

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.

IPR2024-00836
Patent 10,189,294 B2

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

KHAN, *Administrative Patent Judge*.

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

I. INTRODUCTION

A. *Background and Summary*

Giesecke+Devrient GmbH, Giesecke+Devrient Currency Technology GmbH, and Papierfabrik Louisenenthal GmbH (collectively, “Petitioner”) filed a Petition (Paper 1, “Pet.”) requesting an *inter partes* review of claims 1, 6–14, 28, and 32–39 (“the challenged claims”) of U.S. Patent No. 10,189,294 B2 (“the ’294 patent,” Ex. 1001). Lumenco, LLC (“Patent Owner”) timely filed a Preliminary Response (Paper 7, “Prelim. Resp.”). After consideration of the Petition, Preliminary Response and the record evidence, we instituted *inter partes* review of all the challenged claims on all grounds. Paper 8 (“Dec. Inst.”).

After institution, Patent Owner filed a Patent Owner Response (Paper 13, “PO Resp.”), Petitioner filed a Reply (Paper 17, “Pet. Reply”), and Patent Owner filed a Sur-Reply (Paper 18, “PO Sur-reply”). An oral hearing was held on August 26, 2025, and the hearing transcript is included in the record. Paper 30 (“Tr.”).

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision, issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73, addresses issues and evidence raised during the *inter partes* review. For the reasons that follow, Petitioner demonstrates by a preponderance of the evidence that claims 1, 6–14, 28, and 32–39 are unpatentable.

B. *Related Proceedings*

The parties identify the following pending matters as involving the ’294 patent: *Lumenco, LLC v. Giesecke+Devrient GmbH*, No. 2:23-cv-00100 (E.D. Tex.); and *Lumenco, LLC v. United States*, No. 1:24-cv-00139 (Fed. Cl.). Pet. 75; Paper 5, 2.

C. The '294 Patent (Ex. 1001)

The '294 patent, titled “Arrays of Individually Oriented Micro Mirrors for Use in Imaging Security Devices for Currency and Brand Authentication,” relates to a visual display assembly useful as an authentication or anti-counterfeiting element, including a substrate and an array of micro mirrors receiving ambient light on the surface of the substrate. Ex. 1001, code (54), Abstract. The '294 patent endeavors to fill a “need for advancements in the design and fabrication of assemblies or elements that display imagery useful for anti-counterfeiting and/or product/document authentication,” allowing “new anti-counterfeiting devices or elements to be produced for use with currency, labels, credit/debit cards, and other items” that “would be much more difficult if not nearly impossible to duplicate or copy” and that “provide a surprising visual effect or ‘wow factor’ with their displayed imagery.” *Id.* at 2:15–29.

Figure 2 of the '294 patent, reproduced below, shows a side view of an object (i.e., currency, document, financial card) including an embodiment of an anti-counterfeiting or authentication element/device:

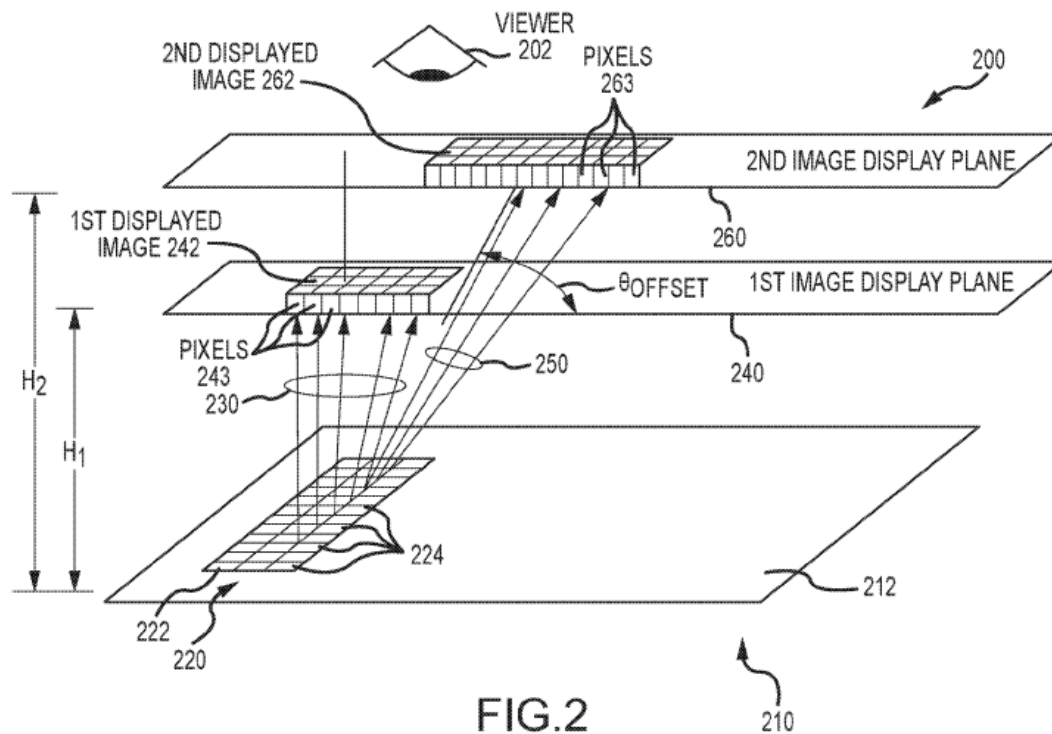


Figure 2 depicts an object (i.e., currency, document, financial card) 210 and anti-counterfeiting or authentication or security element/device 220 formed on the upper surface 212 of the object. *Id.* at 7:23–30. Security device 220 has an exposed surface 222 that provides “an array of micro mirrors 224, which may be individually oriented to provide reflection of ambient light striking the surface 222 of the security element 220 so as to display one or more floating images that can be observed by a viewer 202 to authenticate the object 210.” *Id.* at 7:30–36. “[A] first number of the micro mirrors 224 may be configured to provide sets of pixel-providing micro mirrors that reflect ambient light as shown with arrows 230 to ‘write’ or display a first image 242 made up of a plurality of pixels 243,” and “[a] second number of the micro mirrors 224 is configured to provide[] sets of pixel-providing micro mirrors that reflect ambient light as shown with arrows 250 to ‘write’ or display a second displayed image 262 made up of a

plurality of pixels 263.” *Id.* at 7:37–49. As a result, the viewer 202 observes the first displayed image 242 as floating in the first image display plane 240 that is a different height above the surface 212 of the object 210 from the second displayed image 262 that appears as floating in the second image display plane 260, and the pixels 243 of the first image 242 are at a viewing angle offset from the pixels 263 of the second image 262, such that “the viewer 202 typically only views one of the floating images 242, 262 at a time.” *Id.* at 7:63–8:7.

Although the claims of the ’294 patent recite the term “voxel” (*see, e.g., id.* at 20:63–67), we note that the specification of the ’294 patent uses the term “pixel” and not “voxel.” *See generally* Ex. 1001.

Patent Owner contends:

A POSITA would have understood that a voxel is a type, or subspecies, of a pixel. Specifically, a voxel is a 3-dimensional pixel. Generally, “voxel” means “volume pixel” and “represents a quantity of 3-D data just as a pixel represents a point or cluster of points in 2-D data.”

PO. Resp. 14–15 (citing Ex. 2002, 1; quoting Ex. 2003, 575). Petitioner agrees that a voxel is a pixel that has volume. Pet. Reply 4; *see also* Ex. 1003 ¶ 176 (Dr. Hesselink’s testimony that “[w]hile [the] ’294 patent does not use the term ‘voxel,’ voxels generally have a volume”), Ex. 1003 ¶ 168.

D. Illustrative Claims

Claims 1, 28, and 35, the independent claims of the ’294 patent at issue in the proceeding, are reproduced below with limitation identifiers in brackets corresponding to claim analysis headings in the Petition. *See, e.g.,* Pet. 16–44.

[1Pre] A visual display assembly useful as a security element on paper and coin currency, and product labels, comprising:

[1a] a substrate; and

[1b.1] on a surface of the substrate, an array of micro mirrors receiving ambient light and,

[1b.2] in response, displaying an image in a plane spaced a distance apart from the surface of the substrate, wherein the image comprises a plurality of pixels and

[1b.3] 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

[1b.4] wherein each of the different sets concurrently reflect the ambient light to concurrently generate the plurality of pixels,

[1b.5] and wherein a voxel is created at each of the points on the plane via intersection of two or more beams of the reflected ambient light and

[1b.6] wherein each of the created voxels produces an effect of a point source of light floating above the surface of the substrate in the plane.

Ex. 1001, 20:46–67.

[28Pre] A visual display assembly useful as a security element on paper and coin currency, and product labels, comprising:

[28a] a substrate; and

[28b.1] on a surface of the substrate, an array of micro mirrors receiving ambient light and

[28b.2] in response, displaying a first image and a second image in a plane spaced a distance apart from the surface of the substrate at first and second viewing angles, respectively, wherein the first and second images each comprises a plurality of pixels,

[28b.3] wherein the array of micro mirrors includes for each of the pixels a unique set of the micro mirrors each having a

reflective surface rigidly oriented, by rotating a body of each of the micro mirrors about at least one of two rotations axes extending through the body, to reflect the ambient light away from the substrate toward a point on the plane corresponding to one of the pixels,

[28b.4] wherein each of the unique sets of the micro mirrors includes a number of the micro mirrors in the range of 2 to 40, and

[28b.5] wherein the reflected ambient light from the number of the micro mirrors intersects at the point corresponding to the one of the pixels to create a voxel,

[28b.6] whereby the voxel acts like a point light source positioned in the plane at the point corresponding to the one of the pixels.

Id. at 22:65–23:23.

[35Pre] A visual display assembly useful as a security element on paper and coin currency, and product labels, comprising:

[35a] a substrate; and

[35b.1] on a surface of the substrate, an array of micro mirrors receiving ambient light and,

[35b.2] in response, displaying an image in a plane spaced a distance apart from the surface of the substrate, wherein the image comprises a plurality of pixels,

[35b.3] 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, differently from others of the micro mirrors in the different set, to reflect the ambient light away from the substrate and toward a point on the plane corresponding to one of the pixels,

[35b.4] a first set of voxels concurrently being created at the points on the plane via intersection of two or more beams of the reflected ambient light at each of the points on the plane to concurrently display the pixels of the image, wherein,

[35b.5] further in response to the receiving of the ambient light, the array of micro mirrors displays a second image in a second plane spaced a distance apart from the plane displaying the image,

[35b.6] wherein the second image comprises a plurality of pixels, and

[35b.7] wherein the array of micro mirrors includes, for each of the pixels of the second image, a different set of the micro mirrors each having a reflective surface oriented, differently from others of the micro mirrors in the different set, to reflect the ambient light away from the substrate and toward a point on the second plane corresponding to one of the pixels of the second image,

[35b.8] a second set of voxels concurrently being created at the points on the second plane via intersection of two or more beams of the reflected ambient light at each of the points to concurrently display the pixels of the second image.

Id. at 24:4–41.

E. Evidence

The Petition relies on the following references:

Reference	Exhibit No.
DE 10 2010 048 262 A1; filed Oct. 12, 2010; published Apr. 12, 2012. We cite to the English translation. (“Fuhse262”) (Ex. 1006)	1005
US 10,639,925; filed May 4, 2016; issued May 5, 2020 (“Fuhse925”)	1008
US 2014/0367957 A1; filed June 13, 2014; published Dec. 18, 2014 (“Jordan”)	1009
US 2013/0093172 A1; filed Dec. 3, 2010; published Apr. 18, 2013 (“Fuhse172”)	1035

Petitioner also relies on the Declaration of Lambertus Hesselink, Ph.D. (Ex. 1003) in support of its arguments. Patent Owner relies on the

Declaration of Dr. Mikael Lindstrand (Ex. 2004) in support of its arguments.
The parties rely on other exhibits as discussed below.

F. Asserted Grounds of Unpatentability

Petitioner asserts that claims 1, 6–14, 28, and 32–39 would have been unpatentable on the following grounds:

Ground	Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
1	1, 6–13, 28, 32, 33, 35–38	103	Fuhse262
2	1, 6–13, 28, 32, 33, 35–38	103	Fuhse262, Fuhse925
3	1, 6–13, 28, 32, 33, 35–38	103	Fuhse262, Jordan
4	1, 6–13, 28, 32, 33, 35–38	103	Fuhse262, Fuhse925, Jordan
5	14, 34, 39	103	Fuhse262, Fuhse172
6	14, 34, 39	103	Fuhse262, Fuhse925, Fuhse172
7	14, 34, 39	103	Fuhse262, Jordan, Fuhse172
8	14, 34, 39	103	Fuhse262, Fuhse925, Jordan, Fuhse172

II. ANALYSIS

A. Principles of Law

Petitioner bears the burden of persuasion to prove unpatentability of the claims challenged in the Petition, and that burden never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

A patent claim is unpatentable under 35 U.S.C. § 103 if the differences between the claimed invention and the prior art are such that the claimed invention as a 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. 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) any objective evidence of obviousness or non-obviousness¹. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

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).

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. 12 (citing Ex. 1003 ¶¶ 68–74).

Patent Owner states that a person of ordinary skill in the art “as of the date of alleged invention in the ’294 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. 2004 ¶ 23). Patent Owner adds that such a “similar field” would “include at least computer science degrees with engineering coursework.” *Id.* at 9.

¹ Neither party has introduced any objective evidence of nonobviousness.

We adopt Petitioner’s proposed level of ordinary skill in the art because it is more 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 ’294 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, 1:25–37. The ’294 patent also discusses using lenses to create holograms. *Id.* at 2:1–14. Similarly, the prior art in this field, such as Fuhse262, relates to the use of lenses and mirrors to create hologram images for security purposes. Ex. 1006 ¶¶ 1–7. 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 of 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 two ways: the first is the inclusion of “or a similar field” when describing the education level of a POSITA, and second is the inclusion of “with diffusive light” when describing the experience level of a POSITA. We decline to include either of these additional requirements in the definition of the level of ordinary skill.

As to the first difference, Patent Owner does not explain what aspects of computer science would make it a field similar to the others listed, nor what additional engineering coursework would suffice. *See* Ex. 2004 ¶ 25. Nor does Patent Owner explain, generally, what makes a field “similar” to the ones listed or how to make that determination. We determine that Patent

Owner's proposed definition introduces vagueness and unnecessary uncertainty into the definition and, therefore, do not adopt it.

As to the second difference, Patent Owner proposes that the level of skill include two years' experience with "diffusive light micro-optic security features." The '294 patent, however, does not mention "diffusive light." Instead, the challenge claims and the written description of the '294 patent use the term "ambient light." *See, e.g.,* Ex. 1001, Abstract, 20:50, 59. Ambient light, such as sunlight, includes both parallel and diffuse light. *See* Ex. 1055, 97:21–98:8; Ex. 1006 ¶ 54 (describing the use of sunlight or ceiling light). The '294 patent mentions ambient light in an ordinary manner without discussing any distinctions between parallel light and diffuse light or giving any significance to the nature of diffuse light and its effects on the invention.

We, therefore, adopt Petitioner's definition of level of ordinary skill 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 person of ordinary skill in the art because "[t]here is no evidence that Dr. Hesselink has any experience working with diffusive light systems like those disclosed by the '294 patent" and, thus, is unqualified to offer an opinion. PO Resp. 11 (citing Ex. 1003 ¶ 6).

Patent Owner has not moved to exclude Dr. Hesselink's testimony. *See* 37 C.F.R. § 42.46. 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.

Patent Owner’s argument is premised on its proposed level of ordinary skill in the art, which we do not adopt. We therefore disagree with Patent Owner that Dr. Hesselink’s testimony should be given little or no weight.

D. Claim Construction

We apply the same claim construction standard used in district court actions under 35 U.S.C. § 282(b), namely that articulated in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). See 37 C.F.R. § 42.100(b) (2020).

In applying that standard, claim terms generally are given their ordinary and customary meaning as would have been 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. *Phillips*, 415 F.3d at 1312–13. “In determining the meaning of the disputed claim limitation, we look principally to the intrinsic evidence of record, examining the claim language itself, the written description, and the prosecution history, if in evidence.” *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 469 F.3d 1005, 1014 (Fed. Cir. 2006) (citing *Phillips*, 415 F.3d at 1312–17). Only claim terms in controversy require express construction, “and only to the extent necessary to resolve the controversy.” *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017); *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

Petitioner argues that “no claim terms require express construction to resolve the challenges here.” Pet. 13. Patent Owner “agree[s] that the terms

do not require construction for purposes of evaluating the Petition.” PO Resp. 13–14.

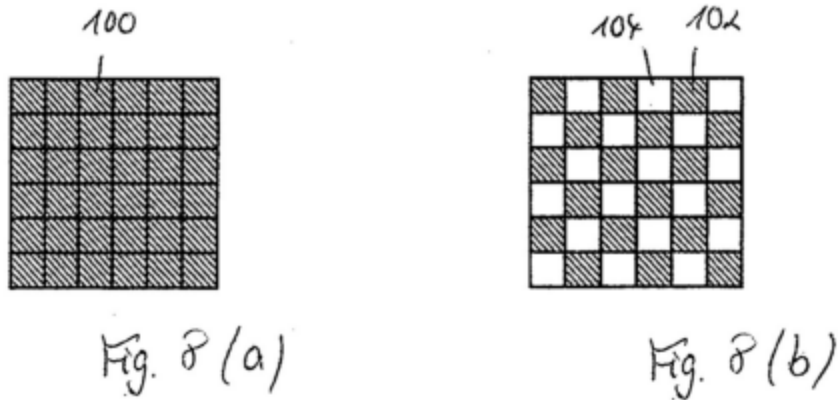
Having reviewed the record and the arguments before us, we determine that no claim terms require express construction to resolve the dispute between the parties.

E. Ground 1 – Obviousness over Fuhse262

Petitioner argues that claims 1, 6–13, 28, 32, 33, and 35–38 of the ’294 patent would have been obvious over Fuhse262. Pet. 13–44. Below we provide a brief overview of the prior art reference and then analyze Petitioner’s contentions in light of Patent Owner’s arguments.

1. Fuhse262 (Ex. 1006)

Fuhse262 is titled “Depiction element,” and “relates to a depiction element having a substrate with a surface region in which a plurality of optical elements are arranged,” “creating a depiction element . . . which has an attractive visual appearance,” and “a high level of protection against counterfeiting” that is “easy for laypeople to check for authenticity.” Ex. 1006, code (54), ¶¶ 1, 8. Figures 8(a) and 8(b), reproduced below, depict embodiments in which a curved concave mirror is broken down into micro-optical elements with a square base and a flat mirror surface:



Figures 8(a) and 8(b) depict a concave mirror for producing a light spot being replaced by an arrangement of square, flat micromirrors. *Id.* ¶ 87. Figure 8(a) depicts $n \times n$ micromirrors 100 arranged next to one another without any distance between them in the surface of the security element. *Id.* Figure 8(b) depicts that the micromirrors 102 are arranged in a checkerboard-like manner in the surface region of the security element, so that every second mirror position remains free. *Id.* ¶ 88.

Figures 9(a) and 9(b), reproduced below, depict the checkerboard-like arrangement depicted in Figure 8(b), above, covered with micromirrors:

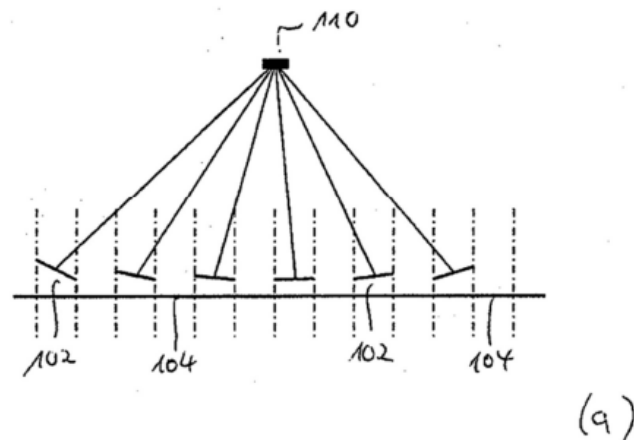
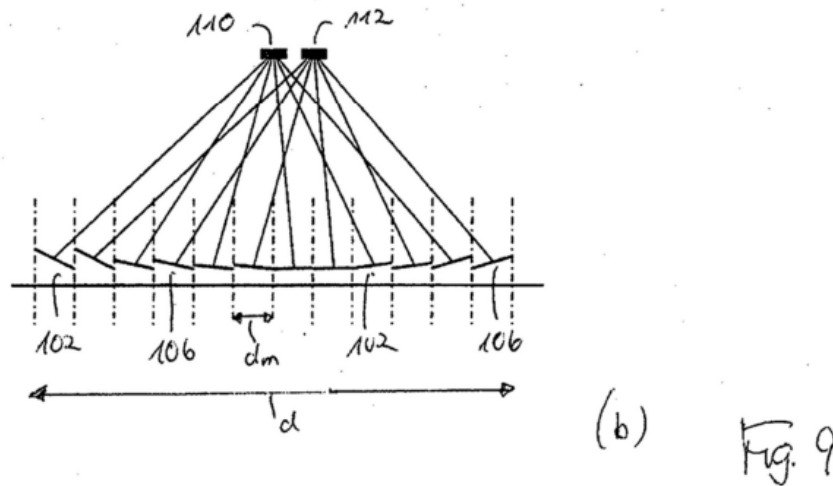


Figure 9(a) depicts an intermediate step with only one micromirror group, and Figure 9(b) depicts complete covering with two micromirror groups for two closely adjacent light spots. *Id.* ¶ 49. In Figure 9(a), the micromirrors 102 covering every second field produces first light spot 110, and the “[m]icromirrors 102 form a group of micromirrors, which are all assigned to the same light spot 110 and produce it together when illuminated.” *Id.* ¶ 91. In Figure 9(b), “[f]ields 104 between micromirrors 102 are available for coverage with micromirrors that are assigned to other light spots,” and “fields 104 can be covered with micromirrors 106, which

serve to produce a light spot 112 that is only one micromirror diameter . . . away from first light spot 110.” *Id.* ¶ 92.

2. *Motivation to Combine*

Petitioner states that it “relies on a combination of Fuhse262 Figures 1, 2, 8(a)–8(d), and 9–10 and accompanying disclosures” for Ground 1 and that it would have been obvious to combine these multiple embodiments from Fuhse262. Pet. 13 (citing Ex. 1003 ¶¶ 101–102). Specifically, Petitioner argues that it relies on the embodiment of Figure 2 to explain the principle of the invention and that Figures 8(a)–8(d) build on Figure 2 by replacing curved concave mirrors with micromirrors. *Id.* at 14 (citing Ex. 1006 ¶¶ 56–60, 48). According to Petitioner, “Fuhse262 provides explicit motivation to replace the curved mirrors of Figure 2 with micromirrors, including that ‘higher resolution’ is obtained and that ‘flat surfaces are easier to calculate and produce.’” *Id.* (citing Ex. 1006 ¶¶ 83, 86; Ex. 1003 ¶ 104). Petitioner argues that “Fuhse262 explicitly refers back to the ‘previous exemplary embodiments’ in building on those teachings.” *Id.* (citing Ex. 1006 ¶¶ 83, 87).

Figure 9 builds on the teachings of Figures 8(a)–8(d) by illustrating in a section view, according to Petitioner. *Id.* (citing Ex. 1006 ¶¶ 91–94, 49). Likewise, Figure 10 builds on the teachings of Figures 8(a)–8(d) and Figure 9 by “describing how to calculate and orient the surfaces of the micromirrors.” *Id.* (citing Ex. 1006 ¶¶ 95–101, 50). Petitioner alleges that “Fuhse262 also describes a ‘further development of the invention’ regarding providing different images to the viewer when viewed at different angles (*see* ¶¶ 111–15), and describes a ‘preferred procedure’ to produce the

structures of these combined teachings.” *Id.* at 14–15 (citing Ex. 1006 ¶¶ 125–128, 36; Ex. 1003 ¶ 105).

Petitioner contends that a POSITA would have had a reasonable expectation of success combining the embodiments of Fuhse262 because the embodiments relied on represent different aspects of the invention that all operate on the same principle. Pet. 15. Petitioner argues that features such as the substrate and ambient light would operate on the same principles when applied to concave mirrors and when applied to micromirrors. *Id.* Petitioner points out that Fuhse262 “teaches to ‘replace[]’ the curved mirrors of Figure 2 with micromirrors 100” and a “POSITA would have reasonably been able to adapt those teachings regarding Figure 2 to micromirrors.” *Id.* (citing Ex. 1003 ¶ 107) (alteration in original). Petitioner also points to the predictable nature of the combination and the fact that micromirror arrays were “textbook knowledge” as evidence that a POSITA would have no difficulty in combining the embodiments of Fuhse262. *Id.* at 16 (citing Ex. 1003 ¶ 109).

Patent Owner disputes Petitioner’s contentions regarding motivation to combine with respect to certain limitations, such as limitation 35b.6. PO Sur-Reply 10–11 (arguing that Petitioner does not identify any reason why a POSITA would be motivated to modify Fuhse262 to achieve the features of limitation 35b.5 and instead relies on hindsight bias to lead to the claimed feature). We address Patent Owner’s arguments in the relevant sections of our analysis of the claims below.

As to Petitioner’s more general allegations regarding motivation to combine the embodiments of Fuhse262 and reasonable expectation of success, we agree with Petitioner for the reasons provided in the Petition and summarized above. Specifically, we agree with Petitioner that Fuhse262

provides explicit motivation to combine the embodiments that utilize larger concave mirrors and lenses with embodiments that use micromirrors. *See* Ex. 1006 ¶ 83 (“In order to still obtain a higher resolution in the produced light-spot image with an unchanged high floating height, the large mirrors or lenses used in the previous exemplary embodiments are each replaced by a plurality of smaller micromirrors or microprisms, which together have essentially the same optical effect as the original optical element.”).

We also agree that the embodiments of Fuhse262 build on each other and often refer back to each other. For example, Fuhse262 expressly refers back to “previous exemplary embodiments” when explaining that micromirrors may replace other optical elements in the various embodiments. Ex. 1006 ¶ 83. Fuhse262’s Figures 8(a) through 8(d) build on each successive example, adding and modifying the configuration of mirrors disclosed in the previous figure. *See Id.* ¶¶ 88, 94 (explaining that Figure 8(b) is based on Figure 8(a) but shows mirrors arranged in checkerboard-like manner and Figures 8(c) and 8(d) further modify the configuration with every “fourth field” and “ninth field” respectively being assigned to specific light spots.) Fuhse262 also explains that Figure 9 is a sectional view of Figure 8 and that Figure 10 illustrates the “calculation of the flat mirror surfaces of the micromirrors” of Figures 8 and 9. *Id.* ¶¶ 91, 95.

For the aforementioned reasons, we determine that Petitioner has demonstrated, by a preponderance of the evidence, that a person of ordinary skill would have been motivated to combine the teachings of the relied upon embodiments of Fuhse262.

3. *Analysis of Independent Claim 1*

Petitioner contends that Fuhse262 renders obvious the preamble and limitations 1a–1b.6. Pet. 16–34. Petitioner supports its arguments with citations to Fuhse262 and to the testimony of Dr. Hesselink. *Id.* Patent Owner’s arguments are focused on Petitioner’s contentions for limitation 1b.5. We analyze Petitioner’s contentions regarding the preamble and limitations of claim 1 below.

a) Preamble

The preamble of claim 1 recites “A visual display assembly useful as a security element on paper and coin currency, and product labels.” Petitioner contends Fuhse262 teaches the preamble by disclosing a depiction element for security applications (“visual display assembly useful as a security element”) such as for banknotes (“paper . . . currency”). Pet. 17 (citing Ex. 1006 ¶¶ 8–12, 37; Ex. 1003 ¶¶ 116–120). Patent Owner does not dispute Petitioner’s contentions for the preamble. *See* PO Resp.

We agree with Petitioner.² Fuhse262 discloses a “depiction element” “[f]or security applications” with a “high level of protection against counterfeiting.” Ex. 1006 ¶ 8. The security “depiction element” is arranged on a “value document” such as a “paper banknote,” “identification card,” “credit card” or “passport,” etc. *Id.* ¶ 37. Fuhse262’s disclosure of a depiction element for security applications to prevent counterfeiting of paper banknotes sufficiently supports Petitioner’s contention that Fuhse262

² Petitioner argues that the preamble is not limiting. Pet. 16. Because we determine Petitioner has shown sufficiently that the prior art satisfies the recitation in the preamble, we need not resolve the issue of whether the preamble is limiting.

discloses a “visual display assembly useful as a security element on paper and coin currency, and product labels” as recited in the preamble.

b) Limitations 1a and 1b.1

Limitation 1a and 1b.1 recite “a substrate; and on a surface of the substrate, an array of micro mirrors receiving ambient light.” Petitioner contends Fuhse262 teaches a substrate depicted as element 22 in Figure 2 of Fuhse262. Pet. 17–18 (citing Ex. 1006, Abstract, ¶¶ 1, 10, 35, 56–65, 110, Fig. 2; Ex. 1003 ¶ 101). Petitioner further contends that Fuhse262 discloses a substrate with a surface region on which a plurality of optical elements are arranged and that the optical elements may be a plurality of micromirrors. *Id.* at 18 (citing Ex. 1006, Abstract, ¶¶ 1, 10, 13, 22, 30, 35, 56–65, 83, 87–95, 110). Petitioner contends that the arrangement of micromirrors are an array that receive ambient light such as from sunlight or a ceiling lamp. *Id.* at 19–20 (citing Ex. 1006 ¶¶ 13, 22, 20, 57–59, 60–61, 83, 87–95, Figs. 2, 8(a)–8(d); Ex. 1003 ¶¶ 128–131). Patent Owner does not separately dispute Petitioner’s contentions regarding limitations 1a and 1b.1. *See* PO Resp.

We agree with Petitioner. Fuhse262 discloses that “a generic depiction element contains a substrate with a surface region in which a plurality of optical elements are arranged. The depiction element is designed and intended to produce, upon illumination, a light-spot image composed of a plurality of light spots, that for a viewer appear floating above or below the surface region” Ex. 1006 ¶ 10. Fuhse262 further discloses that reflective optical elements such as a “plurality of micromirrors” are used, upon illumination from “sunlight or a ceiling lamp,” to create a three-dimensional motif. *Id.* ¶¶ 60, 54. These disclosures support Petitioner’s contention that Fuhse262 teaches limitation 1a and 1b.1.

c) *Limitation 1b.2*

Limitation 1b.2 recites “in response, displaying an image in a plane spaced a distance apart from the surface of the substrate, wherein the image comprises a plurality of pixels.” Petitioner contends that Fuhse262 teaches that upon illumination a light-spot image composed of light spots is created to appear floating above or below the surface region of the substrate. Pet. 21 (citing Ex. 1006 ¶¶ 10–12, 15, 35, 36, 54–56, 83, 84, 126–128).

Furthermore, while Fuhse262 teaches forming three-dimensional images, Petitioner contends that it alternatively teaches forming two dimensional images in which all light spots have the same floating height. *Id.* (citing Ex. 1006 ¶¶ 68; Ex. 1003 ¶¶ 136–137). According to Petitioner, providing image points all at the same height above the surface of the substrate results in “displaying an image in a plane spaced a distance apart from the surface of the substrate.” *Id.* at 22 (citing Ex. 1006 ¶¶ 36, 125–128) (emphasis omitted). Petitioner contends that Fuhse262’s light spots and image points teach the recited “pixels.” *Id.* (citing Ex. 1006 ¶¶ 126, 128; Ex. 1003 ¶¶ 137–138). Patent Owner does not separately dispute Petitioner’s contentions regarding limitations 1b.2. *See* PO Resp.

We agree with Petitioner. Fuhse262 discloses creating a “truly three-dimensional motif” but that “[i]n some configurations, however, it may also be advisable to design all convex mirrors with the same focal length, so that all light spots in the light-spot image have the same floating height.” Ex. 1006 ¶ 68. By having the same floating height, we agree with Petitioner that Fuhse262 teaches displaying an image in a plane spaced a distance apart from the surface of the substrate. We also agree with Petitioner that Fuhse262’s image points and light spots teach the recited “pixels.” Ex. 1003 ¶¶ 137–138.

d) Limitations 1b.3 and 1b.4

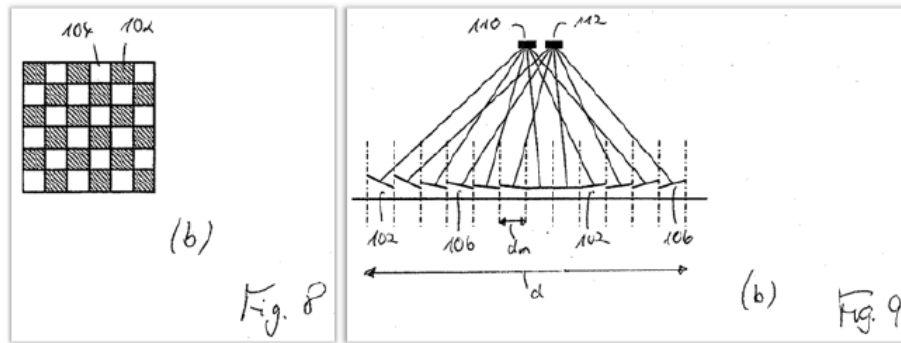
Limitations 1b.3 and 1b.4 recite:

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

wherein each of the different sets concurrently reflect the ambient light to concurrently generate the plurality of pixels.

Petitioner argues that Fuhse262 teaches limitation 1b.3 by disclosing that groups of optical elements (“sets” of micromirrors) are each assigned to different light spots and that Fuhse262’s micromirrors are permanently oriented, by being rotated about certain axes, to reflect light towards a light spot of the image. Pet. 23–29 (citing Ex. 1006 ¶¶ 10–11, 13, 19–20, 36, 60, 84, 88, 91–92, 95–101, 126–128, 144–145, Figs. 8a, 8b, and 9b; Ex. 1003 ¶¶ 144–157). Petitioner argues that Fuhse262 teaches limitation 1b.4 by disclosing that the ambient light is concurrently incident on all micromirrors and that they concurrently generate the plurality of pixels. *Id.* at 29–31 (citing Ex. 1003 ¶¶ 159–164). Patent Owner does not separately dispute Petitioner’s contentions regarding limitations 1b.3 and 1b.4. *See* PO Resp.

We agree with Petitioner. Fuhse262 discloses that “a plurality of optical elements is assigned to every light spot” such that “groups of optical elements . . . are each assigned to different light spots.” Ex. 1006 ¶¶ 19–20. Figures 8(b) and 9(b) of Fuhse262 from the Petition are reproduced below.



Figures 8(b) and 9(b) of Fuhse262 depict micromirrors arranged in a “checkerboard-like manner” in which shaded micromirrors 102 are assigned to “produce first light spot 110” while unshaded (white) micromirrors 106 “serve to produce a light spot 112.” *Id.* ¶¶ 88, 91–92.

Fuhse262 further discloses that the micromirrors are oriented in a specified direction, described by their normal vector n , to reflect light to a specific focal point. *Id.* ¶¶ 95–101; Ex. 1003 ¶ 148–153. Figure 10 of Fuhse262 is depicted below.

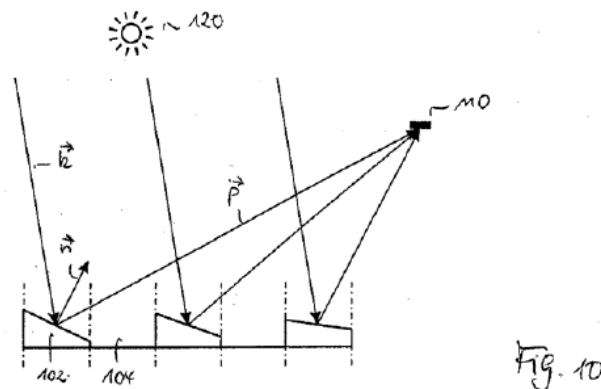
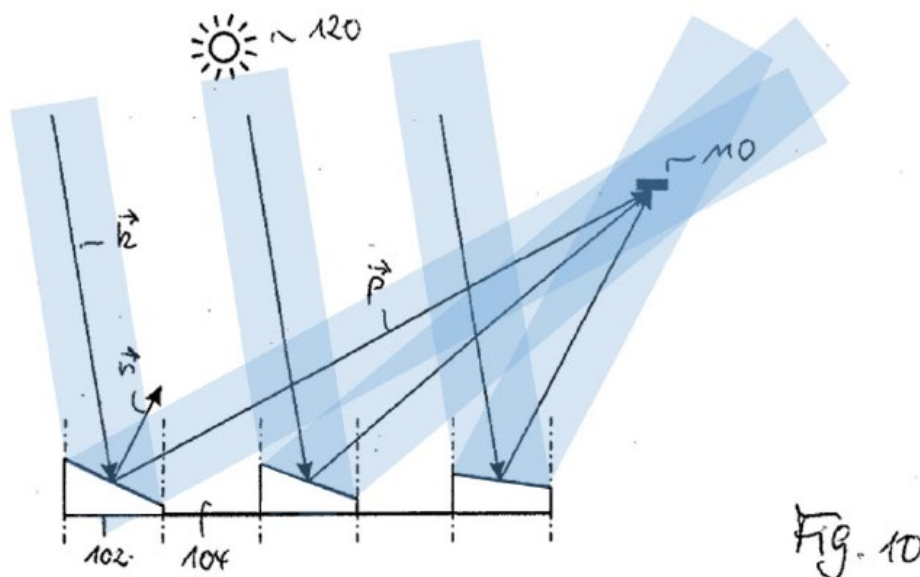


Figure 10 shows mirrors oriented in a specific direction given by their normal vector n to reflect incident light to light spot 110. The disclosed orientation demonstrates that the mirrors are rotated about rotation axes extending through the bodies of the mirrors. Ex. 1003 ¶¶ 144–157. The mirrors receive and reflect ambient light concurrently and by reflecting the ambient light, generate pixels concurrently. *Id.* ¶¶ 159–164.

e) Limitation 1b.5

Limitation 1b.5 recites “and wherein a voxel is created at each of the points on the plane via intersection of two or more beams of the reflected ambient light.” Both parties agree that voxels are 3-dimensional pixels that have volume. Pet. 31 (citing Ex. 1003 ¶¶ 167–168); PO Resp. 14 (“Patent Owner agrees . . . that “[a] POSITA would understand[that] “voxels” have volume,” and that a “voxel is a 3-dimensional pixel.” (second and third alterations in original)). The parties dispute, however, whether Fuhse262 discloses or teaches voxels.

Petitioner contends that it does. Petitioner argues that Figure 10 of Fuhse262 shows “chief light rays” for each optical element converging on a light spot. Pet. 31 (citing Ex. 1006 ¶¶ 95–97, Fig. 10). Petitioner notes, however, that ambient light reflects off the entire surface of the mirror, not just the center point, as depicted in Figure 10 of Fuhse262, and thus light reflecting off the mirror forms a beam which consists of more than just the chief light ray. *Id.* (citing Ex. 1003 ¶ 170). A version of Figure 10, annotated by Petitioner, is reproduced below.



Pet. 32. The annotated version of Figure 10 of Fuhse262, depicted above, shows light beams, not just their chief light rays, reflecting off of the entire surface of Fuhse262's mirrors. According to Petitioner, the intersection of these beams of light from the set of micromirrors converging on a light spot forms a "voxel." *Id.* at 31–33 (citing Ex. 1003 ¶¶ 166–175). Petitioner contends that the volume of the voxel corresponds to the intersection of the beams from the micromirror set, with the center of the voxel being the coordinates of the point where all the beams intersect. *Id.* at 32 (citing Ex. 1003 ¶¶ 171–172).

Patent Owner argues that Fuhse262 does not disclose voxels and does not teach or suggest the creation of pixels with volume. PO Resp. 15. In fact, according to Patent Owner, "Fuhse262 does not use the term 'voxel' and does not mention 'pixels with volume' or '3D pixels' or any similar term." *Id.* Instead, according to Patent Owner, Fuhse262 "consistently and unambiguously refers to the creation of 'pixels P_j ,' which it also refers to as 'image *points* P_j .'" *Id.* (citing Ex. 1006 ¶¶ 36, 126–128). Consequently, Patent Owner argues that "[a] POSITA would understand Fuhse262's consistent description of a pixel as an 'image *point*' as disclosure of a 2d pixel" rather than a voxel. *Id.*

Because Fuhse262 does not explicitly use the term "voxel," Patent Owner asserts that the "Petition appears to argue that Fuhse262 inherently discloses the creation of voxels" but that the marked up version of Figure 10 provided by Petitioner does not meet the high standard required to show that Fuhse262 inherently discloses voxels. PO Resp. 15–16. Specifically, Patent Owner argues that, at best, Petitioner has shown that the micro mirror array of Fuhse262 might result in overlapping light beams, but does not show how

light beams overlapping with an irregular shape or in an unintentional or haphazard manner would necessarily form a voxel. *Id.*

According to Patent Owner, creating a voxel in an ambient light environment is a “highly technical endeavor” that requires more than just pointing two mirrors towards each other. PO Resp. 17 (citing Ex. 2004 ¶ 45). This is because the light rays that create the voxel encounter interference from other light rays in an ambient environment and are degraded as they approach the intersection point. *Id.* at 17–18 (citing Ex. 2004 ¶ 47). Because of the interference, voxels require more intense and focused light rays than pixels do (which require less information than voxels to create), and thus, add more complexity and costs to the system, argues Patent Owner. *Id.* at 18 (citing Ex. 2004 ¶¶ 49–50).

Patent Owner argues that Dr. Hesselink fails to address these concerns because of lack of experience with diffusive light environments leading to a failure to understand the complexities in creating a voxel. PO Resp. 19 (citing Ex. 2004 ¶¶ 52–55).

Finally, Patent Owner argues that if voxels were necessarily the result of the Fuhse262 system, then all images produced by Fuhse262 would be three-dimensional and the system would not be able to create the two-dimensional images disclosed by Fuhse262. PO Resp. 20 (citing Ex. 1006 ¶¶ 26–27, 117; Ex. 2004 ¶ 58).

Having reviewed Petitioner’s contentions and Patent Owner’s arguments to the contrary, we determine Petitioner has demonstrated that Fuhse262 teaches limitation 1b.5. Specifically, we determine that even though Fuhse262 does not expressly use the term “voxel,” Fuhse262’s disclosure would have taught a person of ordinary skill in the art that its mirrors form voxels. *Merck & Co. v. Biocraft Labs., Inc.*, 874 F.2d 804, 807

(Fed. Cir. 1989) (“[T]he question under 35 USC 103 is not merely what the references expressly teach but what they would have *suggested* to one of ordinary skill in the art at the time the invention was made”) (quoting *In re Lamberti*, 545 F.2d 747, 750 (CCPA 1976)) (emphasis added); *Syntex (U.S.A.) LLC v. Apotex, Inc.*, 407 F.3d 1371, 1380 (Fed. Cir. 2005) (“What a reference teaches a person of ordinary skill is not . . . limited to what a reference specifically ‘talks about’ or what is specifically ‘mentioned’ or ‘written’ in the reference.”). Here, Petitioner has established that Fuhse262 discloses mirrors that reflect light rays converging at a light spot. Ex. 1006 ¶¶ 95–96, Fig. 10. Dr. Hesselink credibly testifies that while Fuhse262 depicts rays that form a light spot, the rays depicted are “chief rays” that depict only the center rays of light for each optical element. Ex. 1003 ¶¶ 169–170. Ambient light, however, reflects from the entire surface of the mirrors and forms reflected beams of light, not just the center rays aimed at the centerpoint. *Id.* ¶ 170. According to Dr. Hesselink, the “chief ray” is representative of the larger bundle of rays that form the beams of light reflected off of the mirrors. *See Id.* ¶ 44. The volume of the voxel is set by the intersection of these beams and the center of the voxel is the point at which the center rays of each beam intersect. *Id.* ¶ 171. Although Dr. Lindstrand testifies a POSITA would not have understood Fuhse262 to disclose creating a voxel (Ex. 2004 ¶ 43), Dr. Lindstrand does not dispute Dr. Hesselink’s testimony that light would reflect off of the entire surface of Fuhse262’s mirrors and form reflected beams of light. *See* Ex. 2004 ¶¶ 42–58; Ex. 1055, 112:15–21 (“You also agree the ambient light would not just strike the center of the surface, it would strike the entire surface, correct? . . . THE WITNESS: I would say that that is a fair and accurate description.”)

We determine Dr. Hesselink’s testimony explaining that light beams would reflect off the entire surface of Fuhse262’s micromirrors and would create a voxel when they intersect with each other, provides sufficient support demonstrating how a person of ordinary skill in the art would have understood Fuhse262’s disclosure of light rays being reflected off of mirrors and converging at a light spot shown in Figure 10. *See Unification Techs. LLC v. Micron Tech. Inc.*, 2024 WL 3738401 at *7 (Fed. Cir. Aug. 9, 2024) (affirming the use of expert testimony to demonstrate how a skilled artisan would have understood a prior art reference’s disclosure as teaching a claim limitation).

We disagree with Patent Owner’s argument that Petitioner relies on inherency in its contentions. Rather, as we explain above, Petitioner’s contentions, supported by the testimony of Dr. Hesselink, describe what a person of ordinary skill would have understood from the teachings of Fuhse262, explaining that reflected light from Fuhse262’s micromirrors would form a beam, not just a single ray, of light and how the intersection of these beams would form a voxel. Pet. 31-33 (citing Ex. 1003 ¶¶ 169–174). Patent Owner argues that when “an element is missing from the applied prior art, the Petitioner bears the burden of supplying the missing element by demonstrating: 1) The missing element is disclosed by another piece of prior art; 2) the missing element is ‘common sense;’ and/or 3) the missing element is inherently disclosed by the prior art reference.” PO Sur-Reply 2.

According to Patent Owner, Petitioner has not established any of the three possibilities above. *Id.* at 2–4. Contrary to Patent Owner’s argument, however, this not a situation where an element is missing from the applied prior art. Instead, as we explain above, a person of ordinary skill in the art would have understood Fuhse262 to teach or suggest voxels because of the

fact that light would reflect off of not just a single point on Fuhse262's mirrors but would, instead, reflect off the entire surface of the mirrors and by doing so would converge to form a voxel. We determine that the limitation is, therefore, found within the teachings of Fuhse262 as understood by a person of ordinary skill in the art.

Patent Owner argues that light beams that intersect in an irregular or unintentional manner would not necessarily form a voxel, but does not explicitly show that Fuhse262's light beams do, in fact, intersect in an irregular manner. Instead, Petitioner has shown, as supported by Fuhse262's disclosure, that Fuhse262's mirrors are each oriented intentionally to point to a spot that allows them to create a light spot at the intended coordinates. *See* Pet. 26 ("In particular, Fuhse262 explains that '[t]he position of the mirror surfaces, i.e. the normal vector n , is to be determined in such a way that the light incident from a specified direction k is reflected onto the focal point (x_0, y_0, z_0) for all micromirrors 102 assigned to light spot 110.'") (quoting Ex. 1006 ¶¶ 96–97) (alternation in original). This disclosure, combined with Dr. Hesselink's testimony that the intersection of light beams from the mirrors would create not just a spot but a voxel due to light reflecting off the entire surface of Fuhse262's mirrors, demonstrates that Fuhse262 teaches limitation 1b.5.

Patent Owner argues that creating voxels requires more than just pointing mirrors towards each other and that it requires added complexity and cost to create voxels due to interference from ambient light. PO Resp. 17–18. As explained above, Petitioner demonstrates that Fuhse262 discloses mirrors that are oriented intentionally to point to a spot that allows them to create a light spot at the intended coordinates. *See* Pet. 26. Petitioner also contends that in some embodiments up to 50 micromirrors may be assigned

to a single light spot and contribute together to the creation of a voxel. Pet. 24 (citing Ex. 1006 ¶¶ 87, 91–92, Figs. 8b, 9b). Dr. Hesselink credibly testifies that the ordinary artisan would have understood Fuhse262’s disclosure as teaching the creation of voxels. Patent Owner does not rebut these points and does not explain what more is required of Fuhse262 to disclose the creation of voxels, other than requiring that Fuhse262 use the same words as recited in the claim.³ *Teva Pharm. Indus. Ltd. v. AstraZeneca Pharms. LP*, 661 F.3d 1378, 1384 (Fed. Cir. 2011) (“The prior inventor does not need to . . . conceive of its invention using the same words as the patentee would later use to claim it.”).

Similarly, Dr. Lindstrand also does not identify specific deficiencies in Fuhse262 that would prevent it from creating voxels or identify the additional complexity required to modify Fuhse262 to allow it to create voxels. Ex. 2004 ¶¶ 43–58. Instead, the portions of Dr. Lindstrand’s testimony that Patent Owner relies on merely repeats Patent Owner’s allegations nearly verbatim without sufficient additional explanation or citations to evidence. *Id.* Such testimony is entitled to little weight in our patentability analysis. *See* 37 C.F.R. § 42.65(a) (“Expert testimony that does not disclose the underlying facts or data on which the opinion is based is

³ At the hearing Patent Owner was unable to identify any structural characteristics that would help explain why Fuhse262 would not be able to create voxels. *See* Tr. 42:22–43:5 (“I have nothing to rely on, other than I think our expert has worked in this field and there’s an opinion that Fuhse262 would not necessarily display a voxel, and I understand their expert opines otherwise. As to structure . . . it’s not described in our specification, but my understanding is the random selection of the mirrors assists with limiting the interference that you get from the regular grid pattern, of Fuhse262, for example. But we haven’t relied heavily on that because we don’t talk about that in the specification in detail, Your Honor.”)

entitled to little or no weight.”); *Xerox Corp. v. Bytemark, Inc.*, IPR2022-00624, Paper 9 at 15–17 (PTAB Aug. 24, 2022) (precedential) (“We have reviewed this excerpt from Dr. Jones’ declaration and note that it merely repeats, *verbatim*, the conclusory assertion for which it is offered to support. . . . [T]he cited declaration testimony is conclusory and unsupported, adds little to the conclusory assertion for which it is offered to support, and is entitled to little weight.”); *Upjohn Co. v. Mova Pharm. Corp.*, 225 F.3d 1306, 1311 (Fed. Cir. 2000) (“Lack of factual support for expert opinion going to factual determinations, however, may render the testimony of little probative value in a validity determination.”) (quoting *Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.*, 776 F.2d 281, 294 (Fed. Cir. 1985)).

Moreover, Patent Owner’s argument is not commensurate with the scope of the claim. Even if the light beams do encounter interference and degrade as they travel to the intersection point (PO Resp. 18), the claims do not exclude degraded or faint voxels, or otherwise require the production of voxels having any particular intensity.

Patent Owner argues that if voxels were necessarily the result of the Fuhse262 system, then all images produced by Fuhse262 would be three-dimensional and the system would not be able to create the two-dimensional images disclosed by Fuhse262. PO Resp. 20 (citing Ex. 1006 ¶¶ 26–27, 117; Ex. 2004 ¶ 58). Fuhse262, however, refers to two-dimensional images as those where its light spots are all in the same plane. Ex. 1006 ¶ 117 (describing a “two-dimensional motif” as a motif “in which all image points are at the same height.”). Thus, even if Fuhse262’s light spots are three-dimensional voxels, this fact does not prevent them from being in the same plane and does not prevent Fuhse262 from having two-dimensional images.

f) Limitation 1b.6

Limitation 1b.6 recites “wherein each of the created voxels produces an effect of a point source of light floating above the surface of the substrate in the plane.” Petitioner contends Fuhse262 teaches limitation 1b.6 by disclosing a “light spot image composed of a plurality of light spots” and that the image “floats at a certain height above . . . the substrate surface.” Pet. 33 (citing Ex. 1006 ¶¶ 10, 11, 15, 35, 58–59, 63–69, 83, 89; Ex. 1003 ¶ 177). Petitioner argues that Fuhse262 teaches voxels being produced as an effect of a point source of light when a cone can be described in which the voxel is the cone’s apex and the micro mirrors are within the base of the cone. *Id.* at 34 (citing Ex. 1006 ¶¶ 36, 126; Ex. 1003 ¶¶ 178–180). Patent Owner does not separately dispute Petitioner’s contentions for limitation 1b.6. *See* PO Resp.

We agree with Petitioner. Fuhse262 discloses that its image is a “light spot image composed of a plurality of light spots” (Ex. 1006 ¶ 10) and that this image “floats at a certain height above . . . the substrate surface.” (Ex. 1006 ¶ 68). Further, Dr. Hesselink provides credible testimony that because light rays continue on their paths until disturbed, the light rays depicted in Fuhse262’s Figure 10 would produce an effect of a point source of light when those continuing light rays reach the viewer’s eye. Ex. 1003 ¶ 178. Dr. Hesselink testifies that a voxel produces an effect of a point source of light when a cone can be described in which the voxel is the cone’s apex and the micro mirrors are within the base of the cone. Ex. 1003 ¶ 180 (citing Ex. 1006 ¶¶ 36, 126); Ex. 1006 ¶ 36 (“there are assigned to the image points P_j aperture cones . . . for every image point P_j , a sphere of influence E_j is determined by an intersection of the aperture cone originating from the image point with the xy plane.”). Dr. Hesselink further testifies that

Fuhse262 teaches such a cone with micro mirrors within the base of the cone. *Id.* We find Dr. Hesselink's testimony to be credible and sufficiently supports that Fuhse262 contains the specific structure to produce the claimed effect of a point source of light.

g) *Conclusion – Claim 1*

Based on the record, for the foregoing reasons, we determine that Petitioner has demonstrated that Fuhse262 teaches or suggests the limitations of claim 1.

4. *Analysis of Independent Claim 28*

Petitioner contends that Fuhse262 renders obvious the preamble and limitations 28a–28b.6. Pet. 34–40. Petitioner supports its arguments with citations to Fuhse262 and to the testimony of Dr. Hesselink. *Id.* Patent Owner does not separately dispute Petitioner's contentions regarding these limitations other than raise the same argument for limitation 28b.5 as it did for limitation 1b.5. *See* PO Resp. 20. We analyze Petitioner's contentions regarding the preamble and limitations of claim 28 below.

a) *Preamble, Limitation 28a, Limitation 28b.1*

The preamble, limitation 28a, and limitation 28b.1 of claim 28 are similar in scope to the preamble, limitation 1a, and limitation 1b.1 of claim 1 and Petitioner relies on its contentions for claim 1 here for claim 28. Pet. 35. For the same reasons discussed above in our analysis of the preamble, limitation 1a, and limitation 1b.1 of claim 1, we determine Petitioner has sufficiently shown that Fuhse262 teaches the corresponding preamble, limitation 28a, and limitation 28b.1 of claim 28.

b) Limitation 28b.2

Limitation 28b.2 recites “in response, displaying a first image and a second image in a plane spaced a distance apart from the surface of the substrate at first and second viewing angles, respectively, wherein the first and second images each comprises a plurality of pixels.” Petitioner contends that Fuhse262 teaches displaying the recited “first image . . . in a plane spaced a distance apart from the surface of the substrate” for the reasons provided in its contentions for limitation 1b.2. Pet. 35. Petitioner further argues that Fuhse262 discloses displaying two light spot images A and B and that these images lie next to each other or appear in the same place when the viewing direction changes. *Id.* at 36 (citing Ex. 1006 ¶¶ 27, 111–120). These two images, Petitioner argues, are in a plane spaced a distance apart from the surface of the substrate because they have the same height above the surface of the substrate. *Id.* at 36 (citing Ex. 1006 ¶ 36, 125–128; Ex. 1003 ¶¶ 190–192). Petitioner also argues that the two images can be viewed at first and second viewing angles. *Id.* at 37 (citing Ex. 1006 ¶ 111, 24; Ex. 1003 ¶ 94).

Anticipating an argument from Patent Owner, Petitioner argues that “[t]o the extent it could be argued that Fuhse262 only explicitly discloses a three-dimensional image in the same place or next to a two-dimensional image (*see* ¶¶ 0027, 0118), it would have been obvious to provide two two-dimensional images.” Pet. 36. Petitioner argues that, given Fuhse262 teaches creating a 3-dimensional image, a POSITA would understand that it can create a 2-dimensional image by fixing the height of the pixels and that the result would be two 2-dimensional images next to each other that are a distance apart from the surface of the substrate. *Id.* at 36–37 (citing Ex. 1003 ¶ 192).

Patent Owner does not separately dispute this limitation. Based on our review, we determine Petitioner has sufficiently demonstrated that Fuhse262 teaches limitation 28b.2. Fuhse262 discloses that it produces light spot images consisting of light spots “that for a viewer appear floating above or below the surface region and that are arranged in the form of a specified motif” which indicates that it produces images “in a plane spaced a distance apart from the surface of the substrate” as recited by the limitation. Ex. 1006 ¶ 10.

Fuhse262 further discloses “the security element can also produce a changing light-spot image when illuminated, in which different images become visible to the viewer from different directions” such that “[w]hen tilted to the side, the security element should show an image change from a light-spot image A to a light-spot image B.” Ex. 1006 ¶ 111. Fuhse262 explains that the images can be both 3D and 2D images and that “[t]he 2D and 3D areas can therefore lie next to each other and/or appear alternately in the same place when the viewing direction is changed.” *Id.* ¶ 118. These disclosures indicate that Fuhse262 teaches “displaying a first image and a second image . . . at first and second viewing angles.”

In sum, the above disclosures sufficiently support Petitioner’s argument that Fuhse262 teaches “displaying a first image and a second image in a plane spaced a distance apart from the surface of the substrate at first and second viewing angles,” as recited in this limitation.

c) Limitation 28b.3

Limitation 28b.3 recites “wherein the array of micro mirrors includes for each of the pixels a unique set of the micro mirrors each having a reflective surface rigidly oriented, by rotating a body of each of the micro

mirrors about at least one of two rotations axes extending through the body, to reflect the ambient light away from the substrate toward a point on the plane corresponding to one of the pixels.” This limitation is similar in scope to limitation 1b.3 and Petitioner relies on its contentions for limitation 1b.3 for limitation 28b.3. Pet. 38. To account for slight differences in the language of the two limitations, Petitioner contends that “[t]he sets of micro mirrors for each pixel are **unique** for the same reasons the sets are **different**” and that “[t]he micro mirrors are oriented **rigidly** for the same reasons the micro mirrors are oriented **in a fixed manner**.” *Id.* Petitioner further contends that “the reflected light is away from the substrate for the same reasons it is directed **toward a point on the plane corresponding to one of the pixels**” and that “reflections from the micromirrors are always **away from the substrate**.” *Id.* (citing Ex. 1003 ¶¶ 196–199). Patent Owner does not separately dispute Petitioner’s contentions regarding limitation 28b.3. *See* PO Resp. We agree with Petitioner for the reasons provided in the Petition and summarized here.

d) Limitation 28b.4

Limitation 28b.4 recites “wherein each of the unique sets of the micro mirrors includes a number of the micro mirrors in the range of 2 to 40.” Petitioner contends that Fuhse262 teaches this limitation by disclosing embodiments with 100 micromirrors or 288 micromirrors where every fourth mirror is assigned to a specific light spot. Pet. 38–39 (citing Ex. 1006 ¶¶ 90–92, 94; Ex. 1003 ¶¶ 201–202). Similarly, Petitioner points to another example where every ninth mirror is assigned to a light spot. *Id.* at 39 (citing Ex. 1006 ¶ 94; Ex. 1003 ¶ 202). Patent Owner does not separately dispute Petitioner’s contentions regarding limitation 28b.4. *See* PO Resp.

We agree with Petitioner. Fuhse262 teaches that the total number of micromirrors may be “for example, a few tens, a few hundred or even several thousand.” Ex. 1006 ¶ 56. Fuhse262 discloses that in Figure 8 “[t]he number $n \times n$ of micromirrors is, for example, 10×10 ,” which totals 100 micromirrors and also another example with two arrangements of 12×12 micromirrors for a total of 288 micromirrors. Ex. 1006 ¶¶ 87, 90–92, Fig. 8. Fuhse262 discloses in the example of Figure 8(c) “every fourth field can be covered with micromirrors 102 that are assigned to a specific light spot.” Ex. 1006 ¶ 94. This means that a unique set of twenty-five mirrors is assigned to a light spot. Similarly, in Figure 8(d) “every ninth field is covered by micromirrors 102 assigned to a specific light spot.” Ex. 1006 ¶ 94. This would mean that eleven mirrors are assigned to a light spot for the 100 micromirror arrangement and thirty-two mirrors would be assigned to a light spot for the 288 micromirror arrangement. Ex. 1003 ¶¶ 201–202. These disclosures demonstrate by a preponderance of the evidence that Fuhse262 teaches limitation 28b.4.

e) Limitation 28b.5

Limitation 28b.5 recites “wherein the reflected ambient light from the number of the micro mirrors intersects at the point corresponding to the one of the pixels to create a voxel.” This limitation is similar in scope to limitation 1b.5. Petitioner relies on its contentions for limitation 1b.5 for limitation 28b.5. *See* Pet. 39. Patent Owner disputes Petitioner’s contentions for limitation 28b.5 for the same reasons as for limitation 1b.5. *See* PO Resp. 20. We determine Petitioner has demonstrated that Fuhse262 teaches limitation 28b.5 for the same reasons explained in our analysis of limitation 1b.5 above.

f) Limitation 28b.6

Limitation 28b.6 recites “whereby the voxel acts like a point light source positioned in the plane at the point corresponding to the one of the pixels.” This limitation is similar in scope to limitation 1b.6. Petitioner relies on its contentions for limitation 1b.6 for limitation 28b.6. *See* Pet. 40. Patent Owner does not separately dispute Petitioner’s contentions for limitation 28b.6.⁴ We determine Petitioner has demonstrated that Fuhse262 teaches limitation 28b.6 for the reasons explained in our analysis of limitation 1b.6.

g) Conclusion – Claim 28

Based on the record, for the foregoing reasons, we determine that Petitioner has demonstrated that Fuhse262 teaches or suggests the limitations of claim 28.

5. Analysis of Independent Claim 35

Petitioner contends that Fuhse262 renders obvious the preamble and limitations 35a–36b.8. Pet. 40–44. Petitioner supports its arguments with citations to Fuhse262 and to the testimony of Dr. Hesselink. *Id.* Patent Owner does not separately dispute Petitioner’s contentions regarding these limitations other than for limitation 35b.5. *See* PO Resp. 21–24. We analyze Petitioner’s contentions regarding the preamble and limitations of claim 35 below.

⁴ Patent Owner states that “element [28b.6] recites limitations similar to those recited in element [1b.6]” and that “Fuhse262 does not teach or suggest limitations [1v.5] (sic) or [1b.6] . . . [f]or the same reasons [it] does not teach or suggest limitations [28b.5] or [28b.6].” PO Resp. 20–21. Patent Owner, however, does not separately dispute Petitioner’s contentions for 1b.6. *See* PO Resp.

a) Preamble, Limitation 35a, Limitation 35b.1, Limitation 35b.2

The preamble, limitation 35a, limitation 35b.1, 35b.2, 35b.3, and 35b.4 of claim 35 are similar in scope to the preamble, limitation 1a, limitation 1b.1, 1b.2, 1b.3, and 1b.4 of claim 1 and Petitioner relies on these contentions for claim 1 here for claim 35. Pet. 40–42. For the same reasons discussed above in our analysis of the preamble, limitation 1a, limitation 1b.1, 1b.2, 1b.3, and 1b.4 of claim 1, we determine Petitioner has sufficiently shown that Fuhse262 teaches the corresponding preamble, limitation 35a, limitation 35b.1, 35b.2, 35b.3, and 35b.4 of claim 35.

b) Limitation 35b.5

Limitation 35b.5 recites “further in response to the receiving of the ambient light, the array of micro mirrors displays a second image in a second plane spaced a distance apart from the plane displaying the image.” Relying on its contentions for limitation 28b.2, in which Petitioner argued that Fuhse262 “discloses displaying two images in the same plane,” Petitioner adds that Fuhse262 also teaches that the two images may be in the foreground and background of each other, meaning, according to Petitioner, that they are spaced apart from each other. Pet. 43 (citing Ex. 1003 ¶¶ 220–221; Ex. 1006 ¶ 117). Because the paragraph which Petitioner relies on for this additional teaching discusses a three-dimensional image in the foreground of a two-dimensional image, rather than two two-dimensional images, Petitioner argues that “[t]o the extent it could be argued that Fuhse262 only explicitly discloses a three-dimensional image in the foreground of a two-dimensional image . . . [b]ased on Fuhse262’s teachings that multiple images may be created in the foreground and background of each other, and that images may be two-dimensional, it would have been

understood to a POSITA to provide two two-dimensional images at different heights (*i.e.*, in different planes).” Pet. 43 (citing Ex. 1003 ¶ 222).

Patent Owner argues that “[t]he cited paragraph of Fuhse262 discloses a single light-spot image that contains both a 3-D motif and a 2-D motif,” and that “[f]rom Fuhse262’s disclosure of a *single light-spot image* that *combines* a 3-D motif and a 2-D motif, a POSITA would understand that the 3-D motif and the 2-D motif are both displayed *within the same three-dimensional plane*.” PO Resp. 21–22 (citing Ex. 2004 ¶ 65; Ex. 1006 ¶ 117). Patent Owner also argues that Fuhse262’s disclosure of two motifs that are in the foreground and background of each other does not mean that they are in two planes spaced a distance apart from one another. PO Sur-Reply 9. In addition, Patent Owner argues that Petitioner does not identify any reason why a POSITA would be motivated to modify Fuhse262 to achieve the features of limitation 35b.5 and instead relies on hindsight bias to lead to the claimed feature. PO Sur-Reply 10–11.

Having reviewed Petitioner’s contentions and Patent Owner’s arguments to the contrary, we determine Petitioner has demonstrated by a preponderance of the evidence, that Fuhse262 teaches limitation 35b.2. Petitioner has demonstrated that Fuhse262 discloses two-dimensional images in a plane. Pet. 21 (citing Ex. 1006 ¶ 68). For example, Fuhse262 discloses creating a “truly three-dimensional motif” but that “[i]n some configurations, however, it may also be advisable to design all convex mirrors with the same focal length, so that all light spots in the light-spot image have the same floating height.” Ex. 1006 ¶ 68. Petitioner has also demonstrated that Fuhse262 discloses a two-dimensional image in the foreground of a three-dimensional background image. Pet. 43 (citing Ex. 1003 ¶¶ 220–221; Ex. 1006 ¶ 117). Fuhse262 discloses that “if a two-

dimensional foreground motif is combined with a three-dimensional background motif, the light-spot image does not disappear completely, even in poor illumination conditions, but is simply reduced to the more robust two-dimensional foreground motif.” Ex. 1006 ¶ 117. Based on these disclosures, we agree with Petitioner that instead of having a two-dimensional image in the foreground of a three-dimensional background image, it would have been obvious to have a two-dimensional image in the foreground of a two-dimensional background image. Pet. 43 (citing Ex. 1003 ¶ 222). Petitioner’s contentions are supported by Dr. Hesselink who credibly testifies that:

As discussed in element [1b.2] . . . by teaching any arbitrary three-dimensional image in space (*i.e.*, x, y, z space) can be constructed of pixels, a POSITA would understand that a two-dimensional image can be constructed by fixing the height (z) values of the pixels. Based on Fuhse262’s teachings that multiple images may be created in the foreground and background of each other, and that images may be two-dimensional, it would have been obvious to a POSITA to provide two two-dimensional images at different heights (*i.e.*, in different planes).

Ex. 1003 ¶ 222.

Patent Owner argues that the two-dimensional foreground image and three-dimensional background image are “*within the same three-dimensional plane*,” and therefore not spaced apart from one another. PO Resp. 22 (citing Ex. 1006 ¶ 117; Ex. 2004 ¶ 65); *see also* PO Sur-Reply 11–13 (arguing that “the two motifs in Fuhse262 are ‘combined’ within a single image and are therefore in the same plane.”). This argument, however, does not address Petitioner’s contentions, which are based on two two-dimensional images, rather than a two-dimensional image and three-dimensional image. We agree with Petitioner that in the case of two two-

dimensional images in which one is in the foreground and the other in the background, the images would be in planes spaced apart from each other.

Patent Owner argues that Fuhse262's disclosure of two motifs, one of which appears as if it is in the foreground of the other does not mean that the two motifs are spaced a distance apart from each other. PO Sur-Reply 9–10. In the case of two two-dimensional images, however, we determine that one being in the foreground and one in the background would teach or suggest to a person of ordinary skill in the art that the two images are in planes spaced apart from each other. Patent Owner does offer any explanation⁵ to rebut this natural understanding of a two-dimensional image being in the foreground of another two-dimensional image—i.e. that one image is spaced a distance in front of (apart from) the other image.

Finally, Patent Owner argues that Petitioner has not sufficiently provided a reason to modify the teachings of Fuhse262 to provide two two-dimensional images at different heights. PO Sur-Reply 10. Instead, according to Patent Owner, Petitioner's arguments are based on conclusory expert testimony and on hindsight bias. *Id.* at 10–11. We disagree. Dr. Hesselink testifies that “[b]ased on Fuhse262's teachings that multiple images may be created in the foreground and background of each other, and

⁵ At the hearing Patent Owner argued that a two-dimensional image could appear to be in the foreground of another in the same way that a tree could appear to be in the foreground of a mountain in a painting, even though the tree and the mountain are on the same flat canvas and thus on the same plane. *See* Tr. 48:5–19. This argument was not made by Patent Owner in its Response or its Sur-Reply. Moreover, Fuhse262's motifs appear to float in three-dimensional space, not on a flat surface such as a canvas. In three-dimensional space, it would be more natural to assume that the foreground image is spaced apart from the background image rather than the two being in the same plane.

that images may be two-dimensional, it would have been obvious to a POSITA to provide two two-dimensional images at different heights (i.e., in different planes).” Ex. 1003 ¶¶ 222. Dr. Hesselink’s testimony is supported by Fuhse262’s disclosure. Fuhse262 explains that its mirrors can create “truly three-dimensional” image but that “[i]n some configurations . . . it may also be advisable to . . . [have] all light spots in the light-spot image hav[ing] the same floating height” creating a two-dimensional image instead. Ex. 1006 ¶ 68; Pet. 21. Fuhse262 also discloses that the height of the image points may be “specified.” Ex. 1006 ¶ 36; Pet. 22. Finally, Fuhse262 discloses that a two-dimensional image may be in the foreground of a three-dimensional background image. Ex. 1006 ¶ 117. Because Fuhse262 discloses that in some situations a two-dimensional image may be advisable over a three-dimensional image, it follows that it would have been obvious, given Fuhse262’s disclosure of a two-dimensional image in the foreground and a three-dimensional image in the background, to have two two-dimensional images with one in the foreground and one in the background instead. Fuhse262’s disclosures of two and three-dimensional images are interrelated and it would not have required a leap of inventiveness to make the modification of simply using a two-dimensional image in place of a three-dimensional one. *See Boston Sci. Scimed, Inc. v. Cordis Corp.*, 554 F.3d 982, 991 (Fed. Cir. 2009) (“[c]ombining two embodiments disclosed adjacent to each other in a prior art patent does not require a leap of inventiveness.”).

c) Limitation 35b.6

Limitation 35b.6 recites “wherein the second image comprises a plurality of pixels.” Petitioner relies on its contentions for limitation 28b.2.

See Pet. 43. Petitioner’s contentions for limitation 28b.2, in turn, rely on its contentions for limitation 1b.2. *See* Pet. 35. In its contentions for limitation 1b.2 Petitioner argues that Fuhse262 discloses images consisting of light spots, which Petitioner argues are pixels. Pet. 21 (citing Ex. 1006 ¶ 68; Ex. 1003 ¶¶ 136–137). We determine Petitioner has demonstrated that Fuhse262 teaches limitation 35b.6 for the reasons explained in our analysis of limitation 1b.2 (explaining that light spots teach the recited pixels). Ex. 1003 ¶¶ 137–138.

d) Limitation 35b.7

Limitation 35b.7 recites “wherein the array of micro mirrors includes, for each of the pixels of the second image, a different set of the micro mirrors each having a reflective surface oriented, differently from others of the micro mirrors in the different set, to reflect the ambient light away from the substrate and toward a point on the second plane corresponding to one of the pixels of the second image.” This limitation is similar to limitation 35b.3 except that it refers to the second image rather than the initial image. Petitioner relies on its contentions for limitation 35b.3 here along with its contentions for 35b.5 for the “second image” aspect of limitation 35b.7. Pet. 44. Patent Owner does not separately dispute Petitioner’s contentions for this limitation. We determine Petitioner has demonstrated that Fuhse262 teaches limitation 35b.7 for the reasons explained in our analysis of limitation 35b.3 along with our determination in our analysis of limitation 35b.5 that Fuhse262 teaches “display[ing] a second image in a second plane.”

e) Limitation 35b.8

Limitation 35b.8 recites “a second set of voxels concurrently being created at the points on the second plane via intersection of two or more beams of the reflected ambient light at each of the points to concurrently display the pixels of the second image.” This limitation is similar to limitation 35b.4 except, as with limitation 35b.7, it refers to the second image rather than the initial image. Petitioner relies on its contentions for limitation 35b.4 here along with its contentions for 35b.5 for the “second image” aspect of limitation 35b.7. Pet. 44. Patent Owner does not separately dispute Petitioner’s contentions for this limitation. We determine Petitioner has demonstrated that Fuhse262 teaches limitation 35b.8 for the reasons explained in our analysis of limitation 35b.4 along with our determination in our analysis of limitation 35b.5 that Fuhse262 teaches “display[ing] a second image in a second plane.”

f) Conclusion – Claim 35

Based on the record, for the foregoing reasons, we determine that Petitioner has demonstrated that Fuhse262 teaches or suggests the limitations of claim 35.

6. Dependent Claim 6

Claim 6 recites “[t]he assembly of claim 1, wherein each of the sets of the micro mirrors includes a number of the micro mirrors in the range of 2 to 40 and wherein the reflected ambient light from at least twenty of the micro mirrors intersects at the point corresponding to the one of the pixels.” Claim 37 recites nearly an identical limitation.

Petitioner relies on its contentions for limitation 28b.4 for demonstrating that Fush262 teaches micro mirrors in the range of 2 to 40.

Pet. 52 (citing Ex. 1003 ¶ 255). Petitioner further contends that Fuhse262 teaches that “amounts such as 25 or 32 micromirrors” may be used to provide reflected ambient light that intersects to form a light spot as explained in its contentions for limitation 28b.4. *Id.* (citing Ex. 1003 ¶¶ 256–257).

Patent Owner does not dispute Petitioner’s contentions for this limitation. We determine Petitioner has demonstrated, by a preponderance of the evidence, that Fuhse262 teaches the limitations of claims 6 and 37 for the reasons provided by Petitioner.

7. *Dependent Claim 7*

Claim 7 recites “[t]he assembly of claim 6, wherein each of the sets of the micro minors includes at least thirty of the micro mirrors.” Relying on its contentions for limitation 28b.4 Petitioner contends that “[f]or the 288 micromirror example, **each of the sets** would have 32 (*i.e.*, 288 divided by nine) micromirrors (**at least thirty of the micro mirrors**).” Pet. 53 (citing Ex. 1003 ¶ 260).

Patent Owner does not dispute Petitioner’s contentions for this limitation. We determine Petitioner has demonstrated, by a preponderance of the evidence, that Fuhse262 teaches the limitations of claim 7 for the reasons provided by Petitioner.

8. *Dependent Claims 8 and 32*

Claim 8 recites “[t]he assembly of claim 6, wherein the point on the plane corresponds to an apex of a cone and the at least twenty of the micro mirrors are located within a base of the cone coplanar with the surface of the substrate.” Claim 32 recites a nearly identical limitation.

Petitioner contends “Fuhse262 teaches that ‘every image point P_j ,’ **(the point on the plane) corresponds to** a ‘cone originating from’ or ‘emanating from’ the image point **(an apex of a cone)**. EX1006, ¶¶ 0036, 0126. Further, ‘a sphere of influence E_j [**a base of the cone**] is determined by an intersection of the aperture cone originating from the image point with the xy plane’ **(coplanar with the surface of the substrate)**.” Pet. 54 (citing Ex. 1006 ¶¶ 36, 125–128) (alteration in original). Petitioner further contends “all of the micromirrors (in this case, **the at least twenty of the micro mirrors**) that ‘contribute to producing the light spot that corresponds to image point P_j ’” are selected from fields in the xy plane that are ‘in the sphere of influence E_j of the image point P_j ’ **(within a base of the cone)**.” *Id.* (citing Ex. 1006 ¶¶ 36, 125–128; Ex. 1003 ¶ 263).

Patent Owner does not dispute Petitioner’s contentions for this limitation. We determine Petitioner has demonstrated, by a preponderance of the evidence, that Fuhse262 teaches the limitations of claims 8 and 32 for the reasons provided by Petitioner.

9. *Dependent Claims 9 and 33*

Claim 9 recites “[t]he assembly of claim 8, wherein the micro mirrors within the base of the cone and excluded from the set of the micro mirrors displaying the pixel are oriented to reflect the ambient light away from point on the plane corresponding to the pixel to provide a dark background for the image.” Claim 33 recites a nearly identical limitation.

Petitioner contends that “Fuhse262 teaches producing two light spots that are visible at different viewing angles, explaining that ‘different images become visible to the viewer from different directions’ by omitting the

‘micromirrors in which the x component n_x of the normal vector is greater than zero’ for image A’ and omitting the micromirrors ‘where the x component n_x of the normal vector is less than zero’ for the light-spot image B.” Pet. 55 (citing Ex.1006 ¶¶ 111–113; Ex. 1003 ¶ 266). According to Petitioner, Fuhse26 “recognizes that there are areas that ‘must be kept **dark**’ in order to create ‘a visually appealing three-dimensional light-spot image.’” *Id.* (citing Ex. 1006 ¶¶ 106-07).

Petitioner contends that Fuhse262 discloses displaying foreground and background images and that micromirrors assigned to one of the images are excluded from the set of micromirrors assigned to the other image and reflect light away from the point on the plane corresponding to the pixels of the first image. Pet. 56–57 (citing Ex. 1003 ¶¶ 272–273). This allows Fuhse262 to provide a dark background for one of the images (i.e. the foreground or the background image). *Id.* at 57 (citing Ex. 1003 ¶ 273). Petitioner argues that the micromirrors performing this darkening are both (1) **the micro mirrors within the base of the cone**, and (2) **excluded from the set of the micro mirrors displaying the pixel.**” *Id.* at 57–58 (citing Ex. 1003 ¶¶ 274–276; Ex. 1006 ¶¶ 36, 106–107, 125–128).

Patent Owner does not dispute Petitioner’s contentions for this limitation. We determine that Petitioner has demonstrated, by a preponderance of the evidence, that Fuhse262 teaches the limitations of claims 9 and 33 for the reasons provided by Petitioner.

10. Dependent Claim 10

Claim 10 recites:

The assembly of claim 1, wherein, further in response to the receiving of the ambient light, the array of micro mirrors displays a second image in a second plane spaced a distance apart from

the plane displaying the image, wherein the second image comprises a plurality of pixels and wherein the array of micro mirrors includes, for each of the pixels of the second image, a set of the micro mirrors each having a reflective surface oriented to reflect the ambient light toward a point on the second plane corresponding to one of the pixels of the second image.

Petitioner relies on its contentions for limitation 35b.5 and 35b.6 for this dependent claim 10. Pet. 58–59 (citing Ex. 1003 ¶ 277). Patent Owner does not dispute Petitioner’s contentions for this limitation. We determine Petitioner has demonstrated, by a preponderance of the evidence, that Fuhse262 teaches the limitations of claim 10 for the reasons provided by Petitioner.

11. Dependent Claims 11 and 36

Claim 11 recites “[t]he assembly of claim 10, wherein the image has a first viewing angle and the second image has a second viewing angle offset from the first viewing angle by at least 10 degrees.” Claim 36 has a nearly identical limitation.

Petitioner argues that Fuhse262 discloses “that ‘different images become visible to the viewer from different directions’” for example, when the assembly is tilted to the side. Pet. 59 (citing Ex. 1006 ¶ 111, 24). Petitioner relies on an embodiment in which “three light-spot images A, B, C to change when tilted vertically” in which “the size of the visibility range can be set as desired.” *Id.* (quoting Ex. 1006 ¶ 115). According to Petitioner “[a] POSITA would understand that at least 10 degrees would be needed to be provided to the third image.” *Id.* at 59–60 (citing Ex. 1003 ¶ 281).

Patent Owner does not dispute Petitioner’s contentions for this limitation. Although Petitioner has not cited any specific teaching from Fuhse262 expressly teaching at least a 10 degree offset between viewing

angles, we determine that such an offset would be have been obvious to one of ordinary skill in the art given the disclosures of Fuhse262 summarized above. Specifically, Fuhse262 discloses that in the case of three images with viewing angles in the vertical direction “the size of the visibility range can be set as desired.” Ex. 1003 ¶ 115. Setting the viewing angles so that the images could be properly visible would be within the ambit of the ordinary artisan. *See In re Boesch*, 617 F.2d 272, 276 (CCPA 1980) (“[D]iscovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art”); *see also In re Aller*, 220 F.2d 454, 456 (CCPA 1955) (explaining that “where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.”). We determine, therefore, that Petitioner has demonstrated, by a preponderance of the evidence, that Fuhse262 teaches the limitations of claims 11 and 36 for the reasons provided by Petitioner.

12. Dependent Claim 12

Claim 12 recites “[t]he assembly of claim 1, wherein the plane is above, below, or coinciding with the focal plane for the array of the micro mirrors.” Claim 38 recites a nearly identical limitation.

Petitioner argues that in Fuhse262, “[b]ecause all the pixels are in the plane . . . all the focal points for the plurality of pixels form a **focal plane**. Thus, the plane **coincid[es]** with **the focal plane for the array of the micro mirrors**.” Pet. 62 (citing Ex. 1003 ¶ 286) (third alteration in original).

Patent Owner does not dispute Petitioner’s contentions for this limitation. We determine Petitioner has demonstrated, by a preponderance

of the evidence, that Fuhse262 teaches the limitations of claims 12 and 38 for the reasons provided by Petitioner.

13. Dependent Claim 13

Claim 13 recites “[t]he assembly of claim 12, wherein the micro mirrors are configured to display the image with colors.”

Petitioner contends that Fuhse262 discloses “layer systems that show a color change when tilted.” Pet. 62 (citing Ex. 1006 ¶ 34). According to Petitioner, Fuhse262 also discloses its mirror have “a thin-film element with a color-shifting effect.” *Id.* at 62–63 (citing Ex. 1006 ¶ 32).

Patent Owner does not dispute Petitioner’s contentions for this limitation. We determine Petitioner has demonstrated, by a preponderance of the evidence, that Fuhse262 teaches the limitations of claim 13 for the reasons provided by Petitioner.

14. Conclusion – Ground 1

Accordingly, having considered the arguments and evidence, we are persuaded that Petitioner has demonstrated by a preponderance of the evidence that the subject matter of claims 1, 6–13, 28, 32, 33, 35–38 of the ’294 patent would have been obvious over Fuhse262.

F. Remaining Grounds 2–8

Petitioner argues claims 1, 6–13, 28, 32, 33, and 35–38 of the ’294 patent would have been obvious over Fuhse262 and Fuhse925 (Ground 2), Fuhse262 and Jordan (Ground 3), Fuhse262, Fuhse925 and Jordan (Ground 4. Pet. 44–64. Petitioner argues claims 14, 34, and 39 would have been obvious over Fuhse262 and Fuhse172 (Ground 5), Fuhse262, Fuhse925, and Fuhse172 (Ground 6), Fuhse262, Jordan and Fuhse172 (Ground 7) and

Fuhse²⁶² Fuhse²⁹⁵, Jordan, and Fuhse¹⁷² (Ground 8). *Id.* at 64–68.
Below we provide a brief overview of these additional prior art references.

1. Fuhse925 (Ex. 1008)

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, specifically the occurrence of a three-dimensional appearance and a movement effect when the security element is tilted. *Id.* at 6:49–55, 7:10–12. Fuhse925 describes an embodiment with ray-optically effective reflective facets 30 that constitute small included micromirrors that direct incident light in a reflection direction given by the condition ‘angle of incidence equals angle of reflection,’” and this “arrangement of the reflective facets 30 is . . . also referred to as a micromirror arrangement.” *Id.* at 7:43–48.

2. Jordan (Ex. 1009)

Jordan is titled “Moiré Magnification Systems,” and relates to “[i]ntegral image and moiré magnification devices” that “have been employed to provide authentication of currency and documents, to identify and distinguish authentic products from counterfeit products, and to provide visual enhancement of manufactured articles and packaging.” Ex. 1009, code (54), ¶ 35.

3. Fuhse172 (Ex. 1035)

Fuhse172 is titled “Security Element, Value Document Comprising Such a Security Element, and Method for Producing Such a Security Element,” and “relates to a security element for a security paper, value

document or the like, to a value document having such a security element, and to a method for manufacturing such a security element.” Ex. 1035, code (54), ¶ 1. Fuhse172 discloses forming color-shifting coating on facets as a thin-film system or thin-film interference coating, as an interference filter, or as liquid-crystal layer, and that the color-shifting coating on facets can be constructed of reflector, dielectric, absorber (formed on the facets). *Id.* ¶¶ 27–29.

4. *Ground 2 – Obviousness of Fuhse262 and Fuhse925*

Petitioner states that Ground 2 is “the same as Ground 1, but additionally relies on Fuhse925’s teachings regarding orientation of its micromirrors, as teaching limitation [1b.3]/[28.b3].”⁶ Pet. 44.

a) *Combination of Fuhse262 and Fuhse925*

As a motivation to combine the teachings of Fuhse262 and Fuhse925, Petitioner notes that the two references share the same inventor and relate to the same field of security elements for banknotes. Pet. 44–45 (citing Ex. 1006, Abstract; Ex. 1008, Abstract; Ex. 1003 ¶ 228). Petitioner argues that Fuhse262 describes the proper orientation of its mirrors by a normal vector n of its reflective surface and that while a POSITA would understand how much to rotate the mirror surfaces in the x and y axes to achieve the normal vector n , this is not expressed in explicit detail. Fuhse925, on the other hand, does provide this explicit detail, according to Petitioner. *Id.* at 45 (citing Ex. 1008, 7:33–63). Petitioner argues that based on these teachings it would have been obvious for a POSITA to examine how mirror surface orientations are achieved with Fuhse262. *Id.* at 45–46 (citing Ex. 1003

⁶ Although Petitioner does not list it, Petitioner relies on Fuhse925 for limitation 35b.3 as well as 1b.3 and 28b.3.

¶ 229). Petitioner also argues that a POSITA would have had a reasonable expectation of success in implementing the combination because the structures of Fuhse262 and Fuhse925 are similar with similar dimensions and construction. *Id.* at 46–47 (citing Ex. 1006 ¶¶ 95–99; Ex. 1008, 5:36–5:38; Ex. 1003 ¶¶ 233–234).

Patent Owner does not address Petitioner’s contentions regarding motivation to combine or reasonable expectation of success. We determine a POSITA would have been motivated to combine the teachings of Fuhse262 and Fuhse925 and would have had a reasonable expectation of success for the reasons provided by Petitioner.

b) Analysis of Independent Claims 1, 28, and 35

Petitioner relies on the combination of Fuhse262 and Fuhse925 for only the preamble and one limitation (limitations 1b.3, 28b.3 and 35b.3) of claims 1, 28 and 35. Pet. 47–50. For the remaining limitations, Petitioner relies on Fuhse262 alone and on the same contentions as it did for Ground 1. Pet. 44 (“This ground is the same as Ground 1.”). Because of the similarities of the preamble and limitations 1b.3, 28b.3 and 35b.3, Petitioner combines its contentions for all three independent claims. We analyze Petitioner’s contentions for the preamble and limitations 1b.3, 28b.3 and 35b.3 below. For the remaining limitations, we determine Petitioner has carried its burden for the same reasons provided in our analysis of Ground 1.

(1) Preamble of Claims 1, 28, and 35

The preamble of claim 1 recites “[a] visual display assembly useful as a security element on paper and coin currency, and product labels.” The preambles of claims 28 and 35 are identical. Petitioner contends while Fuhse262 describes its invention is applicable to any data carrier, it does not

list all of its applications. Pet. 48. Fuhse925 “additionally teaches that its invention is **useful as a security element on** not only banknotes, but also on ‘labels on goods and packaging’ (**product labels**).” Pet. 47 (citing Ex. 1008, 6:55-60; Ex. 1003 ¶ 238). According to Petitioner, a “POSITA would have been motivated to look at other references, including Fuhse925, to find additional data carriers for additional applications.” Pet. 48 citing (Ex. 1003 ¶ 239). Patent Owner does not separately dispute Petitioner’s contentions for Ground 2. We determine Petitioner has demonstrated, by a preponderance of the evidence, that the combination of Fuhse262 and Fuhse925 teaches the preambles of claims 1, 28, and 35 for the reasons provided by Petitioner.

(2) *Limitation 1b.3, 28b.3, and 35b.3*

Limitations 1b.3, 28b.3 and 35b.3 are similar. We reproduce limitation 1b.3 below for reference:

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.

Petitioner contends that Fuhse262 “discloses that the micromirrors each have a normal vector n of its reflective surface defined in the x and y axes, and a POSITA would understand rotating the surface in the x and y axis to achieve that normal vector n .” Pet. 48. However, according to Petitioner, to the extent Fuhse262 does not, Fuhse925 does. *Id.*

Petitioner argues that Fuhse925 “further teaches that the normal surface N can be broken down into two ‘inclination components’ that

represent the inclination angle of the mirror in each respective axis.” Pet. 49 (citing Ex. 1008, 7:33-63). According to Petitioner, Fush925 “explains, $N_{\parallel}$ and $N_{\perp}$ are the ‘mirror slope’ in each of the x and y axes (**first and second rotation axes**), such that the **body of each of the micro mirrors [is] rotated about** the x-axis **extending through the body** by an amount of $N_{\parallel}$, and the **body of each of the micro mirrors [is] rotated about** the y-axis **extending through the body** by an amount of $N_{\perp}$ to achieve the proper orientation of the micro mirrors.” *Id.* at 50 (citing Ex. 1008, 7:33-58; Ex. 1003 ¶ 245). Petitioner argues that “the micro-mirrors are oriented **in a fixed manner** by explaining that its reflective planar facets 30 are “characterized by an inclination angle.” *Id.* (citing Ex. 1008, 7:37-42, claim 1).

Patent Owner does not separately dispute Petitioner’s contentions for Ground 2. We determine Petitioner has demonstrated, by a preponderance of the evidence, that the combination of Fush925 and Fush926 teaches limitations 1b.3, 28b.3 and 35b.3 for the reasons provided by Petitioner.

(3) *Conclusion – Independent Claims 1, 28, and 35*

Based on the record, for the foregoing reasons, we determine that Petitioner has demonstrated that Fush926 teaches or suggests the limitations of claim 28.

c) *Analysis of Dependent Claims 6–13, 32, 33, and 36–38*

For the dependent claims, Petitioner largely relies on its contentions for Ground 1 except that it relies, in the alternative, on Fush925 for claims 11 and 36 (requiring that the viewing angle for the first image and the viewing angle of the second image are offset by 10 degrees). Pet. 52, 60–61, 64. Patent Owner does not separately dispute Petitioner’s contentions for

any of the dependent claims. *See* PO Resp. We determine Petitioner has demonstrated, by a preponderance of the evidence, that Fuhse262 and Fuhse925 teaches or suggests the limitations of claims 6–13, 32, 33, and 36–38.

d) Conclusion – Ground 2

Accordingly, having considered the arguments and evidence, we are persuaded that Petitioner has demonstrated, by a preponderance of the evidence, that the subject matter of claims 1, 6–13, 28, 32, 33, 35–38 of the '294 patent would have been obvious over Fuhse262 and Fuhse925.

5. Grounds 3 and 4 – Obviousness over the Combination of Fuhse262 and Jordan and the Combination of Fuhse262, Fuhse925, and Jordan

According to Petitioner Grounds 3 and 4 are the same as Grounds 1 and 2 respectively, except that they “additionally rel[y] on Jordan’s teachings regarding the useful applications of optical security elements, as relevant to the preamble.” Pet. 50.

a) Combination of Fuhse262 and Jordan and Combination of Fuhse262, Fuhse925 and Jordan

Petitioner argues that “[w]hile Fuhse262 describes its invention may be applicable to any ‘data carrier,’ it does not explicitly list all of its application. A POSITA would have been motivated to look at other references, including Jordan, to find additional data carriers.” Pet. 51 (citing Ex. 1003 ¶ 247). Petitioner argues that a POSITA would have had a reasonable expectation of success in implementing the combinations because “the art was relatively predictable” and would have been able to make the combination “without difficulty.” *Id.* (citing Ex. 1003 ¶ 248). Petitioner also alleges that “[b]ecause coin currency and product labels were known in the art as useful applications of OVD [Optically Variable Device]

technology, a POSITA would have routinely recognized that Fuhse262 would be ‘useful as a security element’ for those applications.” *Id.* (citing Ex. 1003 ¶ 249).

Patent Owner does not address Petitioner’s contentions regarding motivation to combine or reasonable expectation of success. We determine a POSITA would have been motivated to combine the teachings of Fuhse262, Fuhse925, and Jordan and would have had a reasonable expectation of success for the reasons provided by Petitioner.

b) Analysis of Independent Claims 1, 28, and 35

Petitioner relies on the combination of Fuhse262 and Jordan and the combination of Fuhse262, Fuhse925, and Jordan for only the preamble of claims 1, 28 and 35. Pet. 51–52. For the remaining limitations, Petitioner relies on Fuhse262 alone and on the same contentions as it did for Grounds 1 and 2. *Id.* at 50. We analyze Petitioner’s contentions for the preamble of claims 1, 28, and 35. For the remaining limitations, we determine Petitioner has carried its burden for the same reasons provided in our analysis of Grounds 1 and 2.

(1) Preamble of Claims 1, 28, and 35

The preamble of claim 1 recites “[a] visual display assembly useful as a security element on paper and coin currency, and product labels.” The preambles of claims 28 and 35 are identical. Petitioner contends that “Jordan teaches methods of using arrays of reflective microstructures that produce images ‘as a security and anti-counterfeiting feature to identify and distinguish authentic products from counterfeit products,’ such as ‘banknotes’ or ‘coinage,’ as well as ‘product marking and labeling’ and

‘packaging.’” Pet. 52 (citing Ex. 1009, Abstract, ¶¶ 13, 2–4, 113–114, 124–125, 154, 159, 174–177; Ex. 1003 ¶ 253).

Patent Owner does not separately dispute Petitioner’s contentions for Grounds 3 and 4. We determine Petitioner has demonstrated, by a preponderance of the evidence, that the combination of Fuhse262 and Jordan and the combination of Fuhse262, Fuhse925, and Jordan teach the preambles of claims 1, 28, and 35 for the reasons provided by Petitioner.

c) Analysis of Dependent Claims 6–13, 32, 33, and 36–38

For the dependent claims, Petitioner largely relies on its contentions for Ground 1 except that it relies, in the alternative, on Fuhse925 for claims 11 and 36 (requiring that the viewing angle for the first image and the viewing angle of the second image are offset by 10 degrees). Pet. 52, 60–61, and 64. Patent Owner does not separately dispute Petitioner’s contentions for any of the dependent claims. *See* PO Resp. We determine Petitioner has demonstrated, by a preponderance of the evidence, that the combination of Fuhse262, Fuhse925, and Jordan teaches or suggests the limitations of dependent claims 6–13, 32, 33, and 36–38.

d) Conclusion – Grounds 3 and 4

Accordingly, having considered the arguments and evidence, we are persuaded that Petitioner has demonstrated, by a preponderance of the evidence, that the subject matter of claims 1, 6–13, 28, 32, 33, 35–38 of the ’294 patent would have been obvious over the combination of Fuhse262, Fuhse925, and Jordan.

6. Analysis of Grounds 5–8

Grounds 5–8, which challenge dependent claims 14, 34, and 39, are based on Grounds 1–4, respectively, except with the addition of Fuhse172 as

part of the combination. Petitioner argues that “[t]he positions for these claims are the same in view of Grounds 1, 2, 3, or 4, as the inclusion of Fuhse925 and/or Jordan do not affect the positions.” Pet. 64 (citing Ex. 1003 ¶¶ 305–306).

a) Combination of Fuhse172 with the References of Grounds 1–4

Petitioner argues that it would have been obvious to apply the teachings of Fuhse172 to Fuhse262. Petitioner argues that the two references are in the same field. Pet. 65 (citing Ex. 1006, Abstract; Ex. 1008, Abstract; Ex. 1003 ¶ 298). Petitioner contends that Fuhse262 teaches thin-film elements with color-shifting but that it does not provide details on how to implement the thin-films in order to provide color-shifting. Pet. 65 (citing Ex. 1006 ¶¶ 32, 34). According to Petitioner, Fuhse172 does provide those details. *Id.* (citing Ex. 1003 ¶ 299). Specifically, Fuhse172 teaches that dielectric materials may be used to provide color-shifting and provides the details of such an implementation. *Id.* (citing Ex. 1035 ¶¶ 118, 27–29; Ex. 1003 ¶¶ 300–301). Petitioner adds that using Fuhse172’s teachings would have involved known techniques to improve Fuhse262 in a known way without unpredictable results. *Id.* at 65–66 (citing Ex. 1003 ¶ 302).

Patent Owner does not address Petitioner’s contentions regarding motivation to combine or reasonable expectation of success. We determine a POSITA would have been motivated to combine the teachings of Fuhse172 with the teachings of Fuhse262 as it is relied upon in Grounds 1–4, and would have had a reasonable expectation of success for the reasons provided by Petitioner.

b) Dependent Claims 14, 34, and 39

Dependent claims 14, 34, and 39 each recite “wherein at least one of ink, plasmonic resonance, and dielectric material is used to configure the micro mirrors to display the image with the colors.” Petitioner argues that “Fuhse172 discloses that in order ‘to apply a color-shifting coating, in particular a thin-film system, to the facets,’ the thin-film system can have multiples ‘**dielectric** layer[s]’ formed one on the other.” Pet. 67 (citing Ex. 1035 ¶¶ 118, 27–29). According to Petitioner, “[t]his ‘dielectric layer’ is a **dielectric material** that is **used to configure the micro mirrors to display the image with the colors.**” *Id.* (citing Ex. 1003 ¶ 308). Petitioner contends that “instead of multiple dielectric layers, a combination of dielectric layers and metal layers may also be used, which also means a **dielectric material** is used.” Ex. 1035 ¶¶ 27–29; Ex. 1003 ¶¶ 309–311).

Patent Owner does not separately dispute Petitioner’s contentions for Grounds 5–8. We determine Petitioner has demonstrated, by a preponderance of the evidence, that the Fuhse172, when combined with the references relied upon for Grounds 1–4, teaches the limitations of claims 14, 34, and 39 for the reasons provided by Petitioner.

c) Conclusion – Grounds 5–8

Accordingly, having considered the arguments and evidence, we are persuaded that Petitioner has demonstrated, by a preponderance of the evidence, that the subject matter of claims 14, 34, and 39 of the ’294 patent would have been obvious over the combinations relied upon in Grounds 5–8.

III. CONCLUSION⁷

The table below summarizes our conclusions as to the challenged claims.

⁷ 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).

Claims	35 U.S.C. §	Reference(s) /Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1, 6–13, 28, 32, 33, 35–38	103	Fuhse262	1, 6–13, 28, 32, 33, 35–38	
1, 6–13, 28, 32, 33, 35–38	103	Fuhse262, Fuhse925	1, 6–13, 28, 32, 33, 35–38	
1, 6–13, 28, 32, 33, 35–38	103	Fuhse262, Jordan	1, 6–13, 28, 32, 33, 35–38	
1, 6–13, 28, 32, 33, 35–38	103	Fuhse262, Fuhse925, Jordan	1, 6–13, 28, 32, 33, 35–38	
14, 34, 39	103	Fuhse262, Fuhse172	14, 34, 39	
14, 34, 39	103	Fuhse262, Fuhse925, Fuhse172	14, 34, 39	
14, 34, 39	103	Fuhse262, Jordan, Fuhse172	14, 34, 39	
14, 34, 39	103	Fuhse262, Fuhse925, Jordan, Fuhse172	14, 34, 39	
Overall Outcome			1, 6–14, 28, 32–39	

IV. ORDER

For the foregoing reasons, it is

ORDERED that Petitioner has shown by a preponderance of the evidence that claims 1, 6–14, 28, and 32–39 of the '294 patent are unpatentable; and

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

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