UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

KOITO MANUFACTURING CO., LTD.
Petitioner

v.

LONGHORN AUTOMOTIVE GROUP LLC,
Patent Owner.

U.S. PATENT NO. 8,810,803

DECLARATION OF ADAM PHENIS

Declaration

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

Date: April 29, 2025

By: Adam Phenis Digitally signed by Adam Phenis Date: 2025.04.29 11:33:11 -07'00'

Adam Phenis

Contents

I, Adam Phenis, do hereby declare:

1. I am making this declaration at the request of Koito Manufacturing Co. Ltd. ("Koito") in the matter of Koito's petition for *inter partes* review of U.S. Patent No. 8,810,803.

2. I am being compensated for my work in this matter at my standard hourly rate of $350 for consulting services. My compensation in no way depends on the outcome of this proceeding or the content of my testimony.

3. In preparing this Declaration, I considered the following materials:

Exhibit	Description
1001	U.S. Patent No. 8,810,803 to Bell
1002	Prosecution File History of U.S. Patent No. 8,810,803
1004	German Patent Application Publication No. 10129743C2 (Weidel)
1005	U.S. Patent No. 7,563,008B2 (Chinniah)
1006	German Patent Application Publication No. 102006004587A1 (Brandenburg)
1007	U.S. Patent No. 7,736,036B2 (Tatsukawa)
1008	U.S. Patent No. 7,733,574B2 (Mizusawa)
1009	U.S. Patent Application Publication No. 2007/0263903A1 (Hilaire)
1010	Korean Patent Application Publication No. 100482557B1 (Cheon)
1011	Japanese Patent Application Publication No. 2004214144A (Osawa)
1012	My CV

I. Professional Background

4. All of my opinions stated in this Declaration are based on my own personal knowledge and professional judgment. In forming my opinions, I have relied on my knowledge and experience in designing, developing, researching, and teaching the technology referenced in this Declaration.
5. I am over 18 years of age and, if I am called upon to do so, I would be competent to testify as to the matters set forth herein. I understand that a copy of my current curriculum vitae, which details my education, professional and academic experience, is being submitted as EX1012. The following provides an overview of some of my experience that is relevant to the matters set forth in this Declaration.
6. I am an Optical Engineering consultant with experience in a broad range of optical systems working from conception through production and delivery.
7. I have a Bachelor of Science degree in Optical Science and Engineering from the University of California, Davis, and a Master of Science degree in Optical Science from the University of Arizona.
8. I have been an optical engineer since 2003, working for companies including Lockheed Martin at their Advanced Technology Center, AOptix Technologies, B.E. Myers, Inc., and ASML.

9. In 2010, I founded AMP Optics, LLC., an optical engineering consulting company, to provide innovative, pragmatic and cost-effective optical engineering services in an effort to help customers realize optical systems that meet their needs. I support my customers by performing system requirements derivation and analysis, optical design, optimization, performance, tolerance, and stray light analyses, optical element specifications, supplier identification and interfacing, build, alignment and testing to deliver a final optical system. In this role, I also work across functions to ensure project success. Areas of specialty include imaging systems, applied imaging systems including hyperspectral and polarimetric, spectroscopic, laser systems and physical optics propagation, wavefront sensors, interferometry, illumination design, lens drawings, optical testing and alignment.

10. My design and development expertise focuses on the pragmatic and practical aspects of optical and electro-optical system development. I am currently supporting customers as the Lead Optical Engineer on multiple space-based Visible and Infrared Optical Payloads and material processing with high power lasers. Other experience examples of optical systems include electro-optical (ultraviolet through the very long wave infrared),

LiDAR, adaptive optics, hyperspectral, polarimetric, spectroscopic, low-light imaging and detection, fluorescence, directed energy, lasers and laser diodes. My systems have operated or are operating in environments from the lab to research facilities to harsh environments that include space, airborne, automotive, and weapon mounted. My knowledge of optical manufacturers and their capabilities allow me to design systems in a cost-effective manner with an eye on manufacturability from the start.

11. Projects I have consulted on include:

• NASA DEMETER IIP (0.2-50 μm) – Lead Optical Engineer – Optical design, analysis, alignment, integration and testing

• Space-Based Overhead Non-Imaging Infrared Sensors (3-5 μm) – Lead Optical Engineer – Optical design and analysis, stray light, alignment, integration and testing, radiometry, optical coatings, etc…

• Illumination design for robot Universal Product Code (UPC) scanner – Optical design of both illumination and imaging systems

• Freeform optical testing interferometer – Optical engineer – Design, analysis, architecture

• Space-Based Free Space Laser Communications – Lead Optical Engineer

- Ground terminal for Space-Based Free Space Laser Communications – Stray Light analyst, Consulting Optical Engineer
- Lunar-Based Free Space Laser Communications – Lead Optical Engineer
- NASA SAGE IV IIP – Ground precursor for space-based ozone monitoring, unobscured telescope – Lead Optical Engineer
- Cost effective star camera baffle stray light analysis – stray light analyst
- Airborne LiDAR – Tolerance Analysis
- Space launched imager – structural, thermal optical performance analysis
- Weapon mounted riflescope display – optical design and development
- Handheld, Long Wave Infrared Hyperspectral Selfie (8-14 μm) – Lead Optical Engineer, concept development, design
- Mars Science Laboratory Mast Camera (Mastcam) on the Mars Curiosity Rover– structural, thermal optical performance analysis
- NASA ARCSTONE – Visible, Near Infrared and Short Wave Infrared Prism-Grating-Prism Hyperspectral Imagers – structural, thermal optical performance analysis, design review and consulting
- Cost effective magnification aid for the visually impaired – Project Lead, optical design

- NASA L'RALPH telescope on the NASA LUCY Mission – Tolerance analysis, fabrication, optical coatings, structural, thermal optical performance analysis, alignment and optical testing
- Space-Based Free Space Laser Communications – Optical component design and development
- Mid Wave Infrared through Long Wave Infrared Zoom lens (3-12 μm) – Optical design optimization and narcissus reduction
- Spectral gas monitoring – Design and Analysis, 80% production unit cost reduction
- 400+ mm diameter telescope with eyepiece – Design, analysis, and optical systems engineering
- 400+ mm diameter LEO telescope – Design, analysis, structural, thermal optical performance analysis, and optical systems engineering
- Ultraviolet Laser Machining System – Design, analysis, and optical systems engineering
- Scheimpflug imaging system
- Conceptual development of multiple optical systems

12. I serve as the Chair for the joint SPIE and Optics and Electro-Optics Standards Council (OEOSC) Infrared Materials Standards Working Group,

Chair of OEOSC and I am one of the authors of Chapter 6 titled *Infrared Optical Systems* for the SPIE book titled "Review of Optical Manufacturing 2000-2020."

13. Throughout my career, I have designed, built, tested and contributed to various optical and electro-optical systems. Systems pertinent to the matters delineated in this Declaration include Light Detection and Ranging (LiDAR), laser range finders, wavefront sensors, Scheimpflug imaging systems, illumination systems, and projection systems. LiDAR and laser range finders are relevant as these systems project light as either collimated beams or focused spots, whether they be single or multiple, akin to what is discussed in the '803 patent. Wavefront sensors, particularly those that utilize a lenslet array, are often employed in applications such as free-space laser communications. The '803 system utilizes infrared LEDs for illumination, and I have engineered multiple LED-based systems for object illumination. Additionally, projection systems reimage a small, pixelated display onto an object at a larger size; I have expertise in designing these systems as well.

14. For additional information about my background as well as a list of my publications, please see my attached CV.

II. The ‘803 Patent

A. Summary

15. The ’803 Patent (EX1001) shows a lens system for generating a light pattern to be used with computer vision systems. EX1001, Abstract. The ’803 Patent says that the lens system addresses a need for more accurate tracking and determination of object positions, which the patent says was not met by prior art that provides a light pattern that was “too regular.” EX1001, 1:20-35, 2:51-58.

16. The ’803 Patent describes that its light pattern is created via a combination of a light emitting diode (LED) cluster 110, a condenser lens 120, and a lens cluster 130. EX1001, 5:64-6:17, FIG. 4 (reproduced below).

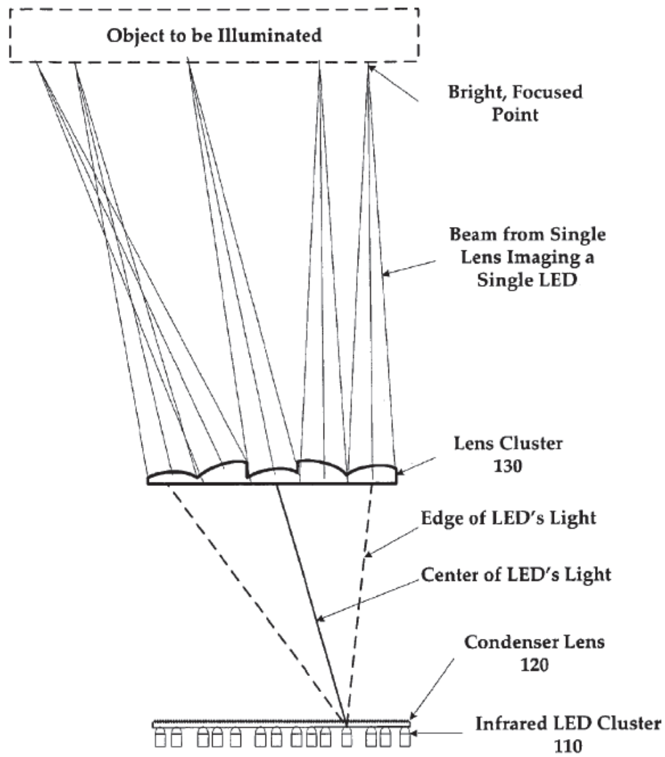


FIGURE 4

EX1001, FIG. 4.

17. The ’803 Patent says that the condenser lens 120 redirects light from the LED cluster 110, towards the center of the lens cluster 130, and the lens cluster 130 focuses the light onto different locations on a distant plane, e.g., Object to be Illuminated. This creates a discernable light pattern that may be detected by a camera and processed by a computing device in order to track an object illuminated by the light pattern. EX1001, 6:4-27.

18. As explained in more detail below, the use of an irregular light pattern and the combination of a LED cluster, a condenser lens, and a lens cluster, however, was well known in the art prior to the ‘803 patent.

B. Prosecution History

19. I am informed that the patent application (U.S. Application No. 13/448,321) (the “Application”) for the ’803 Patent was filed on April 16, 2012, and is a divisional application of U.S. Application No. 12/269,849, filed on November 12, 2008, which claims priority to Provisional Application No. 60/987,315, filed on November 12, 2007.

20. The Challenged Claims were allowed on April 16, 2014, after the Applicant amended independent claims 1, 8, and 21 of the Application (independent claims 1, 8, and 15 of the ’803 Patent, respectively), and an Examiner’s Amendment to claim 8, to describe an aspect of the function of a “cluster of lenses.” EX1002, pp. 385-392.

21. In an Amendment (September 23, 2013), the Applicant amended independent claims 1 and 8 in response to claims 1, 2, 4-9, 11-14, and 21-25 being rejected as obvious based on U.S. Patent Application No. 2005/0110964 (“Bell”) in view of U.S. Patent Application No. 2008/0245952 (“Troxell”) and U.S. Patent Application No. 2006/0078015 (“Franck”) as follows:

> a cluster of lenses located in front of the light source, wherein each lens of the cluster of lenses is configured to receive light from the plurality of emitters and the cluster of lenses is configured to concurrently focus and project light from each of the emitters in a plurality of directions~~, the focused and projected light forming the pattern of light~~; and

EX1002, p. 343 (amendment to claim 1).

> receiving light from the plurality of emitters at a plurality of points; and
>
> concurrently focusing the ~~emitted~~ light from each of the plurality of lights in a plurality of directions from the central location~~, the focused light forming a pattern of light~~.

EX1002, p. 344 (amendment to claim 8).

22. In a Final Office Action (January 17, 2014), independent claims 1 and 8 were indicated to be allowable for the following reasons:

> As to **claim 1**, the prior art of record, taken alone or in combination, fails to disclose or render obvious in a system for projecting a pattern of light 'a cluster of lenses located in front of the light source, wherein each lens of the cluster of lenses is configured to receive light from the plurality of emitters and the cluster of lenses is configured to concurrently focus and project light from each of the emitters in a plurality of directions,' in combination with the rest of the limitations of **claim 1. Claims 2, 4-7, and 24** are allowable by virtue of their dependency from **claim 1.**

EX1002, p. 358 (reasons for allowance of claim 1).

> As to **claim 21**, the prior art of record, taken alone or in combination, fails to disclose or render obvious in a system for projecting a pattern of light 'a cluster of lenses, each lens included in the cluster of lenses being configured to receive the emitted light from each of the plurality of emitters' in combination with the rest of the limitations of **claim 21. Claims 22 and 23** are allowable by virtue of their dependency from **claim 21.**

EX1002, p. 358 (reasons for allowance of claim 21).

23. In the Final Office Action, the rejection based on Bell, Troxell, and Franck was maintained for claims 8-9, 11-13, and 25. EX1002, p. 355.

24. Following an After-Final Amendment filed March 14, 2014, the Examiner entered an Examiner's Amendment for claim 8 and allowed the Challenged Claims on April 16, 2014. EX1002, p. 391. The Examiner's Amendment to claim 8 was as follows:

> **Claim 8** lines 8-10 is amended from 'concurrently focusing, from the cluster of lenses, the received and concentrated light from the plurality of emitters in a plurality of directions.' to read -concurrently focusing, from each lens of the cluster of lenses, the received and concentrated light from each of the plurality of emitters in a plurality of directions.-

EX1002, p. 391 (Examiner's Amendment to claim 8). On August 19, 2014, the Application issued as the '803 Patent. EX1002, p. 416.

III. Relevant Legal Standards

25. I am not an attorney. My analysis and opinions are based on my expertise in this technical field, as well as the instructions I have been given by counsel for the legal standards relating to patent validity.

26. The materials I have reviewed in connection with my analysis include the '803 patent, its file history, and the cited references and exhibits.

27. I understand that patents are presumed to be valid. I understand that invalidity in this proceeding must be proven by a preponderance of evidence, i.e., more likely than not, and that is the standard I have used throughout my report. Further, I understand that each patent claim is considered separately for purposes of invalidity.

28. I am informed that a patent claim is invalid as "anticipated" if each and every feature of the claim is found, expressly or inherently, in a single prior art reference. Claim limitations that are not expressly found in a prior art reference are inherent if the prior art necessarily functions in accordance with, or includes, the claim limitations. It is acceptable to examine evidence outside the prior art reference (extrinsic evidence) in determining whether a feature, while not expressly discussed in the reference, is necessarily present in it.

29. I understand that a patent claim is invalid as "obvious" if, in view of a prior art reference or a combination of prior art references, it would have been obvious to a person of ordinary skill in the art at the time of the invention, taking into account:

- the scope and content of the prior art;
- the differences between the prior art and the claim under consideration
- the level of ordinary skill in the art.

30. I am informed that legal principles regarding invalidity of a claim due to obviousness were addressed by the U.S. Supreme Court. I am informed that the principles relating to a "motivation," "suggestion," or "teaching" in the prior art to combine references to produce the claimed alleged invention remain an appropriate approach in a validity analysis. I am informed that the suggestion or motivation may be either explicit or implicit, may come from knowledge generally available to one of ordinary skill in the art, and may come from the nature of the problem to be solved. The test for an implicit motivation, suggestion, or teaching is what the combined teachings, knowledge of one of ordinary skill in the art, and the nature of the problem to be solved as a whole would have suggested to those of ordinary skill in

the art. The problem examined is not the specific problem solved by the invention but the general problem that confronted the inventor before the invention was made.

31. I am informed, however, that the U.S. Supreme Court clarified that additional principles may also be applied in such an analysis. I set forth some such additional principles below.

32. As I understand it, it is no longer always required to present evidence of a teaching, suggestion, or motivation to combine prior art references for purposes of determining whether an invention is obvious. Prior art can be combined based on either a teaching, suggestion, or motivation from the prior art itself, or from a reasoned explanation of an expert or other witness.

33. A patent claim composed of several elements, however, is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. In order to prove obviousness, it must be shown that the improvement is not more than the predictable use of prior-art elements according to their established functions. To determine whether there was an apparent reason to combine the known elements in the way a patent claims, it will often be necessary to look to interrelated teachings of multiple pieces of prior art, to the effects of demands known to

the design community or present in the marketplace, and to the background knowledge possessed by a person having ordinary skill in the art. Also, in determining obviousness, one must be aware of the distortion caused by hindsight bias and be cautious of arguments reliant upon hindsight reasoning. An obviousness argument cannot be sustained by mere conclusory statements; instead, it must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.

34. In an obviousness analysis, it is my understanding that there are "secondary considerations" that should be analyzed if they apply. I am told that these considerations include whether the prior art teaches away from the claimed invention, whether there was a long felt but unresolved need for the claimed invention, whether others tried but failed to make the claimed invention, skepticism of experts, whether the claimed invention was commercially successful, whether the claimed invention was praised by others, and whether the claimed invention was copied by others. I am not aware of any secondary considerations, but if any are presented to me, I will consider them in connection with my analysis.

35. I have also been instructed that ultimately claims are construed in light of how one of ordinary skill in the art would understand the claims. It is my

understanding that what is to be considered includes the claims, the patent specification and drawings, and the prosecution history including any art listed by the Examiner or the applicant. It is my understanding that information external to the patent, including expert and inventor testimony and unlisted prior art, are to be considered in construing the claims only if ambiguities remain. However, expert testimony may be useful in helping to explain the technology. I further understand technical dictionaries, encyclopedias, and treatises may also be used in claim construction, as long as these definitions do not contradict any definition found in or ascertained by a reading of the patent documents. In my analysis, I have considered and applied the proposed claim constructions of the Petitioners, unless otherwise indicated.

36. I understand that an issued U.S. patent is presumed to be valid and can be challenged in this proceeding on invalidity grounds only upon proof by a preponderance of evidence.

V. Person of Ordinary Skill in the Art

37. Most of the technology disclosed in the ‘803 patent would be taught in a typical junior-level college course in optical design, for an optics major or physics major with an emphasis in optics. Having said that, a person

having ordinary skill in the technology of the '803 patent would be someone with a bachelor's degree in physics or optics, and at least 2 years of experience designing or analyzing optical systems or equivalent experience.

VI. Claim Construction

38. I have been instructed to employ the plain and ordinary meaning of the claim terms from the eyes of one of ordinary skill, and I have done so in my analysis herein.

VII. LISTING OF GROUNDS

a. GROUND 1: Claims 15-16 are anticipated by Weidel (EX1004);

b. GROUND 2: Claims 1 and 8 are anticipated by Mizusawa (EX1008);

c. GROUND 3: Claim 15 is obvious by Tatsukawa (EX1007) in view of Brandenburg (EX1006).

d. GROUND 4: Claims 1-6, 8-13, and 15-16 are obvious by Weidel (EX1004) in view of Chinniah.

e. GROUND 5: Claims 1-6, 8-13, and 15-16 are obvious by Chinniah (EX1005) in view of Brandenburg (EX1006) and Osawa (EX1011);

f. GROUND 6: Claims 7, 14, and 17 are obvious by Chinniah (EX1005) in view of Brandenburg (EX1006) and Osawa (EX1011), and in further view of Hilaire (EX1009) and/or Cheon (EX1010).

g. GROUND 7: Claims 3-4 and 10 are obvious by Weidel (EX1004) in view of Chinniah (EX1005), and in further view of Osawa (EX1011).

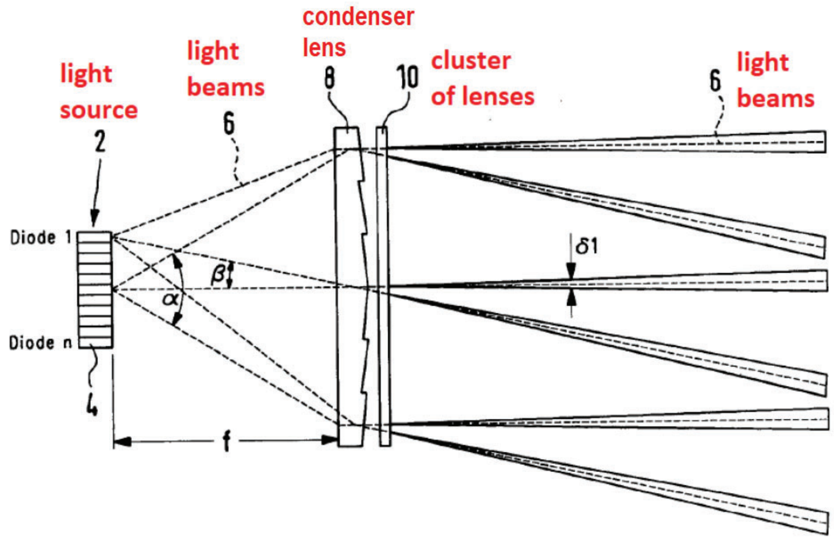
h. GROUND 8: Claims 7, 14, and 17 are obvious by Weidel (EX1004) in view of Chinniah (EX1005), and in further view of Hilaire (EX1009) and/or Cheon (EX1010).

VIII. ANALYSIS OF GROUNDS

A. GROUND 1: Weidel anticipates Claims 15 and 16

39. I have read and analyzed the Weidel reference (EX1004 - German Patent Application Publication No. 10129743C2). Weidel discloses every element of claims 15 and 16. For example, Weidel's Fig. 1 and corresponding discussion discloses a plurality of LEDs (Diodes 1-n) as the "light source", a diffuser 10 made of multiple microlenses as the "cluster of lenses", and a condenser lens 8 between the "light source" and the "cluster of lenses".

40. Weidel (EX1004) discloses a vehicle headlight projection system that projects a pattern of light. EX1004, ¶¶ [0001] and [0009]-[0010]. The system includes a light source (two-dimensional array 2), a cluster of lenses (a diffuser 10 made of micro lenses), and a condenser lens (collecting lens 8) located between the light source and the cluster of lenses. FIG. 1.



EX1004, FIG. 1 (annotated)

41. Weidel explains that the light source (two-dimensional array 2) includes emitters (diodes 4) that emit light and are arranged in a pattern, e.g., a semi-elliptical pattern. EX1004, ¶ [0024]. The emitters may include light emitting diodes 1-n configured to generate infrared light that is detectable by a camera, but not by an eye of a human observer interacting with an object illuminated by at least a portion of the light. EX1004, ¶¶ [0005], [0012], [0018] and [0037].

42. The converging lens 8 concentrates light from each of the plurality of emitters 1-n towards a center of the cluster of lenses 10. EX1004, ¶ [0028]-[0029]; FIG. 1.

43. The cluster of lenses (diffuser 10) can be made of multiple micro-lenses that project light from each of the emitters in many overlapping directions. EX1004, ¶¶ [0013], [0029], [0031], and claim 8.

44. Weidel teaches that his vehicle headlight projection system may be incorporated into a night vision system that also has a camera that captures infrared light emitted from the plurality of emitters and reflected off of objects in front of the vehicle. EX1004, ¶¶ [0005] and [0012].

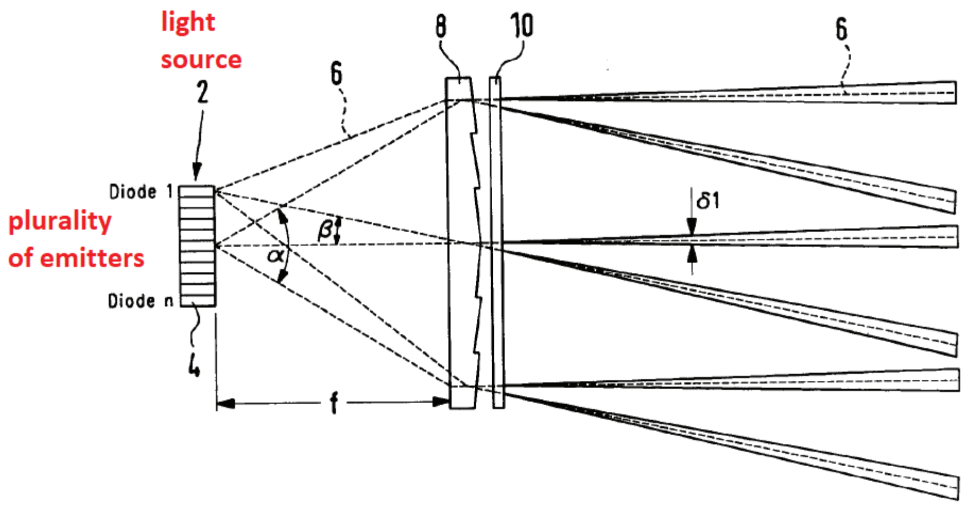
45. **Claim 15**

46. **15[pre] "A system for projecting a pattern of light, the system comprising:"**

47. The Weidel reference includes a system for projecting a pattern of light. EX1004, ¶¶ [0009]-[0010].

48. **15[a] "a light source including a plurality of emitters configured to emit light;"**

49. The Weidel reference teaches a light source (e.g., diode array 2) including a plurality of emitters (e.g., Fig. 1 shows the traced light rays of two diodes in array 2) configured to emit light.

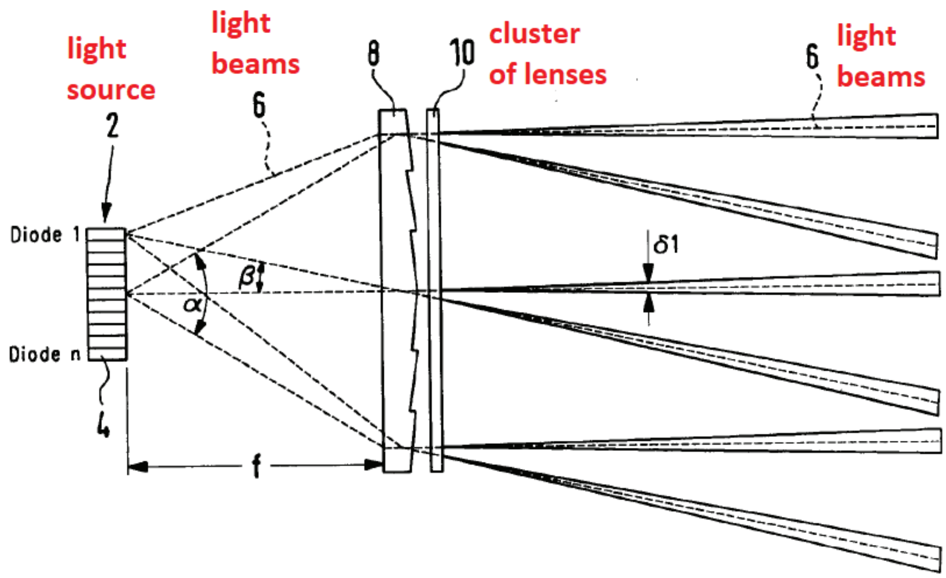


EX1004, FIG. 1 (annotated) *See also* [0023]-[0024];

50. FIG. 1 of Weidel shows the emitters (diodes of array 2) are arranged in a pattern for projecting light.

51. **15[b] "a cluster of lenses, each lens included in the cluster of lenses being configured to receive the emitted light from each of the plurality of emitters; and"**

52. Weidel explains that diffuser 10 can be a collection of microlenses, i.e., "cluster of lenses." EX1004, ¶ [0031] ("[M]icrolenses or microwedges can be used as the diffuser 10.").

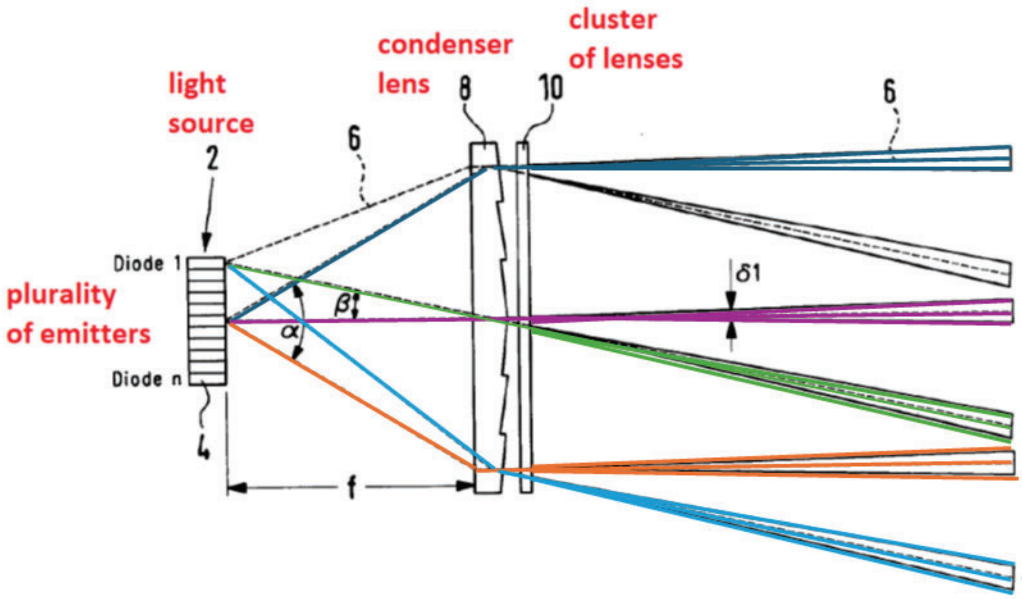


EX1004, FIG. 1 (annotated)

53. As shown in FIG. 1, Weidel also teaches that the entire cluster of lenses (e.g., diffuser 10 including microlenses) receives light from each of the emitters in the light source. EX1004, Claim 8 (describing a "diffuser (10) … in the light path of the light beams (6) of some or ***all of the luminous elements***") (emphasis added). Weidel discloses this element.

54. As also shown in Fig. 1, light from each of the LEDs reaches each lens in the cluster of lenses (e.g., the microlenses between the rays drawn in Fig. 1). As is common in optics drawings, Weidel has only drawn three representative rays coming from each of two example diodes. A person of ordinary skill in the art would understand from reading the Weidel reference and from basic college level physics or optics sources, that 1) more light

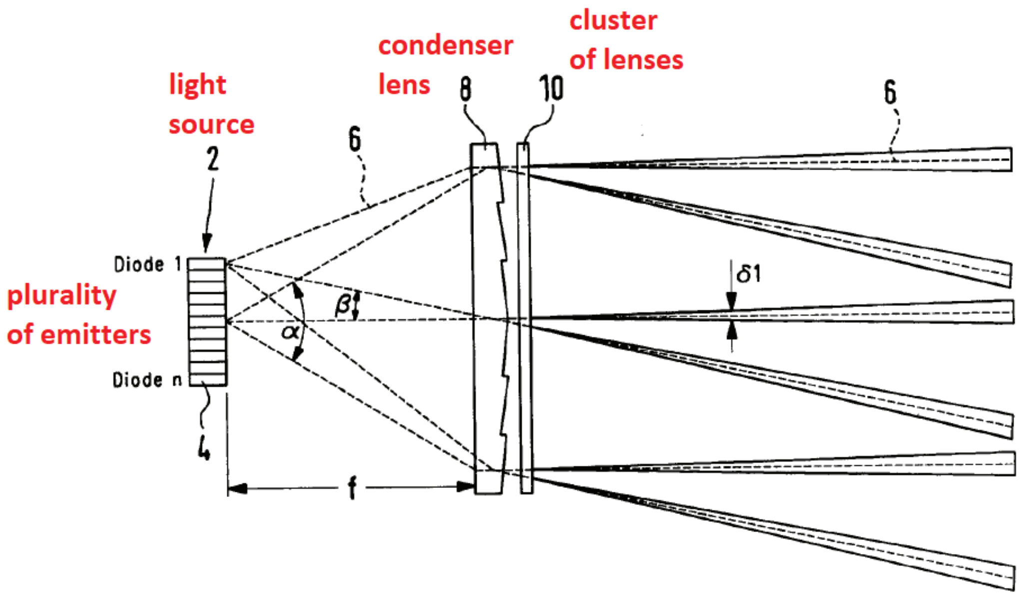
would be emitted from those two diodes than just those two rays – e.g., that the region between the three rays would be lit as well; 2) the diodes shown in Weidel that have no corresponding rays drawn, would also have rays similar to those drawn for Diode 1 and the middle Diode; 3) it is standard knowledge that a Diode emits light nearly into a hemisphere (e.g., 180° cross section); and 4) it is standard practice to draw rays that represent light emitting from a Diode that only captures its solid angle at their full width at half maximum of the peak intensity (e.g., see α in Weidel FIG 1 drawn at approximately 45° -- see also my color annotated version below). Therefore one of ordinary skill would understand that the light emitted from the Diodes in Weidel will overfill, or extend even wider than the rays drawn in FIG. 1. In other words, one of ordinary skill in the art would understand that Weidel is conveying via representative ray drawings, that light from each diode 1-n, will extend beyond the full range as shown by the representative rays in Figure 1 of Weidel.



55. Therefore, one of ordinary skill would understand that every microlens in the diffuser 10 between the uppermost and lowermost rays drawn in Figure 1, would receive light from each diode 1-n.

56. **15[c] "a condenser lens located between said light source and said cluster of lenses, the condenser lens concentrating light from each of the plurality of emitters towards a center of the cluster of lenses."**

57. The Weidel reference includes a condenser lens (collecting lens 8) for collimating diverging light beams of each emitter (in diode array 2) that is located between the light source (diode array 2), and the cluster of lenses (microlenses of diffuser 10). *Id*., FIG. 1; ¶ [0028]; ¶ [0013] ("The diffuser is preferably arranged close to the converging lens on its light exit side[.]"); Claim 8:



EX1004, FIG. 1 (annotated)

58. Weidel also teaches the condenser lens (collecting lens 8) is configured to concentrate the light beams 6 from each of the plurality of emitters (diode array 2) towards a center of the cluster of lenses (microlenses of diffuser 10). *Id*., at ¶ [0028] ("The collecting lens 8 collimates the diverging light beam 6 of each diode 4."); *Id*., at ¶¶ [0031]-[0032] ("[M]icrolenses . . . can . . . form[] the desired headlight distribution from the incoming collimated light.").

59. Thus, Weidel discloses "a condenser lens located between said light source and said cluster of lenses, the condenser lens concentrating light from each of the plurality of emitters towards a center of the cluster of lenses" as claimed.

Claim 16

60.**"The system of claim 15, wherein the plurality of emitters includes light emitting diodes configured to generate infrared light that is not detectable by an eye of a human observer"**

61.Weidel discloses that "one of the arrays can produce infrared light[.]" which includes wavelengths that are "not detectable by an eye of a human observer." *Id*., ¶ [0018], [0016] ("one of the arrays can produce infrared light, and the remaining arrays can produce visible light."). The Weidel reference teaches this so that "[t]he invention can be used in a night vision system[.]" *Id*., at ¶ [0012]; ¶¶ [0005], [0038], and claim 1 ("[A] portion of the number of light elements (4) emits infrared light.");

62. Weidel also discloses the requirement in claim 16 that "the plurality of emitters includes light emitting diodes configured to generate infrared light that is not detectable by an eye of a human observer."

63.For example, paragraphs [0005], [0010], [0016], and [0035] discuss including infrared laser diodes as the light source. *see. e.g.,* [0016] ("one of the arrays can produce infrared light, and the remaining arrays can produce visible light.")

64. It is generally accepted that infrared light spans the wavelength range of starting around 700 nm to 750 nm out to past 30,000 nm, whereas visible light spans the wavelength range of approximately 380 nm to somewhere between 700 nm and 750 nm. The infrared wavelength range is often grouped into subranges as follows:

a. Near Infrared (NIR): 750 nm – 1,100 nm
b. Short Wave Infrared (SWIR): 1,100 nm – 3,000 nm
c. Mid Wave Infrared (MWIR): 3,000 nm – 5,000 nm
d. Long Wave Infrared (LWIR): 5,000 nm – 14,000 nm
e. Very Long Wave Infrared (VLWIR): 14,000 nm – 30,000 nm

Source: ANSI/OEOSC OP1.007-2020: American National Standard For Optics and Electro – Optical Instruments – Optical Elements and Assemblies – Infrared Spectral Bands.(https://www.oeosc.org/standards-for-sale-category/tf6-infrared-materials/?_gl=1*2jp7m3*_ga*MTMyMTg5Mzg2OS4xNzM3NjY5Mjcy*_ga_B4L28MRGR1*MTc0NTI1OTMwOC42LjAuMTc0NTI1OTMwOC4wLjAuMA..)

65. Weidel discloses an example where the infrared emitters emit a wavelength of 810 nm, which is in the near infrared range (750 nm – 1,100 nm).

Weidel also says that "infrared light is almost invisible to the human eye". This is because some younger humans can see wavelengths as high as about 850 nm. But as we age, most people cannot see any infrared light (i.e., over 700 nm). Furthermore, the eye's spectral response to light changes based on how bright it is and as the brightness is reduced, the eyes peak response will shift to the blue, which further reduces the eyes' sensitivity to infrared light.

https://science.nasa.gov/ems/09_visiblelight/#:~:text=The%20visible%20light%20spectrum%20is,from%20380%20to%20700%20nanometers ("Typically, the human eye can detect wavelengths from 380 to 700 nanometers."); Sensitivity of the Human Eye, https://www.giangrandi.org/optics/eye/eye.shtml ("The human eye is sensible to light wave which wavelength is roughly between 400 nm (violet) and 700 nm (red). Wavelengths shorter than 400 nm (ultraviolet, UV) or longer than 700 nm (infrared, IR) are not visible.") Thus, the infrared wavelength discussed by Weidel of 810 nm, will not be detectable by many human eyes and therefore meets the language of claim 16 "the plurality of emitters includes light emitting diodes configured to generate infrared light that is not detectable by an eye of a human observer."

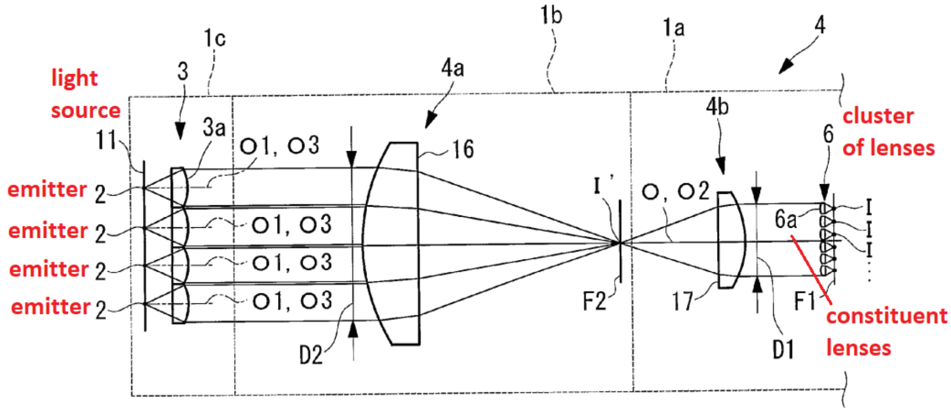
66. As set forth above, each and every limitation of claims 15-16 is disclosed in Weidel, and therefore Weidel anticipates these claims.

B. GROUND 2: Claims 1 and 8 are anticipated by Mizusawa

67. **Overview of Mizusawa**

68. Mizusawa (EX1008) is directed to, *inter alia*, a projection optical system for projecting an image with a light source, a system for projecting a mask pattern onto a photosensitive member, and an observation optical system for examining a target object illuminated with the illumination optical apparatus. EX1008, 6:5-16.

69. Mizusawa describes, *inter alia*, an optical illumination system that collects light emitted from light source 11 that includes light-emitting sections 2, converts diverging beams emitted from the light source 11 into a beam of collimated light, which are then concentrated by lens 16 toward a center of a cluster of lenses (fly-eye lens 6). The system projects the beams through the cluster of lenses (fly-eye lens 6) to form a plurality of light source images. EX1008, Abstract. The design of the illumination system in Mizusawa facilitates brighter illumination, even with dim light sources. EX1008, 5:6-16; FIG. 1A.



EX1005, FIG. 1A (annotated)

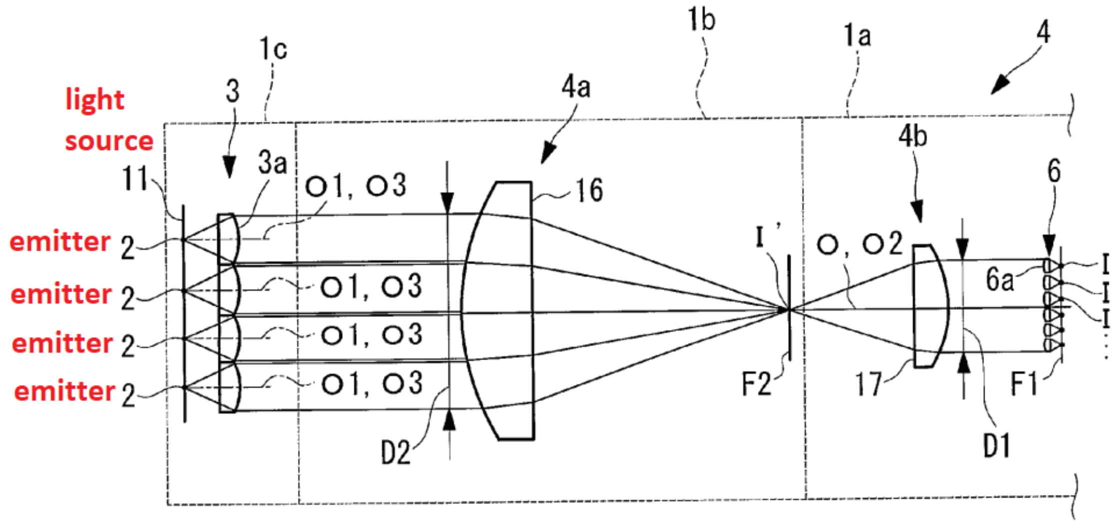
70. **Claim 1**

71. **1[pre] "A system for projecting a pattern of light, the system comprising:"**

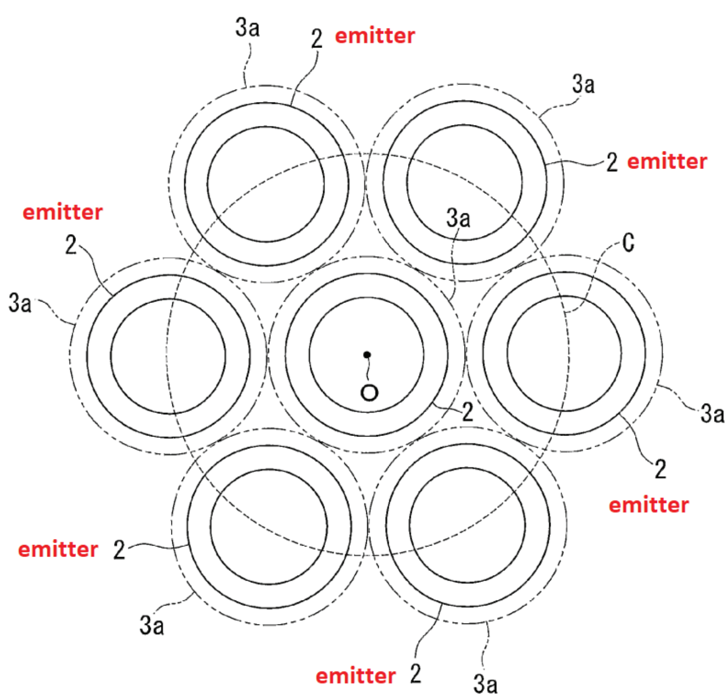
72. Mizusawa discloses a system for projecting a pattern of light, as claimed. EX1008, 4:63-5:5 (describing "a projection apparatus having a projection optical system for projecting an image . . . [and] an exposure apparatus having a projection optical system for projecting a mask pattern").

73. **1[a] "a light source including a plurality of emitters configured to emit light, the plurality of emitters arranged in a pattern;"**

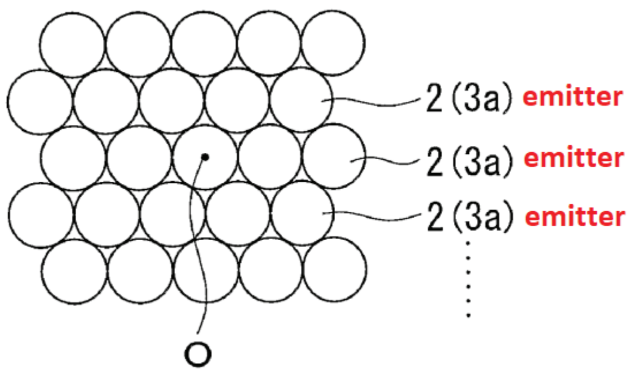
74. Mizusawa discloses a light source including a plurality of emitters (e.g., LED-array light source 11) configured to emit light and arranged in a pattern. EX1008, 6:55-60 ("As shown in FIG. 1A[,] . . . this embodiment includes an LED-array light source 11 . . . [that] are used as the light-emitting sections 2."), FIG. 1A.



EX1008, FIG. 1A (annotated); *see also* 6:56-58, 5:35-37, 7:13-16. In FIG. 1A, the emitters are arranged in a linear array pattern; Mizusawa also teaches to use other patterns as needed, for example, in FIGs 2 and 6A.



EX1008, FIG. 2 (annotated), *See also*, 5:48-50 ("FIG. 6A is a diagram showing another exemplary layout of light-emitting sections, lens elements, and constituent lenses of the illumination optical apparatus shown in FIG. 1A."), FIG. 6A.



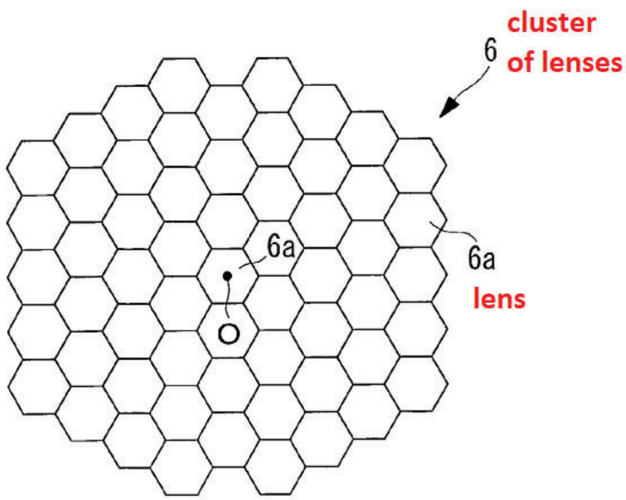
EX1008, FIG. 6A (annotated)

75. Accordingly, Mizusawa teaches to arrange the emitters in a pattern as claimed.

76. **1[b] "a cluster of lenses located in front of the light source, wherein each lens of the cluster of lenses is configured to receive light from the plurality of emitters and the cluster of lenses is configured to concurrently focus and project light from each of the emitters in a plurality of directions; and"**

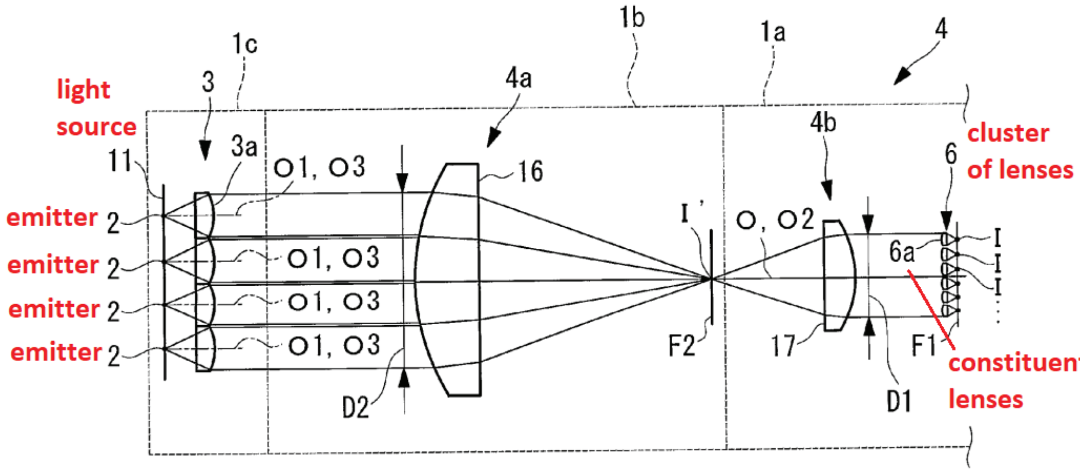
77. Mizusawa teaches a cluster of lenses (e.g., constituent lenses 6a of fly-eye lens 6 in FIGS 1A and 3). EX1008, 4:16-21 ("In the illumination optical apparatus with this structure, the fly-eye lens can form four or more light-source images from one light-emitting section. As a result, the Koehler

illumination optical system can illuminate the illumination surface from more directions than the number of light-emitting sections."). FIG. 3 of Mizusawa is reproduced below with annotation as an example.



EX1008, FIG. 3 (annotated); *See also*, 5:38-40 .

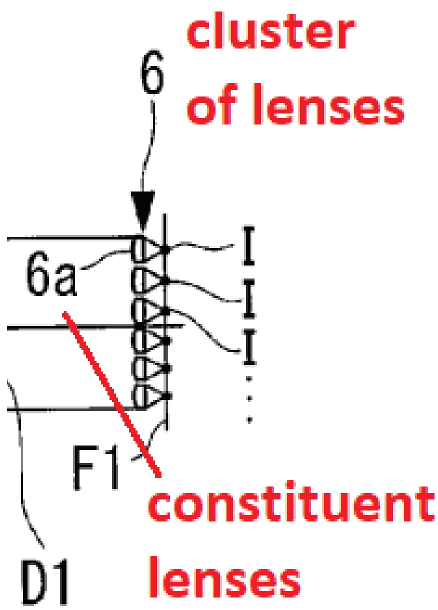
78. Mizusawa also teaches that the cluster of lenses is located in front of the light source and receives light from the light source. EX1008, FIG. 1A (constituent lenses 6a are in front of LED-array light source 11 and receive light from light source 11):



EX1008, FIG. 1A (annotated); *See, also*, 10:12-17 (describing how light-source images are produced from the constituent lenses 6a of the fly-eye lens 6 based on light received from the light-emitting sections 2). Accordingly, Mizusawa discloses that each lens of the cluster of lenses (e.g., constituent lenses 6a of fly-eye lens 6) is configured to receive light from the light source (e.g., LED-array light source 11). Thus, Mizusawa discloses "wherein each lens of the cluster of lenses is configured to receive light from the plurality of emitters" as claimed.

79. Mizusawa also teaches that the cluster of lenses (e.g., constituent lenses 6a of fly-eye lens 6) is configured to concurrently focus and project light from the light source in a plurality of directions. For example, as shown in FIG. 1A, the two representative light rays drawn as exiting from each constituent lens 6a are drawn in two directions ("a plurality of directions") to a focal

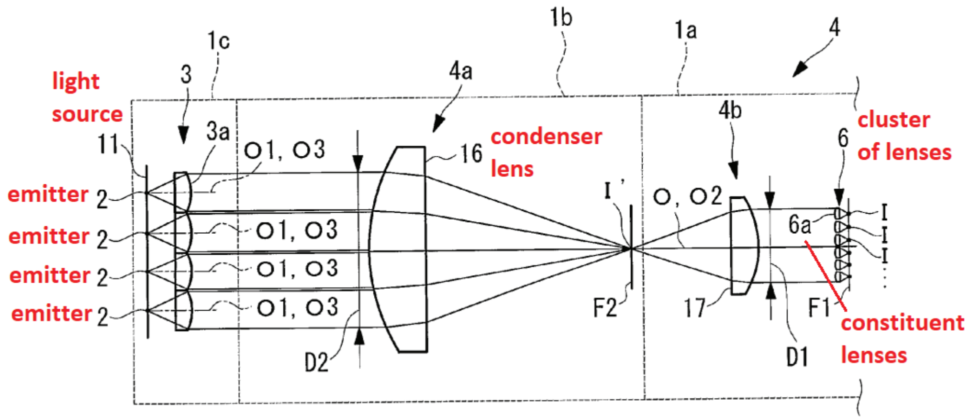
point I along back focal plane F1 indicate the focusing of the exiting light, and one of ordinary skill would understand that additional light rays exist between the drawn rays that would also exit 6a in different directions from the two drawn rays in order to focus at the indicated focal point I:



EX1008, FIG. 1A; EX1008, 9:51-55 ("[t]he Koehler illumination optical system 7 . . . superimpose[es] beams from the light-source images I formed by the fly-eye lens 6 onto the illumination surface F1 from a plurality of directions.") Thus, Mizusawa discloses "the cluster of lenses is configured to concurrently focus and project light from each of the emitters in a plurality of directions" as recited in claim 1 of the '803 patent.

80. **1[c] "a condenser lens located between the light source and the cluster of lenses, wherein the condenser lens is configured to concentrate light from each of the plurality of emitters towards a center of the cluster of lenses."**

81. Mizusawa discloses a condenser lens (e.g., focusing lens 16), located between the light source (LED-array light source 11) and the cluster of lenses (constituent lenses 6a of fly-eye lens 6). EX1008, 7:64-8:5.



EX1008, FIG. 1A (annotated)

82. Mizusawa also discloses that the "focusing lens 16 [is] for converging collimated beams obtained by the lens array 3 to focus images I from the plurality of light-emitting sections 2, . . . [and the] beams [are guided] onto the fly-eye lens 6." *Id.*, 7:64-8:5. Accordingly, Mizusawa discloses that the condenser lens (focusing lens 16) is configured to concentrate light from the light source (LED-array light source 11) towards a center of the cluster of lenses (constituent lenses 6a of fly-eye lens 6). Thus, Mizusawa discloses

"a condenser lens located between the light source and the cluster of lenses, wherein the condenser lens is configured to concentrate light from each of the plurality of emitters towards a center of the cluster of lenses" as claimed.

83. **Claim 8**

84. **8[pre] "A method comprising"**

85. *See* GROUND 2, Claim 1[pre], 1[a], 1[b], 1[c].

86. **8[a] "emitting, from a plurality of emitters, a plurality of lights arranged in a pattern;"**

87. *See* GROUND 2, Claim 1[a].

88. **8[b] "concentrating, via a condenser lens, the plurality of lights towards a central location of a cluster of lenses;"**

89. *See* GROUND 2, Claim 1[c].

90. **8[c] "receiving the concentrated light at a plurality of points within the cluster of lenses; and"**

91. *See* GROUND 2, Claim 1[b].

92. **8[d] "concurrently focusing, from each lens of the cluster of lenses, the received and concentrated light from each of the plurality of emitters in a plurality of directions;"**

See GROUND 2, Claim 1[b] .

C. GROUND 3: Claim 15 is obvious by Tatsukawa in view of Brandenburg

93. **Overview of Tatsukawa**

94. Tatsukawa teaches a vehicle headlamp system with a light source, a projector lens, and an array of lens elements that provide a light diverging function. EX1007, 2:35-61. The vehicle headlamp forms a light distribution pattern with an upper cutoff line, and controls projected light beams to avoid causing glare for oncoming traffic. EX1007, 2:2-7, 2:35-45.

95. **Overview of Brandenburg**

96. Brandenburg (EX1006) is directed to an optical lens that enables an overall light intensity distribution to be influenced by locally shaping the light beams. EX1006, ¶¶4.

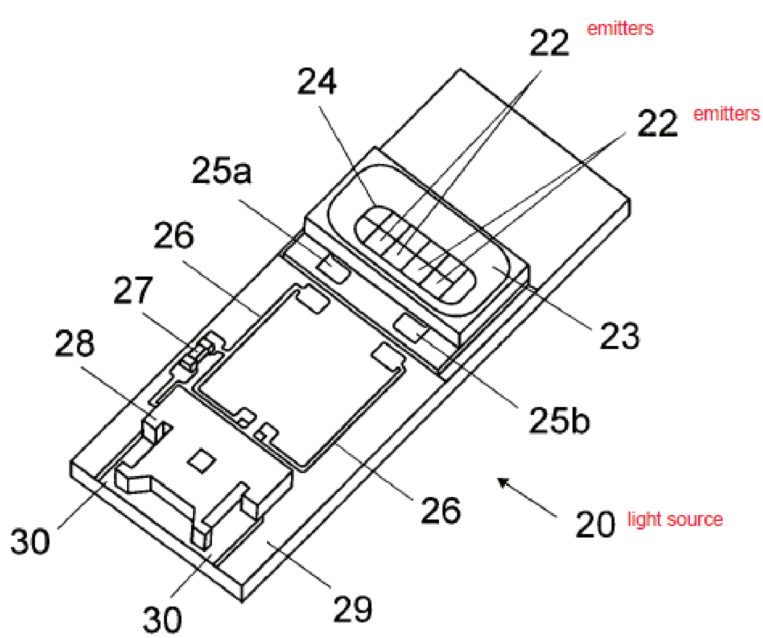


FIG 4

EX1006, FIG. 4 (annotated)

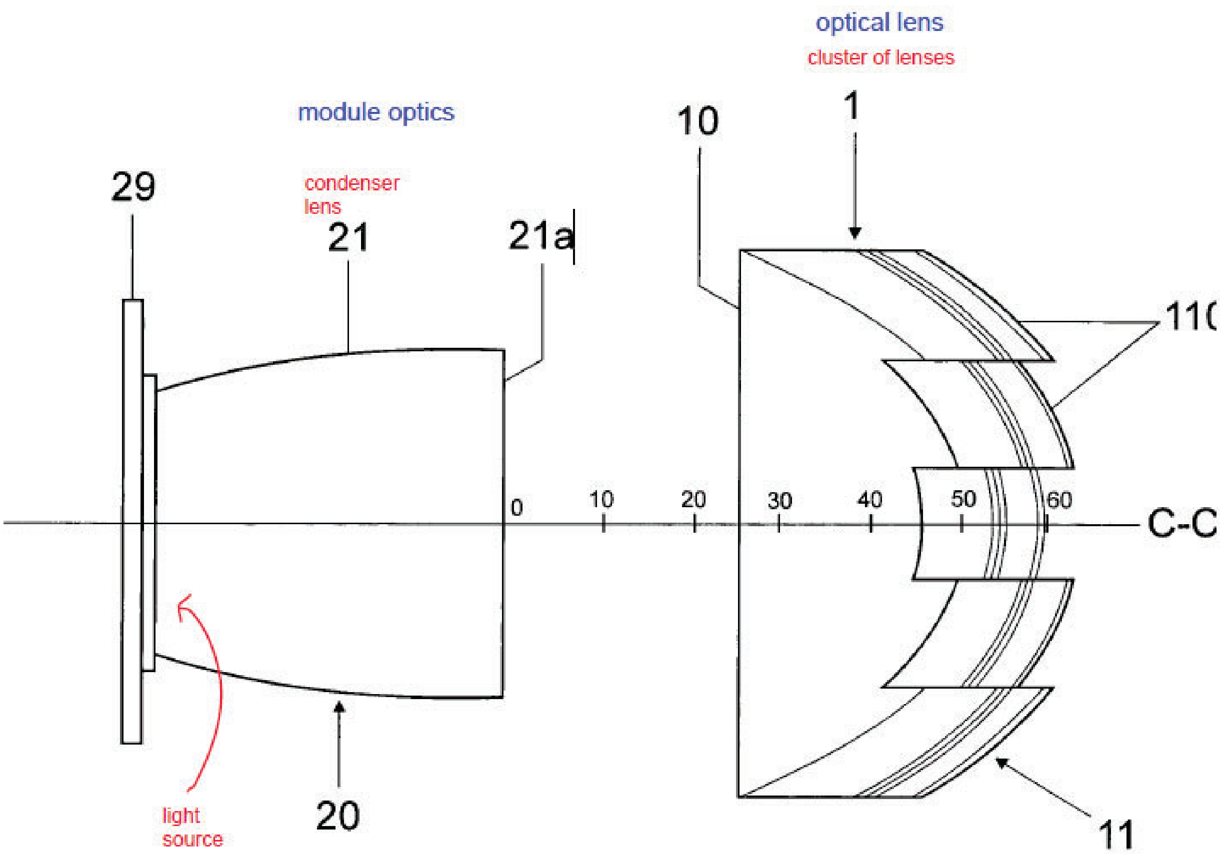


FIG 6

EX1006, FIG. 6 (annotated)

97. Brandenburg discloses a lighting device or system including a light source (light-emitting diode module 20) with emitters (light-emitting diode chips 22) and optical elements (e.g., an optical lens 10) to enable the overall light intensity distribution to be shaped. EX1006, [0004], [0009], and FIGS. 4-6, 7, and 12. The lighting system enables different light intensity distributions,

different color temperatures and colors of light, and different lighting functions. EX1006, [0004], [0009], [0012], [0031], [0039]-[0040].

98. I have read and analyzed the Tatsukawa reference (EX1007) and the Brandenburg reference (EX1006). The combined teachings of these references teach all of the elements of claim 15 of the '803 patent, in the same way that the patent owner has applied claim 15 to certain accused products.

99. Tatsukawa shows a condensing lens 12 that has a pattern formed on its exiting surface 12a. The condensing lens 12 corresponds to the "condenser lens" element of claim 15, and the pattern formed on the surface 12A corresponds to the "cluster of lenses" element of claim 15.

100. As shown in Figure 3 of Tatsukawa, light bends toward the center when it interacts with each of the two surfaces.

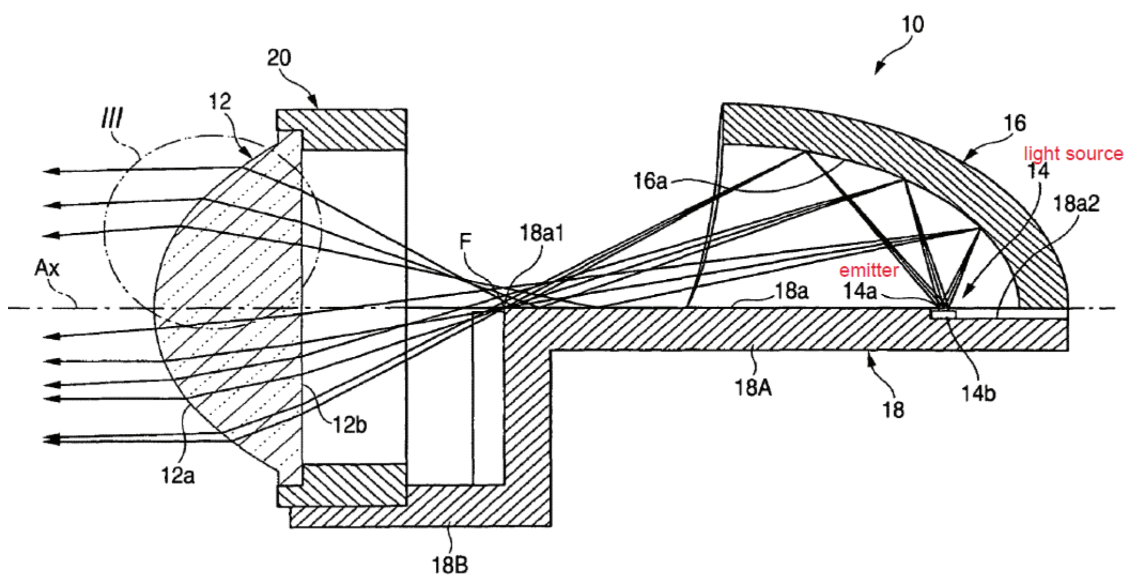
101. When light interacts with a surface whose refractive index is not equal to the incoming surfaces refractive index, then the light will bend per Snell's law of $n_1 \sin\theta_1 = n_1 \sin\theta_2$, where n_1 is the refractive index of the incoming medium and θ_1 is the angle of incidence of light on the incoming surface and n_2 and θ_2 are after refraction.

102. **Claim 15**

103. **15[pre] "A system for projecting a pattern of light, the system comprising:"**

104. Tatsukawa discloses a system for projecting a pattern of light. EX1007, 2:47-57 ("[A] vehicle headlamp is provided with a projector lens[,] . . . for forming a light distribution pattern."); FIG. 2 (pattern of light exiting lens 12).

FIG. 2



EX1007, FIG. 2 (annotated)

105. **15[a] "a light source including a plurality of emitters configured to emit light;"**

106. Tatsukawa discloses a light source (e.g., light emitting element 14). EX1007, 6:47-52, FIG. 2. Tatsukawa does not describe a plurality of emitters, but Brandenburg expressly teaches to use multiple emitters and emitter modules in a vehicle headlight system to make the light brighter. EX1006, [0040] ("So as to achieve, for example, the highest possible light intensity, the illumination device according to the invention, however, can alternatively also comprise multiple light-emitting diode modules 20…"); ¶ [0031] ("In this embodiment, the light-emitting diode module 20 comprises five light-emitting diode chips 22. These light-emitting diode chips 22 are, for example, thin-film light-emitting diode chips 22 with a light output of at least 20 lumens per watt."), FIG. 4., ¶ [0011], FIG. 5.

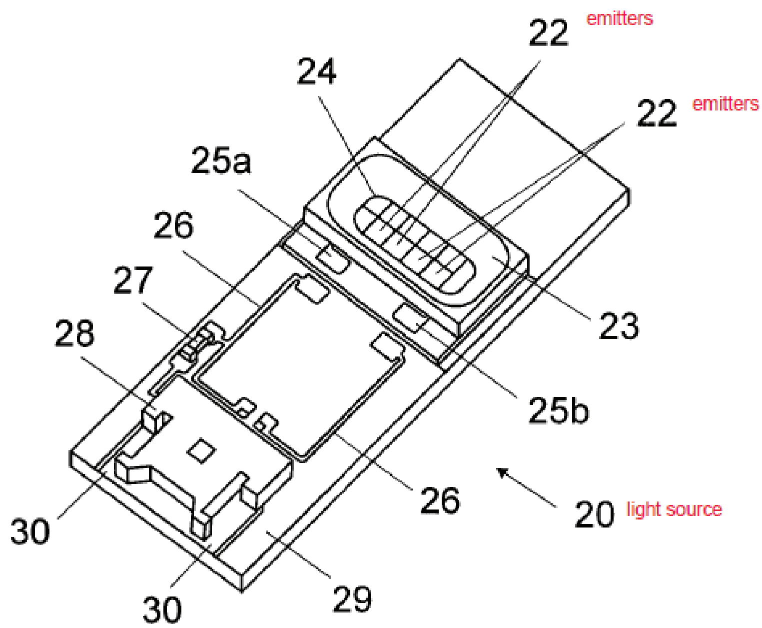


FIG 4

EX1006, FIG. 4 (annotated)

107. Brandenburg also teaches that you can use multiple LED modules to provide variability in the color temperature or light color, and to allow for lighting variability by turning modules on or off as need. see, Pars. [0009], [0012] [0040] ("the brightness can be varied by switching individual light-emitting diode modules 20 on or off or, in the case of differently designed light-emitting diode modules 20, the color temperature or the color of the light can be adjusted by activating or deactivating or dimming individual light-emitting diode modules 20").

108. A person of ordinary skill would have considered it obvious to combine the teachings of Brandenburg to use more than one LED emitter in a Tatsukawa type of system, in order to increase the light output and/or to provide the flexibility in light output intensity, color, and color temperature that Brandenburg teaches.

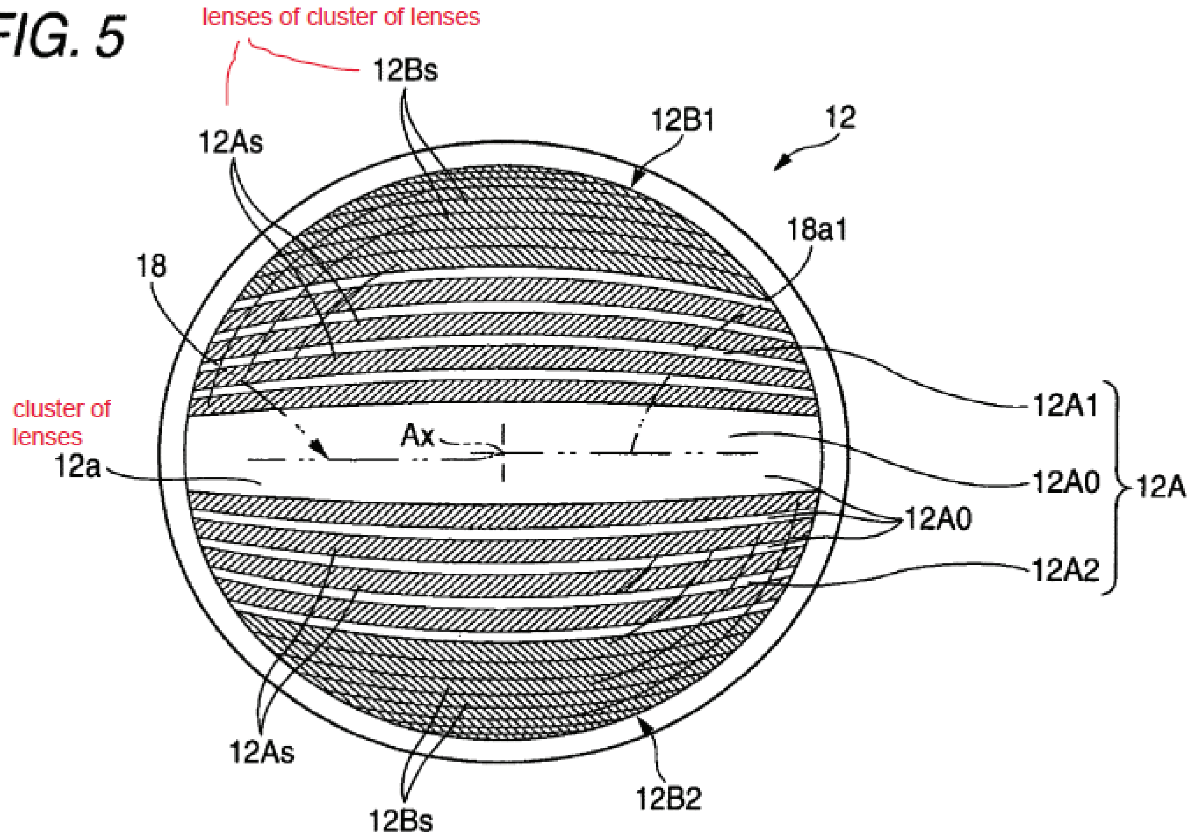
109. **15[b] "a cluster of lenses, each lens included in the cluster of lenses being configured to receive the emitted light from each of the plurality of emitters; and"**

110. Tatsukawa teaches a cluster of lenses (e.g., lens elements 12As and 12Bs).[1] EX1007, 2:58-61 ("In the lamp unit, at least a portion of a surface of the projector lens is constituted as an up and down direction diverging portion comprising a plurality of lens elements."), 7:54-8:57, FIGS. 1-5.

111. FIG. 5 of Tatsukawa is reproduced below.

1 It is my understanding that the Patent Owner has alleged that such lens elements in accused headlamps meets the claimed "cluster of lens".

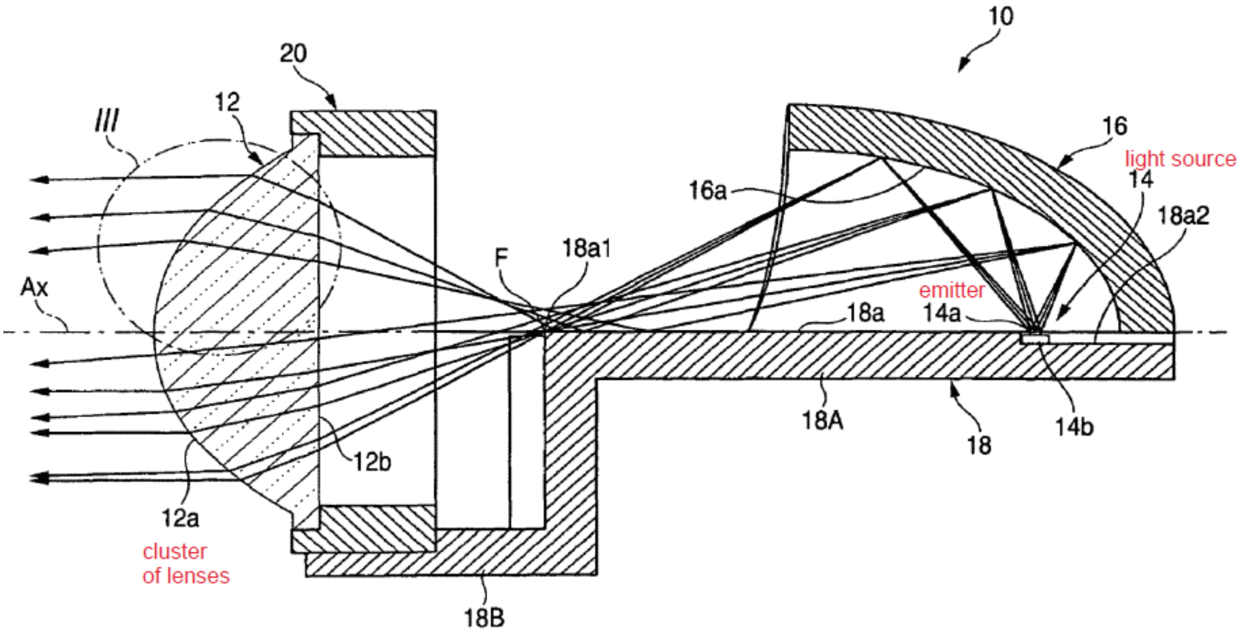
FIG. 5



EX1007, FIG. 5 (annotated)

112. Tatsukawa also teaches that the lens elements 12As and 12Bs are configured to receive light from the light source. EX1007, FIGS. 2-5. FIG. 2 of Tatsukawa is reproduced below as an example.

FIG. 2



EX1007, FIG. 2 (annotated)

113. As shown above in FIG. 2 of Tatsukawa, light from light emitting element 14 reaches the cluster of lenses (lens elements 12As and 12Bs). EX1007, FIGS. 3-4.

114. Moreover, Tatsukawa discloses that the lens elements "are structured to form a plurality of dim light portions on an upper vicinity of the cutoff line, wherein the dim light portions are reduced in luminescence relative to the rest of the light distribution pattern," such that light from light emitting element 14 is received by each of the lens elements. EX1007, claim 1; EX1007, 8:40-44 (describing a function of lens elements 12As and 12Bs). Accordingly, Tatsukawa discloses that each lens of the cluster of lenses

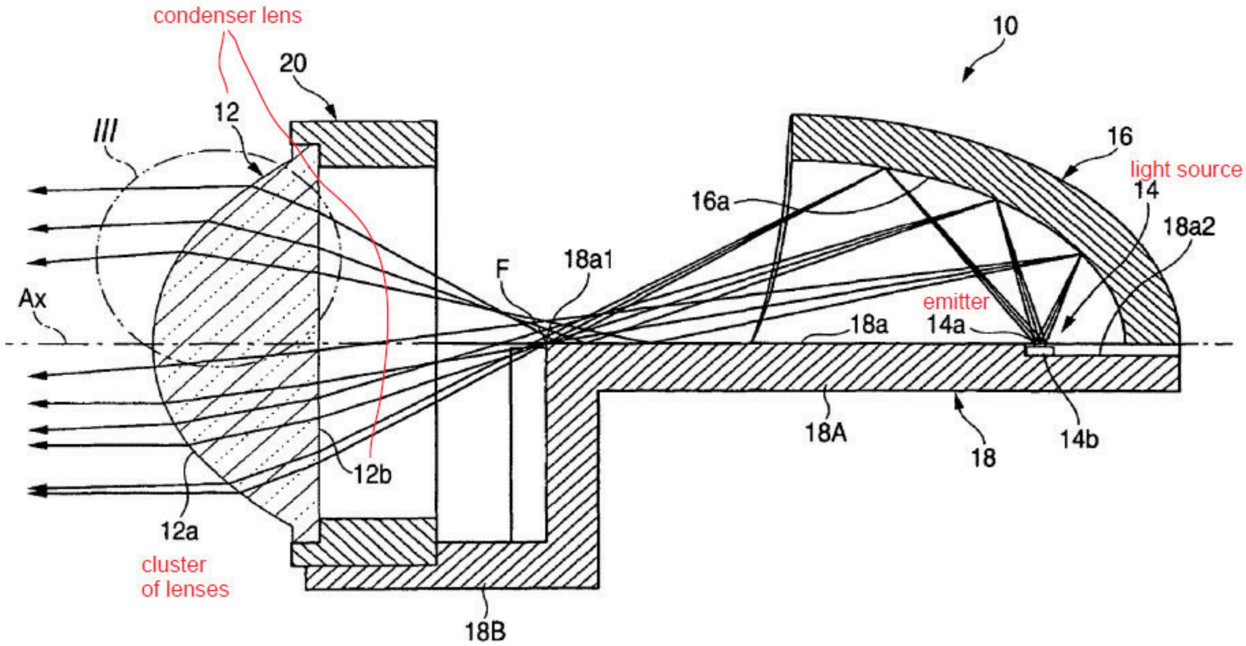
(lens elements 12As and 12Bs) is configured to receive light from the light emitting element 14. Thus, the combination of Tatsukawa and Brandenburg, in which the light source includes a plurality of emitters, discloses "a cluster of lenses, each lens included in the cluster of lenses being configured to receive the emitted light from each of the plurality of emitters" as claimed.

115. **15[c] "a condenser lens located between said light source and said cluster of lenses, the condenser lens concentrating light from each of the plurality of emitters towards a center of the cluster of lenses."**

116. Tatsukawa discloses a condenser lens (e.g., projector lens 12) located between the light emitting element 14 and the cluster of lenses (front lens elements 12As and 12Bs). EX1007, 6:32-36 ("The projector lens 12 is a flat concave aspherical lens made of acrylic resin a front side surface 12 a of which is constituted by a concave face and a rear side surface 12 b is constituted by a flat

face.”).

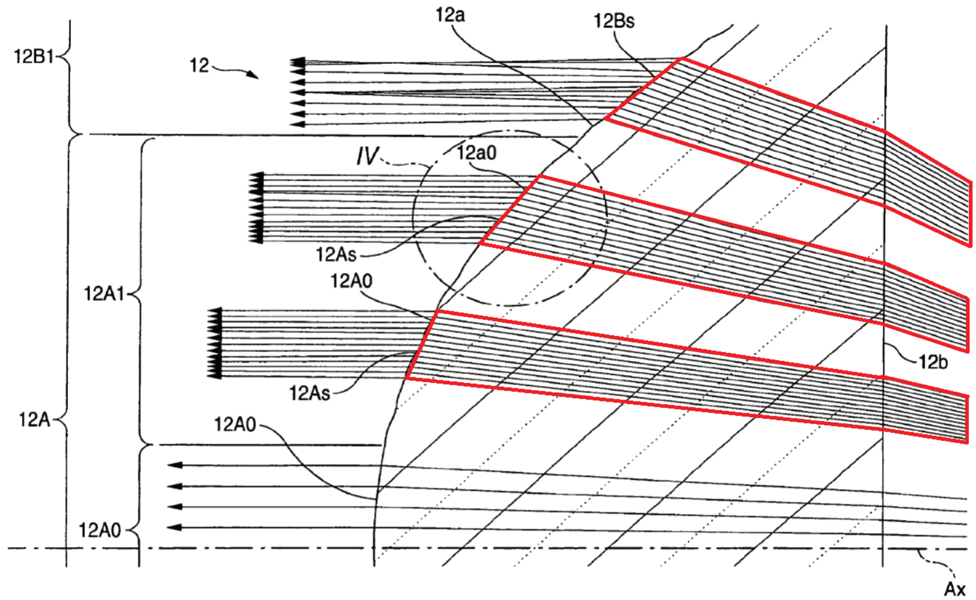
FIG. 2



EX1007, FIG. 2 (annotated)

117. FIG. 3 of Tatsukawa, reproduced below, shows that the condenser lens causes light to bend inwards at the transition of both the rear side surface 12b and the front side surface 12a.

FIG. 3



EX1007, FIG. 3 (annotated)

118. Accordingly, Tatsukawa discloses that the condenser lens is configured to concentrate light from the light emitting element 14 towards a center of the cluster of lenses on at least the front side surface 12a. Thus, the combination of Tatsukawa and Brandenburg discloses "a condenser lens located between said light source and said cluster of lenses, the condenser lens concentrating light from each of the plurality of emitters towards a center of the cluster of lenses," as claimed. [2]

[2] The interpretation that the "cluster of lenses" element and the "condenser lens" element can be read on a single lens with a pattern on one side is based on my understanding of the interpretation that Patent Owner has put forth in accusing products of infringement. Tatsukawa teaches these elements.

...

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D. GROUND 4: Claims 1-6, 8-13, and 15-16 are obvious by Weidel (EX1004) in view of Chinniah (EX1005)

119. **Overview of Chinniah**

120. Chinniah (EX1005) is directed to a headlamp assembly 20 including a light source 22 and a condenser lens 30 for improving control over the beam spread characteristics, while at the same time reducing the package size of the headlamp assembly. EX1005, 1:55-59.

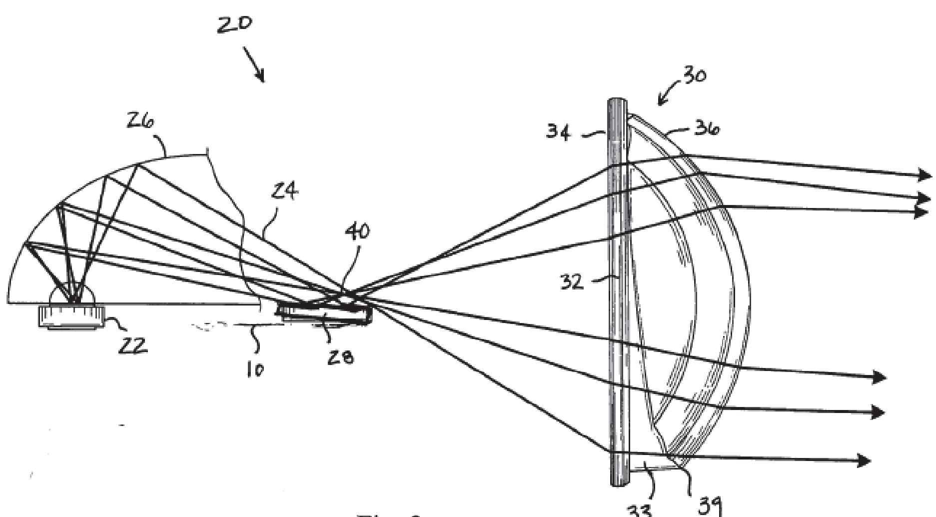


Fig. 3

EX1005, FIG.

121. The objective of the headlamp is "to provide a projector-type headlamp which exhibits improved control over the beam spread characteristics of the outputted light." *Id.*, 1:49-51. "[T]he beam pattern

provided in road illumination should have a certain amount of vertical spread as well as a certain amount of horizontal spread. At the same time, a vertical cut-off should be provided to minimize glare to oncoming traffic." *Id*., 1:17-21.

122. Chinniah also discloses:

> a condenser lens . . . for a projector-type headlamp assembly having a light source emitting light which is projected longitudinally downstream. . . . The condenser lens generally includes a main body of light transmitting material [and] . . . defines a first surface receiving light from the light source and a second surface emitting the light. The second surface has at least one facet structured to spread the light and provide a predetermined beam pattern.

123. *Id*., 1:59-67. Chinniah teaches a facet structure on the surface 36 of the condenser lens for focusing the light. Specifically, Chinniah teaches that the second surface of the condenser lens has "a plurality of facets structured to horizontally focus the light differently from the vertical focus

of the light to provide a predetermined beam pattern" (*Id*., Claim 1), and that at least one facet "horizontally focuses the light differently [than how] the at least one facet vertically focuses the light" (*Id*., Claim 22).

124. **Claim 1**

125. **1[pre] "A system for projecting a pattern of light, the system comprising:"**

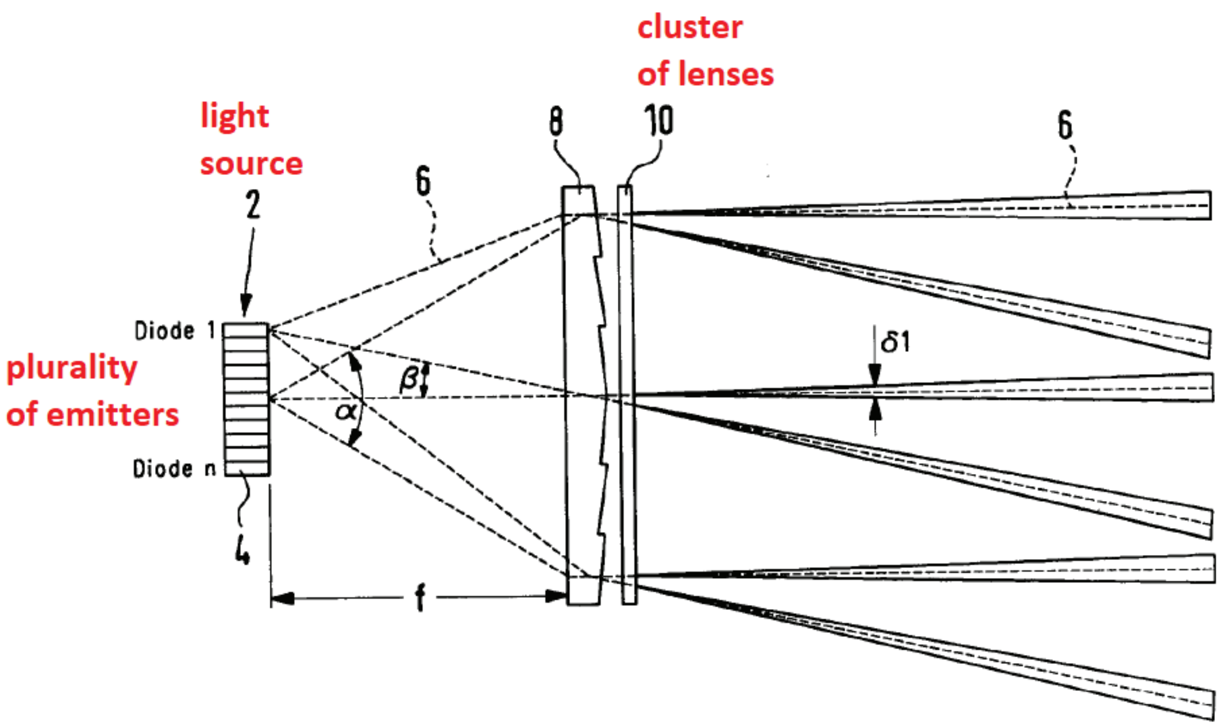
126. Weidel discloses the preamble of claim 1 as discussed in GROUND 1, claim 15[pre].

127. **1[a] "a light source including a plurality of emitters configured to emit light, the plurality of emitters arranged in a pattern;"**

128. Weidel discloses this limitation as discussed in GROUND 1, claim 15[a].

129. Additionally, Weidel discloses this limitation by teaching "a vehicle headlight comprising a two-dimensional array made up of a plurality of electronic luminous elements which are configured to emit a plurality of parallel light beams." *Id*. at ¶ [0010]. Additionally, "[i]n the example shown, the diode array 2 . . . [is] arranged in a rectangular array with n rows and m columns. The arrangement, however, does not have to be rectangular, but can, for example, also be elliptical or semi-elliptical, depending on which areas . . . are to be illuminated." EX1004, ¶ [0024].

130. **1[b] "a cluster of lenses located in front of the light source, wherein each lens of the cluster of lenses is configured to receive light from the plurality of emitters and the cluster of lenses is configured to concurrently focus and project light from each of the emitters in a plurality of directions; and"**



EX1004, FIG. 1 (annotated)

131. In addition, as shown by the representative rays drawn in FIG. 1, Weidel discloses that the entire cluster of lenses 10 receives light from the plurality of emitters and projects light from each of the emitters in a plurality of directions. *Id.*, FIG. 1.

132. Chinniah also teaches to project the light exiting from its cluster of lenses (facets 38, 138, 238) in different directions (EX1005, FIG. 3), but

also expressly teaches to focus the light exiting from its cluster of lenses in a plurality of directions. For example, Chinniah discloses that "the second surface [has] a plurality of facets structured to ***horizontally focus*** the light ***differently from the vertical focus*** of the light to provide a predetermined beam pattern having an increased horizontal beam spread relative to an aspheric condenser lens." EX1005, claim 1 (emphasis added); claim 16 ("[T]he second surface having a generally concave curvature to horizontally and vertically focus the light and provide a predetermined beam pattern, the second surface having at least one vertically elongated facet having one of a convex and a concave curvature that provides a horizontal beam spread component to the predetermined beam pattern."). Chinniah teaches that such focusing in a plurality of different directions is advantageous in vehicle headlight systems to "provide a predetermined beam pattern having an increased horizontal beam spread" so as to illuminate an area that is wider than it is tall. EX1005, claim 1 6:65-66. For vehicle headlights, Chinniah explains that this reduces the chance of blinding oncoming drivers. EX1005, 1:20-21.

133. It would have been obvious to the person of ordinary skill in the art to modify Weidel such that the cluster of lenses concurrently focused and

projected light in different directions as required by claim 1 (and similarly claims 8 and 15) from the teachings of Chinniah. Both Weidel and Chinniah teach vehicle headlights that address similar problems of improving visibility for the driver while minimizing glare to other vehicles. EX1004, ¶ [0002] ("The headlights of oncoming vehicles and the reflections thereof, especially on wet roads, [may] cause the driver to be blinded."); EX1005, 1:20-21 ("[A] vertical cut-off should be provided to minimize glare to oncoming traffic.").

134. A person of ordinary skill in the art implementing Weidel's vehicle headlight system would have been motivated to incorporate a lens with a plurality of facets structured to horizontally focus light differently from the vertical focus of the light, as taught by Chinniah, in order to more precisely illuminate the road and increase visibility by increasing a horizontal beam spread while minimizing glare to oncoming drivers. Indeed, Weidel seeks "[to illuminate traffic scenes as well as possible at night," and to avoid blinding drivers in oncoming vehicles EX1004, ¶¶ [0002]-[0003]. Weidel also recognizes that "[i]f the design divergence is so small that nearby objects would appear in an undesirable striped pattern," a lens, such as a diffuser, or a lens with a plurality of refractive microlenses, "can be

provided to spread the light beams appropriately." EX1004, ¶¶ [0013], [0031].

135. Thus, a person of ordinary skill in the art implementing Weidel's lighting system would have been motivated to incorporate a focusing cluster of lenses, as explicitly taught by Chinniah, to improve visibility, to provide better control of the pattern projected by the lighting system, and to minimize glare to oncoming traffic. *Id.*, 6; *Zup v. Nash Mfg.*, 896 F.3d 1365, 1371 (Fed. Cir. 2018) ("motivation to combine may be found explicitly or implicitly in market forces; design incentives; the interrelated teachings of multiple patents; any need or problem known in the field at the time of invention and addressed by the patent; and the background knowledge, creativity, and common sense of the person of ordinary skill" (internal quotation marks and citations omitted)).

136. A person of ordinary skill in the art would have had a reasonable expectation of success in implementing Weidel's lighting system with a cluster of lenses that focused the light in different directions, as taught by Chinniah, as focusing lenses or facets were well known to a person of ordinary skill in the art. EX1005, FIGs 1-4, 6-9. This would allow for better control of the light projected from Weidel's headlamp system such

that "the desired angular distribution of the light beam 6" is achieved. EX1004, ¶ [0029].

137. Thus, the combination of Weidel and Chinniah teaches a "cluster of lenses is configured to concurrently focus and project light from each of the emitters in a plurality of directions" as claimed.

138. **1[c] "a condenser lens located between the light source and the cluster of lenses, wherein the condenser lens is configured to concentrate light from each of the plurality of emitters towards a center of the cluster of lenses."**

139. See, GROUND 1, claim 15[c].

140. **Claim 2**

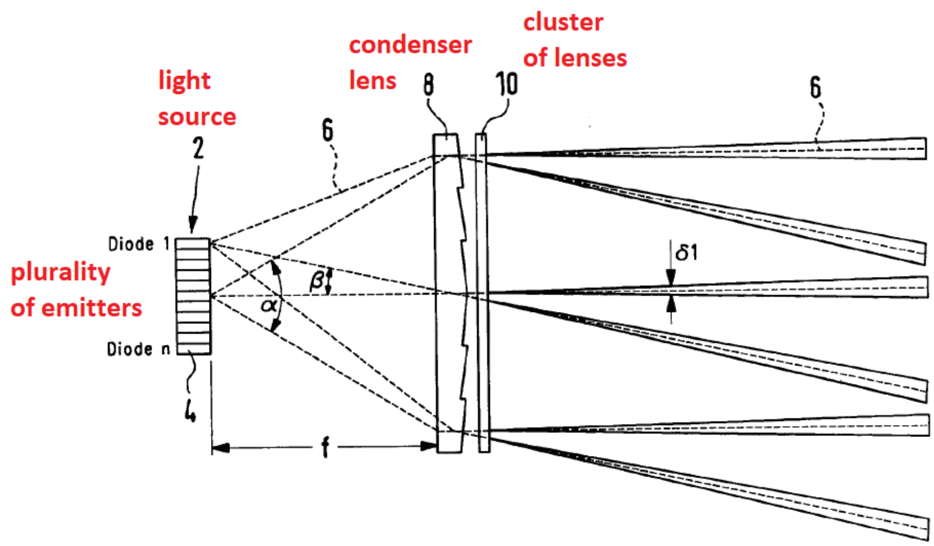
141. **"The system of claim 1, wherein the plurality of emitters includes light emitting diodes configured to generate infrared light that is detectable by a camera but not by an eye of a human observer interacting with an object illuminated by at least a portion of the light."**

142. Weidel discloses this element. See GROUND 1, claim 16.

143. **Claim 3**

144. **"The system of claim 1, wherein the cluster of lenses includes a Fresnel lens."**

145. The Weidel reference teaches that the collecting lens 8 may be a Fresnel lens, and that the diffuser 10 (cluster of lenses) can be integrated into the collecting lens 8. EX1004, ¶¶ [0028], [0031]; FIG. 1.



EX1004, FIG. 1 (annotated)

146. **Claim 4**

147. **"The system of claim 1, wherein the emitters are arranged in an irregular pattern."**

148. Weidel discloses "[i]n the example shown, [t]he diode array 2 . . . [is] arranged in a rectangular array with n rows and m columns. The arrangement, however, does not have to be rectangular, but can also be elliptical or semi-elliptical, depending on which areas . . . are to be illuminated." EX1004, ¶ [0024]. As shown in the excerpts from the Patent Owner's infringement contentions against certain accused products, the Patent Owner has accused "a horizontal row" of LEDs as being the claimed "irregular pattern."

The headlamps consist of a lamp for the low beams and a variable light distribution lamp for the high beams. Multiple LEDs are arranged in a horizontal row inside the variable light distribution lamp, and the high beam illumination distribution can be changed by turning each LED on or off independently.
The vehicle in front of you is recognized by the multi-sensing front camera installed on the windshield. Based on the vehicle's direction and distance information, the control unit determines the area where the high beams should not illuminate and then controls the variable light distribution lamp.

Each Nissan Accused Product comprises the system of claim 1, wherein the emitters are arranged in an irregular pattern.

This element is infringed literally, or in the alternative, under the doctrine of equivalents.

For example, the Nissan ARIYA's headlamp system of is equipped with a light source (e.g., projector LED headlights) with multiple emitters. These emitters are arranged in an irregular pattern.

Patent Owner's Infringement Contentions dated November 22, 2024 served in *Longhorn Automotive Group LLC v. Nissan Motor Co. Ltd., Case No. 2:24-cv-00397 (EDTX May 31, 2024).*

149. Based on the Patent Owner's claim construction and application of this term, the Weidel reference teaches that the emitters may be arranged in irregular patterns.

150. **Claim 5**

151. **"The system of claim 1, wherein a first pattern of light projected by one of the lenses from the cluster of lenses overlaps with a second pattern of light projected by another of the lenses from the cluster of lenses."**

152. Either or both Weidel and Chinniah, as discussed with respect to Claim 1, teach that a first pattern of light projected by one of the lenses

from the cluster of lenses overlaps with a second pattern of light projected by another of the lenses from the cluster of lenses. EX1004, ¶ [0029] ("… the light beams 6 of adjacent diodes 4 ***overlap***[,] and . . . the desired angular distribution of the light beam 6 is created.") (emphasis added).

153. Weidel provides that "a certain divergence . . . [of light beams] is desirable when used as vehicle headlights," and "a diffuser can be provided to spread the light beams appropriately." EX1004, ¶ [0013]. Similarly, Chinniah teaches that "each of the facets 38 may have their own unique curvature in either or both of the vertical and horizontal directions which can be structured to ***overlap*** or separate the light the lens 30 outputs, thereby creating a predetermined beam spread pattern." EX1005, 5:9-13 (emphasis added). Thus, a person of ordinary skill in the art would be further motivated to combine the teachings of Chinniah with Weidel to facilitate better control of the light projected from the lighting system such that "the desired angular distribution of the light beam[s]" is achieved. EX1004, ¶ [0029]. Such a combination would also have a reasonable expectation of success, given that the modification involves simply replacing one optical element for another known optical element.

154. **Claim 6**

155. **"The system of claim 1, wherein a pattern of light projected by the cluster of lenses is aperiodic along at least one dimension."**

156. Chinniah teaches:

> [E]ach of the facets 38 may have their own unique curvature in either or both of the vertical and horizontal directions which can . . . creat[e] a predetermined beam spread pattern. For example, assuming the facets 38 were numbered consecutively from left to right, facets 2 and 5 could be utilized to create a particular hot spot or hot spots while the remainder of the facets could be structured to provide a more uniformly spread beam pattern.

EX1005, 5:9-14.

157. In addition, Chinniah teaches that "an unlimited number of unique single facet and multi-facet embodiments can be readily envisioned by those skilled in the art and can be tailored to specific applications." EX1005, 6:33-36. Thus, Chinniah teaches creating a pattern of light projected by the lens array that are aperiodic.

158. **Claim 8**

159. **8[pre] "A method comprising"**

160. *See* GROUND 4, Claim 1[pre], 1[a], 1[b], 1[c].

161. **8[a] "emitting, from a plurality of emitters, a plurality of lights arranged in a pattern;"**

162. *See* GROUND 4, Claim 1[a].

163. **8[b] "concentrating, via a condenser lens, the plurality of lights towards a central location of a cluster of lenses;"**

164. *See* GROUND 4, Claim 1[c].

165. **8[c] "receiving the concentrated light at a plurality of points within the cluster of lenses; and"**

166. *See* GROUND 4, Claim 1[b].

167. **8[d] "concurrently focusing, from each lens of the cluster of lenses, the received and concentrated light from each of the plurality of emitters in a plurality of directions;"**

168. *See* GROUND 4, Claim 1[b] and Claim 5.

169. **Claim 9**

170. **"The method of claim 8, wherein said emitting includes generating infrared light that is not detectable by an eye of a human observer interacting with an object illuminated by at least a portion of the light."**

171. *See* GROUND 4, Claim 2.

172. **Claim 10**

173. **"The method of claim 8, wherein said concentrating comprises concentrating the plurality of lights towards a center of a cluster of lenses including a Fresnel lens."**

174. *See* GROUND 4, Claims 1[b]-[c] and 3.

175. **Claim 11**

176. **"The method of claim 8, wherein the focused light comprises an irregular pattern."**

177. *See* GROUND 4, Claim 1[a] and 1[b] and Claims 4-6;

178. **Claim 12**

179. **"The method of claim 8, wherein the focused light includes a first pattern of light overlapping with a second pattern of light."**

180. *See* GROUND 4, Claim 1[b] and Claim 5.

181. **Claim 13**

182. **"The method of claim 8, wherein the focused light includes a pattern which is aperiodic along at least one dimension."**

183. *See* GROUND 4, Claims 4, 6, and 11

184. **Claim 15**

185. **15[pre] "A system for projecting a pattern of light, the system comprising:"**

186. *See* GROUND 4, Claim 1[pre], 1[a], 1[b], 1[c].

187. **15[a] "a light source including a plurality of emitters configured to emit light;"**

188. *See* GROUND 4, Claim 1[a].

189. **15[b] "a cluster of lenses, each lens included in the cluster of lenses being configured to receive the emitted light from each of the plurality of emitters; and"**

190. *See* GROUND 4, Claim 1[b].

191. **15[c] "a condenser lens located between said light source and said cluster of lenses, the condenser lens concentrating light from each of the plurality of emitters towards a center of the cluster of lenses."**

192. *See* GROUND 4, Claim 1[c].

193. **Claim 16**

194. **"The system of claim 15, wherein the plurality of emitters includes light emitting diodes configured to generate infrared light that is not detectable by an eye of a human observer"**

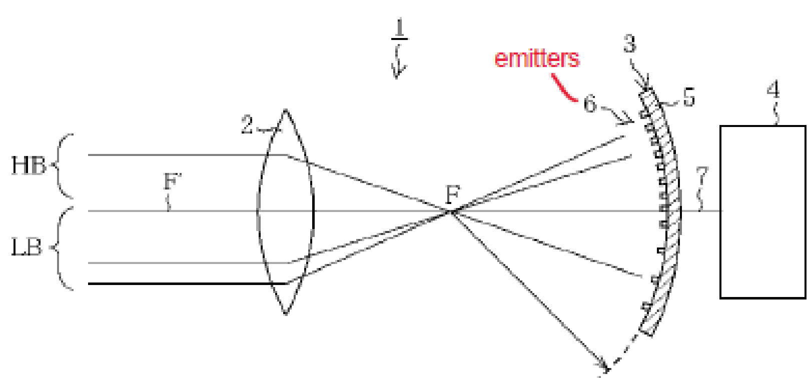
195. *See* GROUND 4, Claim 2.

E. GROUND 5: Claims 1-6, 8-13, and 15-16 are obvious by Chinniah in view of Brandenburg and Osawa

196. **Overview of Osawa**

197. Osawa teaches a lighting device or system (e.g., a vehicle headlight or another optical light projection system) with a light source and optical elements. Osawa teaches a headlight with several emitters (LED chips 6) and a projecting convex lens 2. EX1011, [0009] and [0013], and FIGS. 1-2. Osawa teaches that the LED arrangement facilitates manufacturing compact headlamps with extended life and low power consumption. EX1011, [0008] and [0046].

【図 1】



EX1011, FIG. 1 (annotated)

198. **Claim 1**

199. **1[pre] "A system for projecting a pattern of light, the system comprising:"**

200. Chinniah discloses a system for projecting a pattern of light. EX1005, Abstract ("The condenser lens is provided for a projector-type headlamp assembly having a light source emitting light which is projected longitudinally downstream in front of a motor vehicle."); 1:6-8; FIG. 3 (showing pattern of light rays).

201. **1[a] "a light source including a plurality of emitters configured to emit light, the plurality of emitters arranged in a pattern;"**

202. Chinniah teaches a light source 22 configured to emit light 24. EX1005, 3:59-63 ("[T]he headlamp assembly 20 generally includes a light source 22 emitting light 24 … Preferably, the light source 22 is a LED which generally produces light from a surface area, as is known in the art."); FIG. 3.

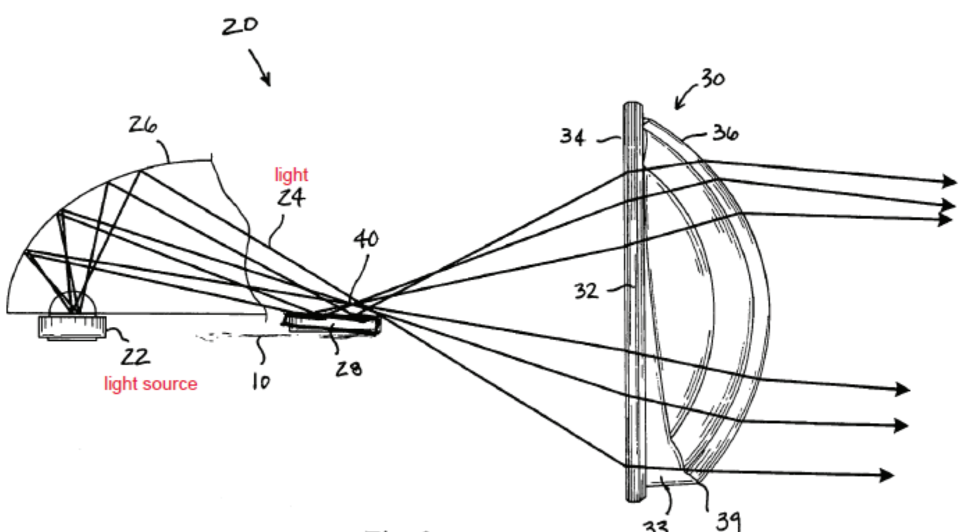


Fig. 3

EX1005, FIG. 3 (annotated)

203. Although Chinniah may not expressly describe a plurality of emitters in its light source, Chinniah recognizes that there is a light output requirement for automotive lighting applications, and that LEDs may be used in such applications to provide the required light output. EX1005, 1:12-15.

204. Brandenburg, which is from the same field as Chinniah, teaches to use a plurality of LEDs to increase the intensity of light and to enable the realization of more complex luminous intensity distributions. EX.1006, ¶ [0040]; FIG. 4 (showing a plurality of emitters 22 arranged in a pattern in module 20), ¶¶ [0031], [0011], FIG. 5.

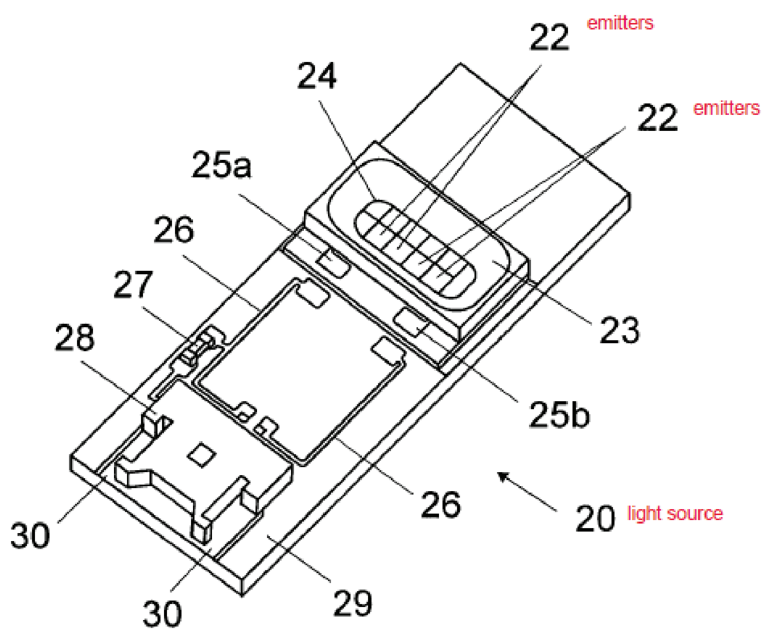


FIG 4

EX1006, FIG. 4 (annotated)

205. As shown above in FIG. 4, Brandenburg also discloses that the emitters (light-emitting diode chips 22) are arranged in a pattern of a two-dimensional array.

206. It would have been obvious to a person of ordinary skill in the art to modify Chinniah to include a plurality of emitters arranged in a pattern to improve light intensity from the teachings of Brandenburg. Brandenburg discloses a plurality of emitters 22 in each module 20, and expressly teaches to use a plurality of emitter modules 20 to increase the light intensity. EX1006, ¶ [0040], [0012], [0031]; and Chinniah EX1005, 3:26-31.

207. Moreover, both Brandenburg and Chinniah are from the same field (vehicle headlight optical systems), and address similar problems relating to controlling illumination, beam distribution, and glare, and one of ordinary skill in the art would be motivated to apply known optimization techniques to improve Chinniah's system based on the disclosure of Brandenburg. EX1005, 1:6-8, 3:59-63; EX1006, ¶ [0004].

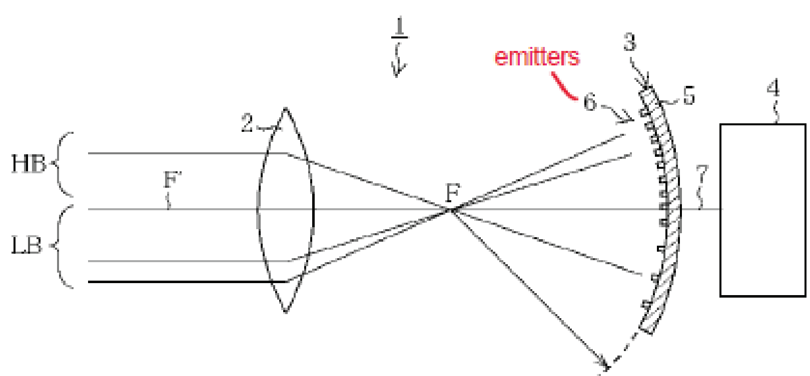
208. Brandenburg also describes that using multiple light-emitting diode chips 22, can provide another benefit of enabling different (or particular) light intensity distributions to be generated for the vehicle's high beam, low beam, daytime running light, and/or fog light. EX1006, ¶¶ [0009], [0012].

209. Accordingly, one of ordinary skill in the art would have been motivated to modify the system of Chinniah with the plurality of light-emitting diode chips 22 arranged in a pattern as shown in Brandenburg's FIG.4, and/or a plurality of patterned modules 20 as taught by Brandenburg, in order to increase the light intensity and/or to achieve different (or particular) light intensity distributions. Further, there would be a reasonable expectation of success in making such a modification, because the modification based on Brandenburg involves simply adding an additional emitter(s) to emit the light.

210. Alternatively, or additionally, it would have been obvious to modify Chinniah based on Osawa to include "a light source including a plurality of emitters configured to emit light, the plurality of emitters arranged in a pattern" as claimed.

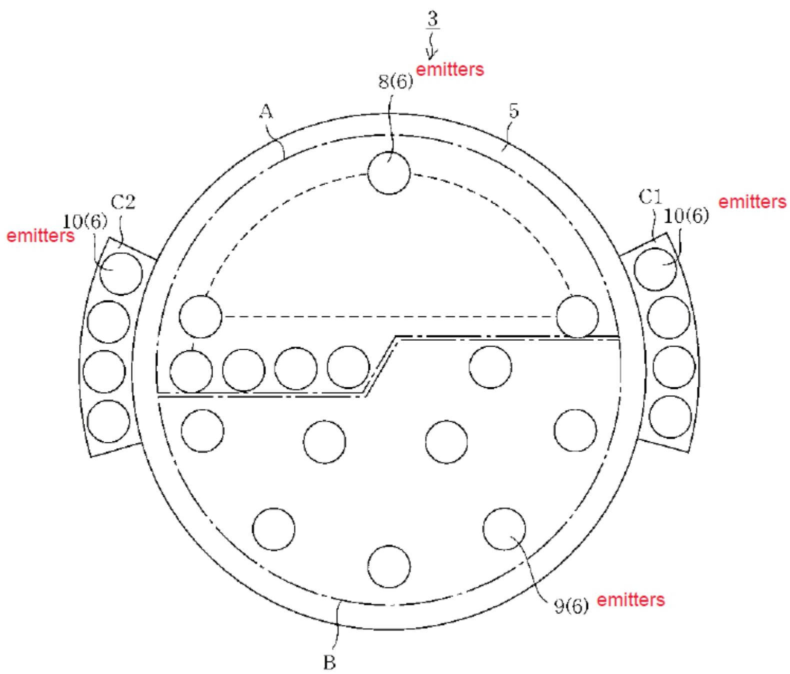
211. Osawa discloses a lighting device or system (e.g., a vehicle headlight or another optical light projection system) with a light source and optical elements and, more specifically, a headlight with a projecting convex lens 2 and a light-emitting surface made of an arrangement of a emitters (LED chips 6). EX1011, ¶¶ [0009] and [0013], FIGS. 1-3. FIGS. 1 and 2 of Osawa are reproduced below with annotation.

【図 1】



EX1011, FIG. 1 (annotated)

【図２】



EX1011, FIG. 2 (annotated)

212. As shown above in FIGS. 1-2 of Osawa, the LED chips 6 are arranged in an irregular pattern. Specifically, the LED chips 6 are arranged in a low beam LED chip group 8 for a low beam, a high beam LED chip group 9 for a high-beam, and a cornering beam LED chip 10 group for a cornering beam. EX1011, ¶¶ [0018]-[0020]. By including the irregular pattern configuration of multiple LED chips 6, the headlight 1 of Osawa can accomplish different light distribution patterns for various functions (e.g., low beam, high beam, cornering beam). EX1011, ¶¶ [0018]-[0020], [0023] ("[T]here is an effect that the light distribution can be freely adjusted.").

Moreover, by including the multiple LED chips 6 in this configuration, a reduction of parts can be realized, and vehicle safety can be improved by providing redundancy in case some LEDs fail. EX1011, ¶ [0023] ("[E]ven if a part of the LED chips 6 falls into a function stop state, if the LED chips 6 of the other groups are turned on, it is possible to prevent the front from becoming dark, and there is an effect that it is possible to secure very high safety during traveling …. Further … since it is not necessary to use a shade which is indispensable in the conventional headlamp, there is an effect that the light distribution can be freely adjusted in addition to the reduction in the number of components.").

213. These teachings directly complement the headlamp designs in Chinniah and Brandenburg, which each provide solutions for automotive headlight applications, including achieving appropriate beam characteristics for automotive headlight applications. EX1005, 3:26-31 ("[S]tandard elliptical reflectors may be employed in conjunction with LED light sources to provide a light output that is suitable for automotive headlight applications while also having the desired beam characteristics."); EX1006, ¶¶ [0009], [0012], [0040]("In order to achieve, for example, the highest possible light intensity, the lighting device according to the invention can

alternatively also comprise a plurality of light-emitting diode modules 20 …"). Also, like Brandenburg, Osawa teaches generating a low beam, a high beam, and a cornering beam via different (or particular) light intensity distributions. EX1006, ¶¶ [0009], [0012].

214. Given the foregoing, a person of ordinary skill in the art would have been motivated to incorporate irregular patterns of emitters, as described in Osawa, in the lighting system of Chinniah to achieve a vehicle headlamp that is capable of producing various desired beam shapes and distributions, while also accomplishing a reduction in parts and improved vehicle safety.

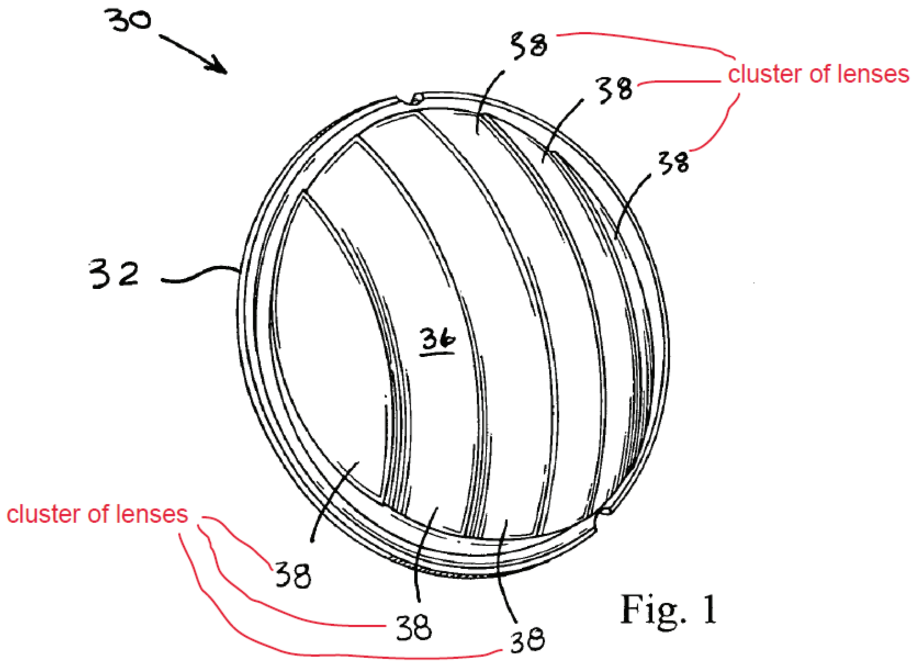
215. At least in view of the above, the combination of Chinniah in view of Brandenburg and Osawa teaches "a light source including a plurality of emitters configured to emit light, the plurality of emitters arranged in a pattern" as claimed.

216. **1[b] "a cluster of lenses located in front of the light source, wherein each lens of the cluster of lenses is configured to receive light from the plurality of emitters and the cluster of lenses is configured to concurrently focus and project light from each of the emitters in a plurality of directions; and"**

217. Chinniah teaches a cluster of lenses (e.g., facets 38 in FIGS. 1-4, facets 138 in FIGS. 6-7, facets 238 in FIG. 8). For example, Chinniah describes that:

> the second surface 36 is formed as a plurality of facets 38, and particularly the embodiment of FIG. 2 includes six (6) facets although any number of facets may be readily employed. The facets 38 are generally vertically extending while being horizontally spaced, although while it is possible to have facets that are both vertically and horizontally spaced like a checker board design pattern. Each of the facets 38 have a generally convex curvature in the horizontal and vertical directions, and most preferably are numerically generated free form surfaces designed to provide a desired output beam … Given that each of the facets 38 may have their own horizontal curvature, a number of peaks and valleys are generally defined by the horizontal curvature of the second surface 36.

EX1005, 3:39-56. FIG. 1 (annotated) of Chinniah is reproduced below.



EX1005, FIG. 1 (annotated)

218. Chinniah also teaches that the cluster of lenses (e.g., facets 38 in FIGS. 2-4, facets 138 in FIGS. 6-7, facets 238 in FIG. 8) is located in front of the light source (e.g., light source 22 including LED 22) to receive light from the light source. EX1005, FIG. 3, FIG. 4, 4:57-64 ("In either case, the condenser lens 30 receives light at its first surface 34, and through the construction of the second surface 36 having a plurality of facets 38, a predetermined beam pattern 44 is produced as shown in FIG. 5."). FIG. 3 (annotated) of Chinniah is reproduced below.

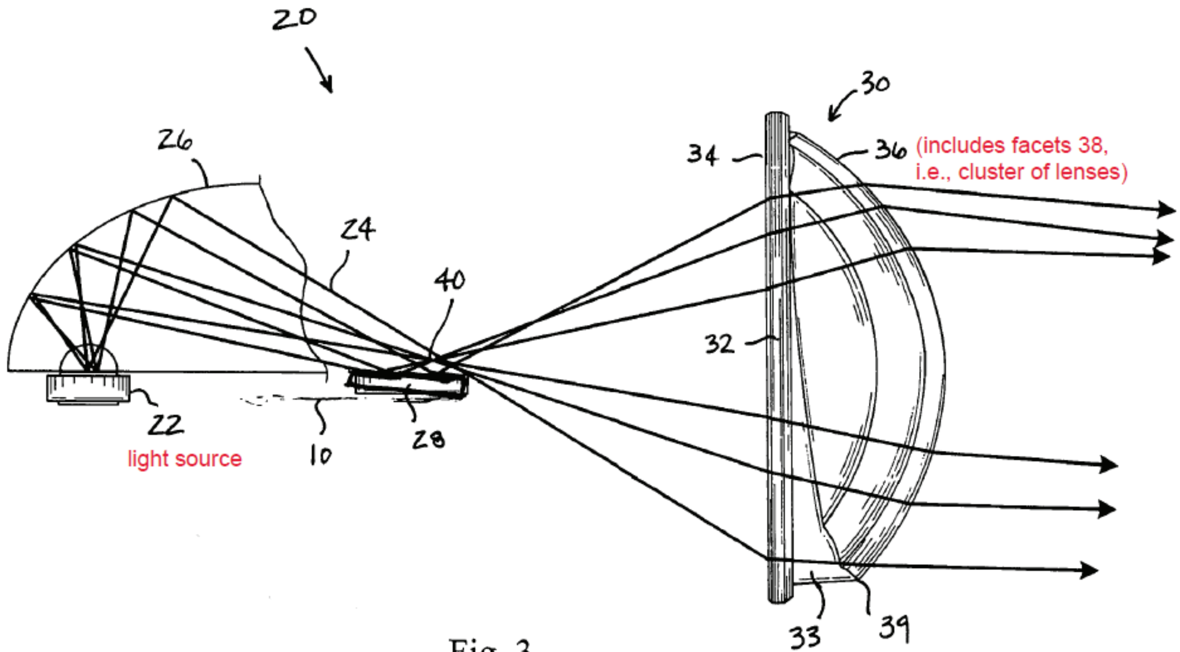


Fig. 3

EX1005, FIG. 3 (annotated)

219. As shown above in FIG. 3, light from a light source 22 reaches the second surface 36, which includes the cluster of lenses (e.g., facets 38). Moreover, Chinniah teaches that each of the facets 38 is used to provide a desired output beam, indicating that light from the light source 22 is received by each of the facets 38. EX1005, 3:46-56. Thus, the combination of Chinniah and Brandenburg teaches "wherein each lens of the cluster of lenses is configured to receive light from the plurality of emitters" as claimed.

220. Chinniah also discloses that the cluster of lenses (e.g., facets 38, facets 138, facets 238) is configured to concurrently focus and project light from the light source 22 in a plurality of directions. For example, Chinniah discloses that "the second surface [has] a plurality of facets structured to horizontally ***focus the light differently*** from the vertical focus of the light to ***provide a predetermined beam pattern*** having an increased horizontal beam spread relative to an aspheric condenser lens." EX1005, Claim 1 (emphasis added); FIG. 1 (showing light being projected in a plurality of directions from facets 38), and Claim 16 ("[T]he second surface having a generally concave curvature to horizontally and vertically ***focus the light and provide a predetermined beam pattern***, the second surface having at least one vertically elongated facet having one of a convex and a concave curvature that provides a horizontal beam spread component to the predetermined beam pattern.") (emphasis added). Thus, the combination of Chinniah and Brandenburg teaches "the cluster of lenses is configured to concurrently focus and project light from each of the emitters in a plurality of directions" as claimed.

221. **1[c] "a condenser lens located between the light source and the cluster of lenses, wherein the condenser lens is configured to concentrate light from each of the plurality of emitters towards a center of the cluster of lenses."**

222. Chinniah discloses a condenser lens (main body 32 and first surface 34) located between the light source 22 and the cluster of lenses (e.g., facets 38 in FIGS. 2-4, facets 138 in FIGS. 6-7, facets 238 in FIG. 8). EX1005, 3:32-37.

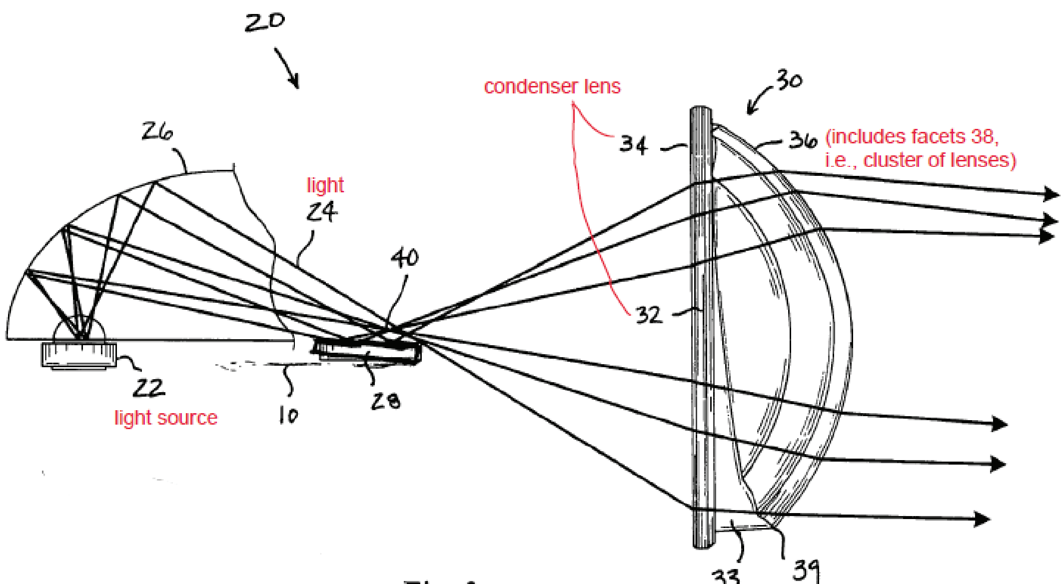


Fig. 3

EX1005, FIG. 3 (annotated)

223. FIG. 3 of Chinniah shows that the condenser lens (32, 34) causes light 24 from the light source 22 to bend inwards towards the center of surface 36.

224. Accordingly, Chinniah discloses that the condenser lens (32, 34) is configured to concentrate light 24 from the light source 22 towards a center of the cluster of lenses (e.g., facets 38). Thus, Chinniah in combination

with Brandenburg discloses "a condenser lens located between the light source and the cluster of lenses, wherein the condenser lens is configured to concentrate light from each of the plurality of emitters towards a center of the cluster of lenses" as claimed.

225. Alternatively, or additionally, it would have been obvious to a person of ordinary skill in the art to replace the reflector 26 and/or a shield 28 of Chinniah with a condenser lens.

226. Chinniah discloses that the reflector 26 collects and redirects light 24 emitted from the light source 22. EX1005, 3:57-4:13. Thus the reflector 26 acts as a condenser lens and one of ordinary skill would understand that the reflector 26 function can be accomplished using a condenser lens. Particularly, Chinniah describes that the reflector 26 performs "focus[ing]" towards a focal point 40. EX1005, 3:65-4:2, FIG. 3. Thus, the reflector 26 concentrates light of the light source 22 towards a center of the cluster of lenses (e.g., facets 38 in FIGS. 2-4, facets 138 in FIGS. 6-7, facets 238 in FIG. 8).

227. Chinniah also recognizes that a person of ordinary skill in the art would have understood that the headlight assembly may be configured as a "direct projection headlamp" where "the LED 22 would be positioned

generally as shown by numeral 22 in the FIG. 4. EX1005, 4:57-61. Chinniah also explains that "[I]n a direct projector unit, no reflector is employed." EX1005, 1:32-35.

228. Brandenburg describes a direct projection headlamp that includes a light source (light-emitting diode module 20 including LED chips 22), a condenser lens (module optics 21), and a cluster of lenses (1). EX1006, ¶¶ [0031]-[0032], FIGS. 4-6. Brandenburg also describes that the condenser lens (concentrator 21) "bundles the light generated by the LED chips 22 so that it exits the front side 21a of the concentrator 21 facing away from the LED chips 22 with reduced divergence." EX1006, ¶ [0031]. A person of ordinary skill in the art would have recognized that this "bund[ling]" by the condenser lens (concentrator 21) improves light collection by the cluster of lenses (optical lens 1).

229. Given that Chinniah recognizes a benefit of improving light collection by a downstream optical element through the use of an upstream optical element(s) and that its headlight assembly may be configured as a direct projection headlamp without a reflector, and given that Brandenburg teaches to use a condenser lens (concentrator 21) to improve light collection in a direct projection headlamp, it would have been obvious to a person of

ordinary skill in the art to include the concentrator 21 as an alternative to the reflector 26/shield 28 structure of Chinniah. There would have been a reasonable expectation of success in making such modification since the modification involves replacing equivalent optical components, i.e., replacing reflector 26 and shield 28 of Chinniah with a condenser lens (concentrator 21) of Brandenburg to perform the same function of light collection. In addition, a person of ordinary skill in the art would have been motivated to modify Chinniah with the concentrator 21 of Brandenburg in order to implement a direct projection headlamp as suggested by Chinniah.

230. **Claim 2**

231. **"The system of claim 1, wherein the plurality of emitters includes light emitting diodes configured to generate infrared light that is detectable by a camera but not by an eye of a human observer interacting with an object illuminated by at least a portion of the light."**

232. Brandenburg discloses that the light-emitting diode chips 22 are configured to generate infrared light that is detectable by a camera, but not by an eye of a human observer interacting with an object illuminated by at least a portion of the light.

233. The term light here should not only include the spectral range of visible electromagnetic radiation, but also **the near infrared range (wavelength range from approx. 800 nm to 1000 nm), which is usually**

used for night vision devices. For example, the lighting device according to the invention can comprise light-emitting diode modules 20 which generate **infrared radiation from the near infrared range exclusively** or in addition to the visible electromagnetic radiation, which is coupled into one or more optical lenses according to the invention in order **to obtain an infrared long beam, for example together with a suitable infrared camera**.

EX1006, ¶ [0042]

234. It would have been obvious to a person of ordinary skill in the art to have the plurality of emitters of the combination of Chinniah in view of Brandenburg and Osawa to include infrared light emitting diodes to improve safety in night driving as taught by Brandenburg. EX1006, ¶ [0042]. There would also have been a reasonable expectation of success by a person of ordinary skill in the art in making such modification since the modification involves simply adding infrared emitters.

235. **Claim 3**

236. **"The system of claim 1, wherein the cluster of lenses includes a Fresnel lens."**

237. Brandenburg teaches that the cluster of lenses (optical lens 1 , 1', or 1'') may be implemented as a Fresnel lens. For example, Brandenburg

explains that "[T]he surface segments [of lens 1, 1', or 1''] can also be arranged in concentric rings, for example, where each ring comprises several stepped surface segments …." EX1006, ¶ [0039]. Brandenburg also explains that such a structure was known in the art as a Fresnel lens. EX1006, ¶ [0002] ("The Fresnel lens is an optical lens with a light-emitting surface that is divided into ring-shaped stepped surface segments, with the stepped surface segments forming concentric rings.").

238. Brandenburg also describes that the cluster of lenses (optical lens 1 , 1', or 1''), and more particularly the surface segments thereof, may have particular shapes and arrangements to achieve a desired light intensity distribution such as, for example, for a high beam, low beam, daytime running light, or fog light. EX1006, ¶ [0009], ¶¶ [0030], [0034]-[0035], [0038], and FIGS. 2, 6, 10-11, and 14-15.

239. In addition Chinniah recognizes that the condenser lens 230 may "take any shape, circular or non-circular, including rectangular, square, oval or other oblong shapes" which can provide a benefit in that "unused material of the condenser lens 230 can be [further] eliminated, reducing the weight of the lens 230 and headlamp assembly, thereby providing a headlamp assembly which is lighter and smaller." EX1005, 5:60-67. One of ordinary

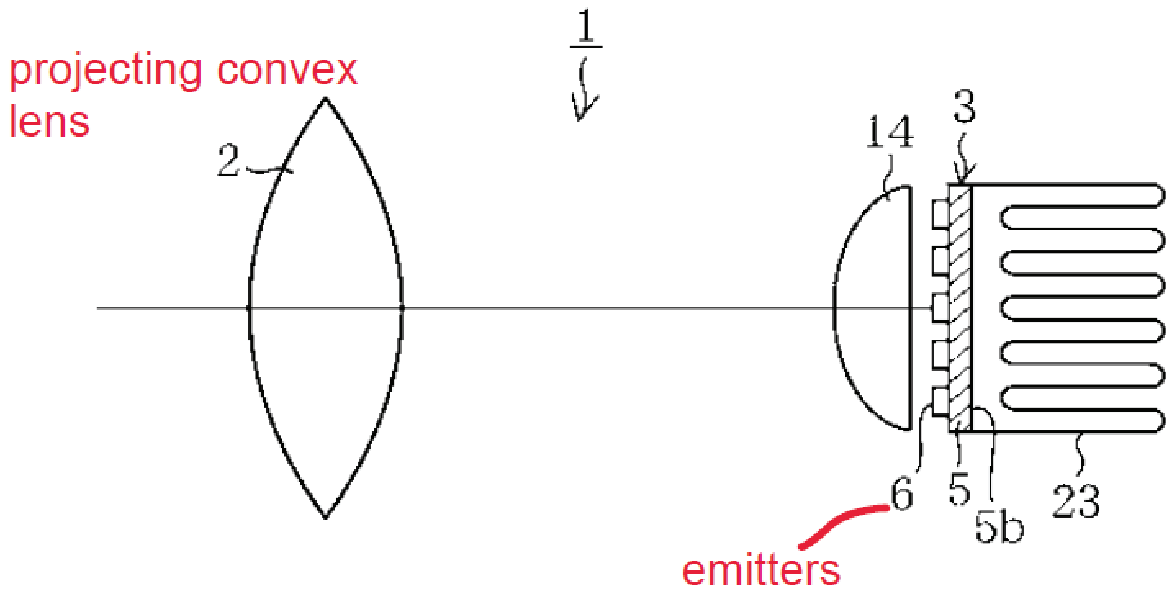
skill would have known that a benefit of using a Fresnel lens is that it has a reduced size, weight and cost relative to a comparable condenser lens.

240. At least in view of the above, it would have been obvious to a person of ordinary skill in the art to modify Chinniah, based on Brandenburg, so that the cluster of lenses includes a Fresnel lens, and there would have been a reasonable expectation of success in making such modification since the modification involves replacing one known optical element for another known optical element. In addition, a person of ordinary skill in the art would have been motivated to make the modification in order to achieve a desired light intensity distribution as described in Brandenburg and/or to provide a headlamp assembly that is lighter, smaller, and cheaper as described in Chinniah. EX1006, ¶ [0009]; EX1005, 5:60-67.

241. This modification is also obvious when considering Chinniah in view of Brandenburg, and in further view of Osawa.

242. Osawa discloses a lighting device or system (e.g., a vehicle headlight or another optical light projection system) with a light source and optical elements and, more specifically, a headlight with a projecting convex lens 2 and a light-emitting surface made of an arrangement of LED chips 6. EX1011, ¶¶ [0009] and [0013], FIG. 7.

【図７】



EX1011, FIG. 7 (annotated);

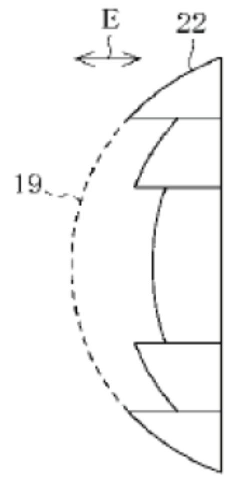


Fig.6

EX1011 FIG. 6.

243. Osawa also describes that the projecting convex lens 2) may be a Fresnel lens. EX1011, ¶ [0044] ("The Fresnel lens is also effective as a convex lens for projection."), claim 14 ("[W]herein one or both of the projecting convex lens and the condensing convex lens are Fresnel lenses.").

244. Osawa teaches that, by incorporating a Fresnel lens in a headlamp, the headlamp may be thinner and lighter than other types of lenses, and it can be easily manufactured by using resin molding, making such lenses cost effective. EX1011, ¶¶ [0044]-[0045].

245. A person of ordinary skill in the art would have been motivated to incorporate a Fresnel lens, as described in Osawa, in or as the condenser lens 30 of the lighting system in Chinniah to reduce the size, weight, and cost of Chinniah's headlamp. Moreover, there would have been a reasonable expectation of success in making such modification because the modification would have involved replacing a known element, a Fresnel lens, in or as the condenser lens.

246. At least in view of the above, the combination of Chinniah, Brandenburg and Osawa renders obvious the claim feature of "wherein the cluster of lenses includes a Fresnel lens."

247. **Claim 4**

248. **"The system of claim 1, wherein the emitters are arranged in an irregular pattern."**

249. As discussed in GROUND 5, claim 1, Osawa describes LED chips 6 arranged in an irregular pattern. EX1011, Figs. 1-2. Specifically, the LED chips 6 are arranged in a low beam LED chip group 8 for a low beam, a high beam LED chip group 9 for a high-beam, and a cornering beam LED chip 10 group for a cornering beam. EX1011, ¶¶ [0018]-[0020]. By including the irregular pattern configuration of multiple LED chips 6, Osawa's headlight 1 can accomplish different light distribution patterns for

various functions (e.g., low beam, high beam, cornering beam). EX1011, ¶¶ [0018]-[0020], [0023]. Moreover, by including LED chips 6 in an irregular pattern configuration, a reduction of parts can be realized, and vehicle safety can be improved by providing redundancy in case some LEDs fail. EX1011, ¶ [0023]. In view of the teachings of Osawa, it would have been obvious to modify Chinniah to include emitters configured in an irregular pattern. EX1011, ¶¶ [0018]-[0020], FIGS. 1-2.

250. **Claim 5**

251. **"The system of claim 1, wherein a first pattern of light projected by one of the lenses from the cluster of lenses overlaps with a second pattern of light projected by another of the lenses from the cluster of lenses."**

252. FIG. 3 of Chinniah shows light rays exiting from the cluster of lenses (facets 38) of surface 36 in different directions such that they will cross (i.e., overlap) downstream.

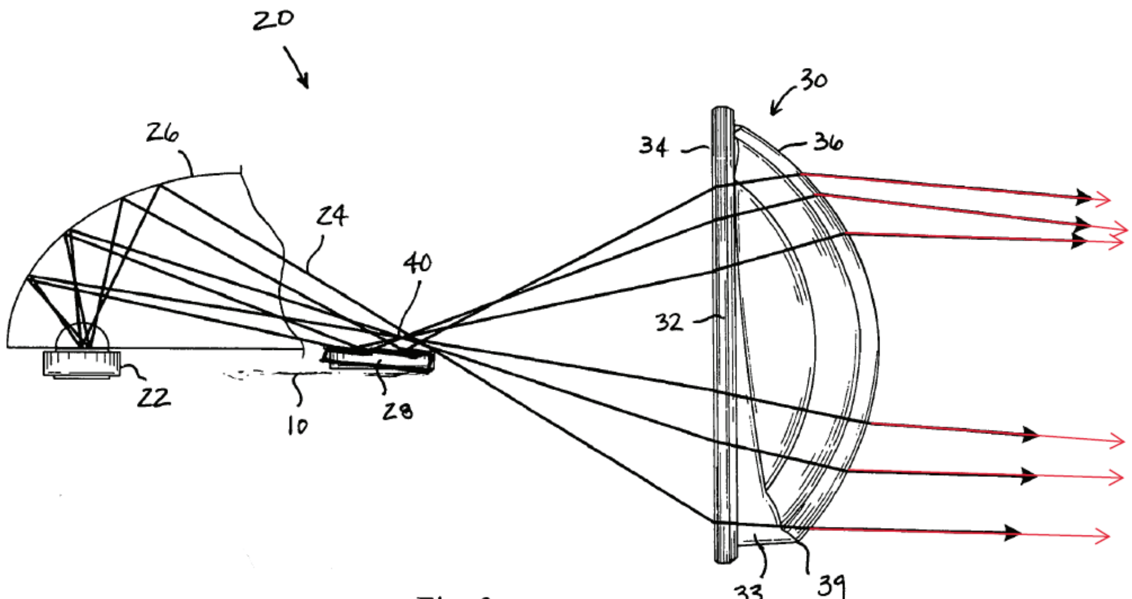


Fig. 3

EX1005, FIG. 3 (annotated)

253. Moreover, Chinniah discloses that "each of the facets 38 may have their own unique curvature in either or both of the vertical and horizontal directions which can be structured **to overlap** or separate **the light the lens 30 outputs**, thereby creating a predetermined beam spread pattern." EX1005, 5:9-13 (emphasis added), 5:13-17 ("For example, assuming the facets 38 were numbered consecutively from left to right, facets 2 and 5 could be utilized to create a particular hot spot or hot spots while the

remainder of the facets could be structured to provide a more uniformly spread beam pattern.”). Thus, Chinniah teaches the claimed “wherein a first pattern of light projected by one of the lenses from the cluster of lenses overlaps with a second pattern of light projected by another of the lenses from the cluster of lenses”.

254. **Claim 6**

255. **“The system of claim 1, wherein a pattern of light projected by the cluster of lenses is aperiodic along at least one dimension.”**

256. In FIG. 3 of Chinniah (shown above in GROUND 5, Claim 5), the upper light rays of the figure extending from the cluster of lenses (facets 38) of the second surface 36 have a different projection angle in comparison to the lower light rays of the figure. This is an irregular (i.e., aperiodic) light pattern along at least one dimension.

257. Moreover, Chinniah discloses that the cluster of lenses (facets 38) may be configured to have a pattern of light with a horizontal focus that differs from a vertical focus thereof. EX1005, claim 1 (“[T]he second surface [has] a plurality of facets structured to horizontally focus the light differently from the vertical focus of the light to provide a predetermined beam pattern having an increased horizontal beam spread relative to an aspheric condenser lens.”). The difference in horizontal and vertical focus

of the light necessarily results in an irregular pattern of light and, more specifically, a pattern of light that is aperiodic along at least one dimension.

258. Accordingly, Chinniah discloses "wherein a pattern of light projected by the cluster of lenses is aperiodic along at least one dimension" as claimed.

259. Additionally, Chinniah modified with the irregular pattern of emitters of Osawa would also result in a pattern of light projected by the cluster of lenses to be irregular (i.e., aperiodic along at least one dimension) due to the irregular pattern of emitters. see also, EX1011, ¶¶ [0018]-[0020], [0023] ("[T]here is an effect that the light distribution can be freely adjusted.").

260. **Claim 8**

261. **8[pre] "A method comprising"**

262. *See* GROUND 5, Claim 1[pre], 1[a], 1[b], 1[c].

263. **8[a] "emitting, from a plurality of emitters, a plurality of lights arranged in a pattern;"**

264. *See* GROUND 5, Claim 1[a].

265. **8[b] "concentrating, via a condenser lens, the plurality of lights towards a central location of a cluster of lenses;"**

266. *See* GROUND 5, Claim 1[c].

267. **8[c] "receiving the concentrated light at a plurality of points within the cluster of lenses; and"**

268. *See* GROUND 5, Claim 1[b].

269. **8[d] "concurrently focusing, from each lens of the cluster of lenses, the received and concentrated light from each of the plurality of emitters in a plurality of directions;"**

270. *See* GROUND 5, Claim 1[b] and Claim 5.

271. **Claim 9**

272. **"The method of claim 8, wherein said emitting includes generating infrared light that is not detectable by an eye of a human observer interacting with an object illuminated by at least a portion of the light."**

273. *See* GROUND 5, Claim 2.

274. **Claim 10**

275. **"The method of claim 8, wherein said concentrating comprises concentrating the plurality of lights towards a center of a cluster of lenses including a Fresnel lens."**

276. *See* GROUND 5, Claims 1[b]-[c] and 3.

277. **Claim 11**

278. **"The method of claim 8, wherein the focused light comprises an irregular pattern."**

279. *See* GROUND 5, Claim 1[a]-[b] and Claims 4-6.

280. **Claim 12**

281. **"The method of claim 8, wherein the focused light includes a first pattern of light overlapping with a second pattern of light."**

282. *See* GROUND 5, Claim 1[b] and Claim 5.

283. **Claim 13**

284. **"The method of claim 8, wherein the focused light includes a pattern which is aperiodic along at least one dimension."**

285. *See* GROUND 5, Claims 4, 6, and 11.

286. **Claim 15**

287. **15[pre] "A system for projecting a pattern of light, the system comprising:"**

288. *See* GROUND 5, Claim 1[pre], 1[a], 1[b], 1[c].

289. **15[a] "a light source including a plurality of emitters configured to emit light;"**

290. *See* GROUND 5, Claim 1[a].

291. **15[b] "a cluster of lenses, each lens included in the cluster of lenses being configured to receive the emitted light from each of the plurality of emitters; and"**

292. *See* GROUND 5, Claim 1[b].

293. **15[c] "a condenser lens located between said light source and said cluster of lenses, the condenser lens concentrating light from each of the plurality of emitters towards a center of the cluster of lenses."**

294. *See* GROUND 5, Claim 1[c].

295. **Claim 16**

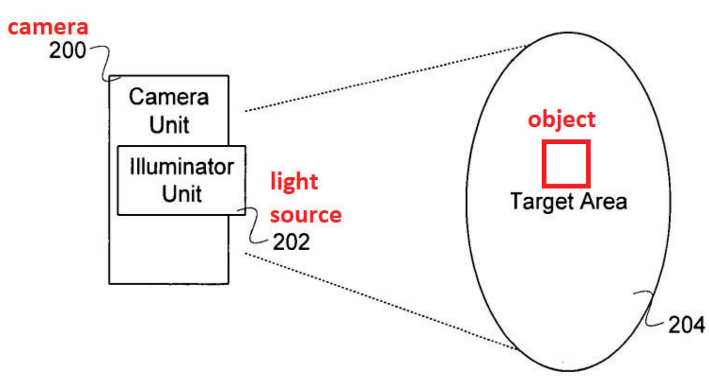
296. **"The system of claim 15, wherein the plurality of emitters includes light emitting diodes configured to generate infrared light that is not detectable by an eye of a human observer"**

297. *See* GROUND 5, Claim 2.

F. GROUND 6: Claims 7, 14, and 17 are obvious by Chinniah in view of Brandenburg and Osawa, and in further view of Hilaire and/or Cheon

298. **Overview of Hilaire**

299. Hilaire (EX1009) teaches a system for focusing and projecting patterns of light such that a location of an object illuminated by the pattern of light can be determined. EX1009, ¶¶ [0002] and [0015]; FIG. 2A.



EX1009, FIG. 2A (annotated)

300. The system creates lighting patterns that are useful to computer vision systems and which allow for more accurate tracking and determination of object positions in space. EX1009, ¶¶ [0002], [0015]-[0016], and [0019].

301. Hilaire states that the LED light source may generate infrared light that interacts with an object and that is detectable by a camera but not by an eye of a human observer. EX1009, ¶¶ [0015]-[0016], and [0021]. Additionally, multiple emitters can be used to generate more patterned features or to better illuminate objects. EX1009, ¶ [0015]. The emitted light may be projected and focused into an irregular pattern. EX1009, ¶ [0032]; FIGS. 7A-7B.

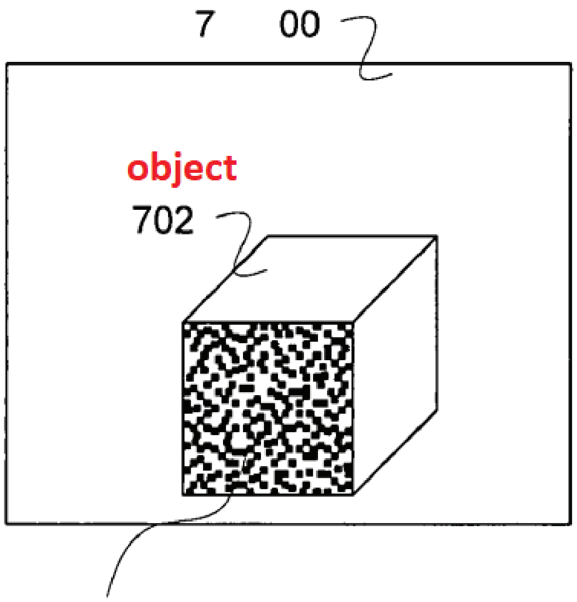
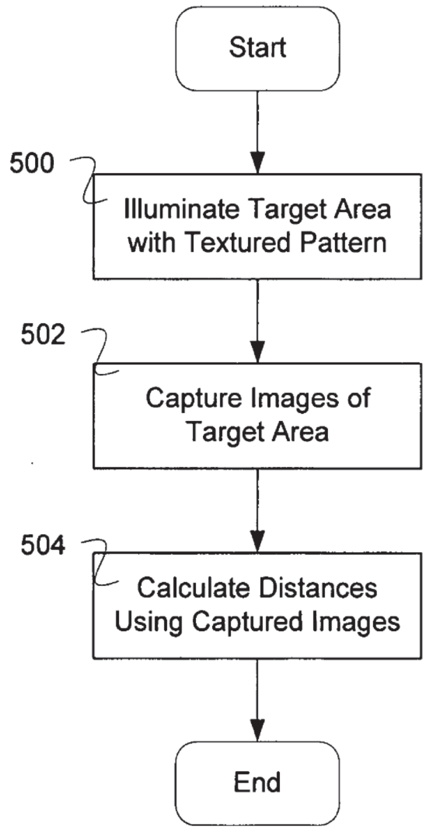


FIG. 7A

EX1009, FIG. 7A (annotated)

302. Hilaire also states that the use of the irregular pattern allows the system to more reliably detect objects that are at a different distances.

EX1009, ¶¶ [0015]-[0016]. The system utilizes its camera and computer to capture and process images of the patterned light reflected off of objects. EX1009, ¶¶ [0009]-[0010], [0013], and [0015]-[0016]. In particular, Hilaire describes a stereopsis algorithm to match features between two or more camera images, and the system will attempt to find matches of corresponding points of the irregular pattern reflected off of an object in the different images. EX1009, ¶¶ [0019], [0022]-[0023], and [0028]-[0029]. The disparity between these corresponding points allows depth calculations to be performed, thereby providing the location of objects in space. *Id.*; FIG. 5.



EX1009, FIG. 5

303. **Overview of Cheon**

304. Cheon (EX1010) teaches a vehicle lighting system that projects infrared light onto objects, such as pedestrians, to detect the objects. EX1010, p. 2, ¶¶ 1-6; p. 4, ¶ 1; FIG. 4.

EX1010, FIG. 4

305. Cheon teaches a vehicle lighting system that includes light sources (near-infrared lamps (40a) (40b)) to generate infrared light that interacts with an object and that is detected by a camera. *Id.*, p. 2, ¶¶ 1-6, 14; p. 4. The system is designed to aid a driver in conditions where visibility is low, while also avoiding glare to other vehicles. *Id.*, p. 2, ¶¶ 2-4. Cheon also discloses that, through the object detection, the system may alert the driver as to the distance to the object. *Id.*, p. 3, ¶¶ 9-12.

306. **Claim 7**

307. **"The system of claim 1, further comprising: a camera configured to detect a pattern of light on an object illuminated by at least a portion of the pattern of light; and a computing device configured to determine a location of the object in space based on at least the detected pattern of light on the object."**

308. Both Hilaire and Cheon teach and render obvious the additional limitations of claim 7. Hilaire teaches a light source (illuminator unit 110, 202), a camera unit 100, 200, and a computing device (distance processor 130, 400), that are used to determine a location of an object in space based on at least the detected pattern of light on the object. EX1009, ¶¶ [0002], [0015]-[0016], [0022]-[0023], [0028], [0031]. More specifically, Hilaire teaches that, in order to calculate distances to an object, the illuminator unit illuminates the object in a target area with a textured pattern of light, the camera unit images the illuminated object, and the distance processor calculates the distance to the object based on the detected textured pattern of light. EX1009, ¶¶ [0019]-][0023]. Hilaire also teaches that the illuminated light may be "non-visible" light (e.g., infrared). EX1009, ¶ [0016] ("Illumination source comprises … an infrared laser … light emitting diode ... A non-visible illumination source will enable the distance system to operate without being detectable by a human being who is in the target area.").

309. Similarly, Cheon discloses a light projection system that "us[es] near-infrared rays to monitor pedestrians or objects on the road ahead during night driving." EX1010, p. 4, ¶ 1. The system includes a light source (near-

infrared lamps (40a) (40b)), a camera (image input unit (50)), and a computing device (image processing unit (60)). *Id*., p. 2, ¶ 9. Cheon also states the "image input unit (50) [that] is a near-infrared camera . . . detects [the] near-infrared rays reflected from objects or pedestrians." *Id*., p. 2, ¶ 15. The system also detects the location of the detected object in space and alerts the driver as to the distance to the object using a speaker. *Id*., p. 2, ¶ 9, p. 3, ¶¶ 1, 11-12. In other words, Cheon describes determining a location of the object in space based on at least the detected pattern of infrared light.

310. It would have been obvious to a person of ordinary skill in the art to modify the vehicle lighting system taught by Chinniah, Brandenburg and Osawa to include a camera and a computing device as required by claim 7 (and similarly claims 14 and 17) from the teachings of Hilaire and/or Cheon. One skilled in the art would be motivated to make the modification in order to provide object detection in conditions where visibility is reduced (such as at night) and/or to avoid blinding other drivers with illumination. EX1006, ¶ [0042]; EX1009, ¶ [0016]; EX1010, p. 2, ¶ 3.

311. Chinniah, Brandenburg, Hilaire and Cheon address similar problems of controlling illumination to detect objects while avoiding negative impacts of the illumination on other individuals. EX1005, 1:17-21 ("[T]he beam

pattern provided in road illumination should have a certain amount of vertical spread as well as a certain amount of horizontal spread. At the same time, a vertical cut-off should be provided to minimize glare to oncoming traffic."); EX1006, ¶ [0009] ("By means of the lighting device according to the invention, asymmetrical light intensity distributions can therefore also be generated. The lighting device according to the invention can therefore advantageously be designed as a vehicle headlight in order to generate, for example, the high beam, **low beam,** daytime running light or fog light."); EX1009, ¶ [0016] ("A non-visible illumination source will enable the distance system to operate without being detectable by a human being"); EX1010, p. 2, ¶¶ 4-6 ("[I]t is difficult to recognize [an] object[,] . . . so a high beam is used[.] . . . [H]owever, in the case of [a] high beam, glare is caused to the drivers of [other] vehicles[.] . . . The present invention was invented to solve the above-stated problems[.]").

312. Additionally, Brandenburg, Chinniah and Cheon each describes an optical system for vehicle headlights and one skilled in the art would look to these references in designing a vehicle headlight. EX1006, ¶ [0001]; EX1005, 1:6-8, 3:59-63; EX1010, Abstract. Both Brandenburg and Cheon recognize using vehicle-based light projection systems with infrared light to

detect objects. EX1006, ¶ [0042]; EX1010, Abstract. Hilaire also teaches projecting infrared light, which is not detectable by the naked eye, to detect objects. EX1009, ¶ [0016] ("Illumination source comprises … an infrared laser … light emitting diode ... A non-visible illumination source will enable the distance system to operate without being detectable by a human being who is in the target area.").

313. Chinniah and Cheon also describe motivations for the modification by teaching the ability to minimize glare onto oncoming traffic. EX1005, 1:20-21 ("[A] vertical cut-off should be provided to minimize glare to oncoming traffic."); Cheon at p. 2, ¶ 3 ("[I]t it is difficult to secure lighting for a sufficient area required by the driver due to problems such as . . . glare to surrounding vehicles."). A person of ordinary skill in the art would have recognized that the use of infrared light described in Hilaire and Cheon, as opposed to visible light, would enable object detection while avoiding glare. EX1006, ¶ [0042] (describing infrared radiation as separate from **visible** electromagnetic radiation); EX1009, ¶ [0016].

314. Incorporating the computing device of Hilaire or Cheon (that is used to determine a location of objects in space based on a detected pattern of light on the object), with Chinniah would provide predictable results of

facilitating the improved detection of objects in conditions where visibility is reduced, such as during night driving. EX1004, ¶ [0042].

315. As demonstrated by the above, there would have also been a reasonable expectation of success in making such modification, because the modifications simply combine known elements (e.g., emitters, cameras and computers) with known methods (such as described in Hilaire and Cheon), to achieve a known or predictable result of object detection using patterned illumination.

316. In view of the above, the combination of Chinniah, Brandenburg and Osawa, in further view of Hilaire and/or Cheong teach "a camera configured to detect a pattern of light on an object illuminated by at least a portion of the pattern of light; and a computing device configured to determine a location of the object in space based on at least the detected pattern of light on the object" as claimed.

317. **Claim 14**

318. **"The method of claim 8, further comprising: detecting a pattern of light on an object illuminated by at least a portion of a pattern of light; and determining a location of the object in space based on at least the detected pattern of light on the object"**

319. *See* GROUND 6, Claim 7.

320. **Claim 17**

321. **"a computing device configured to analyze images of a pattern formed by light projected from each of the emitters on an object to determine a location of the object in space based on at least the pattern of light on the object"**

322. *See* GROUND 6, Claim 7.

G. GROUND 7: Claims 3-4 and 10 are obvious by Weidel in view of Chinniah, and in further view of Osawa

323. **Claim 3**

324. **"The system of claim 1, wherein the cluster of lenses includes a Fresnel lens."**

325. As explained in GROUND 4, claim 3, Weidel in combination with Chinniah discloses this limitation. This limitation is also obvious in view of Osawa.

326. As discussed above for claim 3 in GROUND 4, by incorporating a Fresnel lens in a headlamp as described in Osawa, the headlamp may be produced to be thinner and lighter than other types of lenses, and it can be easily manufactured by using resin molding, making such lenses cost effective. EX1011, ¶¶ [0044]-[0045]; claim 14.

327. One of ordinary skill in the art would be motivated to incorporate a Fresnel lens as described in Osawa, in or as the surface 36 of the condenser lens 30 of the lighting system of the combination of Weidel and Chinniah,

thereby configuring the cluster of lenses, to achieve Chinniah's objective of a vehicle headlamp that is lightweight, small, and cost effective. EX1005, Abstract and 5:63-67. There would also have been a reasonable expectation of success in making such modification since such modification involves replacing one optical element for another known optical element.

328. **Claim 4**

329. **"The system of claim 1, wherein the emitters are arranged in an irregular pattern."**

330. Osawa discloses LED chips 6 arranged in an irregular pattern.

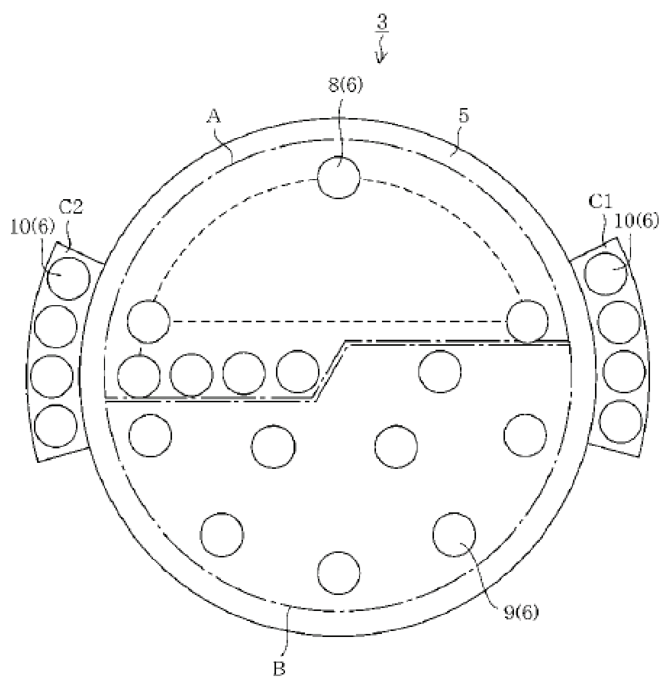


Fig.2

331. The teachings of Osawa directly complement the headlamp designs in Weidel and Chinniah to provide solutions for automotive headlight applications; and, similar to Osawa describing accomplishing a low beam, a high beam, and a cornering beam, Chinniah recognizes a benefit in controlling a light beam distribution. EX1005, Abstract, 1:49-51.

332. A person of ordinary skill in the art would have been motivated to incorporate irregular emitter arrangements, as taught by Osawa, in the lighting system of the combination of Weidel and Chinniah to achieve a vehicle headlamp that is capable of producing various desired beam shapes and distributions, while also accomplishing a reduction in parts and improved vehicle safety. EX1005, 1:19-21, 3:26-31; EX1011, ¶¶ [0023]-[0024].

333. The combination of Weidel, Chinniah and Osawa discloses that "the emitters are arranged in an irregular pattern" as claimed.

334. **Claim 10**

335. **"The method of claim 8, wherein said concentrating comprises concentrating the plurality of lights towards a center of a cluster of lenses including a Fresnel lens."**

336. *See* GROUND 4, Claims 1[c] and GROUND 7, Claim 3.

H. GROUND 8: Claims 7, 14, and 17 are obvious by Weidel in view of Chinniah, and in further view of Hilaire and/or Cheon

337. **Claim 7**

338. **"The system of claim 1, further comprising: a camera configured to detect a pattern** of **light on an object illuminated by at least a portion of the pattern of light; and a computing device configured to determine a location of the object in space based on at least the detected pattern of light on the object."**

339. Weidel discloses "a camera configured to detect a pattern of light on an object illuminated by at least a portion of the pattern of light." Weidel states that "[t]he invention can be used in a night vision system[,] . . . preferably by equipping the headlight with LEDs or laser diodes which emit in the near infrared." EX1004, ¶ [0012]. In describing an exemplary night vision system, Weidel states, "[a] CCD camera for recording the video image is located in the roof area of the vehicle. The CCD camera has an electronic shutter that is synchronized with the [infrared] laser diodes. . . . The video image is shown to the driver on an LCD display." EX1004, ¶ [0005]. Weidel also states, "Since infrared light is almost invisible to the human eye, it can be illuminated permanently," and that "[u]sing a video camera with a fast electronic shutter synchronized with the lasers can

further reduce the light from oncoming vehicles [that would otherwise produce glare in the recorded video image].” *Id*., at ¶¶ [0004]-[0005].

340. Weidel may not expressly describe a computing device configured to determine a location of the object in space based on at least the detected pattern of light on the object, but Weidel does recognize that its system for projecting light has an expanded functionality in addition to illumination, and, as discussed above, may be used for automobile night-vision systems. *Id*., ¶¶ [0002], [0009], and [0012]. The express motivation for using the light projection system with a night vision system is to improve obstacle detection. *Id*., at ¶ [0002] (“Poor visibility at night is a stressful and dangerous situation[,] . . . [which] leads to late detection of non-illuminated obstacles, pedestrians, bicyclists without lights and animals, and thus to accidents.”).

341. Hilaire teaches a light source (illuminator unit 110, 202), a camera (camera unit 100, 200), and a computing device (distance processor 130, 400), that are used to determine a location of an object in space based on at least the detected pattern of light on the object. EX1009, ¶¶ [0002], [0015]-[0016], [0022]-[0023], [0028], [0031]. More specifically, Hilaire teaches that, in order to calculate distances to an object, the illuminator unit

illuminates the object in a target area with a textured pattern of light, the camera unit images the illuminated object, and the distance processor calculates the distance to the object based on the detected textured pattern of light. EX1009, ¶¶ [0019]-][0023]. Hilaire also teaches that the illuminated light may be "non-visible" light (e.g., infrared). EX1009, ¶ [0016] ("Illumination source comprises … an infrared laser … light emitting diode ... A non-visible illumination source will enable the distance system to operate without being detectable by a human being who is in the target area.").

342. In [0022] of Hilaire, at the end of the paragraph, it says "Note also that superimposed textured illumination patterns from multiple sources create patterns that are useful for distance calculation without any change in the calculations." This is important because in '803, they are using multiple sources to create a pattern for determining the location of an object in space and Hilaire is doing the same thing.

343. Cheon, which is from the same field as Weidel and Chinniah of light projection systems, also discloses a light projection system that "us[es] near-infrared rays to monitor pedestrians or objects on the road ahead during night driving." EX1010, p. 4, ¶ 1. The system includes a light source

(e.g., near-infrared lamps (40a) (40b)), a camera (e.g., image input unit (50)), and a computing device (e.g., image processing unit (60)). *Id*., p. 2, ¶ 9. Cheon also states the "image input unit (50) [that] is a near-infrared camera . . . detects [the] near-infrared rays reflected from objects or pedestrians." *Id*., p. 2, ¶ 15. The system also detects the location of the detected object in space and alerts the driver as to the distance to the object using a speaker. *Id*., p. 2, ¶ 9, p. 3, ¶¶ 1, 11-12. In other words, Cheon describes determining a location of the object in space based on at least the detected pattern of infrared light.

344. It would have been obvious to a person of ordinary skill in the art to modify the vehicle lighting system of Weidel and/or Chinniah based on Hilaire and/or Cheon to include a camera and a computing device as required by claim 7 (and similarly claims 14 and 17), to improve the ability to detect objects in conditions where visibility is reduced (such as at night) and/or to avoid blinding other drivers with illumination. EX1004, ¶ [0002]; EX1009, ¶ [0016]; EX1010, p. 2, ¶ 3.

345. Weidel, Chinniah, Hilaire and Cheon address similar problems of controlling illumination to detect objects while avoiding negative impacts of the illumination on other individuals. EX1005, 1:17-21 ("[T]he beam

pattern provided in road illumination should have a certain amount of vertical spread as well as a certain amount of horizontal spread. At the same time, a vertical cut-off should be provided to minimize glare to oncoming traffic."); EX1004, ¶ [0005] ("Since infrared light is almost invisible to the human eye, it can be illuminated permanently in high-beam light mode.") (emphasis added); EX1009, ¶ [0016] ("A non-visible illumination source will enable the distance system to operate without being detectable by a human being"); EX1010, p. 2, ¶¶ 4-6 ("[I]t is difficult to recognize [an] object[,] . . . so [] a high beam is used[.] . . . [H]owever, in the case of high beam[s], glare is caused to [other] drivers[.] . . . The present invention was invented to solve the above-stated problems[.]").

346. Both Weidel and Cheon recognize using vehicle-based light projection systems to detect objects with infrared light. *e.g.,* EX1004, ¶¶ [0012]; EX1010, Abstract. Hilaire also teaches projecting infrared light, which is not detectable by the naked eye, to detect objects. EX1009, ¶ [0016] ("Illumination source comprises … an infrared laser … light emitting diode ... A non-visible illumination source will enable the distance system to operate without being detectable by a human being who is in the target area.").

347. Chinniah and Cheon also describe motivations involving minimizing glare onto oncoming traffic. EX1005, 1:20-21 ("[A] vertical cut-off should be provided to minimize glare to oncoming traffic."); Cheon at p. 2, ¶ 3 ("[I]t it is difficult to secure lighting for a sufficient area required by the driver due to problems such as . . . glare to surrounding vehicles."). A person of ordinary skill in the art would have recognized that the use of infrared light as described in Hilaire and Cheon, as opposed to visible light, would enable object detection while avoiding glare. EX1006, ¶ [0042] (describing infrared radiation as separate from **visible** electromagnetic radiation); EX1009, ¶ [0016].

348. Incorporating the computing device of Hilaire or Cheon (that is used to determine a location of objects in space based on a detected pattern of light on the object), with Weidel and/or Chinniah would provide predictable results of facilitating improved detection of objects in conditions where visibility is reduced, such as at night. EX1004, ¶¶ [0002], [0004], and [0012].

349. As demonstrated by the above, there would have also been a reasonable expectation of success in making such modification, because the modifications simply combine known elements (e.g., emitters, cameras, and

computers) with known methods (such as described in Hilaire and Cheon), to achieve a known or predictable result of object detection using patterned illumination.

350. In view of the above, the combination of Weidel and Chinniah, in further view of Hilaire and/or Cheong teaches "a camera configured to detect a pattern of light on an object illuminated by at least a portion of the pattern of light; and a computing device configured to determine a location of the object in space based on at least the detected pattern of light on the object" as claimed.

351. **Claim 14**

352. **"The method of claim 8, further comprising: detecting a pattern of light on an object illuminated by at least a portion of a pattern of light; and determining a location of the object in space based on at least the detected pattern of light on the object."**

353. See GROUND 8, Claim 7.

354. Claim 17

355. **"a computing device configured to analyze images of a pattern formed by light projected from each of the emitters on an object to determine a location of the object in space based on at least the pattern of light on the object"**

356. See GROUND 8, Claim 7.