

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GIESECKE+DEVRIENT GMBH, GIESECKE+DEVRIENT CURRENCY
TECHNOLOGY GMBH, AND PAPIERFABRIK LOUISENTHAL GMBH,

Petitioners,

v.

LUMENCO, LLC,

Patent Owner.

IPR2024-00839
Patent No. 11,448,863 B2

**PATENT OWNER'S NOTICE OF APPEAL TO THE
UNITED STATES COURT OF APPEALS FOR THE FEDERAL
CIRCUIT**

Filed on behalf of Patent Owner by:

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Paper 34

Pursuant to 28 U.S.C. § 1295(a)(4)(A), 35 U.S.C. §§ 141(c), 142, and 319, and 37 C.F.R. §§ 90.2(a), 90.3, 5 U.S.C. §§ 701–706, and Federal Circuit Rule 15(a)(1), Patent Owner Lumenco, LLC (“Patent Owner”) provides notice that it appeals to the United States Court of Appeals for the Federal Circuit from the Final Written Decision of the Patent Trial and Appeal Board (“Board”) entered November 21, 2025 (Paper 30; copy attached hereto), the Order denying Director review entered March 17, 2026 (Paper 33), and from all underlying and related orders, decisions, rulings, and opinions regarding U.S. Patent No. 11,448,863 (“the ’863 Patent”) in *Inter Partes* Review IPR2024-00839.

In accordance with 37 C.F.R. § 90.2(a)(3)(ii), the expected issues on appeal include, but are not limited to: the Board’s error(s) in determining that claims 1, 2, 5, 6, and 12–20 of the ’863 Patent are unpatentable, as well as all other issues decided adversely to Patent Owner in any orders, decisions, rulings, or opinions in *Inter Partes* Review IPR2024-00839.

Pursuant to 35 U.S.C. § 142 and 37 C.F.R. § 90.2(a), this Notice is being filed with the Director of the United States Patent and Trademark Office and with the Patent Trial and Appeal Board. In addition, a copy of this Notice is being filed with the Clerk’s Office for the United States Court of Appeals for the Federal Circuit *via* its CM/ECF electronic filing system along with the required docketing fee.

Date: May 19, 2026

Respectfully submitted,

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CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §42.6, the undersigned certifies that, on May 19, 2026, the foregoing PATENT OWNER'S NOTICE OF APPEAL TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT was served on counsel of record for Petitioners by filing this document through the End-to-End System, as well as *via* electronic mail to counsel of record for Petitioners at the following addresses:

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UNITED STATES PATENT AND TRADEMARK OFFICE

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GIESECKE+DEVRIENT GMBH, GIESECKE+DEVRIENT CURRENCY
TECHNOLOGY GMBH, and PAPIERFABRIKLOUISENTHAL GMBH,
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IPR2024-00839
Patent 11,448,863 B2

Before MEREDITH C. PETRAVICK, BENJAMIN D. M. WOOD, and
NABEEL U. KHAN, *Administrative Patent Judges*.

PETRAVICK, *Administrative Patent Judge*.

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

I. INTRODUCTION

Giesecke+Devrient GmbH Giesecke+Devrient Currency Technology GmbH, and Papierfabrik Louisenenthal GmbH (collectively, “Petitioner”) filed a Petition for an *inter partes* review of claims 1–20 of U.S. Patent No. 11,448,863 B2 (Ex. 1001, “the ’863 patent,”). Paper 1 (“Pet.”). Lumenco, LLC (“Patent Owner”) filed a Preliminary Response (Paper 7), and, on November 25, 2024, we instituted this *inter partes* review as to all challenged claims and all grounds presented in the Petition (Paper 8).

After institution, Patent Owner filed a Response to the Petition. Paper 12 (“PO Resp.”)¹. Petitioner filed a Reply (Paper 16, “Pet. Reply”), and Patent Owner filed a Sur-Reply (Paper 17, “PO Sur-Reply”). An oral hearing was held on August 26, 2025 and a transcript appears in the record (Paper 29, “Tr.”).

We have jurisdiction under 35 U.S.C. § 6. This is a Final Written Decision under 35 U.S.C. § 318(a) as to the patentability of claims 1–20 of the ’863 patent. For the reasons discussed below, we determine Petitioner establishes by a preponderance of the evidence that claims 1, 2, 5, 6, 12–20 are unpatentable, but has failed to establish by a preponderance of the evidence that claims 3, 4, and 7–11 are unpatentable.

A. *Real Parties-in-Interest*

Petitioner identifies the parties named in the caption as the real parties-in-interest. Pet. 85. Patent Owner identifies itself as the real party-in-interest. Paper 5, 2.

¹ Paper 12 was filed after institution as the Patent Owner’s Response but is mistakenly titled as a Preliminary Response.

B. Related Matters

The parties identify the following related court proceedings:

Lumenco, LLC v. Giesecke+Devrient Currency Technology GmbH, v. Giesecke+Devrient GmbH f/k/a Giesecke & Devrient GmbH, and Papierfabrik Louisenthal GmbH, E.D. Tex. No. 2:23-cv-00100-JRG (E.D. Tex. 2023) (dismissed), and

Lumenco, LLC v. USA, Ct. of Fed. Claims No. 1:24-cv-00139-MRS (Fed Cl 2024) (pending). Paper 5, 2; Paper 6, 1.

Petitioner also identifies the following related *inter partes* reviews: IPR2024-00836, IPR2024-00837, and IPR2024-00838. Paper 1.

C. The '863 Patent

The '863 patent is titled “Method of Fabricating Arrays of Individually Oriented Micro Mirrors for Use in Imaging Security Devices” and issued from an application claiming priority to a provisional application filed on December 3, 2015. Ex. 1001, codes (54), (60).

The '863 patent discloses an anti-counterfeiting device “configured to ‘write’ images with light in one, two, or more spatial planes above and below the surface of an array of micro mirrors.” Ex. 1001, 2:38–41.

Figure 2 of the '863 patent is reproduced below.

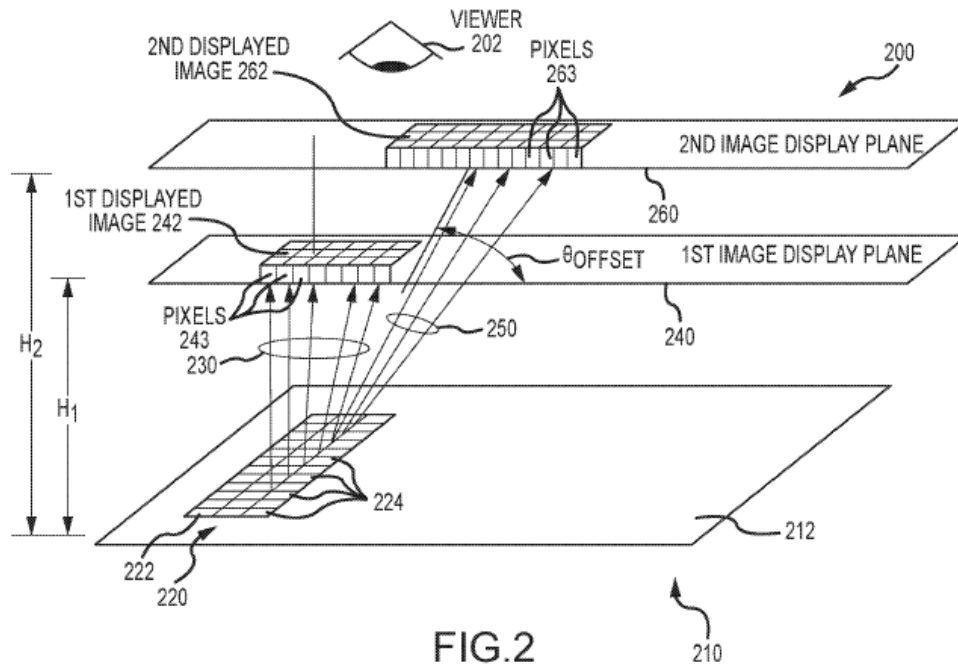


Figure 2 depicts a schematic of an object, such as currency, that includes the anti-counterfeiting device. *Id.* at 4:29–32; 7:28–32. Security device 220 has exposed, upper surface 222 that has an array of micro mirrors 224. *Id.* at 7:35–37. Micro mirrors 224 are “individually oriented to provide reflection of ambient light . . . so as to display one or more floating images that can be observed by a viewer 202.” *Id.* at 7:37–41. First sets of micro mirrors 224 “write” pixels 243 of first display image 242, and second sets of micro mirrors 224 “write” pixels 263 of second display image 262. *Id.* at 7:42–62.

Viewer 202 sees first display image 242 floating above surface 212 and second display image 262 at a greater height above surface 212 and, because of the offset viewing image, viewer 202 typically only sees one image at a time. *Id.* at 8:1–12.

To “write” pixels by reflecting ambient light, each set of micro mirrors is aimed toward an intersection point forming a pixel of an image. *Id.* at 7:50–57.

D. Illustrative Claims

Petitioner challenges claims 1–20 of the ’863 patent. Claims 1, 7, and 12 are independent. Claims 2– 6 depend directly or indirectly from claim 1. Claims 8–11 depend directly or indirectly from claim 7. Claims 13–20 depend from claim 12. Claims 1, 7, and 12 are illustrative and reproduced below, with Petitioner’s labeling added (Pet. 88–90).

1. [1pre] A method of fabricating a security element, comprising:
 - [1a] assigning a first object in a starting digital image to a first image display plane and a second object in the starting digital image to a second image display plane;
 - [1b] with a processor of a computing device, executing code to provide an array design module that operates to select a set of micro mirrors in an array of the micro mirrors to display each of the pixels of the first object in the first image display plane and to display each of the pixels of the second object in the second image display plane;
 - [1c] for each of the pixels, determining with the array design module an angular orientation of each of the micro mirrors in the selected sets of the micro mirrors;
 - [1d] generating a design output file including the angular orientation and location coordinates in the array for each of the micro mirrors in the selected sets of the micro mirrors; and
 - [1e] forming the array of the micromirrors according to the design output file.

7. [7pre] A method of fabricating a security element, comprising:
 - [7a] with a processor of a computing device, executing code to provide an array design module configured to select a set of micro mirrors in an array of the micro mirrors to display pixels of a first object in a first image display plane and to display pixels of a second object in a second image display plane spaced apart from the first image display plane;
 - [7b] for each of the pixels, determining, with the array design module, an angular orientation of each of the micro mirrors in the selected sets of the micro mirrors;
 - [7c.1] generating a design output file including the angular orientation and location coordinates in the array for each of the micro mirrors in the selected sets of the micro mirrors,
 - [7c.2] wherein each of the sets of micro mirrors are selected randomly from a plurality of the micro mirrors located in a base of a cone on a surface containing the array of the micro mirrors
 - [7.d] forming the array of the micro mirrors according to the design output file.
12. [12 pre] A method of fabricating a security element useful on paper and coin currency and on product labels, comprising:
 - [12a] with a processor of a computing device, executing code to provide an array design module configured to define an array of micro mirrors to be formed on a surface of a substrate;
 - [12b] generating a design output file including an angular orientation and location coordinates in the array for each of the micro mirrors; and
 - [12c] forming the array of micro mirrors according to the design output file,

[12d] wherein the array of micro mirrors is configured, when formed on the surface of the substrate, for receiving ambient light and, in response, displaying an image in a plane spaced a distance apart from the surface of the substrate,

[12e] wherein the image comprises a plurality of pixels, and

[12f] wherein the array of micro mirrors includes for each of the pixels a different set of the micro mirrors each having a reflective surface oriented, in a fixed manner, with a body of each of the micro mirrors rotated about at least one of first and second rotation axes extending through the body, to reflect the ambient light toward a point on the plane corresponding to one of the pixels.

Ex. 1001, 20:55–21:6, 21:25–44, 21:58–22:23.

E. Prior Art and Asserted Grounds

Petitioner asserts that claims 1–20 would have been unpatentable on the following grounds:

Ground	Claims Challenged	35 U.S.C. §	Basis
1	1, 2, 4–6, 12–14	103	Fuhse847, ² Rich ³
2	3, 6–14	103	Fuhse847, Rich, Fuhse925 ⁴
3	15–18	103	Fuhse847, Rich, Sauvage-Vincent ⁵
4	15–18	103	Fuhse847, Rich, Fuhse925, Sauvage-Vincent
5	19, 20	103	Fuhse847, Rich, Morford ⁶

² WO 2012/048847 A1 (Ex. 1040). We cite to the English language translation at Exhibit 1022.

³ U.S. Patent No. 10,859,851 B2 (Ex. 1039).

⁴ U.S. Patent No. 10,639,925 B2 (Ex. 1008).

⁵ U.S. Patent Application Publication No. 2014/0285892 (Ex. 1033)

⁶ Robert Morford, Wu-Sheng Shih, and JoElle Dachsteiner “Press-patterned

Ground	Claims Challenged	35 U.S.C. §	Basis
6	19, 20	103	Fuhse847, Rich, Fhuse925, Morford

Pet. 4–5.

Petitioner relies on the Declaration of Lambertus Hesselink, Ph.D.
Ex. 1003.

Patent Owner provides the Declaration of Mikael Lindstrand to
supports its arguments. Ex. 2001.

II. ANALYSIS

A. Legal Standards

In an IPR, the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d, 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)); *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (discussing the burden of proof in *inter partes* review). Although we may indicate in this Decision that certain Patent Owner arguments are not persuasive, in doing so we do not shift the ultimate burden from Petitioner.

A claim is unpatentable under § 103 if the differences between the claimed invention and the prior art are such that the claimed invention, as a

UV-curable high refractive index coatings,” Proc. SPIE 6123, Integrated Optics: Devices, Materials, and Technologies X, 612301 (15 February 2006), available at <https://doi.org/10.1117/12.643164> (Ex. 1024).

whole, would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. “[W]hen a patent claims a structure already known in the prior art that is altered by the mere substitution of one element for another known in the field, the combination must do more than yield a predictable result.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007) (citing *U.S. v. Adams*, 383 U.S. 39, 50–51 (1966)). The question of obviousness is resolved on the basis of underlying factual determinations, including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) when in evidence, objective indicia of non-obviousness (i.e., secondary considerations). *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). The record contains no evidence of objective indicia of non-obviousness.

B. Level of Ordinary Skill in the Art

In determining the level of ordinary skill in the art, various factors may be considered, including the “type of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made; sophistication of the technology; and educational level of active workers in the field.” *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995) (internal quotation marks and citation omitted).

Petitioner proposes that a person of ordinary skill in the art (POSITA) in the field “would have had a minimum of an undergraduate degree in electrical engineering, mechanical engineering, or physics and at least 2

years of experience in micro-optic based security features.” Pet. 11 (citing Ex. 1003 ¶¶ 88–94).

Patent Owner proposes that a POSITA “as of the date of alleged invention in the ’863 patent, would have had an undergraduate degree in electrical engineering, mechanical engineering, physics, or a similar field and at least 2 years of experience with diffusive light micro-optic security features.” PO Resp. 8 (citing Ex. 2001 ¶ 23). Patent Owner argues that a “similar field” would “include at least computer science degrees with engineering coursework.” PO Resp. 8.

We adopt Petitioner’s proposed definition of a POSITA because Petitioner’s definition is consistent with the types of problems encountered in the art, the prior art solutions to those problems, and the sophistication of the technology. For example, the ’863 patent provides, as relevant background, a discussion of anti-counterfeiting devices made up of arrays of lenses used to display unique images, placed on currency and labels for retail products. Ex. 1001, 1:31–43. The ’863 patent also discusses using lenses to create holograms. *Id.* at 2:7–20. Similarly, the prior art in this field, such as Fuhse847, relates to the use of lenses and mirrors to create hologram images for security purposes. Ex. 1022, 1–8. These descriptions demonstrate, consistent with Petitioner’s proposed definition, that a POSITA would need an educational background to understand optics, lenses, and mirrors along with professional experience with optical security features to understand the creation holograms and images using lenses and mirrors for the purpose of preventing counterfeiting of currency and other valuable products.

Patent Owner’s proposed definition differs from Petitioner’s in that it includes “or a similar field” when describing the education level of a

POSITA and it includes “with diffusive light” when describing the experience level of a POSITA.

As to the first difference, the addition of “similar field” introduces vagueness and unnecessary uncertainty into the definition. Patent Owner does not explain what aspects of computer science would make it a field similar to the others listed, or what additional engineering coursework would suffice to make a person a POSITA. *See* Ex. 2001 ¶ 25. Nor does Patent Owner explain, generally, what makes a field “similar” to the ones listed or how to make that determination.

As to the second difference, the addition of “with diffusive light” would be inconsistent with the ’863 patent’s disclosure and claims. The ’863 patent does not mention “diffusive light.” The ’863 patent describes using ambient light (*see, e.g.*, Ex. 1001, code (57), 2:54–558, 3:20–24, 5:57–62, Fig. 1, item 130 (ray labeled “ambient light”)), and, likewise, the claims recites ambient light (*see, e.g., id.* at 22:11–23 (claim 12), 22:24–28 (claim 13)). Ambient light, for example sunlight, includes both parallel and diffuse light. *See* Ex. 1055, 97:21–98:8; Ex. 1022, 13 (describing the use of sunlight or ceiling light). The ’863 patent discusses ambient light and does not discuss any distinctions between parallel light and diffuse light or give any significance to the nature of diffuse light and its effects on the invention.

We, therefore, adopt Petitioner’s definition of a POSITA except that we find that the phrase “at least” in Petitioner’s proposed definition creates a vague, open-ended upper bound for the level of ordinary skill, and we therefore do not adopt that aspect of the proposal.

C. Whether Dr. Hesselink is a POSITA

Patent Owner argues that Dr. Hesselink is not a POSITA because “[t]here is no evidence that Dr. Hesselink has any experience working with diffusive light systems like those disclosed by the ’863 patent” and, thus, is “unqualified to offer opinions regarding the ’863 patent.” PO Resp. 10–13 (citing Ex. 1003).

Patent Owner did not move to exclude Dr. Hesselink’s testimony. *See* 37 C.F.R. § 42.62; Pet. Reply 25 (arguing that Patent Owner waived its ability to challenge Dr. Hesselink’s qualification.). At the hearing, Patent Owner explained that its argument that Dr. Hesselink is not a POSITA “goes to [the] weight” of Dr. Hesselink’s testimony. Tr. 37:8.

In any event, Patent Owner’s argument is based on its proposed definition of a POSITA, which we do not adopt. We, therefore, are not persuaded that Dr. Hesselink testimony should be given little or no weight.

D. Claim Construction

In this *inter partes* review, we apply the same claim construction standard that would be used in a civil action under 35 U.S.C. § 282(b). 37 C.F.R. § 42.100(b). In applying this standard, we generally give claim terms their ordinary and customary meaning as would be understood by a person of ordinary skill in the art at the time of the invention and in the context of the entire patent disclosure. *See id.*; *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–14 (Fed. Cir. 2005) (en banc).

Petitioner contends that “no claim terms require express construction.” Pet. 11. Patent Owner agrees “that the terms do not require construction for purposes of evaluating the Petition.” PO Resp. 13.

We do not need to construe any terms explicitly to reach our decision on institution. *See Realtime Data LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019) (“The Board is required to construe ‘only those terms . . . that are in controversy, and only to the extent necessary to resolve the controversy.’” (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)); *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (approving Board decision not to construe claim language where construction is not material to the dispute).

E. Ground 1

Petitioner contends that claims 1, 2, 4–6, and 12–14 are unpatentable over Fuhse847 and Rich. Pet. 12–54.

1. Summary of Fuhse847

Fuhse847 is titled “Representation Element Comprising Optical Elements Arranged on a Substrate, for Producing an Image Composed of Light Spots and Suspended Above or Below the Substrate” and published on April 19, 2012. Ex. 1022, codes (43), (54).

Fuhse847 discloses a security element created from a reflective micromirror array that reflects light to “light spots” or “pixels,” which together form two- or three-dimensional images (“light-spot images”) that appear to “float” at “floating heights above or below” the substrate surface. Ex.1022, 5. The images can be “visible from the same or different viewing

angles” and each image is “only visible in a limited angle range.” *Id.* at 25–26.

Figure 2 of Fuhse847 is reproduced below.

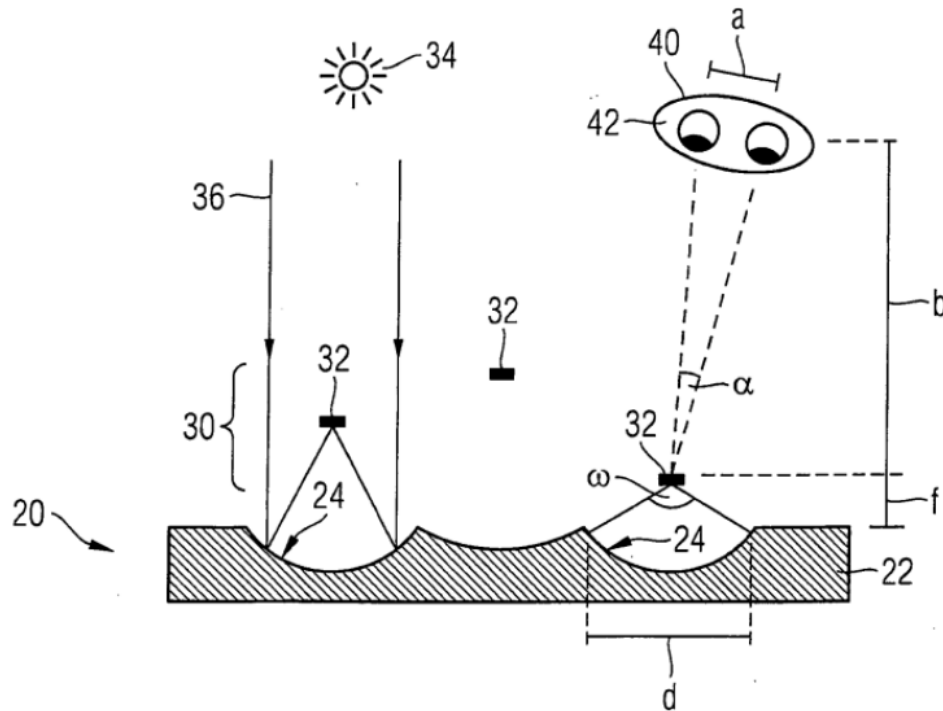
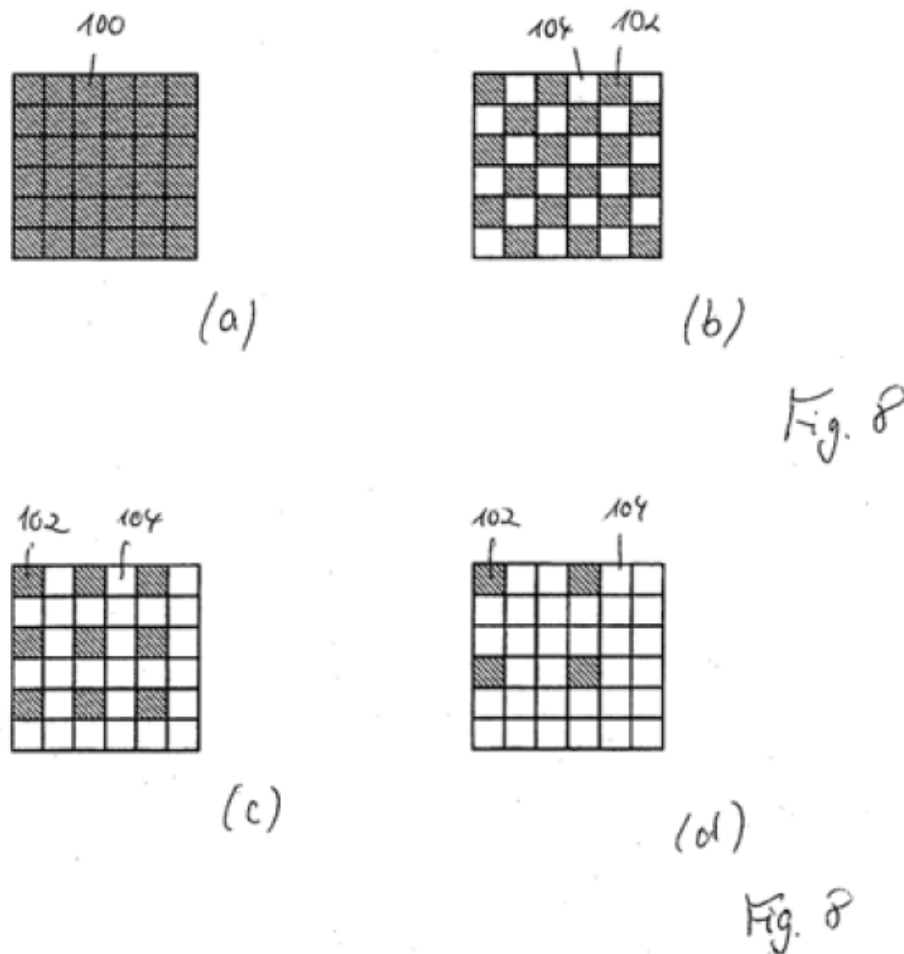


Fig. 2

Figure 2 “shows schematically a first exemplary embodiment of the invention with concave mirrors as reflective optical elements.” *Id.* at 12. Concave mirrors 24 on the surface of substrate 22 reflect light from distant light source 34 to “produce the specified image points as light spots 32.” *Id.* at 13–14.

In the embodiment of Figures 8–10, Fuhse847 replaces the “curved concave mirror” with an array of flat micro mirrors in order to obtain “higher resolution” images, and because “flat surfaces are easier to calculate and produce.” *Id.* at 19–20.

Figures 8(a)–8(d) of Fuhse847 are reproduced below.



Figures 8(a)–8(d) show “four exemplary embodiments in which a curved concave mirror is broken down into micro-optical elements with a square base and a flat mirror surface.” *Id.* at 12. Groups of micro mirrors 102 and 104 are assigned to a light spot or pixel in the light spot image. *Id.* at 20–21.

Fuhse847 describes how to calculate an orientation for each micro-mirror such that it reflects light to its assigned light spot. *Id.* at 19, 21–22, Fig. 10.

Fuhse847 discloses how to produce its images by defining image points for the image, and defining a cone for each image point such that a “sphere of influence” is defined on the substrate plane for assigning micro-

mirrors to that image point. *Id.* at 9–10, 27–29. The images may be 3D, including any 2D image “that floats at a certain height above or below the substrate surface.” *Id.* at 16, 13–14.

2. Summary of Rich

Rich is titled “Optical Products, Masters for Fabricating Optical Products, and Methods for Manufacturing Masters and Optical Products” and issued from an application claiming priority to a provisional application filed on October 24, 2014. Ex. 1039, codes (54), (60).

Rich discloses “[a]n optical product” that “can be configured, when illuminated, to reproduce by reflected . . . light, a 3D image.” *Id.* at Abstract. Rich discloses a method of manufacturing a master 10, which is used to create the optical product. Ex. 1039, 16:33–17:7, Fig. 7.

Figure 1A of Rich is reproduced below:

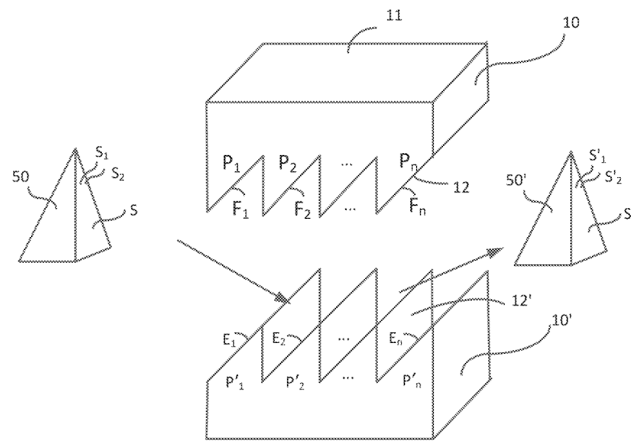


FIG. 1A

Figure “1A schematically illustrates an example master and optical product.” *Id.* at 3:56–57. Master 10 includes a surface 12 having a plurality of portions P_n which correspond to portion P'_n, which can be a cell, pixel, or tile, of optical product 10'. *Id.* at 5:22–29. Each portion P_n of master 10 and each portion P'_n of optical product 10' corresponds to a point of the surface

of 3D object 50. *Id.* at 3:36–38. When illuminated, optical product 10’ reproduces by reflected light a 3D image 50’ of 3D object 50. *Id.* at 3:47–51. “A master can be either a negative or positive master,” and a positive master produces a surface for the optical product that is substantially similar to the surface of the master. *Id.* at 1:53–58.

Rich’s method of manufacture uses a software program to create a data file that describes the pattern of features $F_1 - F_n$ on surface 12 of the master 10. *Id.* at 16:33–37. Rich states: “This data file 340 can be used as a map to generate the pattern of features $F_1, F_2, \dots, F_n$ on the surface 12 of the masters 10.” *Id.* at 17:4–6.

3. Analysis of Independent Claim 1

Petitioner contends that the combination of Fuhse847 and Rich teaches the preamble and all of the limitations of claim 1. Pet. 12–34. Petitioner contends that it would have been obvious to a POSITA to automate the computations for designing micro mirror arrays in Fuhse847 with Rich’s teaching of a processor running software. *Id.* at 14–17.

Patent Owner does not specifically dispute Petitioner’s contentions regarding the preamble, limitations 1b–1e, and the motivation to combine Fuhse847 and Rich. *See generally* PO Resp.

We have reviewed Petitioner’s contentions and supporting evidence and are persuaded that the combination of Fuhse847 and Rich teaches the preamble and undisputed limitations 1b–1e, and that one of ordinary skill in the art would have been motivated to combine Fuhse847 and Rich in the manner set forth in the Petition.

Patent Owner disputes that limitation 1a is disclosed by Fuhse847 and Rich. PO Resp. 8–13. We address this limitation below.

- a) Limitation 1a: assigning a first object in a starting digital image to a first image display plane and a second object in the starting digital image to a second image display plane*

Petitioner contends that Fuhse847 teaches limitation 1a because Fuhse847 teaches a body (i.e., a motif, such as a font or logo) in the form of a digital image and using a motif to form multiple images at different heights. Pet. 18–22. Petitioner maps Fuhse847’s body that represents a motif to the claimed first object and 3D-CAD that contains the body to the starting digital image. Pet. Reply 1–6. Pointing to Fuhse847’s teaching of depicting images in different planes, such as a two-dimensional font or logo, Petitioner argues that a POSITA would have understood that the images or object would have been provided in the same 3D-CAD image. Pet. 21–22; Pet. Reply 3–6.

Patent Owner disputes that Fuhse847 teaches limitation 1a because Fuhse847 does not teach the user selecting a first and second object from the same digital image. PO Resp. 8–13; PO Sur-reply 1–4. According to Patent Owner, Fuhse847 only discloses choosing a first object from a starting digital image and that object is the entirety of the starting digital image. PO Resp. 8–13. Patent Owner, thus, contends that Petitioner has improperly mapped the same body to two different claim terms. *Id.* at 15–17.

We are persuaded by Petitioner’s analysis and evidence that Fuhse847 suggests limitation 1a. Initially, we note that limitation 1a requires the first and second object to be *in* the starting digital image or, in other words, that the objects are part of the starting digital image. Ex. 1001, 55–58. We, thus, are not persuaded that the Petitioner has improperly mapped the same body to two different claim terms. *See* Pet. Reply 1–6.

Fuhse847 discloses that “[d]ata sets describing the surface of a body [i.e., a motif] can, for example, be generated in computer-aided technical drawing or through 3D laser scanning of real three-dimensional bodies.” Ex. 1022, 10. The body may be depicted in a digital image. *Id.* at 10–11; Ex. 1003 ¶¶ 152–154; *see* Pet. Reply 2–3 (explaining that the first body is in the digital image).

Fuhse847 discloses assigning the body to a first image display plane, by defining light spots on the body and corresponding image points in a first image display plane. Ex. 1022, 9–10, 27–28; Ex. 1003 ¶¶ 156–165. Fuhse847 also discloses that parts of a motif (i.e., the body) can be assigned to different planes. Ex. 1022, 13 (describing a three-dimensional light-spot image having light spots, each of which appears to float above or below the level of the security element), 13–15 (describing Figure 2 as depicting a motif having image points that float at different heights above the surface of the substrate), 25–26 (describing a light-spot image A, a light-spot image B, and images in a foreground and background).

Dr. Hesselink testifies:

It would have been obvious that the second image is from **a second object in the starting digital image**. For example, in the case that the two images are two different “two-dimensional” images such as “a font or a logo” (*see* [Ex. 1022,] 5, 7, 26), those two fonts or logos represent two different objects. It would have been obvious that they were both provided in the same **starting digital image**. For example, it was well-known that formats like 3D-CAD, “computer-aided technical drawing,” and “3D laser scanning of real three-dimensional bodies” could provide multiple objects in their images.

Ex. 1003 ¶ 176 (emphasis in original). Patent Owner does not cite to any testimony from Dr. Lindstrand to rebut Dr. Hesselink's testimony as to what a POSITA would have found obvious. *See* PO Resp. 17–18.

We determine that Petitioner's evidence and analysis sufficiently shows by a preponderance of the evidence that Fuhse847 teaches limitation 1a.

b) Conclusion as to Claim 1

We determine that Petitioner has shown by a preponderance of the evidence that claim 1 is unpatentable over Fuhse847 and Rich.

4. Analysis of Claim 12

Petitioner contends that the combination of Fuhse847 and Rich teaches the preamble and all of the limitations of claim 12. Pet. 38–49. Petitioner contends that it would have been obvious to a POSITA to automate the computations for designing micro mirror arrays in Fuhse847 with Rich's teaching of a processor running software. *Id.* at 14–17, 30.

Patent Owner does not specifically dispute Petitioner's contentions regarding the preamble, limitations 12a and 12c–12f, and the motivation to combine Fuhse847 and Rich. *See generally* PO Resp. We have reviewed Petitioner's contentions and supporting evidence and are persuaded that the combination of Fuhse847 and Rich teaches the preamble and undisputed limitations 12a and 12c–12f.

Patent Owner disputes that limitation 12b is disclosed by Rich. PO Resp. 18–21; PO Sur-reply 4–5. We address this limitation below.

(a) Limitation 12b: generating a design output file including an angular orientation and location coordinates in the array for each of the micro mirrors

The mapping for limitation 12b references the Petition’s analysis for limitation 1d (Pet. 30–32). *Id.* at 64. Petitioner’s analysis for limitation 1d references the analysis for limitation 1c. *Id.* at 31. Limitations 1c and 1d recite:

[1c] for each of the pixels, determining with the array design module an angular orientation of each of the micro mirrors in the selected sets of the micro mirrors;

[1d] generating a design output file including the angular orientation and location coordinates in the array for each of the micro mirrors in the selected sets of the micro mirrors.

Ex. 1001, 20:65–21:6. Combined limitations 1c and 1d have similar requirements as limitation 12b.⁷

With respect to limitation 1c, Petitioner argues that “Fuhse847 discloses how to calculate angular orientations of its micromirror surface.” Pet. 28–29 (citing Ex. 1022, 19–23, Fig. 10; Ex. 1003 ¶¶ 210–212). Petitioner relies upon Rich to teach using an array design module to calculate the angular orientations. *Id.* at 29 (citing Ex. 1039, 16:33–17:7; Ex. 1003 ¶¶ 214–215). Petitioner contends: “In the combined system of Fuhse847 and Rich, it would have been obvious for Rich’s processor 330 (**a processor of a computing device**) running a main program 325 (**an array design module**) to compute the orientation calculations provided by Fuhse847.” *Id.* at 30 (citing Ex. 1003 ¶ 217, emphasis in original).

⁷ Patent Owner does not dispute that limitations 1b and 1c are taught by the combination of Fuhse847 and Rich. *See generally* Prelim. Resp.

With respect to limitation 1d, Petitioner relies upon Rich to teach generating a design output file that includes an angular orientation. Pet. 30–32. Petitioner explains that Rich’s data files have data for a plurality of portions and is a map to generate a pattern of features for a master that is used to manufacture the security features. *Id.* at 31–32 (citing Ex. 1039, 16:57–17:7, 17:15–17; Ex. 1003 ¶¶ 220–227).

Patent Owner first argues that Rich does not teach limitation 12b because Rich, specifically at column 16, lines 64–66, teaches determining the orientation of features on a surface of the 3d object and not of individual micro mirrors in a set of micro mirrors. PO Resp. 19–20; *see also* PO Sur-reply 4–5. Patent Owner also argues that Rich fails to disclose a design output file that include locations coordinates in the array for each micro mirror because Rich generates a pattern of features and not location coordinates. PO Resp. 20–21.

Patent Owner’s first argument is misplaced because it is not directed to the proposed combination of Fuhse847 and Rich in the Petition. As explained above, the Petition relies upon Fuhse847 to teach calculating angular orientation of each of the micro mirrors and Rich to teach a data file that could include an angular orientation. *See e.g.*, Pet. 28–32. The Petition proposes to modify Fuhse847 by automating its method of designing arrays of micro mirrors with computing and software as disclosed in Rich. *See e.g.*, Pet. 14–17, 30; Pet Reply 7–9.

Patent Owner’s second argument is unpersuasive. As the Petition points out (Pet. 30–31), Rich discloses a data file 340 that comprises portions that correspond to points on a surface on an object and that data file 340 is used as a map. Ex. 1039, 16:57–17:17. Based on Rich’s disclosure,

Dr. Hesselink testifies that Rich teaches the claim design output file that has location coordinates for each of the micro mirrors. Ex. 1003 ¶¶ 220–228. Patent Owner does not cite to any testimony from Dr. Lindstrand to rebut Dr. Hesselink’s testimony as to what a POSITA would have found obvious. PO Resp. 20–21.

We are persuaded by Petitioner’s evidence and analysis that Fuhse847 teaches an angular orientation in the array for each of the micro mirrors (*see* Ex. 1022, 19–23) and Rich teaches a data file that includes information, such as an angular orientation and location coordinates, used in the manufacture of a security element (*see* Ex. 1039, 16:33–17:7). We are further persuaded by Petitioner that it would have been obvious to a POSITA to automate the computations for designing micro mirror arrays, such as determining the angular orientation and location coordinates for the micro mirrors, in Fuhse847 with Rich’s teaching of a processor running software. Pet. 14–17, 30; Ex. 1003 ¶¶ 129–137, 217.

b) Conclusion as to Claim 12

We determine that Petitioner has shown by a preponderance of the evidence that claim 12 is unpatentable over Fuhse847 and Rich.

5. Claims 2, 5, 6, 13, and 14

For dependent claims 2, 5, 6, 13, and 14 for Ground 1, Petitioner has mapped the limitations of the challenged claims to the teachings of the prior art combinations and articulated reasons why one of ordinary skill in the art would have combined the references, supporting its contentions with citations to the Hesselink Declaration. Pet. 34–36, 49–53.

Patent Owner does not raise any arguments specifically directed to the additional limitations of claim 2, 5, 6, 13 and 14 of Ground 1. *See* PO Resp. 18, 21.

After reviewing the Petition's analysis and evidence, we determine that Petitioner has shown by a preponderance of the evidence that claims 2, 5, 6, 13, and 14 unpatentable over Fuhse847 and Rich.

6. Claim 4

In the Petition, Petitioner contends that the combination of Fuhse847 and Rich teaches the additional limitation of claim 4. Pet. 35. Claim 4, however, depends from claim 3. Ex. 1001, 21:11–14. Petitioner does not challenge claim 3 under Ground 1, but challenges claim 3 under Ground 2, which additionally relies upon Fuhse925. *Id.* at 58–60.

In the Reply, Petitioner contends that claim 4 should have been challenged under Ground 2 and urges us to review claim 4 under Ground 2. Pet. Reply 17–18. Reviewing claim 4 under Ground 2, however, would not change the outcome as to claim 4 because we determine that Petitioner fails to show that claim 3 is unpatentable over Ground 2. *See In re Fritch*, 972 F.2d 1260, 1264-65 (Fed. Cir. 1992) (holding that a reference stands for all of the specific teachings thereof as well as the inferences one of ordinary skill in the art would have reasonably been expected to draw therefrom).

We determine that Petitioner fails to show by a preponderance of the evidence that claim 4 is unpatentable over Fuhse847 and Rich.

F. Ground 2

Petitioner contends that claims 3 and 6–14 are unpatentable over Fuhse847, Rich, and Fuhse925. Pet. 54– 58.

1. Summary of Fuhse925

Fuhse925 is titled “Visually Variable Security Element,” and “relates to an optically variable security element for securing valuable articles.” Ex. 1008, code (54), 1:5–6.

Fuhse925 discloses an optically variable security element in the form of a window security thread that emerges at certain window regions, and the security thread reflects light to display a floating three-dimensional image when the security element is tilted. *Id.* at 6:49–55, 7:10–12, Figs. 1–3.

Fuhse925’s security element is composed of planar facets, characterized by an inclination angle having a parallel component and a normal component. *Id.* at 2:41–55. Figure 3 of Fuhse925 is reproduced below.

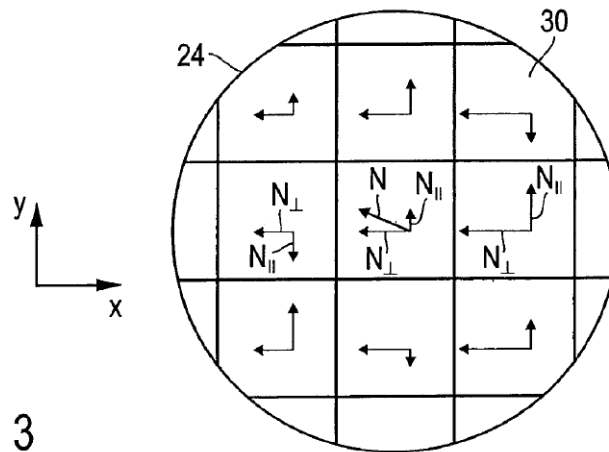


Fig. 3

Figure 3 shows a detailed section of a region of the security element, showing orientation vector N of facets 30. *Id.* at 6:18–20. Orientation vector N is defined by a normal component $N_{\perp}$ and a non-vanishing parallel component

$N_{\parallel}$. *Id.* at 3:3–16, 9:1–31, 11:14–27. Parallel component $N_{\parallel}$ varies irregularly in the spreading range according to a random distribution. *Id.*

2. Analysis of Claim 3

Claim 3 depends from claim 1 and additionally recites “wherein each of the sets of micro mirrors are selected randomly from a plurality of the micro mirrors located in a base of a cone on a surface containing the array of micro mirrors.” Ex. 1001, 21:11–14.

Petitioner relies upon the combination of Fuhse847 and Fuhse925 to teach claim 3. Pet. 60. Petitioner argues:

Fuhse925 teaches that the orientation vector N of each reflective facet 30 is defined by two inclination components – a normal component $N_{\perp}$ and a non-vanishing parallel component $N_{\parallel}$ – whereby the nonvanishing component $N_{\parallel}$ varies irregularly in the spreading range, especially according to a random distribution or a pseudorandom distribution. *See* Fuhse925 at 3:3-16, 9:1-31, 11:14-27. Because the non-vanishing component $N_{\parallel}$ is one inclination component of the orientation vector N of each reflective facet 30, the randomness of the non-vanishing component $N_{\parallel}$ would result in a randomness of the orientation vector N of each reflective facet 30 on the surface of the substrate. It therefore follows that the randomness of the orientation vector N of each reflective facet 30 is the result of a random pattern of the reflective facets 30. *Id.*; EX1003, ¶240.

Each facet 30 is coated with a reflective coating thereby forming micro mirrors arranged in a random pattern. As the facets 30 are arranged in according to [sic] a random distribution or a pseudorandom distribution, a POSITA would understand that making a selection of a subset of micromirrors from the plurality of micromirrors formed on the facets 30 would make for **a random selection**. *Id.*

Pet. 58–59 (emphasis in original); *see also* Pet. Reply 10–13. Petitioner contends that it would have been obvious to apply these teaching of

Fuhse925 to Fuhse847. *Id.* at 54–57. According to Petitioner, Fuhse847 teaches properly angled micro mirrors with a desired surface normal n and Fuhse925 provides explicit detail for how to implement the mirrors. *Id.* at 56. Petitioner asserts: “[T]he teachings in Fuhse925 regarding proper orientation of micro-mirrors would have been incorporated into Fuhse847 with no difficulty.” *Id.* at 57. Petitioner contends that “[v]arying the non-vanishing component for the micro-mirrors of Fuhse847 to form a pattern as taught by Fuhse925 would result in ‘sets of micro mirrors [that] are selected randomly’ as required by the claim.” Pet. Reply 13.

Patent Owner responds that neither Fuhse925, Fuhse847, or the combination of Fuhse847 discloses this limitation. PO Resp. 22–26; Pet. Sur-reply 5–6. Patent Owner argues that “[w]hile Patent Owner agrees that Fuhse925 discloses that the $N_{||}$ inclination component can vary randomly throughout the entire field of mirrors, neither the cited disclosure nor any other disclosure of Fuhse925 teaches or suggests random ***selection of mirrors***, much less random selection of mirrors within a base of a cone, as required by element [1j].” PO Resp. 25. Patent Owner argues that “Fuhse925 cannot possibly disclose that the mirrors for producing a pixel or an image are selected randomly from the set of available mirrors, as required by claim 3, because every single one of the mirrors of Fuhse925 is used to reflect light for the images created by Fuhse925’s optical security feature.” *Id.* at 26. According to the Patent Owner, the Petition does not provide a sufficient explanation as to how combining Fuhse847 and Fuhse925 would arrive at a randomly selected set of micro mirrors as required by claim 3. PO Sur-reply 5–6.

Patent Owner’s argument is persuasive.

Claim 3 depends from claim 1. Claim 3's set of micro mirrors refers to the set of micro mirrors selected in limitation 1b to display each of the pixels of the first and second objects. Ex. 1001, 20:59–64. Claim 3, thus, adds that the selection of the pixel producing sets of micro mirrors from the base of the cone is random.

For limitation 1b, Petitioner asserts that Fuhse847 teaches selecting a set of micro mirrors located in a base of a cone by assigning a group of micro mirrors within a sphere of influence to every light spot in an image, and points to Fuhse847's Figure 8 as showing patterns of selected micro mirrors. Pet. 23–25 (citing Ex. 1022, 5–8, 14–15, 19–21, Figs. 8(a)–(d)), 58 (citing Ex. 1022, 9–10, 27–28). Fuhse847 teaches calculating the normal vector (i.e., the position of the mirror surfaces) to direct the light to a focal point for the assigned light spot. Ex. 1022, 21–19.

Fuhse847, thus, does not explicitly teach that its selection of a set of micro mirrors is random. *See generally* Ex. 1022.

Likewise, Fuhse925 does not explicitly disclose a random selection of micro mirrors within the base of a cone. *See generally* Ex. 1008. At most, Fuhse925 teaches that the normal vector of the reflective facets can have a parallel component $N_{\parallel}$, which can vary randomly. Ex. 1008, 3:3–6 (“The second inclination component of the planar facets advantageously varies irregularly in the spreading range, especially according to a random distribution.”), 9:1–31, 11:14–27.

Petitioner contends that a POSITA would look to Fuhse925 for explicit detail as to how to implement Fuhse847's desired normal vector to direct the light to a focal point for the assigned light spot. Pet. 54–56; Pet. Reply 11–13. Petitioner, however, does not sufficiently explain why a

POSITA would have combined Fuhse847's teaching of assigning a group of micro mirrors within a sphere of influence to every light spot in an image, with Fuhse925's teaching of a normal vector of the reflective micro mirrors having a randomly varying parallel component $N_{\parallel}$, to arrive at a random selection of a set of micro mirrors from a plurality of the micro mirrors located in a base of a cone. Petitioner has not sufficiently explained why randomness of the non-vanishing component $N_{\parallel}$, would result in a randomly selected pattern of the micro-mirrors. *See* Pet. Reply 11; *see also* Ex. 10013 ¶¶ 340–342 (corresponding testimony of Dr. Hesselink).

We are not persuaded that the combination of Fuhse847, Rich, and Fuhse925 teaches the additional limitation of claim 3. Petitioner fails to show by a preponderance of the evidence that claim 3 is unpatentable over Fuhse847, Rich, and Fuhse925.

3. Analysis of Claims 7–11

Claim 7 is independent. Claims 8–11 depend from claim 7. Like the additional limitation of claim 3, limitation 7c.2 recites: “wherein each of the sets of micro mirrors are selected randomly from a plurality of the micro mirrors located in a base of a cone on a surface containing the array of the micro mirrors.” Ex. 1001, 21:39–42.

For the same reason discussed above with respect to claim 3, we are not persuaded that the combination of Fuhse847, Rich, and Fuhse925 teaches element 7c.2.

Petitioner has not shown by a preponderance of the evidence that claims 7–11 are unpatentable over Fuhse847, Rich, and Fuhse925.

4. Analysis of Claims 6 and 12–14

For Ground 1, Petitioner contends that claims 6 and 12–14 are taught by the combination of Fuhse847 and Rich. *See* Pet. 60–62, 64–68. But, to the extent that certain limitations of claims 6 and 12–14 are not taught, Fuhse925 is relied upon to make up the deficiency. Pet. 61, 66.

Above, for Ground 1, we determine that Petitioner has sufficiently demonstrated that claims 6 and 12–14 would have been obvious over Fuhse847 and Rich. Patent Owner makes no arguments particularly directed to whether or not claims 6 and 12–14 would have also been obvious over Fuhse847, Rich, and Fuhse925. *See* PO Resp. 28.

After reviewing the Petition’s evidence and analysis, we determine that Petitioner has shown by a preponderance of the evidence that claims 6 and 12–14 are unpatentable over Fuhse847, Rich, and Fuhse925.

G. Grounds 3–6

Petitioner contends that claims 15–18 are unpatentable over Fuhse847, Rich, and Sauvage-Vincent (Ground 3) and Fuhse847, Rich, Fuhse925, and Sauvage-Vincent (Ground 4); and that claims 19 and 20 are unpatentable over Fuhse847, Rich, and Morford (Ground 5) and Fuhse847, Rich, Fuhse925, and Morford (Ground 6). Pet. 68–80.

Claims 15–20 depend directly or indirectly from claim 12. Above, for Grounds 1 and 2, we determine that Petitioner has sufficiently demonstrated that claim 12 would have been obvious over Fuhse847 and Rich. Patent Owner makes no arguments particularly directed to the additional limitations of claims 15–20 for Grounds 3–8. *See* PO Resp. 28–31.

After reviewing the Petition’s evidence and analysis, we determine that Petitioner has shown by a preponderance of the evidence that claims 15–18 are unpatentable over Fuhse847, Rich, and Sauvage-Vincent and Fuhse847, Rich, Fuhse925, and Sauvage-Vincent; and that claims 19 and 20 are unpatentable over Fuhse847, Rich, and Morford and Fuhse847, Rich, Fuhse925, and Morford.

III. CONCLUSION⁸

We determine that Petitioner shows by a preponderance of the evidence that claims 1, 2, 5, 6, and 12–20 of U.S. Patent No. 11,448,863 B2 are unpatentable, and has failed to show by a preponderance of the evidence that claims 3, 4, and 7–11 of U.S. Patent No. 11,448,863 B2 are unpatentable.

In summary:

Claim(s)	35 U.S.C. §	Reference(s)/Basis	Claim(s) Shown Unpatentable	Claim(s) Not Shown Unpatentable
1, 2, 4–6, 12–14	103	Fuhse847, Rich	1, 2, 5, 6, 12– 14	4
3, 6–14	103	Fuhse847, Rich, Fuhse925	12–14	3, 7–11
15–18	103	Fuhse847, Rich,	15–18	

⁸ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner’s attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. § 42.8(a)(3), (b)(2).

Claim(s)	35 U.S.C. §	Reference(s)/Basis	Claim(s) Shown Unpatentable	Claim(s) Not Shown Unpatentable
		Sauvage-Vincent		
15–18	103	Fuhse847, Rich, Fuhse925, Sauvage-Vincent	15–18	
19, 20	103	Fuhse847, Rich, Morford	19, 20	
19, 20	103	Fuhse847, Rich, Fhuse925, Morford	19, 20	
Overall Outcome			1, 2, 5, 6, 12– 20	3, 4, 7–11

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1, 2, 5, 6, and 12–20 of U.S. Patent No. 11,448,863 B2 are unpatentable;

FURTHER ORDERD that claims 3, 4, and 7–11 of U.S. Patent No. 11,448,863 B2 have not been shown to be unpatentable; and

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

IPR2024-00839
Patent 11,448,863 B2

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE OFFICE OF THE UNDER SECRETARY OF COMMERCE
FOR INTELLECTUAL PROPERTY AND DIRECTOR OF THE
UNITED STATES PATENT AND TRADEMARK OFFICE

GIESECKE+DEVRIENT GMBH, GIESECKE+DEVRIENT CURRENCY
TECHNOLOGY GMBH, and PAPIERFABRIK LOUISENTHAL GMBH,
Petitioner,

v.

LUMENCO, LLC,
Patent Owner.

IPR2024-00838 (Patent 10,901,191 B2)
IPR2024-00839 (Patent 11,448,863 B2)¹

Before JOHN A. SQUIRES, *Under Secretary of Commerce for Intellectual
Property and Director of the United States Patent and Trademark Office.*

ORDER

¹ This order applies to each of the above-listed proceedings.

IPR2024-00838 (Patent 10,901,191 B2)

IPR2024-00839 (Patent 11,448,863 B2)

The Office received a request for Director Review of the Final Written Decision in each of the above-captioned cases and an authorized response to each request. *See* Papers 32, 33.²

Having considered the requests and responses, it is:

ORDERED that the requests for Director Review are denied.

² Citations are to the record in IPR2024-00838. The parties filed similar papers in IPR2024-00839.

IPR2024-00838 (Patent 10,901,191 B2)

IPR2024-00839 (Patent 11,448,863 B2)

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