addresses the concerns stated by Dr. Turk that the systems would be incompatible. Ex. 2040 ¶ 260. The remainder of the majority opinion’s analysis applies to explain why such combinations would be desirable, even in view of Patent Owner’s arguments to the contrary.

For the above reasons, Alden’s Figure 5, as a one-dimensional array having a one-dimensional control switch, provides sufficient description, and where relied upon for its teachings, sufficient teaching, to support the anticipation and obviousness contentions set forth in the Petition.⁴ Therefore, I concur in the determinations of unpatentability set forth in the majority opinion based upon a one-dimensional array interpretation.

⁴ Thus, I need not evaluate the strength of the evidentiary support for the majority opinion’s two-dimensional LED array interpretation.

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