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Filed on behalf of Giesecke+Devrient GmbH, *et al.*

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

U.S. Patent No. 11,448,863
IPR No. 2024-00839

**Petition for *Inter Partes* Review of
U.S. Patent No. 11,448,863**

TABLE OF CONTENTS

I.	INTRODUCTION.....	1
II.	BACKGROUND	2
	A. OVDs for Document Anti-Counterfeiting	2
	B. Micro-mirror Arrays.....	2
III.	THE '863 PATENT.....	3
	A. Specification.....	3
	B. Prosecution History	4
IV.	STATEMENT OF RELIEF REQUESTED	4
	A. Grounds	4
	B. Priority Date	5
	C. The References Are Prior Art.....	5
	D. Overview of the Prior Art.....	6
	1. Fuhse847 (EX1022)	6
	2. Rich (EX1039)	10
	3. Fuhse925 (EX1008)	10
	4. Sauvage-Vincent (EX1033)	10
	5. Morford (EX1024)	10
	E. The Prior Art is Analogous Art.....	11
V.	LEVEL OF ORDINARY SKILL	11
VI.	CLAIM CONSTRUCTION	11

VII. GROUNDS OF UNPATENTABILITY 12

A.	Ground 1: Fuhse847 in view of Rich Renders Obvious Claims 1-2, 4-6, 12-14	12
1.	Combined Teachings of Embodiments of Fuhse847	12
a.	Motivation.....	12
b.	Reasonable Expectation of Success.....	13
2.	Combined Teachings of Fuhse847 in view of Rich.....	14
a.	Motivation.....	14
b.	Reasonable Expectation of Success.....	17
3.	Application to the Challenged Claims	17
4.	Claim 1	17
a.	[1Pre]	17
b.	[1a]:	18
c.	[1b]:	23
d.	[1c]:	27
e.	[1d]:	30
f.	[1e]:	32
5.	Dependent Claims from Claim 1	34
a.	Claim 2:	34
b.	Claim 4:	35
c.	Claim 5:	35

d.	Claim 6:	36
6.	Claim 12.....	38
a.	[12Pre]:	38
b.	[12a]:.....	39
c.	[12b]:.....	42
d.	[12c]:.....	42
e.	[12.d], [12.e]:	42
f.	[12.f]:	44
7.	Dependent Claims from Claim 12	49
a.	Claim 13:	49
b.	Claim 14:	53
B.	Ground 2: Fuhse847 and Rich in view of Fuhse925 Renders Obvious Claims 3 and 6-14.....	54
1.	Combined Teachings of Fuhse847 and Rich in view of Fuhse925	54
a.	Motivation.....	54
b.	Reasonable Expectation of Success.....	57
2.	Application to the Challenged Claims	58
a.	Claim 3:	58
b.	Claim 6:	60
3.	Claim 7	62
a.	[7Pre]:	62

b.	[7a]:	62
c.	[7b]:	63
d.	[7c]:	63
e.	[7d]:	63
f.	[7e]:	64
4.	Dependent Claims from Claim 7	64
a.	Claim 8:	64
b.	Claim 9:	64
c.	Claim 10:	64
d.	Claim 11:	64
5.	Claim 12	64
a.	[12Pre]:	65
b.	[12a]:	65
c.	[12b]:	65
d.	[12c]:	65
e.	[12.d]:	65
f.	[12.e]:	65
g.	[12.f]:	65
6.	Dependent Claims from Claim 7	68
a.	Claim 13:	68
b.	Claim 14:	68

C.	Ground 3: Fuhse847 and Rich (Ground 1) in view of Sauvage-Vincent Renders Obvious Claims 15-18.....	68
1.	Combined Teachings of Fuhse847 and Rich in view of Sauvage-Vincent	69
a.	Motivation to Combine.....	69
b.	Reasonable Expectation of Success.....	70
2.	Challenged Claims	70
a.	Claim 15:	70
b.	Claim 16:	72
c.	Claim 17:	72
d.	Claim 18:	73
D.	Ground 4: Fuhse847, Rich, and Fuhse925 (Ground 2) in view of Sauvage-Vincent Renders Obvious Claims 15-18	74
1.	Combined Teachings of Fuhse847, Rich, and Fuhse925 in view of Sauvage-Vincent.....	75
a.	Motivation to Combine.....	75
b.	Reasonable Expectation of Success.....	75
2.	Application to the Challenged Claims	75
a.	Claim 15:	75
b.	Claim 16:	75
c.	Claim 17:	76
d.	Claim 18:	76

E.	Ground 5: Fuhse847 and Rich (Ground 1) in view of Morford Renders Obvious Claims 19-20.....	76
1.	Combined Teachings of Fuhse847 and Rich in view of Morford	76
a.	Motivation to Combine.....	76
b.	Reasonable Expectation of Success.....	77
2.	Application to the Challenged Claims	77
a.	Claim 19:	77
b.	Claim 20:	78
F.	Ground 6: Fuhse847, Rich, and Fuhse925 (Ground 2) in view of Morford Renders Obvious Claims 19-20	79
1.	Combined Teachings of Fuhse847, Rich, and Fuhse925 in view of Morford.....	79
a.	Motivation to Combine.....	79
b.	Reasonable Expectation of Success.....	80
2.	Application to the Challenged Claims	80
a.	Claim 19:	80
b.	Claim 20:	80
VIII. SECONDARY CONSIDERATIONS OF NONOBVIOUSNESS		80
IX. INSTITUTION IS APPROPRIATE UNDER FINTIV.....		81
X. INSTITUTION IS APPROPRIATE UNDER §325(D)		83
XI. MANDATORY NOTICES.....		85
A.	Real Parties-in-Interest Under 37 C.F.R. § 42.8(b)(1).....	85

B.	Related Matters Under 37 C.F.R. § 42.8(b)(2)	85
C.	Lead and Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3)	85
D.	Service Information Under 37 C.F.R. § 42.8(b)(4).....	86
XII.	 GROUNDS FOR STANDING	86
XIII.	 CONCLUSION	87

TABLE OF AUTHORITIES

	Page(s)
Cases	
<i>Abbot Vascular, Inc. v. Flexstent</i> , IPR2019-00882, Paper 48, 28-29 (Oct. 2, 2020).....	54
<i>Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH</i> , IPR2019-01469, Paper 6 (PTAB Feb. 13, 2020).....	83, 84
<i>Apple v. Fintiv</i> , IPR2020-00019, Paper 11 (PTAB Mar. 20, 2020)	81, 83
<i>Black v. CE Soir Lingerie Co.</i> , No. 2:06-CV-544, 2008 WL 3852722 (E.D. Tex. Aug. 15, 2008).....	54, 55
<i>Boston Sci. Scimed, Inc. v. Cordis Corp.</i> , 554 F.3d 982 (Fed. Cir. 2009)	12, 15
<i>Catalina Mktg. Int’l, Inc. v. Coolsavings.com, Inc.</i> , 289 F.3d 801 (Fed. Cir. 2002)	17, 19, 38
<i>Cellco P’ship d/b/a Verizon Wireless v. Huawei Device Co., Ltd.</i> , IPR2020-01117, Paper 10 (PTAB Feb. 3, 2021).....	84
<i>In re GPAC Inc.</i> , 57 F.3d 1573 (Fed. Cir. 1995)	11
<i>Hulu LLC v. SITO Mobile R&D IP, LLC</i> , IPR2021-00298, Paper 11 (PTAB May 19, 2021)	81
<i>KSR Int’l Co. v. Teleflex, Inc.</i> , 550 U.S. 398 (2007).....	56, 57, 58, 59
<i>Leapfrog Enters. v. Fisher-Price, Inc.</i> , 485 F.3d 1157 (Fed. Cir. 2007)	80
<i>Lumenco, LLC v. Giesecke+Devrient GmbH</i> , No. 2:23-cv-00100 (E.D. Tex. 2023).....	85

<i>Lumenco, LLC v. United States</i> , No. 24-139-T (Fed Cl. 2024)	85
<i>Newell Cos. v. Kenney Mfg. Co.</i> , 864 F.2d 757 (Fed. Cir. 1988)	80
<i>Samsung Elecs. Co. Ltd. v. Dynamics Inc.</i> , IPR2020-00505, Paper 11 (PTAB Aug. 12, 2020).....	82
<i>Sand Revolution II, LLC v. Cont’l Intermodal Grp.-Trucking LLC</i> , IPR2019-01393, Paper 24, 11-12 (PTAB Jun. 16, 2020).....	82
<i>Sony Grp. Corp. v. MZ Audio Scis., LLC</i> , IPR2022-01544, Paper 12 (PTAB Apr. 21, 2023)	84
<i>Sotera Wireless, Inc. v. Masimo Corp.</i> , IPR2020-01019, Paper 12 (PTAB Dec. 1, 2020)	82
<i>Texas Instruments Inc. v. U.S. Int’l Trade Comm’n</i> , 988 F.2d 1165 (Fed. Cir. 1993)	79
<i>Unwired Planet, LLC v. Google Inc.</i> , 841 F.3d 995 (Fed. Cir. 2016)	11
Other Authorities	
28 U.S.C. § 1498	81, 82
35 U.S.C. §102(a)(1).....	5
35 U.S.C. §112	11
35 U.S.C. § 311	1
37 C.F.R. § 42.8(b)(1-4)	85, 86
37 C.F.R. § 42.10(b)	86
37 C.F.R. §42.24(a).....	93
37 C.F.R. § 42.24(d)	93

TABLE OF EXHIBITS

Exhibit	Description
Ex. 1001	U.S. Patent No. 10,317,691 to Raymond (“the ’691 patent”)
Ex. 1002	File History of U.S. Patent No. 10,317,691
Ex. 1003	Declaration of Lambertus Hesselink, Ph.D.
Ex. 1004	U.S. Patent No. 62262767 Provisional
Ex. 1005	DE102010048262A1
Ex. 1006	DE102010048262A1 Official Translation into English (“Fuhse262”)
Ex. 1007	DE102010048262A1 Certificate of translation
Ex. 1008	U.S. Patent No. 10,639,925 to Fuhse (“Fuhse925”)
Ex. 1009	U.S. Patent Application Publication 2014/0367957 (“Jordan”)
Ex. 1010	Reserved
Ex. 1011	Reserved
Ex. 1012	Reserved
Ex. 1013	Reserved
Ex. 1014	Reserved
Ex. 1015	Reserved
Ex. 1016	Reserved
Ex. 1017	Reserved
Ex. 1018	Reserved

Exhibit	Description
Ex. 1019	Reserved
Ex. 1020	Reserved
Ex. 1021	Reserved
Ex. 1022	WO2012048847A1_English (“Fuhse 847”)
Ex. 1023	Reserved
Ex. 1024	Robert Morford, Wu-Sheng Shih, and JoElle Dachsteiner “Press-patterned UV-curable high refractive index coatings”, Proc. SPIE 6123, Integrated Optics: Devices, Materials, and Technologies X, 612301 (15 February 2006); https://doi.org/10.1117/12.643164 (“Morford”)
Ex. 1025	Reserved
Ex. 1026	Lee R.A., Leech P.W., “Development of Optically Variable Devices for Document Security in CSIRO Journal of the Coatings Association of Australia,” Vol. 42(8), August 2005, p. 22-27.
Ex. 1027	<i>Optics</i> , Hecht, 4th Edition (2002)
Ex. 1028	Saleh and Teich. Fundamentals of Photonics (1st Edn. 1991), Ch. 1
Ex. 1029	Ebewele, R.O. 2000. Polymer Science and Technology 1st ed CRC Press.
Ex. 1030	Franssila, S. Introduction to Microfabrication (1st ed. 2004)
Ex. 1031	Finale coin in the Australian Centenary of Federation Program Featuring an Optically Variable Device
Ex. 1032	New method of producing OVD coins
Ex. 1033	U.S. Patent Application Publication No. 2014/0285892 (“Sauvage-Vincent”)
Ex. 1034	Leech, P.W., Lee, R.A., and Brett, Sexton, B.A., and Smith, F., “Hot Embossing of Micrographic Elements in Polypropylene,” <i>Microelectronic Engineering</i> 84: 109–113 (2007).

Exhibit	Description
Ex. 1035	Reserved
Ex. 1036	Curriculum Vitae of Lambertus Hesselink
Ex. 1037	Reserved
Ex. 1038	U.S. Pat. App. Publ. No. 2005/0057812 (“Raber”)
Ex. 1039	U.S. Pat. No. 10,859,851 (“Rich”)
Ex. 1040	WO2012048847A1 (“Fuhse847 Native”)
Ex. 1041	Morford_2006_LC Catalog - Item Information (Full Record)
Ex. 1042	Ex. 1042 - Mahalik - Micromanufacturing and Nanotechnology (Chapter 7)
Ex. 1043	WO2012048847A1_Certified Translation
Ex. 1044	Reserved
Ex. 1045	Reserved
Ex. 1046	Lalev, et al., Data preparation for focused ion beam machining of complex three-dimensional structures (2008)
Ex. 1047	U.S. Patent No. 4,761,253 (“Antes”)
Ex. 1048	<i>Lumenco, LLC v. Giesecke+Devrient GmbH et al.</i> , Civil Action No. 2:23-cv-00100, Dkt. No. 29 (Aug. 9, 2003) (“Docket Control Order”)
Ex. 1049	Reserved
Ex. 1050	File History of U.S Patent No. 10,189,294 (“294 FH”)

I. INTRODUCTION

Giesecke+Devrient GmbH, Giesecke+Devrient Currency Technology GmbH, and Papierfabrik Louisenthal GmbH (collectively, “G+D” or “Petitioners”) requests review under 35 U.S.C. § 311 and cancellation of claims 1, 6-14, 28 and 32-39 of U.S. Patent No. 11,448,863 (EX1001, “the ’863 Patent”) as unpatentable.

Optically variable devices (“OVDs”) for document anti-counterfeiting were introduced in the 1980s. OVDs are applicable to currency (banknotes), passports, ID cards, and product labels, as these solutions use optical features to verify authenticity.

OVD technology has advanced rapidly to “stay ahead” of rapidly advancing counterfeiting technology. The first commercial OVDs were diffraction-based solutions implemented on the Australian ten-dollar banknote in January, 1988. By the early 2000s, pioneered by Petitioners, micromirrors replaced diffraction patterns on currency.

Petitioners patented the subject matter of the challenged claims years before Patent Owner (“PO”). Christian Fuhse, the first named inventor on Fuhse847, is the head of the Optical Effects and Data Processing team at Papierfabrik Louisenthal (one of Petitioners). Wittich Kaule, the second named inventor, is a prolific and pioneering inventor with over 100 issued patents worldwide.

Because the claims cover known techniques published years before the earliest priority date, the Board should claim 1-20 as unpatentable.

II. BACKGROUND

By December 2015 (earliest priority date), micro-mirror arrays for document security already had been known for decades, including the approach pioneered by Petitioners and described herein. EX1003, ¶¶24-34.

A. OVDs for Document Anti-Counterfeiting

1990's, diffraction-based OVD technology became widespread, adopted on a number of national currencies.

By the early 2000s, micromirror OVDs replaced diffraction gratings and advanced rapidly thereafter, with significant efforts from industry, most prominently Petitioners – a preeminent innovator in the field for over 170 years – and governmental organizations. EX1003, ¶¶24-34.

B. Micro-mirror Arrays

Each micromirror in an array around 25-50 microns and reflects incident light in a certain direction determined by the orientation of the micro-mirror surface. The reflected incident light creates an image floating in space from the observer's perspective. EX1003, ¶30.

Banknotes use micromirror OVDs because they are low cost. Through work of Petitioners, micromirror OVD technology advanced rapidly to date. EX1003, ¶¶31-34.

III. THE '863 PATENT

A. Specification

The '863 Patent frames its purported invention as an advancement of currency anti-counterfeiting devices. EX1001, 1:31-2:35. The '863 Patent describes a security element for banknotes, which generates images with light in “spatial planes above and below the surface of an array of micro mirrors.” EX1001, 2:39-53, 3:15-20; EX1003, ¶¶71-73.

The '863 Patent groups the micro-mirrors with the micro-mirrors of each set oriented to reflect ambient light towards a point corresponding to a “pixel.” EX1001, 2:39-53. Numerous pixels together form an image in an “image display plane,” and multiple images may be produced in different image display planes. *Id.* Figure 2 depicts “floating image(s)” at “a height or distance above...the array of micro mirrors.” EX1001, 5:14-6:14; EX1003, ¶¶74-79.



¶¶183-85, 80-81. None of this is novel.

B. Prosecution History

Applicant amended the claims, which were allowed. EX1002, 41-47, 21-29.

IV. STATEMENT OF RELIEF REQUESTED

A. Grounds

No.	Claims Challenged	Ground Statements
1	1-2, 4-6, 12-14	Fuhse847 in view of Rich
2	3, 6-14	Fuhse847 and Rich (Ground 1) in view of Fuhse925

3	15-18	Fuhse847 and Rich (Ground 1) in view of Sauvage-Vincent
4	15-18	Fuhse847, Rich, and Fuhse925 (Ground 2) in view of Sauvage-Vincent
5	19-20	Fuhse847 and Rich (Ground 1) in view of Morford
6	19-20	Fuhse847, Rich, and Fuhse925 (Ground 2) in view of Morford

B. Priority Date

The earliest application to which the '863 Patent claims priority is US62/262,767, filed December 3, 2015 (earliest possible priority date). Petitioners do not concede that the claims are entitled to that priority date. EX1003, ¶70.

C. The References Are Prior Art

All references relied on in the Grounds are prior art under 35 U.S.C. §102(a)(1) or §102(a)(2):

- (1) PCT Publication WO2012/048847 (“Fuhse847”), published April 19, 2012 (EX1022¹);

¹ EX1022 is a verified, official translation of Fuhse847 at EX1040. See EX1043. Fuhse847 claims priority to Fuhse262 (filed October 12, 2010). EX1006 is a verified, official translation of Fuhse262 at EX1005. See EX1007.

- (2) U.S. Patent 10,859,851 (“Rich”) filed Oct. 23, 2015, issued Dec. 8, 2020 (EX1039) or (“Rich”);
- (3) U.S. Patent 10,639,925 (“Fuhse925”) with priority to an application filed May 8, 2015 (EX1008);
- (4) U.S. Pub. 2014/0285892 (“Sauvage-Vincent”) filed April 28, 2014, published September 25, 2014 (EX1033²);
- (5) Robert Morford, et al. “Press-patterned UV-curable high refractive index coatings”, Proc. SPIE 6123, Integrated Optics: Devices, Materials, and Technologies X, 612301 (15 February 2006), (“Morford”) (EX1024³).

D. Overview of the Prior Art

1. Fuhse847 (EX1022)

Fuhse847 discloses a security element created from a reflective micromirror array that reflects light to “light spots” or “pixels,” which together form two- or three-dimensional images (“light-spot images”) that appear to “float” at “floating

² Sauvage-Vincent claims priority to a French application filed on Oct. 28, 2011.

³ Morford was publicly available as of at least 2006 as evidenced by the Library of Congress date stamp of May 16, 2006 (EX1024, 3) and the Library of Record (EX1041).

heights above or below” the substrate surface. EX1022, 5. The images can be “visible from the same or different viewing angles.” EX1022, 26. Each image is “only visible in a limited angle range.” *Id.*, 25. EX1003, ¶¶98-100.

In one embodiment, Figure 2 shows concave mirrors 24 on the surface of substrate 22 that reflect light from distant light source 34 to “produce the specified image points as light spots 32.” EX1022, 13-14; EX1003, ¶¶103-04.

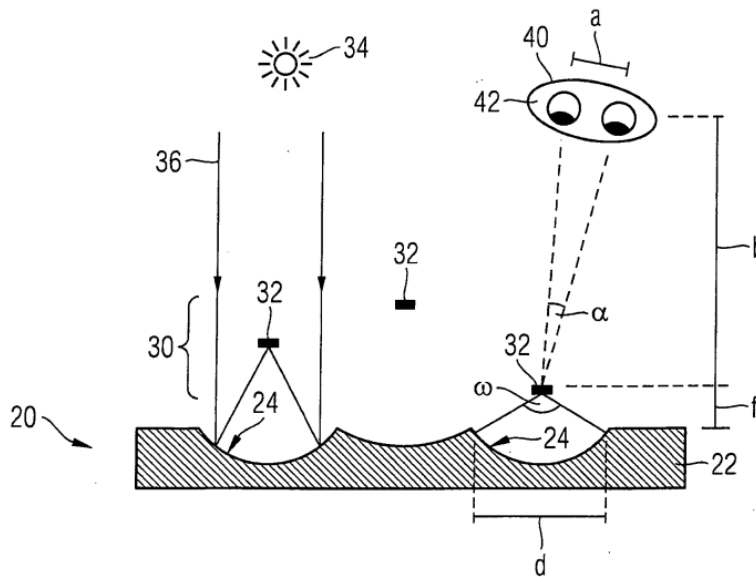
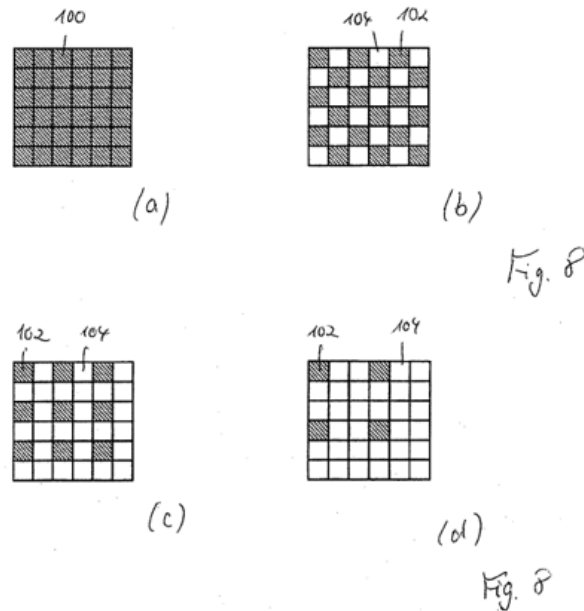


Fig. 2

In another embodiment with respect to Figures 8-10, Fuhse847 replaces the “curved concave mirror” of Figure 2 with a flat micro-mirrors array in order to obtain “higher resolution” images, and because “flat surfaces are easier to calculate and produce.” Fuhse847, 19-20. Figures 8(a)-8(d), Fuhse847 teaches arrays of micro-mirrors.



EX1022, 19-20; EX1003, ¶¶105. The micro-mirrors arrays are “n x n micromirrors” that each have “a flat mirror surface” with a “dimension of 50μm x 50μm.” EX1022, 19-20. Further, the micro-mirrors may be “assigned to every light spot of the light-spot image,” as shown in Figure 9:

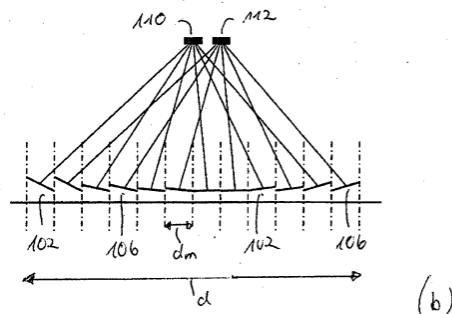
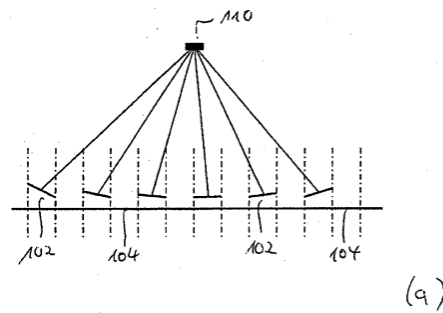


Fig. 9

EX1022, 6; EX1003, ¶¶106-07.

The images may be 3D, including any 2D image “that floats at a certain height above or below the substrate surface.” EX1022, 16, 13-14; EX1003, ¶¶112-15.

Fuhse847 discloses how to produce its images by defining image points for the image, and defining a cone for each image point such that a “sphere of influence” is defined on the substrate plane for assigning micro-mirrors to that image point. EX1022, 9-10, 27-29; EX1003, ¶¶108-10. Fuhse847’s Figure 10 and descriptions further teach how to orient each micro-mirror such that it reflects light to its assigned light spot. EX1022, 21-22; EX1003, ¶111.

2. Rich (EX1039)

Rich relates to “[a]n optical product” (providing an anti-counterfeit feature) that “when illuminated, [can] reproduce by reflected...light, a 3D image.” EX1039, Abstract. Rich discloses running program 325 to determine data file used in manufacturing master 10 (e.g., “determin[ing] the pattern of the features...on the surface”). EX1039, FIG. 2B, 16:33-17:7; EX1003, ¶¶116-17.

3. Fuhse925 (EX1008)

Fuhse925 relates to an optical security element that shows different images at different viewing/tilt angles, that “float alternately a few millimeters above or below the plane of the security thread,” using an array of micromirrors orientated at different angles on a substrate. EX1008, Abstract, 6:67-7:1; EX1003, ¶¶118-19.

4. Sauvage-Vincent (EX1033)

Sauvage-Vincent relates to manufacturing reflective optical security elements, and teaches a “die”/“master” that provides a “stamping operation” to produce microstructure patterns of desired optical elements. EX1033, ¶¶0002, 71, 73, 43, Abstract. EX1003, ¶120.

5. Morford (EX1024)

Morford teaches materials for optical components having properties (e.g., flexibility, high refractivity, curable with UV light). EX1024, Abstract; EX1003, ¶121.

E. The Prior Art is Analogous Art

Petitioners’ references are analogous because they are from the same field as the ’863 Patent, *e.g.*, optical devices for document security, and are pertinent to a problem the inventor was focused on, *e.g.*, displaying images with document security devices. EX1001, Abstract, 1:20-27, 2:21-35; EX1003, ¶¶129, 328, 390, 429. *Unwired Planet, LLC v. Google Inc.*, 841 F.3d 995, 1000 (Fed. Cir. 2016).

V. LEVEL OF ORDINARY SKILL

Based on the relevant factors, *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995), a person of ordinary skill in the art (“POSITA”) 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. EX1003, ¶¶88-94.

VI. CLAIM CONSTRUCTION

PO has sued Petitioners for infringement of the ’863 Patent. *See, infra*, XI.B Although the parties may propose constructions for certain terms, no claim terms require express construction to resolve the challenges here.⁴ EX1003, ¶¶95-96.

⁴ In district court, the parties may dispute whether some claims are invalid under 35 U.S.C. §112. For this proceeding only, Petitioners assumes the claims are not invalid under §112.

VII. GROUNDS OF UNPATENTABILITY

A. Ground 1: Fuhse847 in view of Rich Renders Obvious Claims 1-2, 4-6, 12-14

1. Combined Teachings of Embodiments of Fuhse847

a. Motivation

Fuhse847 discloses “a depiction” element invention. EX1022, 4, Abstract. Particularly, the Petition relies on a combination of Fuhse847 Figures 1-2, 8(a)-(d), and 9-10 and accompanying disclosures. EX1003, ¶124.

It would have been obvious to a POSITA to combine the multiple embodiments. It is well-established that “[c]ombining two embodiments disclosed adjacent to each other in a prior art patent does not require a leap of inventiveness.” *Boston Sci. Scimed, Inc. v. Cordis Corp.*, 554 F.3d 982, 991 (Fed. Cir. 2009).

Fuhse847 provides express motivation to combine the features of its embodiments, and a POSITA would have been motivated to use micromirrors in lieu of concave mirrors, for benefits such as higher resolution and easier production with no adverse effects on the image produced. EX1022, 19; EX1003, ¶125.

Figure 2 shows various aspects and elements “[t]o explain the principle of the invention.” EX1022, 13-15. Figures 8(a)-(d) build on Figure 2 by replacing the “curved concave mirror” of Figure 2 “with micro-mirrors.” EX1022, 12. Fuhse847 explicitly refers back to the “previous exemplary embodiments” in building on those

teachings. EX1022, 19-20. Also, Figures 8(a)-8(d) show different variations of the same teachings. EX1003, ¶125.

Fuhse847 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.” EX1022, 19; EX1003, ¶125.

Likewise, Figure 9 builds on the teachings of Figures 8(a)-8(d) by illustrating them “in a sectional view” and providing further explanation. EX1022, 20-21, 13. Finally, Figure 10 builds on the teachings of Figures 8(a)-8(d) and 9 by describing how to calculate and orient the surfaces of the micromirrors. EX1022, 21-23, 13.

b. Reasonable Expectation of Success

A POSITA would have had a reasonable expectation of success combining the embodiments of Fuhse847. As a POSITA would have recognized, the teachings of Fuhse847 relied on in this Ground represent different aspects of the invention that all operate on the same principle, and work to disclose different aspects that rely on the same principles. The aspects of the Figure 2 descriptions relied on would operate on the same principles, serve the same purpose, and maintain the same relevant characteristics when applied to the micromirrors of Figure 8-10. Fuhse847 teaches to “replace[]” the curved mirrors of Figure 2 with the micromirrors 100 (*see* EX1022,

19), and a POSITA would have reasonably been able to adapt those teachings regarding Figure 2 to micromirrors. EX1003, ¶127.

Likewise, the different specific implementations, such as possible arrays sizes of 100 micromirrors (*see* 19-20) or 288 micromirrors (*see* 20-21), would have been routinely and predictably implemented by a POSITA. EX1003, ¶127.

The predictable nature of the combination is confirmed by evidence showing that the operation of micromirror arrays—and their application to security elements—was well-understood at the time of the alleged priority date. Given that micromirror arrays of the type contemplated in the '294 Patent were textbook knowledge at the time of the alleged invention, a POSITA would have no difficulty combining embodiments of Fuhse847. EX1003, ¶128.

Thus, a POSITA would have been able to implement the obviousness modifications in this ground without difficulty. EX1003, ¶128.

2. Combined Teachings of Fuhse847 in view of Rich

a. Motivation

A POSITA would have found it obvious to apply the teachings of Rich to Fuhse847. EX1003, ¶¶129-137. Fuhse847 and Rich relate to security elements for data carriers reflective micro-mirrors arrays that produce, upon illumination, images, and thus are in the same field. EX1022 (Fuhse847), Abstract; Rich, Abstract. EX1003, ¶129.

A POSITA would have looked to Rich when reviewing Fuhse847. EX1003, ¶130. Fuhse847 teaches techniques that require software running on processors of computer systems, such as 3D-CAD, computer-aided technical drawings, and 3D laser scanning of real three-dimensional bodies. EX1022, 10-11. These techniques implement aspects of Fuhse847’s invention, such as the creating of the “data sets” describing the pixels of the images to be displayed, and assigning micromirrors to pixels. *Id.*; EX1003, ¶130.

Fuhse847 also discloses steps and techniques that a POSITA would understand would be implemented by software running on processors of computer systems because they would be very difficult, if not impossible for large numbers of micromirrors, to manually perform without the aid of computing. EX1003, ¶¶131-32.

However, it is not expressed in detail how to implement this computing in Fuhse847, and a POSITA would be motivated to look to the art for such implementation in order to automate computing orientations of micromirrors. EX1003, ¶¶132-35. Given the large number of micro-mirrors in the arrays, a POSITA implementing Fuhse847 would be *required* to seek a software implementation for micro-optic design, such as Rich, in order to design the micro-mirror arrays that Fuhse847 teaches. EX1003, ¶¶121-34. Rich teaches what Fuhse847 does not explicitly disclose,

namely, processor 330 running a main program 325, as shown in Figure 2B, to provide designs of micro mirror arrays from input images using software. Rich, 16:33-17:7; EX1003, ¶¶132-37.

It would therefore have been obvious for a POSITA to examine how computing methods in micro mirror design are implemented when reviewing Fuhse847 in order to implement what is taught in Fuhse847. EX1003, ¶¶133.

Rich provides explicit detail for implementing Fuhse847, namely a software running on processors of computer systems to take input images and output files to construct micro mirror arrays that produce those images. EX1003, ¶134. Specifically, whereas Fuhse847 discloses methods for preparing micromirror arrays according to digital images that require computing and software, Rich provides further explicit detail for how to implement software running on processors of computer systems in order to do, thus, it would have been obvious for a POSITA to combine Fuhse847 and Rich. EX1003, ¶¶135-36.

Additionally, using Rich's teachings regarding software running on processors of computer systems in Fuhse847's system would have involved using a known technique to improve Fuhse847 in a known way, without unpredictable results, and would thus also have been obvious. EX1003, ¶137.

b. Reasonable Expectation of Success

A POSITA would have had a reasonable expectation of success in implementing the combination. EX1003, ¶¶138-42. Here, the art was relatively predictable in the relevant timeframe (2015), as software methods for micro-optic design were mature and known to work well before 2015. EX1003, ¶¶138-42. The number of tools in the art to implement micro-optic design using software were abundant due to their necessity in producing devices with arrays of optical elements, and accordingly, POSITAs were well accustomed to using them. EX1003, ¶¶140-42. A POSITA would have been able to implement the obviousness modifications in this ground without difficulty. EX1003, ¶¶140-42.

3. Application to the Challenged Claims

Fuhse847 in view of Rich teaches the limitations of claim 1.

4. Claim 1

a. [1Pre]⁵

The preamble is not limiting, because it “only [] state[s] a purpose or intended use for the invention.” EX1003, ¶145. *Catalina Mktg. Int’l, Inc. v. Coolsavings.com, Inc.*, 289 F.3d 801, 808 (Fed. Cir. 2002).

Further, no preamble term provides antecedent basis. EX1003, ¶146.

⁵ Refer to the Claims Appendix for the corresponding element.

Regardless, Fuhse847 teaches the preamble. Fuhse847's teaches "a method for manufacturing such a depiction element" (**[a] method of fabricating a security element**) "[f]or security applications." EX1022, 4-5, 9-10. The depiction element is for a "data carrier" and "[t]he data carrier can in particular be a value document," such as a "paper banknote." EX1022, 11, FIG. 1; EX1003, ¶¶147-48.

Accordingly, Fuhse847 renders obvious [1Pre]. EX1003, ¶¶145-48.

b. [1a]:

Fuhse847 teaches element [1a].

Fuhse847 teaches **assigning a first object in a starting digital image to a first image display**. Fuhse847 teaches "a body" (**a first object**) that may represent a certain motif, such as a two-dimensional or three-dimensional motif, as discussed below. EX1022, 10-11, 4, 7, 9; EX1003, ¶¶150-51.

This body satisfies **a starting digital image** in several ways. EX1003, ¶¶152-55. *First*, the body may be provided in 3D-CAD, which was a well-known computer program that provided digital images. EX1022, 10-11; EX1003, ¶153. *Second*, the body may be depicted in "computer-aided technical drawing," which is another example of **a starting digital image**. EX1022, 10; EX1003, ¶154. *Third*, the body may be depicted "through 3D laser scanning of real three-dimensional bodies."

EX1022, 10; EX1003, ¶155. Each of these three examples independently satisfy a **starting digital image**.

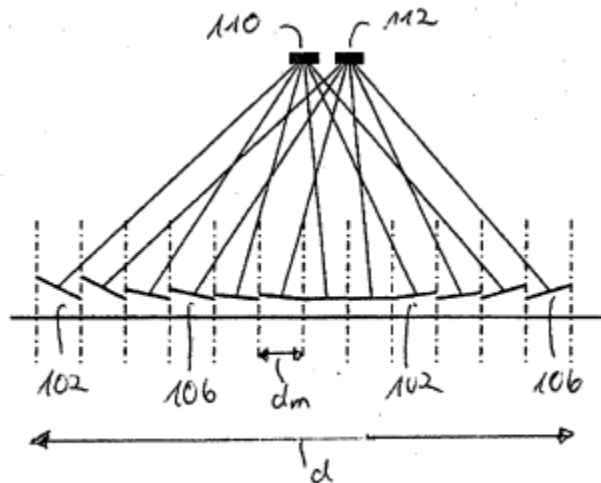
Fuhse847 teaches **assigning** the body in the starting digital image **to a first image display plane**. This is performed by defining “light spots” for every point in the digital image in data sets, which correspond to image points P_j in the **first image display plane**. EX1022, 9-10, 28; EX1003, ¶156.

Specifically, Fuhse847 teaches methods for defining “light spots” for each digital image in “a data set which describes the surface of the body.” EX1022, 10. As Fuhse847 explains, a “body is depicted by floating light spots” using data sets that include information such as the points in space, normal vectors, colors, brightness, etc. of every light point. *Id.*; EX1003, ¶¶157-62. The data sets can be in formats such as VRML, STL, 3D-CAD, or point cloud format. *Id.* These tools were well-known tools for preparing data sets that describe 2-D/3-D digital images with such data. EX1003, ¶¶157-62.

A **first image display plane** is defined when producing a floating two-dimensional image in a plane where all “the light spots of the light-spot image” float “at the same floating height above or below the surface.” EX1022, 5, 16. As discussed further below, Fuhse847 makes clear the image is in an **image display plane** in multiple ways. EX1003, ¶¶162-65.

A two-dimensional image in a plane is simply a three-dimensional image with a small or zero thickness. For example, the surface of the substrate defines a “xy plane” with $z=0$. EX1022, 27-28, 24-25. By teaching any arbitrary three-dimensional image in space (*i.e.*, x, y, z) can be constructed of light points, it is obvious that a two-dimensional image in a plane can be constructed by simply fixing the height (z) values of the pixels, provided the x - y plane is the plane of the surface of the substrate. EX1003, ¶¶165-69.

Moreover, Fuhse847 explicitly teaches that a two dimensional image plane may be formed by fixing the height (z) values of the pixels, teaching that “all light spots in the light-spot image have the same floating height.” EX1022, 16, 5. In fact, Fuhse847 refers to the resulting image as “a two-dimensional motif,” such as “a font or a logo.” EX1022, 5, 7, 26. For example, the given fixed height of the two-dimensional motif (*e.g.*, $z = z_1$), the image is in an **image display plane** defined by (x, y, z_1). EX1003, ¶¶170-71. Figure 9(b) shows an example of “two closely adjacent light spots” 110 and 112 (two pixels) formed at the same height:



(b) Fig. 9

EX1022, 13, 20-21, FIG. 9(b).

Fuhse847 teaches assigning... **a second object in the starting digital image to a second image display plane.** Other than being in a **second image display plane**, **a second object in the starting digital image** has only the same requirements of the **first object in a starting digital image**, and is therefore satisfied by the same teachings discussed above. EX1003, ¶173. Fuhse847 teaches producing multiple images, including “a light-spot image A” and “a light-spot image B,” which are each images according to the teachings discussed. EX1022, 25-27. As discussed, Fuhse847 teaches “two-dimensional” images such as “a font or a logo” (*see* EX1022, 5, 7, 26), and that “several” images may be produced. EX1022, 26. EX1003, ¶174.

Fuhse847 also teaches that the two images may be in different planes (*e.g.*, “foreground” and “background”). *See* EX1022, 9-10, 26, 27-28. EX1003, ¶175.

A POSITA would have understood that the second image is from a **second object in the starting digital image**. EX1003, ¶176. For example, in the case that the two images are two different “two-dimensional” images such as “a font or a logo” (*see* EX1022, 5, 7, 26), they represent two different objects. A POSITA would have further understood that they were both provided in the same **starting digital image**. For example, it was well-known that formats like 3D-CAD, “computer-aided technical drawing,” and “3D laser scanning of real three-dimensional bodies” could provide multiple objects in their images. EX1003, ¶176.

To the extent it could be argued that Fuhse847 only explicitly discloses a three-dimensional image in the foreground of a two-dimensional image (*see* 26), it would have been obvious to provide two two-dimensional images. EX1003, ¶177. A POSITA would understand that a two-dimensional image in an image plane can be constructed by fixing the height (z) values of the pixels. EX1003, ¶¶177, 169, 165. Based on Fuhse847’s teachings that multiple images may be created in the foreground and background of each other, and that images may be two-dimensional, a POSITA would have understood to provide two two-dimensional image planes at different heights (*i.e.*, in different planes). EX1003, ¶177.

Accordingly, Fuhse847 renders obvious element [1a]. EX1003, ¶¶149-78.

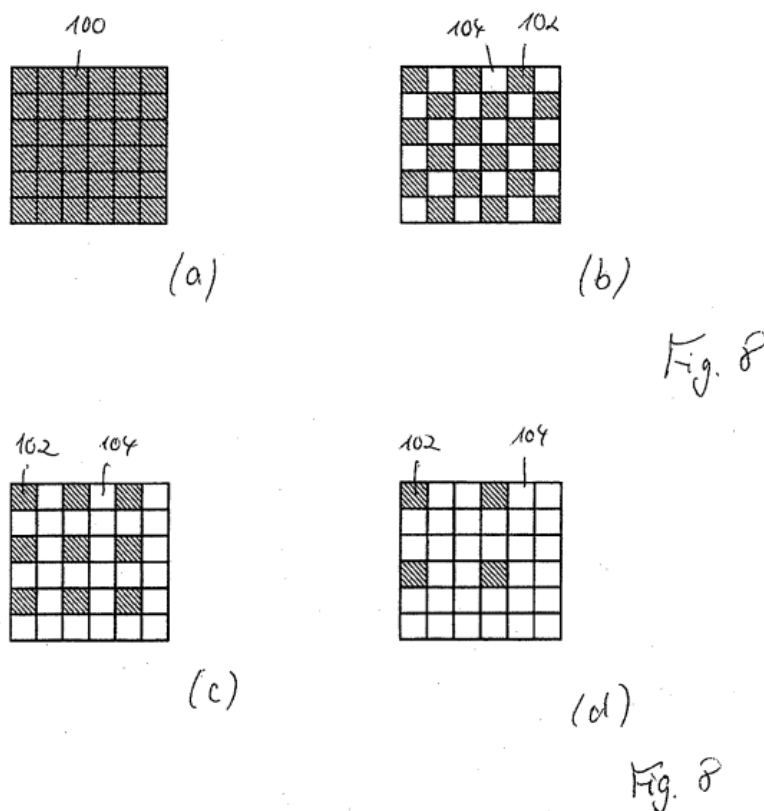
c. [1b]:

Fuhse847 in view of Rich teaches element [1b].

After defining each image points P_j corresponding to light spots in the two-dimensional image, Fuhse847 teaches **to select a set of micro mirrors in an array of the micro mirrors to display each of the pixels of the first object in the first image display plane.** EX1003, ¶180.

(i) Micromirrors

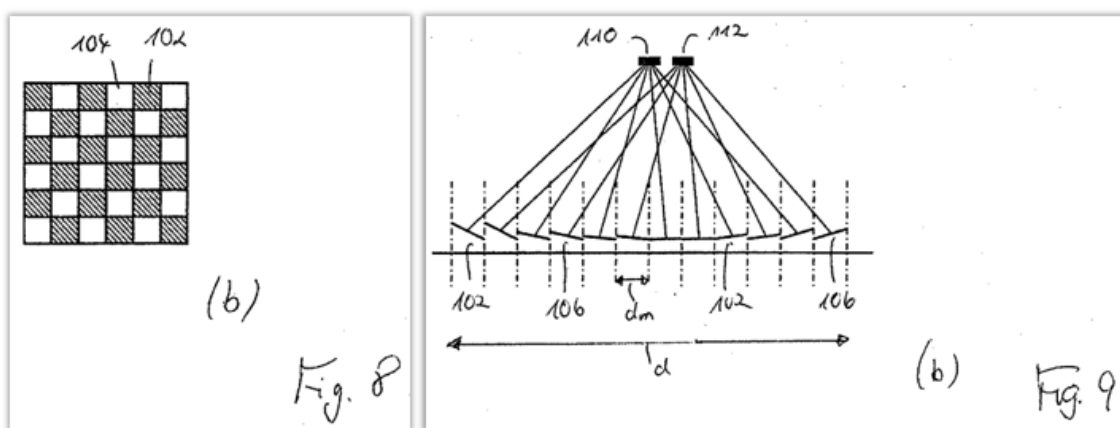
Fuhse847 teaches **an array of the micro mirrors** in the form of an arrangement of $n \times n$ micromirrors (“plurality of micromirrors”) on the surface of the substrate. EX1022, 14-15, 5, 7-8, 19-21 (describing the “checkerboard-like arrangement”). Figure 8 (Figures 8(a)-8(d)) and supporting disclosure provides further detail of the **array of micro mirrors** in the form of “an arrangement of $n \times n$ micromirrors 100.” EX1022, 14-15, 5, 7-8, 19-21. EX1003, ¶¶181-82.



EX1022, FIGs. 8(a)-8(d).

Fuhse847 teaches **to select a set of micro mirrors in** Fushe847's arrangement of micromirrors **to display each of the pixels of the first object in the first image display plane.** EX1003, ¶183. Fuhse847 discloses that **the array of micro mirrors includes for each of the pixels a different set of the micro mirrors.** EX1022, 6, 9-10, 19-21. Fuhse847 explains that for every light spot in the image, “a plurality of optical elements is assigned to every light spot,” such that “groups of optical elements” “are each assigned to different light spots” **(to select a set of micro mirrors... to display each of the pixels of the first object / second object in the first**

/ **second image display plane**). EX1022, 6. Fuhse847 does so by defining “a number of fine fields” “for every image point P_j ,” (**each of the pixels**),⁶ and providing that the optical elements in those fine fields (**a set of the micro mirrors**) “contribute to producing the light spot that corresponds to image point P_j ” (**to display each of the pixels of the first object / second object in the first / second image display plane**). EX1022, 9-10, 27-28. Figures 8 and 9 below depict micromirror arrays where the shaded micromirrors 102 form one set for a pixel and the white micromirrors 106” form a second set for another pixel. EX1003, ¶¶184-86.



EX1022, FIGs. 8(b) and 9(b).

(ii) Processing / computing device

Fuhse847 in view of Rich render obvious that this selection is done using a **processor of a computing device, executing code to provide an array design**

⁶ The term “each of the pixels” appears to antecedent basis.

module. EX1003, ¶187. In the '863 Patent, processor 610 is a conventional processor that runs software that is described functionally. EX1003, ¶¶188-91.

A POSITA would have understood that operations using these data files (which Fuhse⁸⁴⁷ teaches are on a computer), such as assigning micro mirrors to the light points and determining the angular orientation, are performed on **a processor of a computing device by executing code** of software (such as **an array design module**). EX1022, 9-11; EX1003, ¶¶192-93.

Rich discloses such tasks, such as the converting of input image to a data file 340 that defines the micro-mirror array for fabrication, are performed on **a processor of a computing device by executing code** of software (such as **an array design module**). EX1003, ¶¶194-96. Rich discloses processor 330 (**a processor of a computing device**) running a main program 325 (**an array design module**). Processor 330 (red) and main program 325 (green) are shown below in Figure 2B.

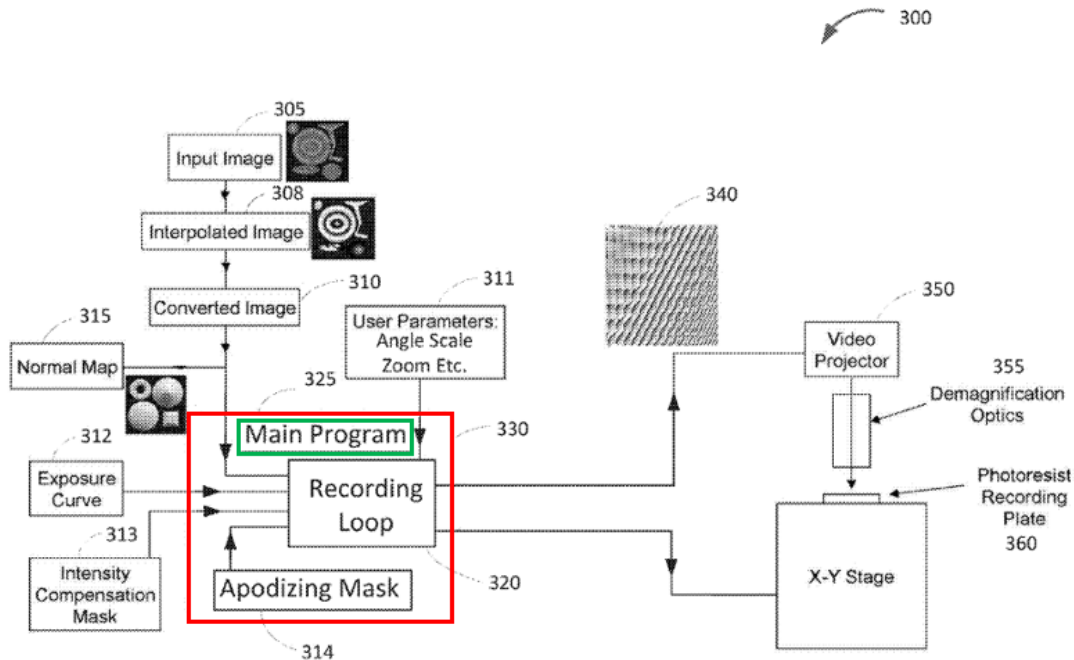


FIG. 2B

Rich, FIG. 2B (annotated); EX1003, ¶197.

Processor 330 (**a processor of a computing device**) running a main program 325 (**an array design module**) takes the input image file (describing the image), and uses it “to determine the pattern of the features $F_1, F_2, \dots, F_n$ on the surface 12 of the master 10.” Rich, 1:16-23, 2:9-12, 5:20-35, 16:33-17:7, FIG. 1A; EX1003, ¶¶197-208.

Accordingly, Fuhse847 in view of Rich renders obvious element [1b]. EX1003, ¶¶179-208.

d. [1c]:

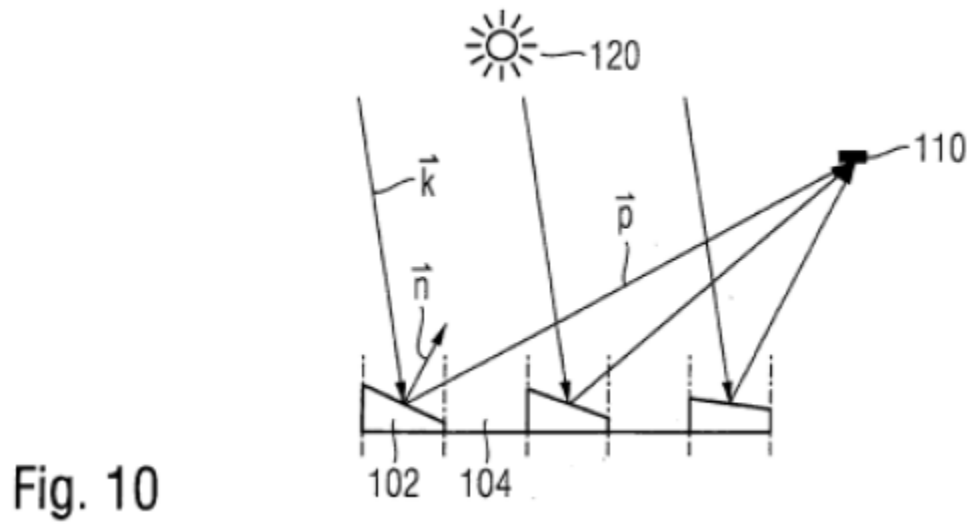
Fuhse847 in view of Rich teaches element [1c].

Fuhse847 teaches **for each of the pixels, determining ... an angular orientation of each of the micro mirrors in the selected sets of the micro mirrors.**

Fuhse847 discloses how to calculate angular orientations of its micromirror surfaces with respect to Figure 10 and corresponding disclosures. EX1022, 19-23. Fuhse847 explains that “[t]he position of the mirror surfaces, i.e. the normal vector $\vec{n}$, is to be determined in such a way that the light incident from a specified direction $\vec{k}$ is reflected onto the focal point (x_0, y_0, z_0) for all micromirrors 102 assigned to light spot 110,” the following equations are used to define the normal vector $\vec{n}$ (**an angular orientation of each of the micro mirrors in the selected sets of the micro mirrors**), incident light $\vec{k}$, and reflected light ray $\vec{p}$ **for each of the pixels**:

$$\vec{n} = \frac{\frac{\vec{p}}{|\vec{p}|} - \frac{\vec{k}}{|\vec{k}|}}{\left| \frac{\vec{p}}{|\vec{p}|} - \frac{\vec{k}}{|\vec{k}|} \right|}, \quad \vec{p} = \begin{pmatrix} x_0 - x \\ y_0 - y \\ z_0 \end{pmatrix}, \quad |\vec{p}| = \sqrt{(x_0 - x)^2 + (y_0 - y)^2 + z_0^2}$$

EX1022, 21-22. EX1003, ¶¶210-11. Thus, the normal vector $\vec{n}$ of the micromirrors is oriented such that reflected light ray $\vec{p}$ is directed towards the point (x_0, y_0, z_0) corresponding to one of the pixels. These vectors are shown in Figure 10:



EX1022, FIG. 10; EX1003, ¶212. Claim 2 requires that “the angular orientation is defined by coordinates of a normal vector from a reflective surface,” meaning that such a normal vector is within the scope of “an angular orientation” for claim 1.

Fuhse847 in view of Rich render obvious that this determination is **with the array design module**. Using the method of FIG. 2B, Rich’s processor 330 (**a processor of a computing device**) running a main program 325 (**an array design module**) computes the “orientation” of each micromirror. Rich, 16:33-17:7; EX1003, ¶¶214-15.

As shown in Figure 1C, and just as in the ’863 Patent and in Fuhse847, this orientation includes two rotation axes: an azimuth angle ϕ and a polar angle θ .

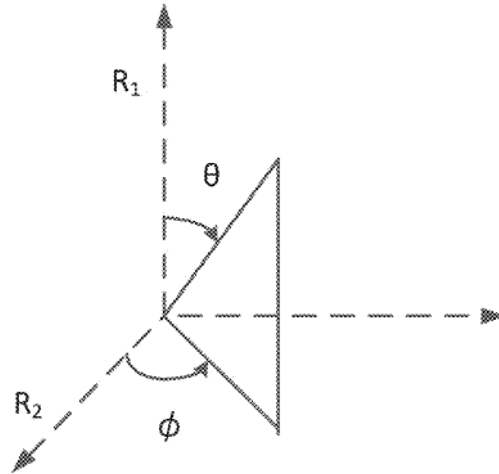


FIG. 1C

Rich, 12:57-61, 13:18-44, FIG. 1C; EX1003, ¶216.

In the combined system of Fuhse847 and Rich, it would have been obvious for Rich's processor 330 (**a processor of a computing device**) running a main program 325 (**an array design module**) to compute the orientation calculations provided by Fuhse847. EX1003, ¶217.

Accordingly, Fuhse847 in view of Rich renders obvious element [1c]. EX1003, ¶¶209-18.

e. [1d]:

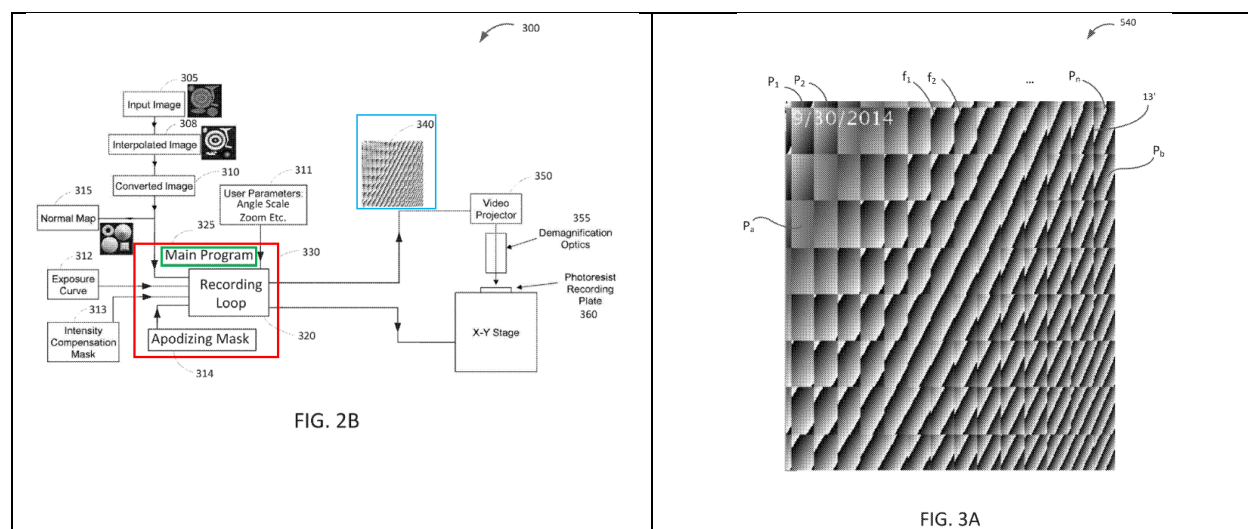
Fuhse847 in view of Rich teaches element [1d].

Rich teaches generating a **design output file** in the form of a data file 340. Data file 340 **includ[es]** the “orientation of the features” (**the angular orientation...**

for each of the micro mirrors in the selected sets of the micro mirrors), as discussed above in element [1c]. Data file 340 includ[es] the location coordinates in the array for each of the micro mirrors in the selected sets of the micro mirrors.

As Rich explains, the data file includes the “plurality of portions,” and is “a map to generate the pattern of features $F_1, F_2, \dots F_n$ on the surface 12 of the master 10.” Rich, 16:57-17:7; EX1003, ¶¶220-23.

As Rich further explains, “[t]he data file can provide the pattern of the features $F_1, F_2, \dots F_n$ on the surface 12 of the master 10” (see 15:33-35), and “[t]he pixels of the data file 340 can also correspond to one or more portions $P_1, P_2, \dots P_n$ of the surface 12 of the master 10.” Rich, 17:15-17, 16:57-17:7; EX1003, ¶¶224-27.



Rich, FIG. 2B (annotated) (showing generated data file 340 (blue) (design output file)), FIG. 3A (same), 17:6-7, 17:51-18:3; EX1003, ¶¶224-27.

Accordingly, Fuhse847 in view of Rich renders obvious element [1d].
EX1003, ¶¶219-28.

f. [1e]:

Fuhse847 in view of Rich teaches element [1e]. Rich teaches **forming the array of the micro mirrors according to the design output file** because it teaches “manufacturing the master based at least in part on the 2D data file.” Rich, 2:38-40, 15:45-48; EX1003, ¶230. As summarized in Figure 2, the “data file 340 can be used... to generate the pattern of features $F_1, F_2, \dots F_n$ on the surface 12 of the master 10,” and photolithography is “used to produce the pattern of features $F_1, F_2, \dots F_n$ in a light sensitive material, *e.g.*, a photoresist.” Rich, 17:4-7, 18:8-24.

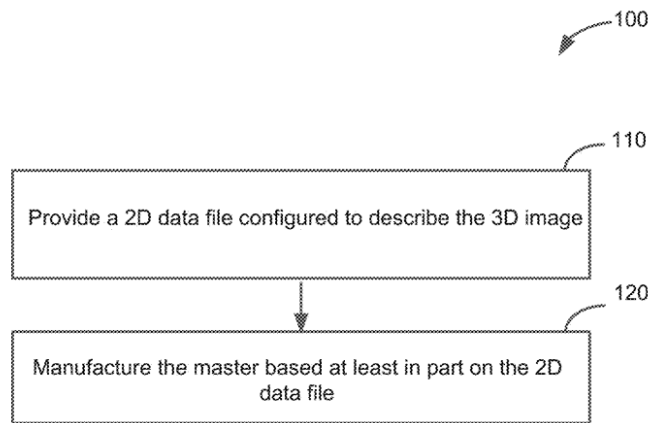


FIG. 2

Rich, FIG. 2. This is shown in Figure 2B, with the forming of the micro mirrors (purple) according to the data file (blue):

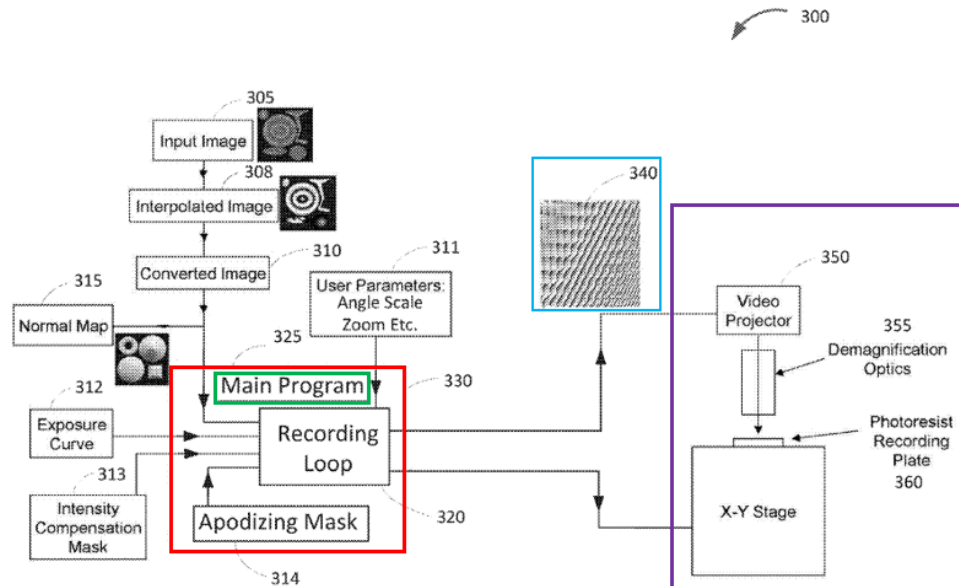


FIG. 2B

Rich, FIG. 2B (annotated); EX1003, ¶¶231-33.

As discussed above, just like Rich, the '863 Patent teaches that the computer-implemented process is used to create the master shim, which is then used to mass-produce security element end-product. *See* '863 Patent, 16:1-29. To the extent that **the array of the micro mirrors** in the limitation **forming the array of the micro mirrors according to the design output file** means the security element end-product, then Rich teaches that in the same way as the '863 Patent. EX1003, ¶¶234-35. In other words, because “the master 10 can be used to fabricate an optical product 10’,” Rich teaches **forming the array of the micro mirrors** (of end product optical product 10’) **according to the design output file** because the data file is used to

produce the master, and the master is used to produce **the array of the micro mirrors** of end product optical product 10’.

Fuhse847 in view of Rich therefore teaches element [1e]. EX1003, ¶¶229-37.

5. Dependent Claims from Claim 1

a. Claim 2:

Fuhse847 renders obvious this claim. *See, supra*, Section VII.A.4.d ([1c]).

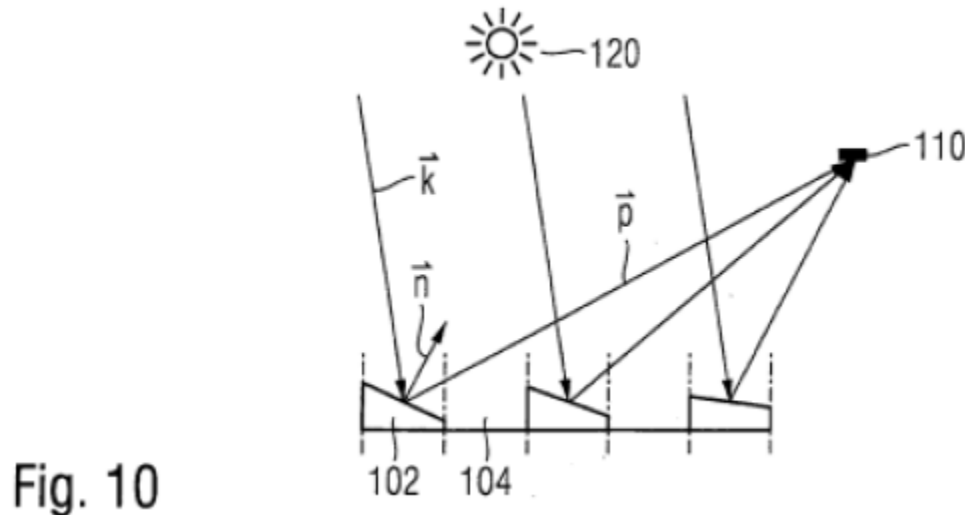
Fuhse847 discloses how to calculate angular orientations of its micromirror surfaces with respect to Figure 10 and corresponding disclosures. EX1022, 21-23, 19. In particular, Fuhse847 explains that “[t]he position of the mirror surfaces [**a reflective surface of each of the micro mirrors**], i.e. the normal vector $\vec{n}$ [**coordinates of a normal vector**], is to be determined in such a way that the light incident from a specified direction $\vec{k}$ is reflected onto the focal point (x_0, y_0, z_0) for all micro-mirrors 102 assigned to light spot 110 [**directing light to one of the pixels**],” the following equations are used to define the normal vector $\vec{n}$, incident light $\vec{k}$, and reflected light ray $\vec{p}$ for each of the **pixels**:

$$\vec{n} = \frac{\frac{\vec{p}}{|\vec{p}|} - \frac{\vec{k}}{|\vec{k}|}}{\left| \frac{\vec{p}}{|\vec{p}|} - \frac{\vec{k}}{|\vec{k}|} \right|}, \quad \vec{p} = \begin{pmatrix} x_0 - x \\ y_0 - y \\ z_0 \end{pmatrix}, \quad |\vec{p}| = \sqrt{(x_0 - x)^2 + (y_0 - y)^2 + z_0^2}$$

EX1022, 21-22; EX1003, ¶239.

In other words, the normal vector $\vec{n}$ of the micromirrors such that reflected light ray $\vec{p}$ is directed towards the point (x_0, y_0, z_0) corresponding to one of the pixels.

EX1022, 21-22. These vectors are shown in Figure 10:



EX1022, FIG. 10; EX1003, ¶240.

b. Claim 4:

Fuhse847 renders obvious this claim.

Fuhse847 teaches that “every image point P_j ,” (every **pixel**, including **one of the pixels on the first or second image display planes**) **coinciding with coordinates of a “cone originating from” or “emanating from” the image point (an apex of the cone)**. EX1022, 9-10, 28. Each pixel is at “the intersection” of the emanating cone, which defines the apex. EX1003, ¶¶241-42.

c. Claim 5:

Fuhse847 renders obvious this claim.

As discussed, Fuhse847 discloses how to calculate angular orientations of its micromirror surfaces with respect to Figure 10 and corresponding disclosures. EX1022, 21-23, 19. In these calculations, (x_0, y_0, z_0) “denotes the position of” every light spot, meaning z_0 is the height of the image display plane for each pixel (including **heights of the first and second image display**). EX1022, 21-22; EX1003, ¶¶ 244-45.

As discussed, **the angular orientations are calculated** based on the normal vector $\vec{n}$ for all micromirrors assigned to the light spot 110:

$$\vec{n} = \frac{\frac{\vec{p}}{|\vec{p}|} - \frac{\vec{k}}{|\vec{k}|}}{\left| \frac{\vec{p}}{|\vec{p}|} - \frac{\vec{k}}{|\vec{k}|} \right|}, \quad \vec{p} = \begin{pmatrix} x_0 - x \\ y_0 - y \\ z_0 \end{pmatrix}, \quad |\vec{p}| = \sqrt{(x_0 - x)^2 + (y_0 - y)^2 + z_0^2}$$

EX1022, 21-22. As can be seen in the equations, the normal vector $\vec{n}$ is **calculated based on** $\vec{p}$ and $|\vec{p}|$, which both are both **calculated based on** z_0 . EX1022, 21-22; EX1003, ¶¶ 246-47.

d. Claim 6:

Fuhse847 renders obvious this claim.

Fuhse847 teaches that “different images become visible to the viewer from different directions.” EX1022, 25 (“When tilted to the side, the security element should show an image change from a light-spot image A to a light-spot image B.”),

7. In other words, light-spot image A (in **the first image display plane**) is viewable from a certain angle, and an “image change” to light-spot image B (in **the second image display plane**) occurs when “tilted to the side.” As discussed under element [1c] (*see, supra*, Section VII.A.4.d ([1c])), the **angular orientations are calculated** to reflect light to the assigned pixel (forming part of light-spot image A or B); EX1003, ¶¶248-50.

Fuhse847 further teaches a **predefined angular offset** in the two viewing angles by providing the ability “to separate the light-spot images of a changing image.” EX1022, 5. For example, Fuhse847 teaches “the size of the visibility range can be set as desired,” including between “three light-spot images A, B, C to change when tilted vertically.” EX1022, 26. When chosen such that light-spot image A (in **the first image display plane**) is viewable from a certain angle (**a first viewing angle**), and light-spot image B (in **the second image display plane**) is viewable from another certain angle, with a third image viewable at an angle between those images, the **predefined angular offset** would be understood to be **least 10 degrees**. At least 10 degrees would be needed to be provided to the third image. EX1003, ¶251.

Further, before the relevant time, micro mirror devices had the known advantage of providing a large separation between images compared to other types of optical security devices known in the art. EX1003, ¶252 (citing EX1042, 164).

6. Claim 12

Fuhse847 teaches claim 12, as detailed below.

a. [12Pre]:

The preamble is not limiting. The preamble merely states what the invention is “useful on” (*see* EX1003, ¶255), and preambles that “only to state a purpose or intended use for the invention” are not limiting. *Catalina Mktg.*, 289 F.3d at 808.

Further, no preamble term provides antecedent basis to terms in the claim body, so the preamble does not contribute to the structural completeness of the claim body. EX1003, ¶256.

To the extent the preamble is limiting, Fuhse847 teaches the preamble. EX1022, 4-5, 11, FIG. 1. *See, supra*, Section VII.A.4.a [1Pre] (“A method of fabricating a security element”). The security element is **useful on paper and coin currency and on product labels**. The depiction element has “security applications” for a “data carrier,” and “[t]he data carrier can in particular be a value document,” such as a “paper banknote” (**paper... currency**). EX1022, 11, 4-5, FIG. 1. A POSITA would understand that “data carriers” includes **coin currency** and **product labels**. EX1003, ¶¶257-62.

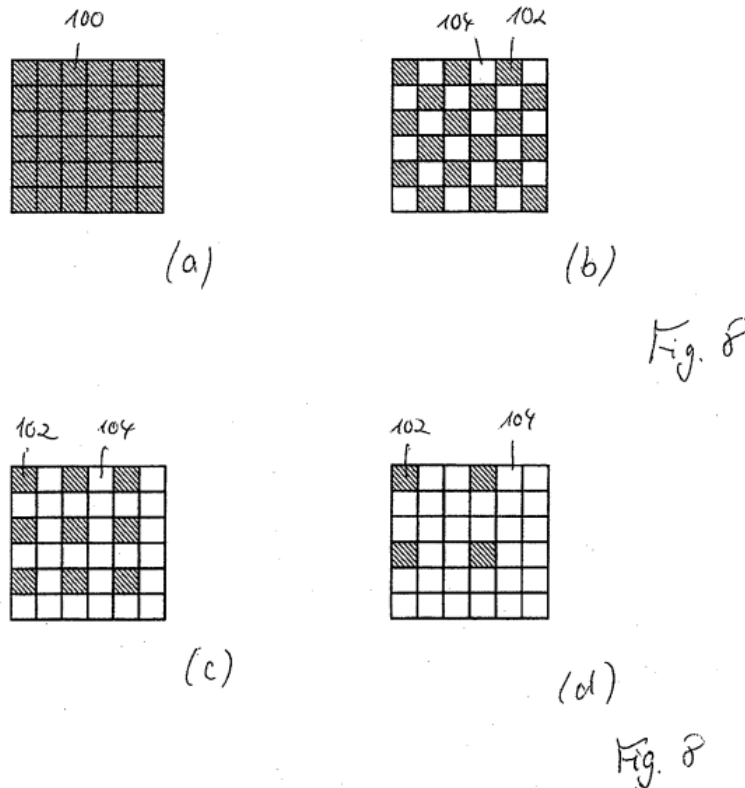
b. [12a]:

Fuhse847 in view of Rich renders obvious the limitation. *See, supra*, Section VII.A.4.c ([1b]). Fuhse847 teaches **a substrate**, such as substrate 22, shown annotated in blue in the below reproduction of Figure 2. EX1022, Abstract, 4, 9, 13-14, 24-25. The surface of the substrate defines a “xy plane” or “substrate plane” ($z=0$). EX1022, 28, 24-25. EX1003, ¶¶263-66.

Fuhse847’s substrate has “a surface region” (**on a surface of the substrate**) “in which a plurality of optical elements are arranged.” *See* EX1022, 4, 9, 13-14, 24-25. The optical elements may be “plurality of micromirrors” (**an array of micro mirrors**) “distributed over a certain surface region of substrate 22” (**on a surface of the substrate**). EX1022, 14, 5, 7-8, 19-21; EX1003, ¶266.

Figure 8(a)-(d) and supporting disclosure provides further detail of the **array of micro mirrors** in the form of “an arrangement of $n \times n$ micromirrors 100, which are arranged next to one another without any distance between them in the surface of the security element.” EX1022, 14, 5, 7-8, 19-21 (describing a “checkerboard-like arrangement”). Specifically, the curved mirrors of Figure 2 are “replaced by” the plurality of flat micromirrors 100 because they are “easier to calculate and produce,” which would have been an obvious modification (*see, supra*, VII.A.1)

EX1022, 19. This ordered arrangement of micromirrors 100 is **an array**. EX1003, ¶267.



EX1022, FIGs. 8(a)-8(d).

As discussed in Ground 1, element [1b], Rich teaches **a processor of a computing device, executing code to provide an array design module**. *See, supra*, Section VII.A.4.c ([1b]). Rich also teaches an **array of micro mirrors**. As Rich explains, Rich's master and corresponding optical product have arrays of micro mirrors with similar dimensions to that of Fuhse847 and the '863 patent. Rich, 5:24-

35; EX1003, ¶¶268-69. An example of Rich’s array of micro mirrors is further shown in FIG. 1B.

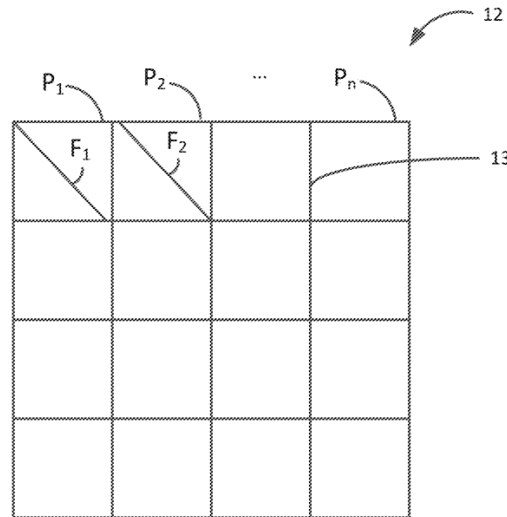


FIG. 1B

Rich, 10:44-50, FIG. 1B; EX1003, ¶270.

It would have been obvious from Fuhse847 in view of Rich that Rich’s **processor of a computing device, executing code to provide an array design module** would **define** the array of micro mirrors to be formed on a surface of a substrate. EX1003, ¶271. Rich explains that the array is **defined**, explaining that “[t]he number of cells is not particularly limited and can depend on factors such as size and resolution of the image to be reproduced.” Rich, 10:37-39. Accordingly, in the previously discussed method of FIG. 2B of Rich (see Ground 1, element [1b], performed by the **processor of a computing device, executing code to provide an array design module**), array is **define[d]** through the process of receiving input

images and translating them into data files that are a “map” for the lithographic tools to produce the array of micro mirrors. *See* Rich, 16:33-17; EX1003, ¶272.

c. [12b]:

Fuhse847 in view of Rich renders obvious the limitation. *See, supra*, Section VII.A.4.e (Ground 1, element [1d]). EX1003, ¶273.

d. [12c]:

Fuhse847 in view of Rich renders obvious the limitation. *See, supra*, Section VII.A.4.f (Ground 1, element [1e]). EX1003, ¶274.

e. [12.d], [12.e]:

Fuhse847 teaches ([12d] and [12.e]). Fuhse847’s micromirrors **receiv[e] ambient light**, such as from “sunlight or a ceiling lamp,” and are “illuminated.” EX1022, 18-20. Hence, the illumination is with **ambient light** that is **receiv[ed]** by the **array of micro mirrors when formed on the surface of the substrate**, as shown in Fuhse847 Fig. 2 below (depicting the sun which is ambient light) and combined with the Figs. 8-10 embodiment. EX1022, 13-14; *see, supra*, Section VII.A.6.b (for **array of micro mirrors when formed on the surface of the substrate**).



EX1022, FIG. 2 (annotated), 14-15, *see also* 8 (distinguishing “normal illumination” “visible to the naked eye” with “directed illumination”); EX1003, ¶¶46, 276-77.

In response to illumination, Fuhse847 produces a light-spot image (**displaying an image** which **comprises a plurality of pixels**) that floats (with all light spots in the image at the “same height”, meaning they are in a plane). Fuhse847, pp. 26, 8, 5. That image in the plane is above the surface region of the substrate (**a distance apart from the surface of the substrate**). EX1003, ¶278.

The image is **in a plane**. EX1003, ¶¶279, 284-88. *First*, a POSITA would understand that a floating two-dimensional image in space is in a plane based on Fuhse847's teaching. EX1022, 16, 5, 7, 26; EX1003, ¶¶279, 286-88. *Second*, for a 3D image, a POSITA would understand that planed images are within this teaching

because a two-dimensional plane is a three-dimensional space with one dimension fixed. EX1022, pp. 4-5, 9-10; EX1003, ¶¶279, 285.

Accordingly, Fuhse847 renders obvious elements [12.d] and [12.e]. EX1003, ¶¶275-89.

f. [12.f]:

Fuhse847 renders obvious this limitation.

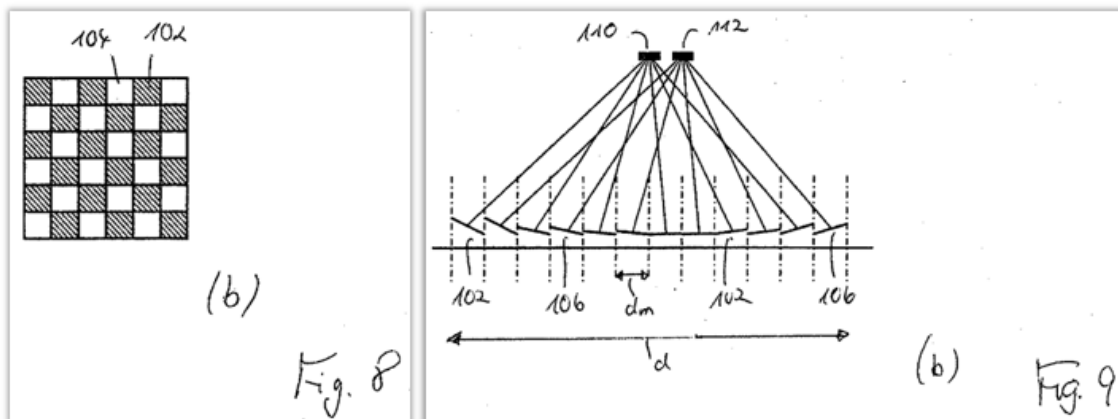
Fuhse847 describes an assignment system to assign micromirrors to light spots (**pixels**) in which each pixel is assigned a “group” of micromirrors, such that each micromirror is assigned to at most one pixel. Figure 10 and its descriptions teach how to properly orient each micromirror to reflect light to its assigned pixel. The micromirrors are fixed in the xy-plane (i.e., **the substrate surface plane**), and each of the x and y axes are rotation axes by which the bodies of the micromirrors are oriented to properly reflect light to the assigned pixel. EX1003, ¶291.

Fuhse847 discloses that **the array of micro mirrors includes for each of the pixels a different set of the micro mirrors**. EX1022, 6, 9-10, 19-21. Fuhse847 explains that “a plurality of optical elements is assigned to every light spot” (**for each of the pixels a different set of the micro mirrors**), such that “groups of optical elements” “are each assigned to different light spots.” EX1022, 6 (emphasis added). Fuhse847 does so by defining “a number of fine fields” “for every image point P_j ,”

(**each of the pixels**), and providing that the optical elements in those fine fields (**a different set of the micro mirrors**) “contribute to producing the light spot that corresponds to image point P_j .” EX1022, 9-10, 28. EX1003, ¶292.

In the example of FIG. 8b, (shaded) micromirrors 102 form a set **of micro mirrors**, and (white) “fields 104 [] covered with micromirrors 106” form a second **set of micro mirrors**, and the sets are different because they comprise different micromirrors. EX1022, 20-21. In other words, each micromirror is assigned to a single light spot. No micromirrors are shared with multiple light spots. Thus, the set of micromirrors for each light spot contains a unique set of micromirrors. EX1003, ¶293.

As shown in Figure 9(b), “[m]icromirrors 102 form a group of micromirrors, which are all assigned to the same light spot 110 and produce it together when illuminated,” while micromirrors 106 “serve to produce a light spot 112,” meaning a **different set of the micro mirrors is assigned for each of the pixels**. *Id.* Fuhse⁸⁴⁷ states that in the “[t]he number $n \times n$ of micromirrors is, for example, 10×10 ,” (totaling 100) meaning that in FIG. 8(b), each **set of micro mirrors** would have 50 micromirrors. EX1022, 19-20.



EX1022, FIGs. 8(b) and 9(b); EX1003, ¶294.

Fuhse847 discloses that **the micro mirrors each having a reflective surface oriented... to reflect the ambient light toward a point on the plane corresponding to one of the pixels**. Fuhse847 discloses that its micromirrors may be “purely reflective.” EX1022, 4-5, 9-10, 14-15. In particular, Fuhse847 discloses that “the flat mirror surfaces of the micromirrors” “reflect[]” incident light (**the micro mirrors each having a reflective surface**). EX1022, 21-22. For each of the pixels, the micromirror surfaces reflect incident light (**reflect the ambient light**), such as light source 120, **towards** the point (x_0, y_0, z_0) , which “denotes the position of light spot 110” (**a point on the plane corresponding to one of the pixels**). EX1022, 21-22; EX1003, ¶295.

Fuhse847 discloses that such orientation is **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**. EX1022, 21-23. As an initial matter,

Fuhse847's orientation of all its mirrors is **in a fixed manner** because each one has one permanent orientation (normal vector $\vec{n}$, as discussed below is fixed). Micro-mirrors for security elements on, for example, currency, are generally manufactured with a particular orientation to produce a particular image, and generally are not variably controlled. EX1003, ¶296.

Fuhse847 further teaches that its micromirrors are produced by embossing a lacquer layer and providing a metallized coating on top to increase reflectivity. Fuhse847, 8-9. The structure of the micromirrors (including the orientation of the mirrored surface) would be **fixed** upon embossing and metallization. EX1003, ¶¶297-99.

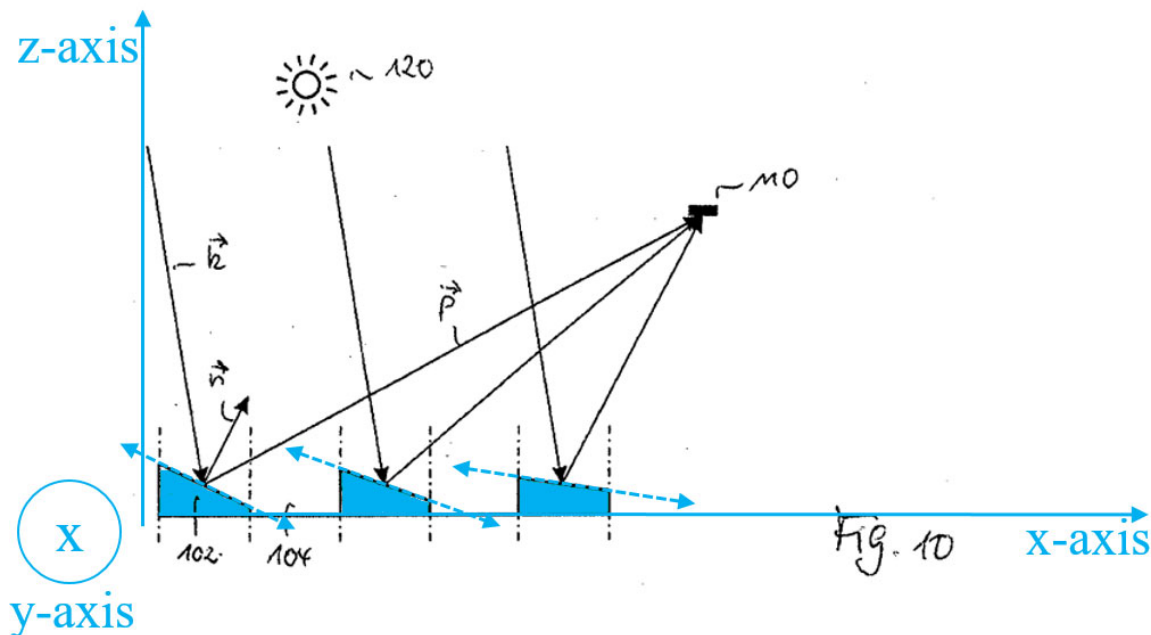
Fuhse847 discloses how to calculate orientations of its flat micromirror surfaces with respect to Figure 10 and corresponding disclosures. *Id.* In particular, Fuhse847 explains that “[t]he position of the mirror surfaces, i.e. the normal vector n , is to be determined in such a way that the light incident from a specified direction $k \rightarrow$ is reflected onto the focal point (x_0, y_0, z_0) for all micromirrors 102 assigned to light spot 110,” the following equations are used to define the normal vector n , incident light k , and reflected light ray p (these vectors are shown in FIG. 10):

$$\vec{n} = \frac{\frac{\vec{p}}{|\vec{p}|} - \frac{\vec{k}}{|\vec{k}|}}{\left\| \frac{\vec{p}}{|\vec{p}|} - \frac{\vec{k}}{|\vec{k}|} \right\|}, \quad \vec{p} = \begin{pmatrix} x_0 - x \\ y_0 - y \\ z_0 \end{pmatrix}, \quad |\vec{p}| = \sqrt{(x_0 - x)^2 + (y_0 - y)^2 + z_0^2}$$

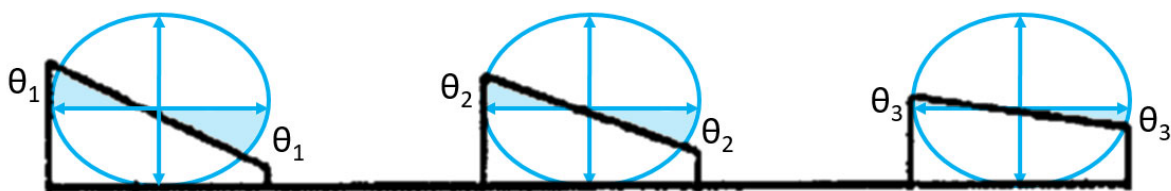
EX1022, 21-22; EX1003, ¶300.

The x and y axes are **first and second rotation axes**, such that **a body of each of the micro mirrors rotated about at least one of first and second rotation axes extending through the body** in order to align the normal vector n of the micro-mirrors such that reflected light ray p is directed towards the point (x_0, y_0, z_0) corresponding to one of the pixels. In the '863 Patent, the **first and second rotation axes** are likewise the x and y axes. *See* EX1001, FIG. 1 (“1ST ROTATION AXIS (Y-AXIS)” and “2ND ROTATION AXIS (X-AXIS)”). EX1003, ¶301.

As shown in annotated Figure 10 below, **a body of each of the micro mirrors** has been **rotated about at least one of first and second rotation axes extending through the body**. Assuming the axes shown in annotated Figure 10 below, with the x axis extending along the horizontal, the z axis extending along the vertical, and the y axis extending perpendicular to the page, the below micromirrors have been rotated about **y rotation axis**, which **extend[s]** through the y - length of the micro-mirror **body**. EX1003, ¶302.



The annotated FIG. 10 below shows the rotation of each mirror about the y rotation axis. As shown, each mirror has been rotated by a particular angle (i.e., θ_1 , θ_2 , θ_3) to reflect light to the coordinates of light spot 110. EX1003, ¶303.



Accordingly, Fuhse847 renders obvious element [12.f]. EX1003, ¶¶290-304.

7. Dependent Claims from Claim 12

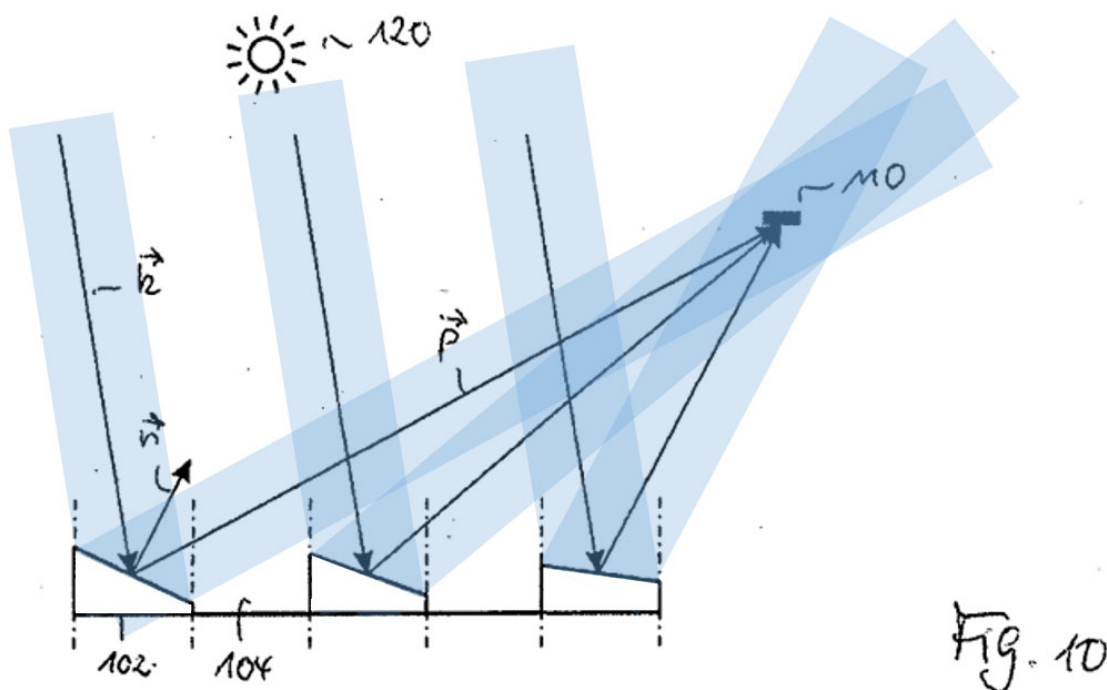
a. Claim 13:

Fuhse847 teaches the claim. EX1022, 21-22, FIG. 9-10.

The '863 patent does not use the term “voxel,” but A POSITA would understand the “voxels” have a volume. EX1003, ¶¶306-07.

As discussed with respect to element [12.f], for each of the pixels, a light spot at point (x_0, y_0, z_0) is a **point on the plane corresponding to one of the pixels**. EX1022, 21-22. In other words, each light spot is defined in three-dimensional space (i.e., x, y, z coordinates), which is the center-point of a **voxel is created at each of the points on the plane**. EX1003, ¶308.

Figure 10 shows chief light rays for each optical element and converging on light spot 110. See Section VII.A.5.g ([12.f]). Ambient and reflected light form beams of light that reflect off the entire surface of the mirror, not just the center point, shown below. EX1003, ¶309.



The volume of the voxel corresponds to the intersection of beams from micro-mirror set, with the center of the voxel being the coordinates of the point (x_0, y_0, z_0) where all the beams intersect. As more micro-mirrors are added for a given pixel, the pixel or voxel becomes brighter and more defined. EX1003, ¶¶310-11.

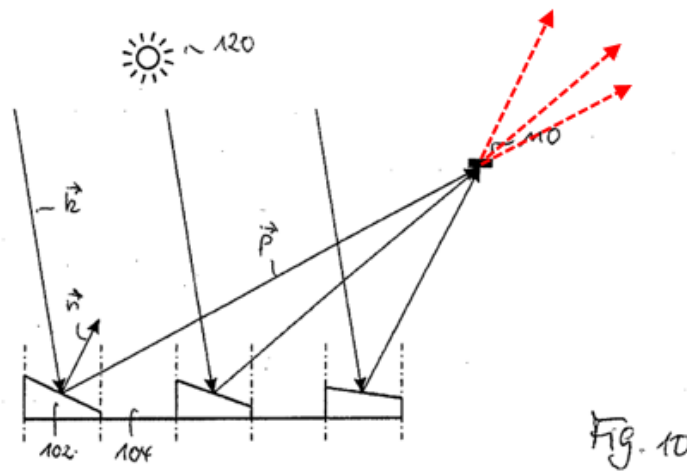
As shown in Figure 10, Fuhse847 creates a voxel via intersection of two or **more beams of the reflected ambient light**. As discussed for element [12.f], the reflected ambient light for each micromirror is given by “reflected light ray” of direction vector $\vec{p}$, as shown in Figure 10, which is the chief ray for each mirror. EX1022, 21-22; EX1003, ¶312.

Each “reflected light ray” (i.e., the chief ray in each image) represents the center of each **beam[] of the reflected ambient light**. Because each pixel is required to be formed with a “set of micro mirrors” (as required by [12.f]), the voxel would include **two or more beams**. As shown in Figure 10, each point (x_0, y_0, z_0) (**a point on the plane corresponding to one of the pixels**) is the center-point of each voxel. EX1003, ¶313.

Fuhse847 teaches that its “light-spot image composed of a plurality of light spots” (**each of the created voxels**) “for a viewer appear floating above... the surface region” in the form of a specified motif (**produces an effect of a point source of light floating above the surface of the substrate in the plane**). EX1022, 4-5, 9,

0058-59, 14-16, 19-20. The image in the plane “floats at a certain height above... the substrate surface” because “all light spots in the light-spot image have the same floating height.” EX1022, 16; EX1003, ¶314.

The **effect of a point source** is evident from Fuhse847’s Figure 10. EX1003, ¶¶316-17, 36.



Analogous to the teachings of the '863 Patent, **voxels produce[] an effect of a point source of light** at least 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. Likewise, Fuhse847 teaches a “cone” can be described “originating from the image point” and including all the micromirrors within the base of the cone (*i.e.*, “sphere of influence E_j ”). EX1022, 9-10, 28; EX1003, ¶317.

Accordingly, Fuhse847 renders obvious element claim 13. EX1003, ¶305-18.

b. Claim 14:

Fuhse847 teaches claim 14. Fuhse847's **array of micro mirrors receiving ambient light** is an array of micro-mirrors arranged on, *e.g.*, a banknote that receive the same **ambient light** that is the same for all micro-mirrors (*e.g.*, sunlight in FIGs. 2, 10). *See, supra*, Section VII.A.5.e ([12d]). Fuhse847 relies on **ambient light** that is **concurrently** incident on all micro-mirrors, not focused light that is only incident on particular micromirrors at a given time. EX1003, ¶¶320-21. Fuhse847's micro-mirrors are passive reflectors, and when illuminated with such concurrently incident ambient light, concurrently reflect the light, such that the micromirrors of **each of the different sets concurrently reflect the ambient light** in the manner discussed in element [12.f]. *See, supra*, Section VII.A.5.g ([12.f]); EX1003, ¶322.

Further, each of the different sets **concurrently generate the plurality of pixels** in the manner discussed for [12.f]. *See, supra*, Section VII.A.5.g ([12.f]). As long as the micro-mirrors are properly oriented or aimed to generate their respective pixels, the concurrent reflections of ambient light will **concurrently generate the plurality of pixels**. EX1003, ¶323.

The '863 Patent does not use the term “concurrent” and does not even discuss the concept of concurrent operation of sets of micro-mirrors. This limitation is trivially met by any array of passive micromirrors that operate based on reflecting ambient light. EX1003, ¶¶324-25.

Accordingly, Fuhse847 renders obvious element claim 14. EX1003, ¶¶319-26.

B. Ground 2: Fuhse847 and Rich in view of Fuhse925 Renders Obvious Claims 3 and 6-14

This ground is the same as Ground 1, but additionally relies on Fuhse925’s teachings regarding orientation of its micro-mirrors, as teaching limitation [12.f]. EX1003, ¶¶327-36. Ground 1 in view of Fuhse925 also teaches claims 3 and 6.

1. Combined Teachings of Fuhse847 and Rich in view of Fuhse925

a. Motivation

Fuhse847 and Fuhse925 share the same inventor and assignee, which weighs strongly in favor of finding a motivation to combine the two references. *See, e.g., Abbot Vascular, Inc. v. Flexstent*, IPR2019-00882, Paper 48, 28-29 (Oct. 2, 2020); *Black v. CE Soir Lingerie Co.*, No. 2:06-CV-544, 2008 WL 3852722, at *14 (E.D. Tex. Aug. 15, 2008) (“strong motivation to combine” prior art “patented by the same inventor”).

A POSITA would have found it obvious to apply the teachings of Fuhse925 to Fuhse847. Fuhse847 and Fuhse925 both relate to security elements for data carriers (e.g., banknotes, etc.) with arrays of optical elements that are arranged to produce, upon illumination, three-dimensional motifs, and thus are in the same field. EX1022, Abstract; EX1008, Abstract; EX1003, ¶328.

A POSITA would have looked to Fuhse925 when reviewing Fuhse847. Fuhse847 describes the proper orientation (*i.e.*, to produce the light spot in the correct location in three-dimensional space) of its micro-mirrors in the surface plane (*i.e.*, x-y axes) by a normal vector n of its reflective surface. EX1022, 21-22; EX1003, ¶329. While a POSITA would understand how much to rotate the mirror surface in the x and y axes to achieve the normal vector n (as is shown in Fuhse847 (FIGs. 9-10)), it is not expressed in explicit detail. EX1003, ¶329. Fuhse925, however, *does* provide that explicit detail. Fuhse925 further teaches that the normal surface N can be broken down into two “inclination components” that represent the inclination angle (*i.e.*, how much the mirror surface should be rotated or tilted) of the mirror in each respective axis. EX1008, 7:33-63. It would therefore have been obvious for a POSITA to examine how mirror surface orientations are achieved with Fuhse847. *Id.*

Fuhse925 provides explicit detail for implementing what Fuhse847 teaches, namely a micro-mirror with a desired surface normal n . As Fuhse925 explains, $N_{\parallel}$ and $N_{\perp}$ are the “mirror slope” in each of the x and y 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 micromirrors. EX1008, 7:33-63. Whereas Fuhse847 discloses a desired surface normal for each micromirror and shows the properly angled mirrors (see FIGs. 9-10), Fuhse925 provides further explicit detail for how to implement the properly oriented mirrors using “inclination components,” thus, it would have been obvious for a POSITA to combine Fuhse847 and Fuhse925. EX1003, ¶330.

Additionally, using Fuhse925’s teachings regarding inclination components in Fuhse847’s system would have involved using a known technique to improve Fuhse847 in a known way, without unpredictable results, and would thus also have been obvious under *KSR Int’l Co. v. Teleflex, Inc.*, 550 U.S. 398, 416-18 (2007). EX1003, ¶331.

b. Reasonable Expectation of Success

A POSITA would have had a reasonable expectation of success in implementing the combination of Fuhse847 and Fuhse925. As a POSITA would have recognized, the structures of Fuhse847 and Fuhse925 are similar and compatible. EX1003, ¶¶322-35.

Fuhse847 teaches that its micromirrors may “for example, have a dimension of $50\text{ }\mu\text{m} \times 50\text{ }\mu\text{m}$ and can be formed with a flat mirror surface.” EX1022, 21-22. Fuhse925’s facets are “micromirrors” with “the dimensions... between $20\text{ }\mu\text{m}$ and $300\text{ }\mu\text{m}$, preferably between $50\text{ }\mu\text{m}$ and $200\text{ }\mu\text{m}$.” EX1008, 5:36-38, 7:43-48; EX1003, ¶333. Fuhse provides almost identical teachings regarding how the micromirrors in Fuhse847 and Fuhse925 should be made, further showing the compatibility in their teachings. *Compare* Fuhse847, 8-9 with EX1008, 5:4-8; EX1003, ¶333. Thus, the teachings in Fuhse925 regarding proper orientation of micro-mirrors would have been incorporated into Fuhse847 with no difficulty. EX1003, ¶334.

As discussed in Ground 1 (*see* VII.A.1.b), the art was relatively predictable in the relevant timeframe (2015). EX1003, ¶¶334-35. Thus, a POSITA would have been able to implement the obviousness modifications in this ground without difficulty. *Id.*

2. Application to the Challenged Claims

Fuhse847 and Rich in view of Fuhse925 teaches the limitations of claims 3 and 6-14.

a. Claim 3:

Fuhse847 in view of Fuhse925 renders obvious this claim.

Fuhse847 teaches that “every image point P_j ,” corresponds to a “cone originating from” or “emanating from” the image point (an apex of **a cone**). EX1022, 9-10, 28. 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” (**on a surface containing the array of micro mirrors**). *Id.* The “xy plane” is understood to be the **surface of the substrate** because it is the plane that is divided into fields that are “covered with” the optical elements (micromirrors) which are the surface of the substrate. EX1022, 4, 9-10, 27-28; EX1003, ¶338.

In Fuhse847, all of the micromirrors 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 ” (**a plurality of the micro mirrors located in a base of a cone**). EX1022, 9-10, 27-28; EX1003, ¶339.

Fuhse925 teaches that the orientation vector N of each reflective facet 30 is defined by two inclination components – a normal component $N_{\perp}$ and a non-vanish-

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

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

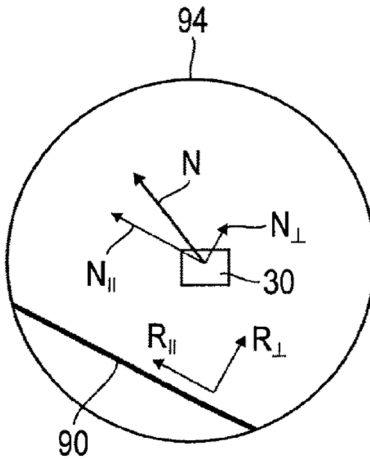


Fig. 7(b)

Fuhse925, FIG. 7(b); EX1003, ¶341.

Further, Fuhse925 discloses the that “additional parallel component $N_{\parallel}$ ensures that a viewer still sees the line 16 floating at the depth T even if he tilts the security element upward or downward about the x -axis by a certain angle within the second angle range.” *Id.*, 9:27-31. A POSITA would understand that the random arrangement of facets 30 is such that an image of line 16 floating at depth T is visible to the observer. EX1003, ¶342.

Accordingly, Fuhse847 in view of Fuhse925 teaches claim 3. EX1003, ¶¶337-42.

b. Claim 6:

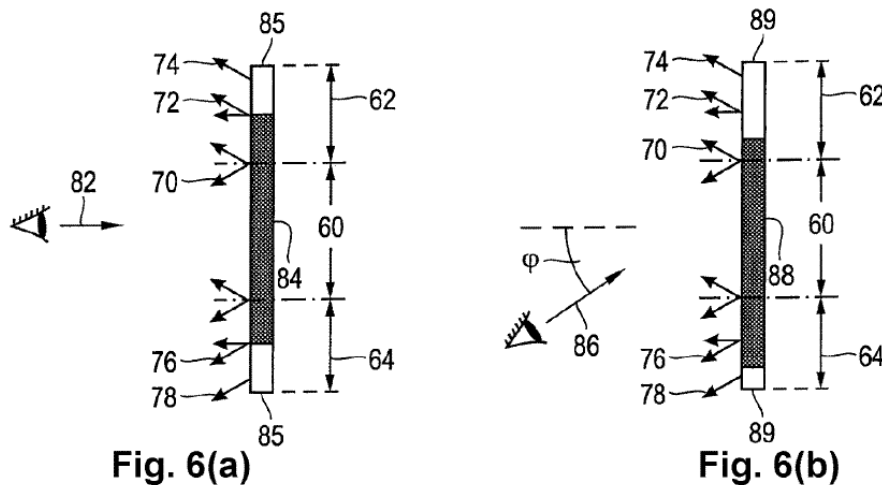
Fuhse847 in view of Fuhse925 renders obvious this claim.

As discussed in Ground 1, claim 6, Fuhse847 renders obvious this claims.

See, supra, Section VII.A.5.d (Ground 1, claim 6). EX1003, ¶345.

If it is argued that Fushe262 does not satisfy the claim, Fushe262 in combination with Fushe925 does, and a POSITA would have been motivated to combine them with reasonable expectation of success. *See, supra*, Sections VII.B.1.a (Ground 2, Motivation to Combine) and VII.B.1.b (Ground 2, Reasonable Expectation of Success). EX1003, ¶346.

To the extent that Fushe262 does not provide express detail of a predefined angular offset of at least 10 degrees, Fushe925 does such as seen in Figs. 6(a)-(b) below. Fuhse925, Figs. 6(a)-(b); 6:26-27 (“FIGS. 6(a) and 6(b) illustrations of the effect achieved by reducing the spreading range for two viewing directions”). EX1003, ¶347.



Fuhse925 describes what happens when viewing each image from different angles as be seen in Figures 6(a) and 6(b). “In the perpendicular view 82 shown

in FIG. 6(a) (corresponding to a viewing angle $\varphi=0^\circ$), the viewer sees that portion 84 of the line 16 in which the spreading range includes the angle $\varphi=0^\circ$.” Fuhse925, 9:66-10:2. “In the view 86, shown in FIG. 6(b), obliquely from below at an angle $\varphi=-10^\circ$, the viewer sees that portion 88 of the line 16 in which the spreading range includes the angle $\varphi=-10^\circ$.” Fuhse925, 10:9-12. EX1003, ¶348.

The difference in the two viewing angles ($\varphi=0^\circ$ and $\varphi=-10^\circ$) is 10° , which is **a predefined angular offset of at least 10 degrees**. Accordingly, a POSITA would understand that the image and the second image have viewing angles and an offset between them. EX1003, ¶¶349-50. Further, as discussed, micromirror devices had the known benefit of providing a large separation between images compared to other types of optical security devices known in the art. EX1003, ¶351.

3. Claim 7

Fuhse847 teaches claim 7, as detailed below.

a. [7Pre]:

Fuhse847 renders obvious the limitation. *See, supra*, Section VII.A.4.a (Ground 1, [1Pre]). EX1003, ¶353.

b. [7a]:

Fuhse847 renders obvious this limitation. *See, supra*, Sections VII.A.4.b (Ground 1, [1a]) and VII.A.4.c (Ground 1, [1b]). EX1003, ¶354.

The second image display plane is **spaced apart from the first image display plane**. *See, supra*, Sections VII.A.4.b ([1a]) (explaining the two image planes are in the foreground and background of each other). EX1003, ¶355.

As discussed, Fuhse847 also teaches that the two images may be in different planes. Fuhse847 teaches that two images to be in the “foreground” and “background” of each other. EX1022, 26. A POSITA would have understood that for two images to be in the foreground and background of each other, they are **spaced apart** from each other. EX1003, ¶356. This is accomplished by selecting the image points P_j of the **second image display plane** to have a height values Z_j that are different from height values Z_j of the **first image display plane**. *See, supra*, Section VII.A.6.e ([12.d]); EX1022, 9-10, 27-28.

c. [7b]:

Fuhse847 renders obvious this limitation. *See, supra*, Section VII.A.4.d (Ground 1, [1c]). EX1003, ¶357.

d. [7c]:

Fuhse847 renders obvious this limitation. *See, supra*, Section VII.A.4.e (Ground 1, [1d]). EX1003, ¶358.

e. [7d]:

Fuhse847 teaches element [7d]. *See, supra*, Section VII.B.2.a (Ground 2, claim 3). EX1003, ¶359.

f. [7e]:

Fuhse847 renders obvious this limitation. *See, supra*, Section VII.A.4.f (Ground 1, [1e]). EX1003, ¶360.

4. Dependent Claims from Claim 7

a. Claim 8:

Fuhse847 renders obvious this claim. *See, supra*, Section VII.A.5.b (claim 4). EX1003, ¶361.

b. Claim 9:

Fuhse847 renders obvious this claim. *See, supra*, Section VII.A.5.a (claim 2). EX1003, ¶362.

c. Claim 10:

Fuhse847 renders obvious this claim. *See, supra*, Section VII.A.5.c (claim 5). EX1003, ¶363.

d. Claim 11:

Fuhse847 renders obvious this claim. *See, supra*, Section VII.A.5.d (claim 6). EX1003, ¶364.

5. Claim 12

Fuhse847 teaches claim 12, as detailed below.

a. [12Pre]:

Fuhse847 renders obvious the limitation. *See, supra*, Section VII.A.6.a (Ground 1, element [12Pre]). EX1003, ¶¶366-74.

b. [12a]:

Fuhse847 in view of Rich renders obvious the limitation. *See, supra*, Section VII.A.6.b (Ground 1, Section [12a]). EX1003, ¶375.

c. [12b]:

Fuhse847 in view of Rich renders obvious the limitation. *See, supra*, Section VII.A.4.e (Ground 1, element [1d]). EX1003, ¶376.

d. [12c]:

Fuhse847 in view of Rich renders obvious the limitation. *See, supra*, Section VII.A.4.f (Ground 1, element [1e]). EX1003, ¶377.

e. [12.d]:

f. [12.e]:

Fuhse847 renders obvious these limitations ([12.d] and [12.e]). *See, supra*, Section VII.A.6.e (Ground 1, elements [12.d], [12.e]). EX1003, ¶378.

g. [12.f]:

Fuhse847 in view of Fuhse925 renders obvious element [12.f] with respect to the phrase **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. Fuhse847 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 . EX1003, ¶¶379-80. However, to the extent it would not, Fuhse925's additional teachings would.

Like Fuhse847, Fuhse925 teaches a security element (for currency, for example) using arrays of reflective micromirrors to create three-dimensional images appearing to float above the security element. EX1008, 6:63-7:18, 7:33-48. Also like Fuhse847, each micromirror is taught to have a normal – “slope N ” – that defines the overall surface orientation of the micromirror. EX1008, 7:55-58. 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. EX1008, 7:33-63. Fuhse925 Figures 2 and 3, referenced in the passage above, are reproduced below:

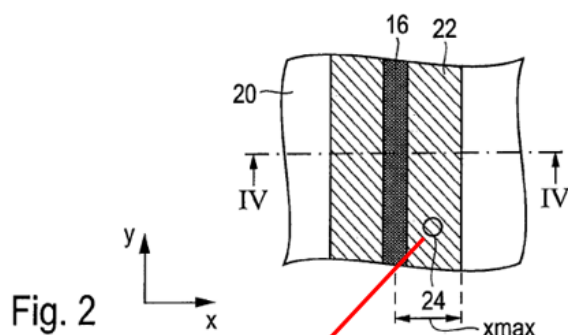


Fig. 2

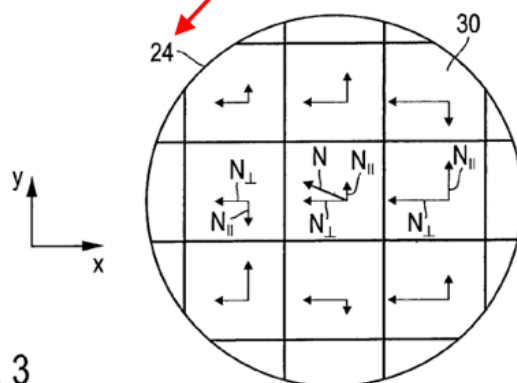


Fig. 3

EX1008, 7:33-58; EX1003, ¶¶381-83. As Fuhse925 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 micromirrors. EX1008, 7:33-58, 6:63-7:18; EX1003, ¶384.

Fuhse925 also clarifies that the micro-mirrors are oriented **in a fixed manner** by explaining that its reflective planar facets 30 are “characterized by an inclination angle.” EX1008, 7:37-42, claim 1. The planar facets 30 are “characterized” by this

single “inclination angle” because they are manufactured to provide that angle to achieve a desired reflection. EX1003, ¶385.

Accordingly, Fuhse847 in view of Fuhse925 renders obvious element [12.f]. EX1003, ¶¶379-86.

6. Dependent Claims from Claim 7

a. Claim 13:

Fuhse847 renders obvious this claim. *See, supra*, Section VII.A.7.a (Ground 1, claim 13). EX1003, ¶387.

b. Claim 14:

Fuhse847 renders obvious this claim. *See, supra*, Section VII.A.7.b (Ground 1, claim 14). EX1003, ¶388.

C. Ground 3: Fuhse847 and Rich (Ground 1) in view of Sauvage-Vincent Renders Obvious Claims 15-18

Fuhse847 and Rich in view of Sauvage-Vincent render obvious claims 15-18 of the '863 patent. The positions for claim 12 are the same as the inclusion of Sauvage-Vincent does not affect those positions. EX1003, ¶389.

1. Combined Teachings of Fuhse847 and Rich in view of Sauvage-Vincent

a. Motivation to Combine

A POSITA would have found it obvious to apply the teachings of Sauvage-Vincent to Fuhse847. Fuhse847 and Sauvage-Vincent both relate to security elements that are arranged to illuminate motifs, and thus are in the same field. Fuhse847, Abstract; EX1033, Abstract; EX1003, ¶390.

A POSITA would have looked to Sauvage-Vincent when reviewing Fuhse847. While Fuhse847 teaches that its “optical elements are designed as embossed structures in an embossing lacquer layer” (EX1022, 8-9, 16), embossing is not expressed in explicit detail. Sauvage-Vincent teaches that a “die” or “master” may provide a “stamping operation” to produce the microstructure pattern of the desired optical elements. EX1033, ¶¶71, 73, 43, Abstract. It would therefore have been obvious for a POSITA to examine how embossed structures are produced. That is, Sauvage-Vincent provides explicit detail for implementing what Fuhse847 teaches. EX1003, ¶¶391-94.

Additionally, using Sauvage-Vincent’s teachings regarding dies in Fuhse847’s system would have involved using a known technique to improve Fuhse847 in a known way, without unpredictable results, and would thus also have been obvious. EX1003, ¶395.

b. Reasonable Expectation of Success

A POSITA would have had a reasonable expectation of success in implementing the combination of Fuhse847 and Sauvage-Vincent. Given the mature stage of device fabrication the art in the relevant timeframe (2015), it was relatively predictable and known to work. EX1003, ¶¶396-98. A POSITA would have been able to implement the obviousness modifications in this ground without difficulty. *Id.*

2. Challenged Claims

Fuhse847 and Rich in view of Sauvage-Vincent teaches the limitations of claim 15-18.

a. Claim 15:

Fuhse847 in view of Sauvage-Vincent renders obvious this claim.

Fuhse847 teaches that its “optical elements are designed [**the forming the array of micro mirrors comprises**] as embossed structures in an embossing lacquer layer.” 1022, 8-9, 16. While embossing is a well-known fabrication technique that typically involves using an embossing tool, it is not explicitly disclosed in Fuhse847. EX1003, ¶¶401-02.

Sauvage-Vincent uses a nickel “die” or “master” (**a mirror tool**) to provide an “embossed layer” relief structure of the desired optical elements. EX1033, ¶¶71, 73, 43, Abstract. For example, as shown in Figure 1A, Sauvage-Vincent teaches

that its “optical structures” are formed by the stamping operation as applied to “dielectric material 101 (FIG. 1A), “typically a stamping lacquer a few microns thick borne by a 12 μm to 50 μm film of polymer material, for example of PET (polyethylene terephthalate)” that forms part of the **substrate**. (*Id.*); EX1003, ¶403.

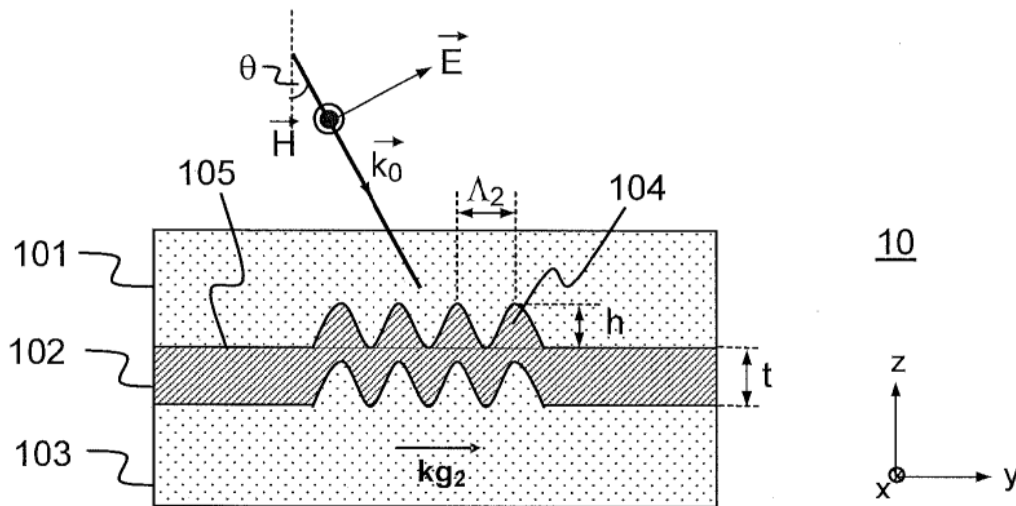


FIG.1A

The **casting the micro mirrors** occurs when “stamping operation is performed from the die to transfer the microstructure onto a film and structure the layer of dielectric material 101” (a **mirror tool in contact with the surface of the substrate**). EX1033, ¶¶71, FIG. 1A. In particular, this “stamping may be done... by molding then cross-linking (“UV **casting**”).” *Id.* (emphasis added). As another example, dielectric material 101 may be stamped by “hot pressing” or “hot embossing,” which is another form of **casting**. EX1003, ¶¶404-05.

b. Claim 16:

Fuhse847 in view of Sauvage-Vincent renders obvious this claim.

Sauvage-Vincent’s substrate includes “dielectric material 101 (FIG. 1 A),” which is “typically a stamping lacquer a few microns thick borne by a 12 μm to 50 μm film of **polymer** material,” (**polymer**) “for example of PET (polyethylene terephthalate),” which is **a clear, energy-cured polymer**. EX1033, ¶¶71, FIG. 1A. PET was a known, transparent thermoplastic polymer resin of the polyester family before the relevant date. EX1003, ¶¶407, 411.

Further, layer 101 is **clear** because it is “transparent in said observation spectral band,” and is also referred to as a “transparent layer 101.” EX1033, Abstract, ¶¶0009, 0030, 0073, FIG. 1A. EX1003, ¶408.

The dielectric material 101 is an **energy-cured** polymer under two separate examples. First, the transparent dielectric material 101 may be “UV cast[ed]” that is formed when it is molded by the die, meaning that UV **energy cure[s] the** dielectric material. EX1033, ¶71. Second, dielectric material 101 may be stamped by “hot pressing” or “hot embossing,” (i.e., the polymer structures are formed when the die presses against it at elevated temperature) which provides the **energy** for the layer to be **cured**. EX1033, ¶71; EX1003, ¶¶409-10.

c. Claim 17:

Fuhse847 in view of Sauvage-Vincent renders obvious this claim.

Fuhse847 teaches that the forming the array of micro mirrors includes providing “the embossed structures... a reflection-increasing coating[] [and] [i]n particular, **a full-surface or gridded metallization**” (**metallization of surfaces of the micro mirrors**). EX1022, 8-9. The “full-surface or gridded metallization” is “a reflection-increasing coating” of the micromirrors, meaning it is provided **to form reflective surfaces**. Layers of aluminum, gold, and silver are three of the most common materials to use for highly reflective surfaces of micromirrors, however, it is not explicitly disclosed in Fuhse847. EX103, ¶¶413-14.

Sauvage-Vincent likewise teaches that the forming desired optical elements includes that a “metallization” (**metallization**). EX1033, ¶71. This “metallization is done in a vacuum, for example, one of the following metals: **silver, aluminum, gold**” (**a layer of aluminum, gold, or silver to form reflective surfaces**). *Id.*; EX1003, ¶415.

d. Claim 18:

Fuhse847 in view of Sauvage-Vincent renders obvious this claim.

As discussed in claim 15, Fuhse847 teaches that its “optical elements are designed [**the forming the array of micro mirrors comprises**] as embossed structures in an embossing lacquer layer,” which renders obvious **embossing the surface**

of the substrate to form the surfaces of the micro mirrors and wherein the surface of the substrate includes an embossable coating or layer. Fuhse847, pp. 8-9, 16. Fuhse847 further teaches that “the embossed structures” are provided with a “metallization,” meaning the embossing must have come **prior to the metallization of the surfaces of the micro mirrors.** Fuhse847, pp. 8-9; EX1003, ¶417.

Sauvage-Vincent further teaches a nickel “die” or “master” creates the microstructures by “hot pressing of the dielectric material (‘hot embossing’)” (**embossing the surface of the substrate to form the surfaces of the micro mirrors**). EX1033, ¶71. This process results in an “embossed layer” (**an embossable... layer**). *Id.* As shown in FIGs. 1A and 7A, the dielectric material 101 is part of the **surface of the substrate**, and **the surface of the substrate includes** the dielectric material 101. EX1033, ¶73 (noting layers 71 and 73 in FIG. 7A are to be removed upon transfer); EX1003, ¶419.

The embossing is **prior to the metallization of the surfaces of the micro mirrors** because “[t]he duly embossed layer is **then** metalized,” meaning the embossing occurred before the metallization. EX1033, ¶71 (emphasis added); EX1003, ¶420.

D. Ground 4: Fuhse847, Rich, and Fuhse925 (Ground 2) in view of Sauvage-Vincent Renders Obvious Claims 15-18

Fuhse847 in view of Rich render obvious claims 15-18 of the ’863 patent.

1. Combined Teachings of Fuhse847, Rich, and Fuhse925 in view of Sauvage-Vincent

a. Motivation to Combine

See, supra, Section VII.C.1.a (Ground 3, Motivation). The presence of Fuhse925 in the combination does not affect the motivation to combine discussed in Ground 3. EX1003, ¶421.

b. Reasonable Expectation of Success

See, supra, Section VII.C.1.b. The presence of Fuhse925 in the combination does not affect the reasonable expectation of success discussed in Ground 3. EX1003, ¶422.

2. Application to the Challenged Claims

Fuhse847, Rich, and Fuhse925 (Ground 2) in view of Sauvage-Vincent teaches the limitations of claims 15-18. EX1003, ¶423.

a. Claim 15:

Fuhse847 in view of Sauvage-Vincent renders obvious this claim. *See, supra*, Section VII.C.2.a (Ground 3, claim 15). EX1003, ¶424.

b. Claim 16:

Fuhse847 in view of Sauvage-Vincent renders obvious this claim. *See, supra*, Section VII.C.2.b (Ground 3, claim 16). EX1003, ¶425.

c. Claim 17:

Fuhse847 in view of Sauvage-Vincent renders obvious this claim. *See, supra*, Section VII.C.2.c (Ground 3, claim 17). EX1003, ¶426.

d. Claim 18:

Fuhse847 in view of Sauvage-Vincent renders obvious this claim. *See, supra*, Section VII.C.2.d (Ground 3, claim 18). EX1003, ¶427.

E. Ground 5: Fuhse847 and Rich (Ground 1) in view of Morford Renders Obvious Claims 19-20

Fuhse847 and Rich in view of Morford render obvious claims 19-20 of the '863 patent. EX1003, ¶428.

1. Combined Teachings of Fuhse847 and Rich in view of Morford

a. Motivation to Combine

A POSITA would have found it obvious to apply the teachings of Morford to Fuhse847. EX1003, ¶¶429-36. Fuhse847 relates to micro-optic components, and Morford relates to materials for use in micro-optics components, and thus are in the same field. EX1022, Abstract; EX1024, Abstract; EX1003, ¶429.

A POSITA would have looked to Morford when reviewing Fuhse847 for implementation details. While Fuhse847 teaches that its micro-mirrors are “embedded in a surrounding material or provided with a protective layer,” Fuhse847 does not specify what material to use. EX1022, 23, FIG. 12. However, Morford teaches that

“a UV-curable high refractive index material” may be used as an optical material. EX1024, 1; EX1003, ¶¶430-32.

Additionally, using Morford’s teachings regarding UV-curable materials in Fuhse847’s system would have involved using a known technique to improve Fuhse847 in a known way, without unpredictable results, and would thus also have been obvious. EX1003, ¶433.

b. Reasonable Expectation of Success

A POSITA would have had a reasonable expectation of success in implementing the combination of Fuhse847 and Morford. Here, the art was relatively predictable in the relevant timeframe (2015). EX1003, ¶¶434-36. A POSITA would have been able to implement the obviousness modifications in this ground without difficulty, as protective layers such as those provided by Morford are relatively simple, and are particularly suited for ease of integration with devices like Fuhs847. *Id.*

2. Application to the Challenged Claims

Fuhse847, Rich, and Fuhse925 (Ground 2) in view of Morford teaches the limitations of claims 19-20. EX1003, ¶437.

a. Claim 19:

Fuhse847 in view of Morford renders obvious this claim. EX1003, ¶¶438-42.

Fuhse847’s micromirrors are “embedded in a surrounding material or provided with a protective layer” (**a filler**). EX1022, 23. As discussed for claim 18

(*see, supra*, Section VII.C.2.d), the micromirrors are “embossed structures,” meaning that they include **recessed surfaces** as a result of the embossing. EX1022, 8-9, 16. A POSITA would have understood that by “surrounding” or “embedding” the micromirrors with the protective layer, the **recessed surfaces** would be **fill[ed] in**. EX1003, ¶¶439-40.

While Fuhse847 does not explicitly disclose the material of the protective layer, but the use of **an ultraviolet (UV) varnish** was known in the art, for example, by Morford. Morford teaches that “a UV-curable high refractive index material” (**an ultraviolet (UV) varnish**) may be used as an optical material. EX1024, 1; EX1003, ¶¶441-42.

b. Claim 20:

Fuhse847 in view of Morford renders obvious this claim.

Fuhse847 teaches that the protective layer usually has “a refractive index of approximately $n = 1.5$.” EX1022, 23. A POSITA would have understood that “approximately” 1.5 includes 1.55 (**the filler has a refractive index of at least 1.55**). EX1003, ¶¶440.

In addition to being a UV varnish, Morford’s varnish has a refractive index of above 1.61 and highly transparent over the entire visible spectrum EX1024. EX1024, 4; EX1003, ¶¶440-44.

The '863 Patent's only teaching with respect to **whereby at least a portion of the received ambient light at extreme angles is reflected to sharpen the displayed image** is that it is a direct result of providing a material with an index of at least 1.55, and is given no weight. *See* '863 Patent, 17:43-47; *Texas Instruments Inc. v. U.S. Int'l Trade Comm'n*, 988 F.2d 1165, 1172 (Fed. Cir. 1993) ("A whereby clause that merely states the result of the limitations in the claim adds nothing to the patentability or substance of the claim."). Thus, because Morford provides an index of over 1.55, it would cause **at least a portion of the received ambient light at extreme angles to be reflected to sharpen the displayed image**. EX1003, ¶¶445.

F. Ground 6: Fuhse847, Rich, and Fuhse925 (Ground 2) in view of Morford Renders Obvious Claims 19-20

Fuhse847, Rich, and Fuhse925 (Ground 2) in view of Morford render obvious claims 19-20 of the '863 patent. EX1003, ¶446.

1. Combined Teachings of Fuhse847, Rich, and Fuhse925 in view of Morford

a. Motivation to Combine

See, supra, Section VII.E.1.a (Ground 5, Motivation to Combine). The presence of Fuhse925 in the combination does not affect the motivation to combine discussed in Ground 5. EX1003, ¶447.

b. Reasonable Expectation of Success

See, supra, Section VII.E.1.b (Ground 5, Reasonable Expectation of Success).

The presence of Fuhse925 in the combination does not affect the reasonable expectation of success discussed in Ground 5. EX1003, ¶448.

2. Application to the Challenged Claims

Fuhse847, Rich, and Fuhse925 (Ground 2) in view of Morford teaches the limitations of claims 19-20. EX1003, ¶449.

a. Claim 19:

Fuhse847 in view of Morford renders obvious this claim. *See, supra*, Section VII.E.2.a (Ground 5, claim 19). EX1003, ¶450.

b. Claim 20:

Fuhse847 in view of Morford renders obvious this claim. *See, supra*, Section VII.E.2.b (Ground 5, claim 20). EX1003, ¶451.

VIII. SECONDARY CONSIDERATIONS OF NONOBVIOUSNESS

Secondary considerations should be considered but do not control the obviousness conclusion. *Newell Cos. v. Kenney Mfg. Co.*, 864 F.2d 757, 768 (Fed. Cir. 1988). Where, as here, a strong *prima facie* obviousness showing exists, even relevant secondary considerations supported by substantial evidence may not dislodge the obviousness conclusion. *Leapfrog Enters. v. Fisher-Price, Inc.*, 485 F.3d 1157,

1162 (Fed. Cir. 2007). Petitioners is aware of no evidence supporting a claim for secondary considerations. EX1003, ¶451.

IX. INSTITUTION IS APPROPRIATE UNDER FINTIV

Efficiency, fairness, and merits support institution despite the existence of co-pending litigation. *Apple v. Fintiv*, IPR2020-00019, Paper 11 (PTAB Mar. 20, 2020) (precedential) (“*Fintiv*”).

Factor 1 (stay) is favors institution, because Petitioners moved for a stay under seal (see Factor 2) based on issues unrelated to this proceeding. *See Hulu LLC v. SITO Mobile R&D IP, LLC*, IPR2021-00298, Paper 11 at 10-11 (PTAB May 19, 2021).

Factor 2 (proximity to trial) favors institution. With this Petition filing, Final Written Decision may be expected by November 2025. While the trial is scheduled for November 18, 2024 (EX1048, p. 1), the case may be transferred to the Court of Federal Claims (CoFC). In a separate litigation before the CoFC concerning the same patents-at-issue and involving the US Government, PO expressly represented that 28 U.S.C. § 1498 covers the nucleus of operative facts concerning alleged infringing products and identifies Petitioners as product contractors to the defendant in that case. Separately, in the EDTX case, Petitioners filed a Motion for Protective Order (including a request for stay) under seal concerning technical information sought by PO in light of the sensitivity of the

information and Petitioners’ defense under §1498. Petitioners expect to have more information prior to institution and can share relevant information with the Board as applicable and with any appropriate protections in place.

Factor 3 (investment in parallel litigation) is neutral. Fact discovery has not closed and the parties have not engaged in expert discovery. EX1048, p. 3. And the *Markman* hearing has been scheduled for June 14, 2024, after the filing of this Petition.

Factor 4 (overlapping issues) is neutral. If the litigation is not transferred to the CoFC prior to institution, Petitioners will consider not pursuing the Petition’s grounds before the district court by stipulation. *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 (PTAB Dec. 1, 2020); *Sand Revolution II, LLC v. Cont’l Intermodal Grp.-Trucking LLC*, IPR2019-01393, Paper 24, 11-12 (PTAB Jun. 16, 2020). However, pending resolution of Factor 2, it is premature to submit a *Sotera* stipulation at this time.

Factor 5 (same parties) may weigh slightly in favor of denial, because Petitioners and PO are the same parties as in the district court. However, based on a “holistic view,” the factors favor institution. *Samsung Elecs. Co. Ltd. v. Dynamics Inc.*, IPR2020-00505, Paper 11 at 15 (PTAB Aug. 12, 2020).

Factor 6 (other considerations) favors institution. Because the challenged claims cover known techniques published years before the earliest priority date, as discussed above, the features of the challenged claims are disclosed/suggested in the prior art presented here. *See, supra*, Section VII. This Petition’s merits are compelling.

Accordingly, *Fintiv* favors institution.

X. INSTITUTION IS APPROPRIATE UNDER §325(D)

Under the two-part *Advanced Bionics* framework, the Board should not exercise discretion. *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 at 8 (PTAB Feb. 13, 2020).

Part One: The grounds/arguments presented in this Petition are not the same or substantially the same as the prior art combinations/arguments raised during prosecution. The Examiner did not reject any of the challenged claims based on prior art disclosures/combinations. *See, supra*, Section III.B. Also, Rich, Fuhse925, and Sauvage-Vincent were not cited during prosecution and therefore were not substantively considered. *Id.*

While Applicant cited Fuhse847 in an IDS (EX1004, 66, 118), the Examiner neither cited nor applied it, and did not consider it in the combinations this Petition relies on (Fuhse847 and Rich (Ground 1), Fuhse847 and Rich in further view of

Fuhse925 and/or Sauvage-Vincent (other grounds)). *Id.* *Sony Grp. Corp. v. MZ Audio Scis., LLC*, IPR2022-01544, Paper 12 at 7-8 (PTAB Apr. 21, 2023).

The prior art disclosures/combinations Petitioners rely on are not cumulative. The Examiner identified certain claim features that were believed to be missing in prior art. *See, supra*, Section III.B. However, such claim features and the challenged claims are obvious in view of the prior art disclosures/combinations Petitioners rely on. *See, supra*, Section VII **Error! Reference source not found..**

Part Two: Even if the art/arguments in this Petition are substantially the same (they are not), the Examiner/Office erred in a manner material to the patentability of the claims. “[I]f the record of the Office’s previous consideration of the art is not well developed or silent, then a petitioner may show the Office erred by overlooking something.” *Advanced Bionics*, Paper 6 at 10.

As discussed above, the Examiner did not substantively discuss or rely on Fuhse847 or consider the combinations based on Fuhse847 and other references. Thus, the record is not well developed and is silent. The Examiner clearly overlooked the relevant disclosures of Fuhse847 and other references, and the combinations in the Petition, which disclose/render obvious such claim features identified by the Examiner and the challenged claims. *See, supra*, Section VII. Thus, the Examiner/Office erred in a material manner. *Cellco P’ship d/b/a Verizon*

Wireless v. Huawei Device Co., Ltd., IPR2020-01117, Paper 10 at 13-15 (PTAB Feb. 3, 2021).

Accordingly, the Board should not exercise its discretion.

XI. MANDATORY NOTICES

A. Real Parties-in-Interest Under 37 C.F.R. § 42.8(b)(1)

There are no real parties-in-interest other than Petitioners.

B. Related Matters Under 37 C.F.R. § 42.8(b)(2)

To the best knowledge of Petitioners, the '191 Patent is involved in the following district court litigation: *Lumenco, LLC v. Giesecke+Devrient GmbH*, No. 2:23-cv-00100 (E.D. Tex. 2023) and *Lumenco, LLC v. United States*, No. 24-139-T (Fed. Cl. 2024).

C. Lead and Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3)

Petitioners provides the following designation of counsel:

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Pursuant to 37 C.F.R. § 42.10(b), a Power of Attorney accompanies this petition.

D. Service Information Under 37 C.F.R. § 42.8(b)(4)

A Power of Attorney is being filed concurrently with this Petition in accordance with 37 C.F.R. § 42.10(b). Petitioner consents to electronic service by e-mail, using the email addresses identified above

XII. GROUNDS FOR STANDING

Petitioners certifies that the '863 Patent is available for IPR; Petitioners is not barred or estopped from requesting IPR; and this petition is being filed within one year of service of the complaint in the co-pending district court litigation.

XIII. CONCLUSION

Petitioners requests institution of this IPR and cancellation of the claims.

Dated: May 2, 2024

Respectfully submitted,

/David M. Tennant/

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CLAIM LISTING APPENDIX

Claim 1	
[1Pre]	A method of fabricating a security element, comprising:
[1a]	assigning a first object in a starting digital image to a first image display plane and a second object in the starting digital image to a second image display plane;
[1b]	with a processor of a computing device, executing code to provide an array design module that operates to select a set of micro mirrors in an array of the micro mirrors to display each of the pixels of the first object in the first image display plane and to display each of the pixels of the second object in the second image display plane;
[1c]	for each of the pixels, determining with the array design module an angular orientation of each of the micro mirrors in the selected sets of the micro mirrors;
[1d]	generating a design output file including the angular orientation and location coordinates in the array for each of the micro mirrors in the selected sets of the micro mirrors; and
[1e]	forming the array of the micro mirrors according to the design output file.
Claim 2	
2	The method of claim 1, wherein the angular orientation is defined by coordinates of a normal vector from a reflective surface of each of the micro mirrors directing light to one of the pixels.
Claim 3	
3	The method of claim 1 wherein each of the sets of micro mirrors are selected randomly from a plurality of the micro mirrors located in a base of a cone on a surface containing the array of micro mirrors.
Claim 4	
4	The method of claim 3, wherein the cone has an apex coinciding with coordinates of one of the pixels on the first or second image display planes.

Claim 5	
5	The method of claim 1, wherein the angular orientations are calculated based on heights of the first and second image display.
Claim 6	
6	The method of claim 1, wherein the angular orientations are calculated to provide a predefined angular offset of at least 10 degrees between the first and second image display planes.
Claim 7	
[7Pre]	A method of fabricating a security element, comprising:
[7a]	with a processor of a computing device, executing code to provide an array design module configured to select a set of micro mirrors in an array of the micro mirrors to display pixels of a first object in a first image display plane and to display pixels of a second object in a second image display plane spaced apart from the first image display plane;
[7b]	for each of the pixels, determining, with the array design module, an angular orientation of each of the micro mirrors in the selected sets of the micro mirrors;
[7c.1]	generating a design output file including the angular orientation and location coordinates in the array for each of the micro mirrors in the selected sets of the micro mirrors,
[7c.2]	wherein each of the sets of micro mirrors are selected randomly from a plurality of the micro mirrors located in a base of a cone on a surface containing the array of the micro mirrors; and
[7.d]	forming the array of the micro mirrors according to the design output file.
Claim 8	
7	8. The method of claim 7, wherein the cone has an apex coinciding with coordinates of one of the pixels on the first or second image display planes.
Claim 9	

8	9. The method of claim 7, wherein the angular orientation is defined by coordinates of a normal vector from a reflective surface of each of the micro mirrors directing light to one of the pixels.
Claim 10	
9	10. The method of claim 7, wherein the angular orientations are calculated based on heights of the first and second image display.
Claim 11	
10	11. The method of claim 7, wherein the angular orientations are calculated to provide a predefined angular offset of at least 10 degrees between the first and second image display planes.
Claim 12	
[12Pre]	A method of fabricating a security element useful on paper and coin currency and on product labels, comprising:
[12a]	with a processor of a computing device, executing code to provide an array design module configured to define an array of micro mirrors to be formed on a surface of a substrate;
[12b]	generating a design output file including an angular orientation and location coordinates in the array for each of the micro mirrors; and
[12c]	forming the array of micro mirrors according to the design output file,
[12d]	wherein the array of micro mirrors is configured, when formed on the surface of the substrate, for receiving ambient light and, in response, displaying an image in a plane spaced a distance apart from the surface of the substrate,
[12e]	wherein the image comprises a plurality of pixels, and
[12f]	wherein the array of micro mirrors includes for each of the pixels a different set of the micro mirrors each having a reflective surface oriented, in a fixed manner, with a body of each of the micro mirrors rotated about at least one of first and second rotation axes extending through the body, to reflect the ambient light toward a point on the plane corresponding to one of the pixels.

Claim 13	
13	The method of claim 12, wherein a voxel is created at each of the point on the plane via intersection of two or more beams of the reflected ambient light, and 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.
Claim 14	
14	The method of claim 12, wherein each of the different sets concurrently reflect the ambient light to concurrently generate the plurality of pixels.
Claim 15	
15	The method of claim 12, further comprising providing the substrate and forming the array of micro mirrors by casting the micro mirrors with a mirror tool in contact with the surface of the substrate.
Claim 16	
16	The method of claim 15, wherein the substrate provided in the providing step comprises a clear, energy-cured polymer.
Claim 17	
17	The method of claim 12, further comprising providing the substrate and forming the array of micro mirrors by metallization of surfaces of the micro mirrors, wherein the metallization applies a layer of aluminum, gold, or silver to form reflective surfaces.
Claim 18	
18	The method of claim 17, wherein the forming the array of micro mirrors includes, prior to the metallization of the surfaces of the micro mirrors, embossing the surface of the substrate to form the surfaces of the micro mirrors and wherein the surface of the substrate includes an embossable coating or layer.
Claim 19	
19	The method of claim 12, further comprising providing the substrate and forming the array of micro mirrors by filling in recessed surfaces associated with the micro mirrors with a filler comprising at least one of an ultraviolet (UV) varnish, an e-beam solvent, and a water-based varnish.

Claim 20	
20	The method of claim 19, wherein the filler has a refractive index of at least 1.55, whereby at least a portion of the received ambient light at extreme angles is reflected to sharpen the displayed image.

CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that foregoing
**PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO.
11,448,863**, exclusive of the parts exempted as provided in 37 C.F.R. §42.24(a),
contains 13,971 words and therefore complies with the type-volume limitations of
37 C.F.R. §42.24(a).

Dated: May 2, 2024

Respectfully submitted,

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CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the foregoing **PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. ,11,448,893 AND EXHIBITS** are being served on May 2, 2024, via Federal Express overnight mail on counsel of record for U.S. Patent No. 11,448,863 as addressed below:

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A courtesy copy is also being served on counsel for the patent holder in the pending litigation via electronic mail.

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