Petitioners' Demonstratives

United States Patent and Trademark Office
Before the Patent Trial and Appeal Board

Giesecke+Devrient Currency Technology GMBH, Giesecke+Devrient GMBH, Papierfabrik Louisenthal GMBH, Petitioners

v.

Lumenco, LLC, Patent Owner

U.S. Patent Nos. 10,189,294; 10,901,191; 11,448,863

Cases: IPR2024-000836, -838, -839

Oral Hearing: August 26, 2025

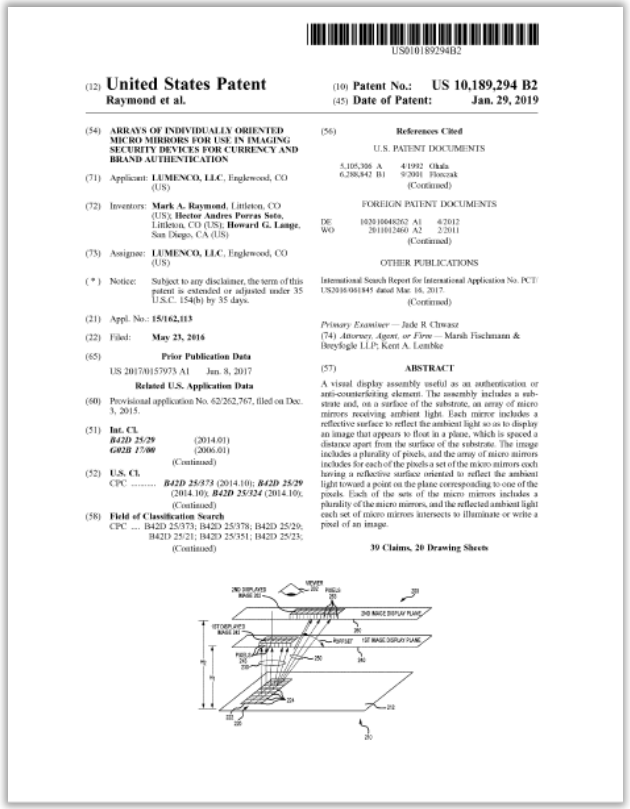
**Giesecke+Devrient GmbH,
Giesecke+Devrient Currency Technology GmbH,
and Papierfabrik Louisenthal GmbH.
IPR2024-00839 - Ex. 1056**

Challenged Patents

Giesecke+Devrient GmbH,
Giesecke+Devrient Currency Technology GmbH,
and Papierfabrik Louisenthal GmbH.
IPR2024-00839 - Ex. 1056

Challenged Patents

’294 Patent
Filed: May 23, 2016
Issued: Jan. 29, 2019



(12) **United States Patent**
Raymond et al.

(10) **Patent No.: US 10,189,294 B2**
(45) **Date of Patent: Jan. 29, 2019**

(54) **ARRAYS OF INDIVIDUALLY ORIENTED MICRO MIRRORS FOR USE IN IMAGING SECURITY DEVICES FOR CURRENCY AND BRAND AUTHENTICATION**

(71) Applicant: **LUMENCO, LLC**, Englewood, CO (US)

(72) Inventors: **Mark A. Raymond**, Littleton, CO (US); **Hector Andres Porras Soto**, Littleton, CO (US); **Howard G. Lange**, San Diego, CA (US)

(73) Assignee: **LUMENCO, LLC**, Englewood, CO (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 35 days.

(21) Appl. No.: **15/162,113**

(22) Filed: **May 23, 2016**

(65) **Prior Publication Data**
US 2017/0157973 A1 Jan. 8, 2017

Related U.S. Application Data

(60) Provisional application No. 62/262,767, filed on Dec. 3, 2015.

(51) **Int. Cl.**
B42D 25/29 (2014.01)
G02B 17/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***B42D 25/373*** (2014.10); ***B42D 25/29*** (2014.10); ***B42D 25/324*** (2014.10);
(Continued)

(58) **Field of Classification Search**
CPC ... B42D 25/373; B42D 25/378; B42D 25/29; B42D 25/21; B42D 25/351; B42D 25/23;
(Continued)

(56) **References Cited**
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(Continued)
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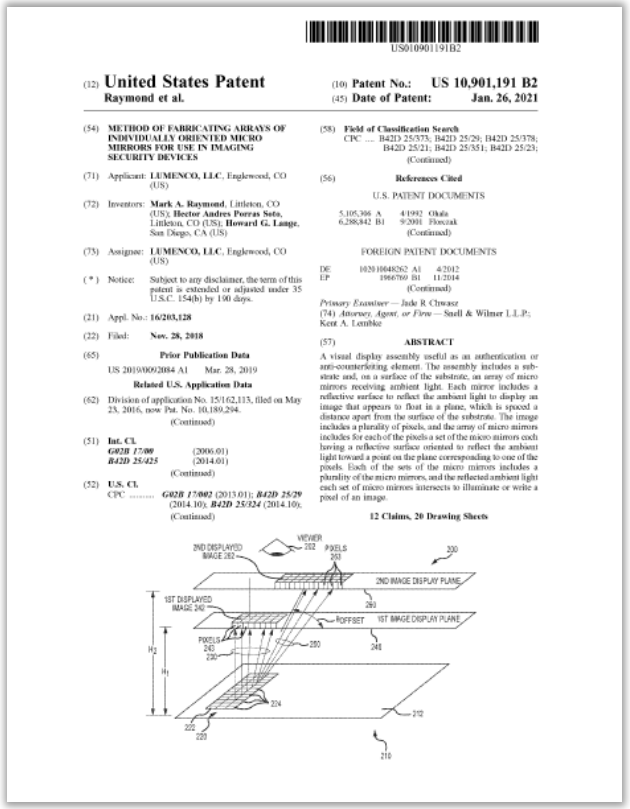
(Continued)
OTHER PUBLICATIONS
International Search Report for International Application No. PCT/US2016/061845 dated Mar. 16, 2017.
(Continued)

Primary Examiner — Jade R Chwasz
(74) *Attorney, Agent, or Firm* — Marsh Fischmann & Breyfogle LLP; Kent A. Lembke

(57) **ABSTRACT**
A visual display assembly useful as an authentication or anti-counterfeiting element. The assembly includes a substrate and, on a surface of the substrate, an array of micro mirrors receiving ambient light. Each mirror includes a reflective surface to reflect the ambient light so as to display an image that appears to float in a plane, which is spaced a distance apart from the surface of the substrate. The image includes a plurality of pixels, and the array of micro mirrors includes for each of the pixels a set of 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. Each of the sets of the micro mirrors includes a plurality of the micro mirrors, and the reflected ambient light each set of micro mirrors intersects to illuminate or write a pixel of an image.

39 Claims, 20 Drawing Sheets

’191 Patent
Filed: Nov. 28, 2018
Issued: Jan. 26, 2021



(12) **United States Patent**
Raymond et al.

(10) **Patent No.: US 10,901,191 B2**
(45) **Date of Patent: Jan. 26, 2021**

(54) **METHOD OF FABRICATING ARRAYS OF INDIVIDUALLY ORIENTED MICRO MIRRORS FOR USE IN IMAGING SECURITY DEVICES**

(71) Applicant: **LUMENCO, LLC**, Englewood, CO (US)

(72) Inventors: **Mark A. Raymond**, Littleton, CO (US); **Hector Andres Porras Soto**, Littleton, CO (US); **Howard G. Lange**, San Diego, CA (US)

(73) Assignee: **LUMENCO, LLC**, Englewood, CO (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 190 days.

(21) Appl. No.: **16/203,128**

(22) Filed: **Nov. 28, 2018**

(65) **Prior Publication Data**
US 2019/0092084 A1 Mar. 28, 2019

Related U.S. Application Data

(62) Division of application No. 15/162,113, filed on May 23, 2016, now Pat. No. 10,189,294.
(Continued)

(51) **Int. Cl.**
G02B 17/00 (2006.01)
B42D 25/425 (2014.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G02B 17/002*** (2013.01); ***B42D 25/29*** (2014.10); ***B42D 25/324*** (2014.10);
(Continued)

(58) **Field of Classification Search**
CPC ... B42D 25/373; B42D 25/29; B42D 25/378; B42D 25/21; B42D 25/351; B42D 25/23;
(Continued)

(56) **References Cited**
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(Continued)
FOREIGN PATENT DOCUMENTS
DE 102010048262 A1 4/2012
EP 1966760 B1 11/2014
(Continued)

Primary Examiner — Jade R Chwasz
(74) *Attorney, Agent, or Firm* — Snell & Wilmer L.L.P.; Kent A. Lembke

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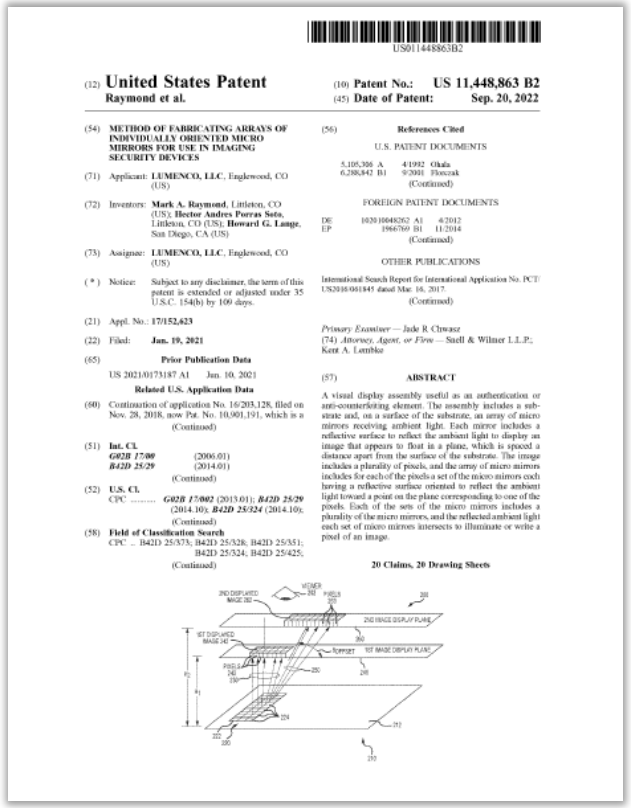
12 Claims, 20 Drawing Sheets

’863 Patent
Filed: Jan. 19, 2021
Issued: Sep. 20, 2022



(12) **United States Patent**
Raymond et al.

(10) **Patent No.: US 11,448,863 B2**
(45) **Date of Patent: Sep. 20, 2022**

(54) **METHOD OF FABRICATING ARRAYS OF INDIVIDUALLY ORIENTED MICRO MIRRORS FOR USE IN IMAGING SECURITY DEVICES**

(71) Applicant: **LUMENCO, LLC**, Englewood, CO (US)

(72) Inventors: **Mark A. Raymond**, Littleton, CO (US); **Hector Andres Porras Soto**, Littleton, CO (US); **Howard G. Lange**, San Diego, CA (US)

(73) Assignee: **LUMENCO, LLC**, Englewood, CO (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 100 days.

(21) Appl. No.: **17/152,623**

(22) Filed: **Jan. 19, 2021**

(65) **Prior Publication Data**
US 2021/0173187 A1 Jan. 10, 2021

Related U.S. Application Data

(60) Continuation of application No. 16/203,128, filed on Nov. 28, 2018, now Pat. No. 10,901,191, which is a
(Continued)

(51) **Int. Cl.**
G02B 17/00 (2006.01)
B42D 25/29 (2014.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G02B 17/002*** (2013.01); ***B42D 25/29*** (2014.10); ***B42D 25/324*** (2014.10);
(Continued)

(58) **Field of Classification Search**
CPC .. B42D 25/373; B42D 25/328; B42D 25/351; B42D 25/324; B42D 25/425;
(Continued)

(56) **References Cited**
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6,288,842 B1 9/2001 Florczak
(Continued)
FOREIGN PATENT DOCUMENTS
DE 102010048262 A1 4/2012
EP 1966760 B1 11/2014
(Continued)
OTHER PUBLICATIONS
International Search Report for International Application No. PCT/US2016/061845 dated Mar. 16, 2017.
(Continued)

Primary Examiner — Jade R Chwasz
(74) *Attorney, Agent, or Firm* — Snell & Wilmer L.L.P.; Kent A. Lembke

(57) **ABSTRACT**
A visual display assembly useful as an authentication or anti-counterfeiting element. The assembly includes a substrate and, on a surface of the substrate, an array of micro mirrors receiving ambient light. Each mirror includes a reflective surface to reflect the ambient light to display an image that appears to float in a plane, which is spaced a distance apart from the surface of the substrate. The image includes a plurality of pixels, and the array of micro mirrors includes for each of the pixels a set of 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. Each of the sets of the micro mirrors includes a plurality of the micro mirrors, and the reflected ambient light each set of micro mirrors intersects to illuminate or write a pixel of an image.

20 Claims, 20 Drawing Sheets

’836 IPR (EX1001); ’838 IPR (EX1001), ’839 IPR (EX1001)

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Giesecke+Devrient GmbH,
Giesecke+Devrient Currency Technology GmbH,
and Papierfabrik Louisenthal GmbH.
IPR2024-00839 - Ex. 1056

Challenged Patents – ’294 Patent

We claim:

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

a substrate; and

on a surface of the substrate, an array of micro mirrors receiving ambient light and, in response, displaying an image in a plane spaced a distance apart from the surface of the substrate, wherein the image comprises a plurality of pixels and wherein the array of micro mirrors includes for each of the pixels a different set of the micro mirrors each having a reflective surface oriented, in a fixed manner with a body of each of the micro mirrors rotated about at least one of first and second rotation axes extending through the body, to reflect the ambient light toward a point on the plane corresponding to one of the pixels, wherein each of the different sets concurrently reflect the ambient light to concurrently generate the plurality of pixels, and wherein a voxel is created at each of the points on the plane via intersection of two or more beams of the reflected ambient light and 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.

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

a substrate; and

on a surface of the substrate, an array of micro mirrors receiving ambient light and, in response, displaying a first image and a second image in a plane spaced a distance apart from the surface of the substrate at first and second viewing angles, respectively,

wherein the first and second images each comprises a plurality of pixels,

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

wherein each of the unique sets of the micro mirrors includes a number of the micro mirrors in the range of 2 to 40, and

wherein the reflected ambient light from the number of the micro mirrors intersects at the point corresponding to the one of the pixels to create a voxel, whereby the voxel acts like a point light source positioned in the plane at the point corresponding to the one of the pixels.

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

a substrate; and

on a surface of the substrate, an array of micro mirrors receiving ambient light and, in response, displaying an image in a plane spaced a distance apart from the surface of the substrate,

wherein the image comprises a plurality of pixels,

wherein the array of micro mirrors includes for each of the pixels a different set of the micro mirrors each having a reflective surface oriented, differently from others of the micro mirrors in the different set, to reflect the ambient light away from the substrate and toward a point on the plane corresponding to one of the pixels, a first set of voxels concurrently being created at the points on the plane via intersection of two or more beams of the reflected ambient light at each of the points on the plane to concurrently display the pixels of the image,

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

wherein the second image comprises a plurality of pixels, and

wherein the array of micro mirrors includes, for each of the pixels of the second image, a different set of the micro mirrors each having a reflective surface oriented, differently from others of the micro mirrors in the different set, to reflect the ambient light away from the substrate and toward a point on the second plane corresponding to one of the pixels of the second image, a second set of voxels concurrently being created at the points on the second plane via intersection of two or more beams of the reflected ambient light at each of the points to concurrently display the pixels of the second image.

Giesecke+Devrient GmbH,
Giesecke+Devrient Currency Technology GmbH,
and Papierfabrik Louisenthal GmbH.

Challenged Patents – ’191 Patent

We claim:

1. A method of fabricating a security element useful on paper and coin currency and product labels, comprising:

providing a substrate; and

forming an array of micro mirrors on a surface of the substrate,

wherein the array of micro mirrors is configured for receiving ambient light and, in response, displaying an image in a plane spaced a distance apart from the surface of the substrate,

wherein the image comprises a plurality of pixels,

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

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

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.

6. A method of fabricating a security element useful on paper and coin currency and product labels, comprising:

providing a substrate; and

forming an array of micro mirrors on a surface of the substrate,

wherein the array of micro mirrors is configured for receiving ambient light and, in response, displaying a first image and a second image in a plane spaced a distance apart from the surface of the substrate at first and second viewing angles, respectively,

wherein the first and second images each comprises a plurality of pixels, and

wherein the array of micro mirrors includes for each of the pixels a unique set of the micro mirrors each having a reflective surface rigidly oriented, by rotating a body of each of the micro mirrors about at least one of two rotation axes extending through the body, to reflect the ambient light away from the substrate toward a point on the plane corresponding to one of the pixels,

wherein each of the unique sets of the micro mirrors includes a number of the micro mirrors in the range of 2 to 40, and

wherein the reflected ambient light from the number of the micro mirrors intersects at the point corresponding to the one of the pixels to create a voxel, whereby the voxel acts like a point light source positioned in the plane at the point corresponding to the one of the pixels.

Giesecke+Devrient GmbH,
Giesecke+Devrient Currency Technology GmbH,
and Papierfabrik Louisenthal GmbH.

Challenged Patents – ’863 Patent

We claim:

1. A method of fabricating a security element, comprising:

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;

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;

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;

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

forming the array of the micro mirrors according to the design output file.

7. A method of fabricating a security element, comprising:

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;

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;

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, 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

forming the array of the micro mirrors according to the design output file.

12. A method of fabricating a security element useful on paper and coin currency and on product labels, comprising:

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;

generating a design output file including an angular orientation and location coordinates in the array for each of the micro mirrors; and

forming the array of micro mirrors according to the design output file,

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,

wherein the image comprises a plurality of pixels, and

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.

Giesecke+Devrient GmbH,
Giesecke+Devrient Currency Technology GmbH,
and Papierfabrik Louisenthal GmbH.
IPR2024-00839 - Ex. 1056

Challenged Patents – Claimed Embodiments (’294 and ’191 Patents)

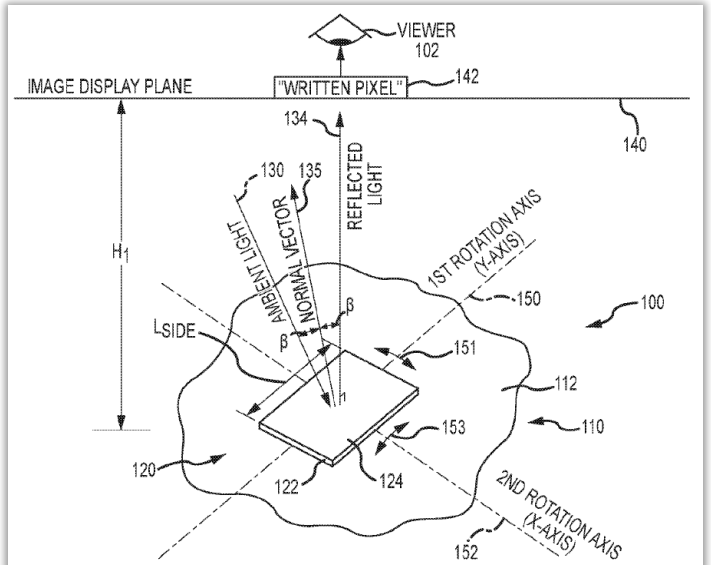


FIG.1

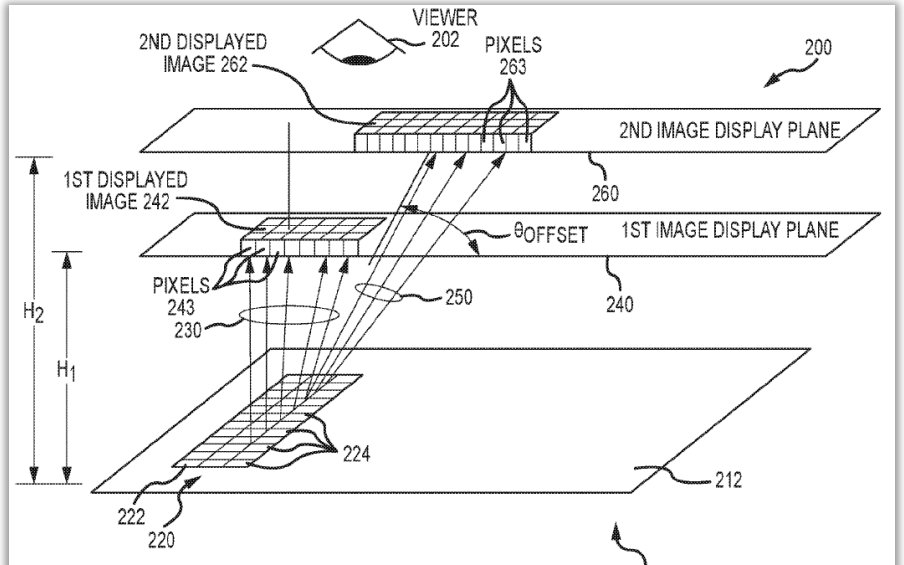


FIG.2

’836 IPR (EX1001, FIGs. 1-2); ’838 IPR (EX1001, FIGs. 1-2)

’836 IPR (Pet., 3-4; Reply, 10-11); ’838 IPR (Pet., 4-5; Reply, 11-12)

Giesecke+Devrient GmbH,
Giesecke+Devrient Currency Technology GmbH,
and Papierfabrik Louisenthal GmbH.
IPR2024-00839 - Ex. 1056

Challenged Patents – Claimed Embodiments (’863 Patent)

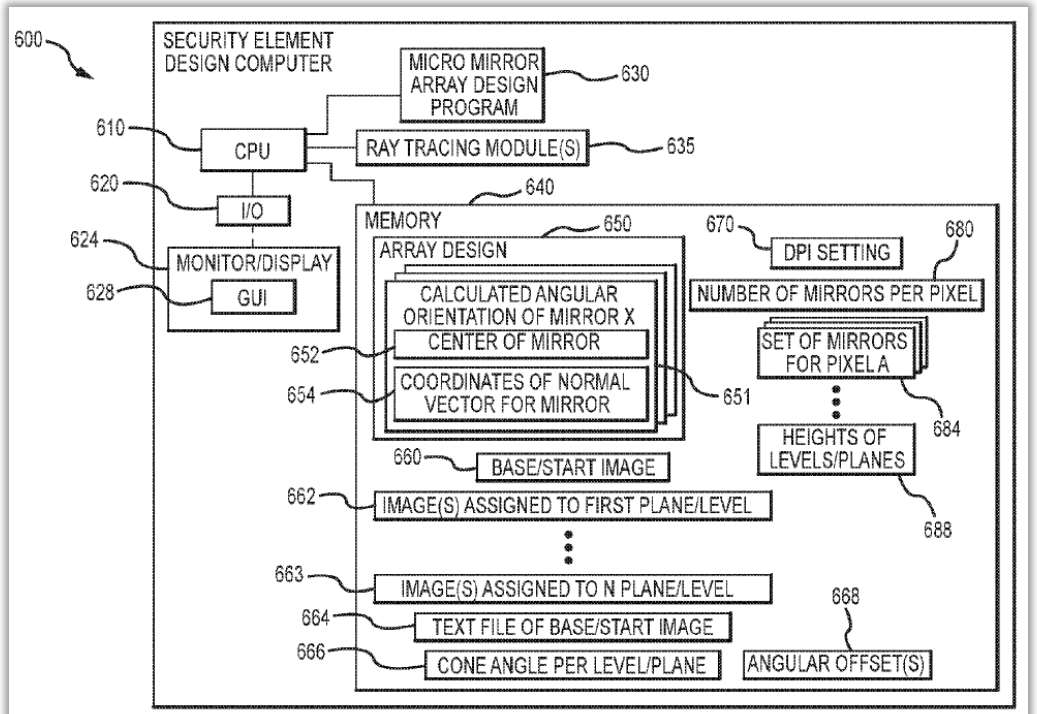


FIG.6

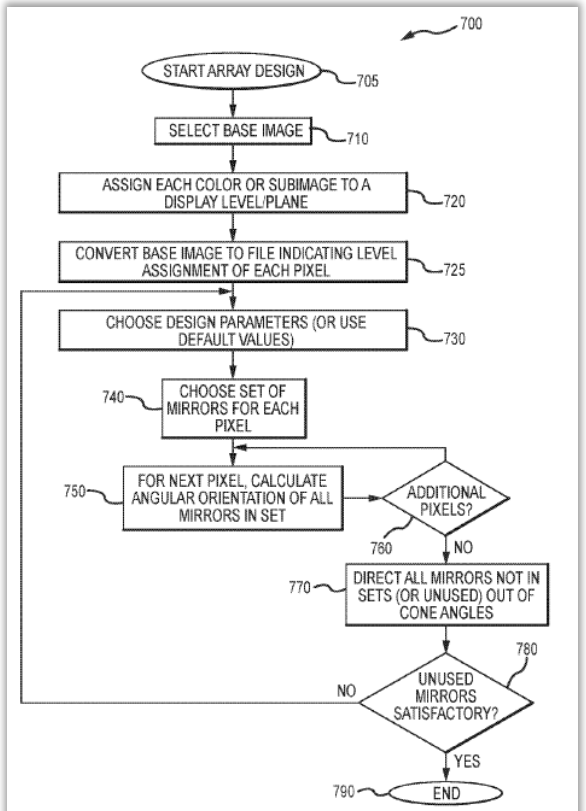


FIG.7

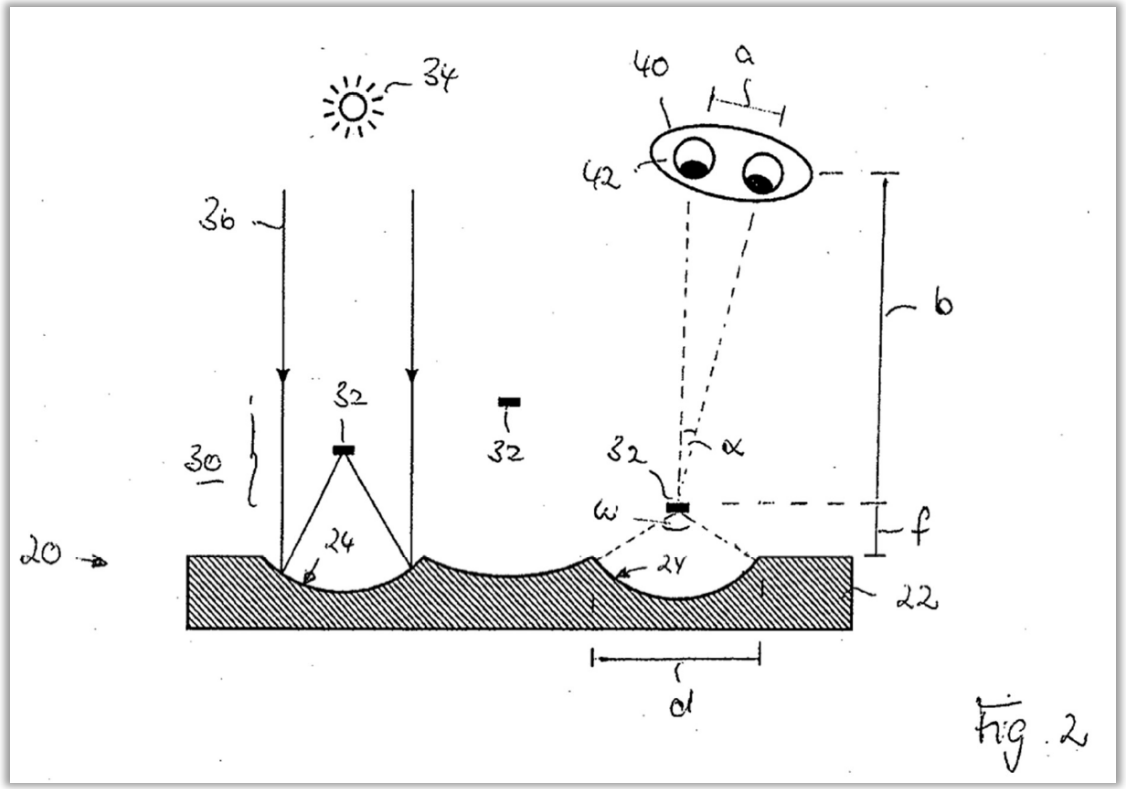
’839 IPR (EX1001, FIGs. 6-7)

Prior Art

Giesecke+Devrient GmbH,
Giesecke+Devrient Currency Technology GmbH,
and Papierfabrik Louisenthal GmbH.

IPR2024-00839 - Ex. 1056

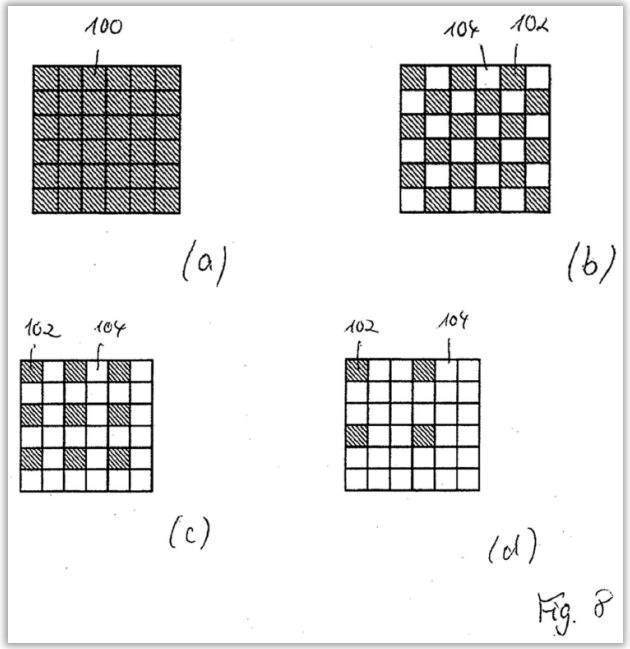
Fuhse262 Discloses Orienting Sets of Micromirrors to Floating Pixels



’836 IPR (EX1006, FIG. 2, ¶0056-57)

Giesecke+Devrient GmbH,
Giesecke+Devrient Currency Technology GmbH,
and Papierfabrik Louisenthal GmbH.
IPR2024-00839 - Ex. 1056

Fuhse262 Discloses Orienting Sets of Micromirrors to Floating Pixels



[0015] According to an advantageous variant of the invention, the light spots of the light-spot image float at several different floating heights above or below the surface region in order to form a three-dimensional motif. According to an alternative, also advantageous variant of the invention, the light spots of the light-spot image all float, in some regions, at the same floating height above or below the surface region in order to form a backdrop motif. A three-dimensional motif can also advantageously be combined with a two-dimensional motif in the light-spot image, since a light-spot image can then still be recognized even in poor illumination conditions and an authenticity check can therefore be carried out.

’836 IPR (EX1006, FIG. 8a-8d, ¶0015)

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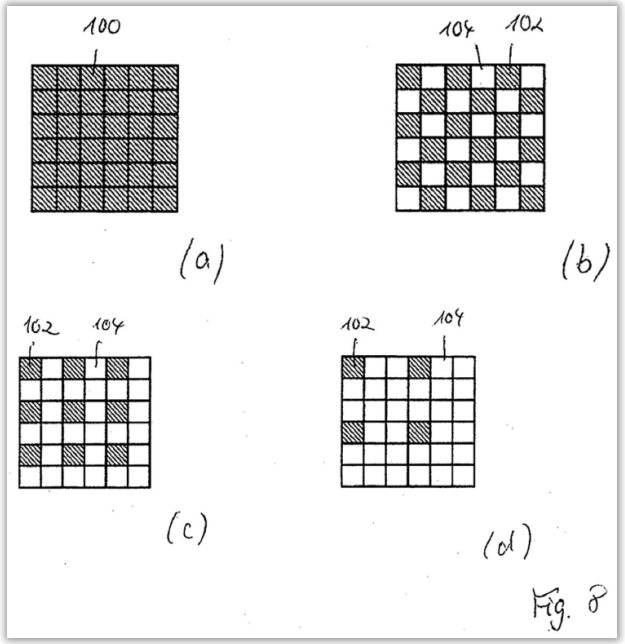
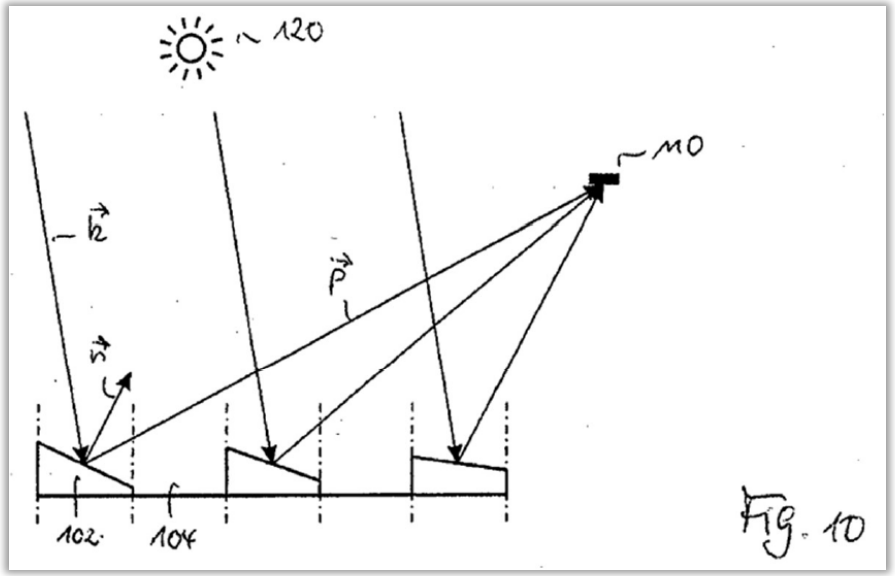
Fuhse262 Discloses Orienting Sets of Micromirrors to Floating Pixels



[0087] To illustrate, Fig. 8 shows four exemplary embodiments in (a) to (d), in which a curved concave mirror is broken down into micro-optical elements 100 with a square base and a flat mirror surface. In the exemplary embodiment of Fig. 8(a), a concave mirror for producing a light spot is replaced by an arrangement of n × n micromirrors 100, which are arranged next to one another without any distance between them in the surface of the security element. Micromirrors 100, for example, have a dimension of 50 µm × 50 µm and can be formed with a flat mirror surface without affecting the imaging quality. The number n × n of micromirrors is, for example, 10 × 10, so that the micromirrors cover a total area of 0.5 mm × 0.5 mm. The calculation of the orientation of the flat mirror surfaces is explained below with reference to Fig. 10. As can be seen by those skilled in the art, the calculation and production of flat micromirrors 100 is significantly simpler than the calculation and production of a curved concave mirror with the same optical effect.

’836 IPR (EX1006, FIG. 8a-8d, ¶¶0086-90)

Fuhse262 Discloses Orienting Sets of Micromirrors to Floating Pixels



[0096] For the calculation, (x_0, y_0, z_0) denotes the position of light spot 110 to be produced with $z_0 > 0$, $(x, y, 0)$ denotes the position of the mirror element to be calculated. $\vec{n}$ is the normal vector of the mirror at position $(x, y, 0)$, $\vec{k}$ is the direction vector of the incident light ray and $\vec{p}$ is the direction vector of the reflected light ray.

[0097] The 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 $\vec{k}$ is reflected onto the focal point (x_0, y_0, z_0) for all micromirrors 102 assigned to light spot 110.

According to the invention, this is achieved by

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

’836 IPR (EX1006, FIG. 10, ¶¶0096-97)

’836 IPR (Pet., 10-11)

Giesecke+Devrient GmbH,
Giesecke+Devrient Currency Technology GmbH,
and Papierfabrik Louisenthal GmbH.
IPR2024-00839 - Ex. 1056

Fuhse262 Discloses Orienting Sets of Micromirrors to Floating Pixels

- a desired three-dimensional motif having image points P_j and height values Z_j above an xy plane is specified, the image points corresponding to the light spots created upon illumination,
- for every image point P_j, a brightness I_j between 0% and 100% is defined,
- there are assigned to the image points P_j aperture cones that have an aperture ratio > 0.2,
- for every image point P_j, a sphere of influence E_j is determined by an intersection of the aperture cone originating from the image point with the xy plane,
- the xy plane is divided into a number of coarse fields, and the coarse fields are each divided into a number of fine fields,
- for every image point P_j, based on the defined height value Z_j and the defined brightness value I_j, a number of fine fields to be filled in is determined,
- the fine fields to be filled in determined for the image point P_j are distributed substantially evenly across the coarse fields in the sphere of influence E_j of the image point P_j, and
- the fine fields to be filled in are covered with refractive and/or reflective optical elements that, upon illumination of the depiction element, contribute to producing the light spot that corresponds to image point P_j.

’836 IPR (EX1006, ¶0036)

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Rich Discloses Programs to Output Micromirror Data Files from Input Images

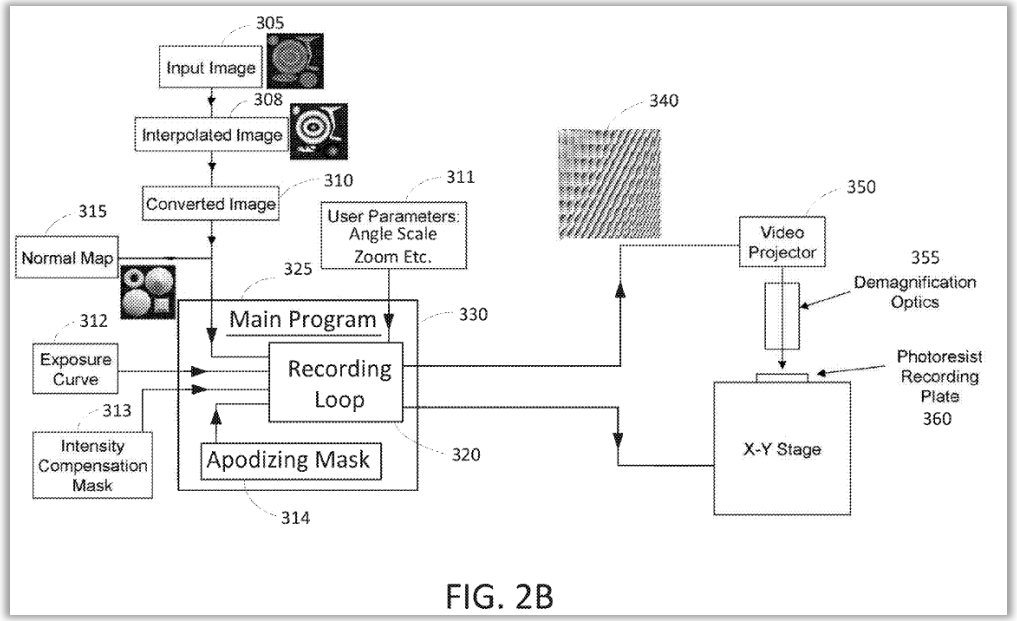

FIG. 2B

’839 IPR (EX1039, FIG. 2B)

For example, in the method **300** shown in FIG. **2**B, the input image **305** can be a 2D input image (e.g., a 2D photograph of the 3D object) or 2D image converted from a 3D image.

’839 IPR (EX1039, 16:40-43)

In the method **300** shown in FIG. **2**B, the converted image **310** (or a normal map **315**) is entered into the recording loop **320** of the main program **325** of the processor **330** in accordance with certain embodiments described herein.

’839 IPR (EX1039, 16:49-52)

This data file **340** can be used as a map to generate the pattern of features F_1, F_2, . . . F_n on the surface **12** of the master **10**. An example data file is discussed with respect to FIG. **3**A.

’839 IPR (EX1039, 17:4-7)

’839 IPR (Pet., 10)

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Fuhse925: Details Regarding Orientation Vector N

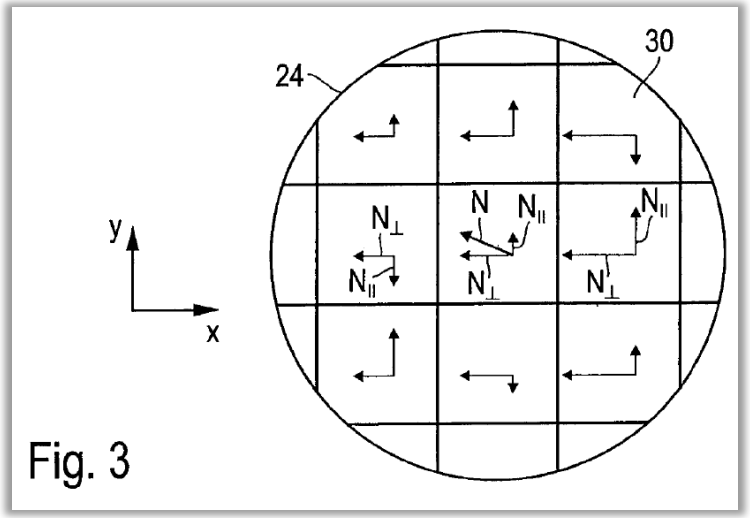

Fig. 3

As shown in the detailed section **24** in FIG. **3**, the depiction region **22** is provided with a plurality of reflective, planar facets **30** that have, for example, a base area of 15 μm×15 μm and a maximum height of a few micrometers. Each of the planar facets **30** is especially characterized by an inclination angle against the plane of the areal motif region **20**, which inclination angle has, as inclination components, a parallel component $N_{\parallel}$ parallel to the line **16** (y-direction in FIGS. **2** and **3**) and a normal component $N_{\perp}$ perpendicular to the line **16** (x-direction in FIGS. **2** and **3**).

’839 IPR (EX1008, FIG. 3, 7:33-42)

’839 IPR (Pet., 10, 66-67)

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Fuhse925: Random Selection

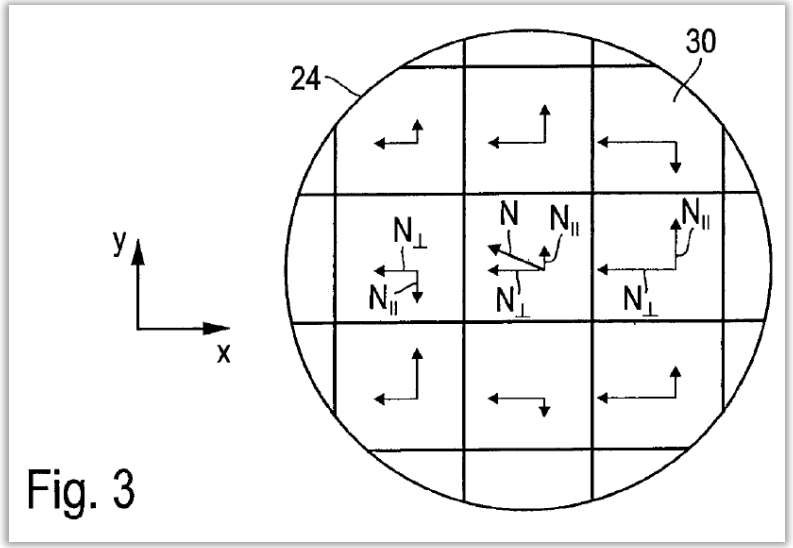

Fig. 3

As a distinctive feature, the inclination of the facets **30** of the areal motif region **20** has, in addition to the normal component $N_{\perp}$, also a non-vanishing parallel component $N_{||}$, parallel to the line **16**, whose value varies randomly in an angle range whose size is comparable with the size of the first angle range in the x-direction. Specifically, the inclination angle of a facet **30** in the position (x,y) parallel to the line **16** in the exemplary embodiment is given by:

$$\alpha_{||}(x,y)=A_y{}^{*}\mathrm{rand}(-1,1), \qquad (2)$$

Wherein rand(−1,1) is a function that yields a random number or pseudorandom number in the interval [−1,1], and A_y indicates the maximum parallel inclination angle.

’839 IPR (EX1008, FIG. 3, 9:1-13)

’839 IPR (Pet., 54-60)

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Disputes

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All Challenged Claims of the ’294 Patent Are Obvious

Ground	Claims	Prior Art
1	**1**, 6-13, **28**, 32, 33, and **35**-38	Fuhse262 (embodiment of Fig. 2) in view of Fuhse262 (embodiment of Figs. 8-10)
2	**1**, 6-13, **28**, 32, 33, and **35**-38	Fuhse262 (Ground 1) in view of Fuhse925
3	**1**, 6-13, **28**, 32-33, and **35**-38	Fuhse262 (Ground 1) in view of Jordan
4	**1**, 6-13, **28**, 32-33, and **35**-38	Fuhse262 and Fuhse925 (Ground 2) in view of Jordan
5-8	14, 34, 39	Grounds 1, 2, 3, or 4 in view of Fuhse172

’836 IPR (Pet., 6)

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All Challenged Claims of the ’191 Patent Are Obvious

Ground	Claims	Prior Art
1	**1-6**	Fuhse262 (embodiment of Fig. 2) in view of Fuhse262 (embodiment of Figs. 8-10)
2	**1-6**	Fuhse262 (Ground 1) in view of Fuhse925
3	2-4, 7-11	Fuhse262 (Ground 1) in view of Fuhse395
4	2-4, 7-11	Fuhse262 (Ground 1) in view of Sauvage-Vincent
5	5, 12	Fuhse262 (Ground 1) in view of Morford
6	2-4, 7-11	Fuhse262, Fuhse925 (Ground 2) and in further view of Fuhse395 (Ground 3)
7	2-4, 7-11	Fuhse262, Fuhse925 (Ground 2) and in further view of Sauvage-Vincent (Ground 4)
8	2, 12	Fuhse262, Fuhse925 (Ground 2) and in further view of Morford (Ground 5)

’838 IPR (Pet., 7)

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All Challenged Claims of the ’863 Patent Are Obvious

Ground	Claims	Prior Art
1	**1**-2, 5-6, **12**-14	Fuhse847 in view of Rich
2	3-4, 6, **7**-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

’839 IPR (Pet., 4-5)

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Patent Owner Arguments: ’294 and ’191 Patents

Argument	Patents	Claims
“voxel”	’294 and ’191	All Independent Claims
“a second image in a second plane”	’294	Independent Claim 35

See ’836 and ’838 IPRs (PORs)

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Patent Owner Arguments: ’294 and ’191 Patents

Argument	Patents	Claims
“voxel”	’294 and ’191	All Independent Claims
“a second image in a second plane”	’294	Independent Claim 35

See ’836 IPR (POR, 14-21); ’838 IPR (POR, 14-20)

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The Parties Agree No Construction Necessary

- **The Parties agree no claim terms require express construction to resolve the challenges.**

’836 IPR (Pet., 13; POR, 13-14), ’838 IPR (Pet., 15-16; POR, 13), ’839 IPR (Pet., 11; POR, 13)

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Claimed "voxel" in the '294 and '191 Patents

We claim:

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

a substrate; and

on a surface of the substrate, an array of micro mirrors receiving ambient light and, in response, displaying an image in a plane spaced a distance apart from the surface of the substrate, wherein the image comprises a plurality of pixels and wherein the array of micro mirrors includes for each of the pixels a different set of the micro mirrors each having a reflective surface oriented, in a fixed manner with a body of each of the micro mirrors rotated about at least one of first and second rotation axes extending through the body, to reflect the ambient light toward a point on the plane corresponding to one of the pixels, wherein each of the different sets concurrently reflect the ambient light to concurrently generate the plurality of pixels, and wherein a voxel is created at each of the points on the plane via intersection of two or more beams of the reflected ambient light and 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.

EX1001 ('294 patent), Claim 1

'836 IPR (Ex. 1001), '838 IPR (Ex. 1001)

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The Parties Agree on the Meaning of “voxel”

The Parties agree a “voxel” is a pixel with volume.

’836 IPR (Pet., 31; POR, 14-15; Reply, 4); ’838 IPR (Pet., 32-33; POR, 14-15; Reply, 5)

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The Shared Specification Does not Use the Term "Voxel"

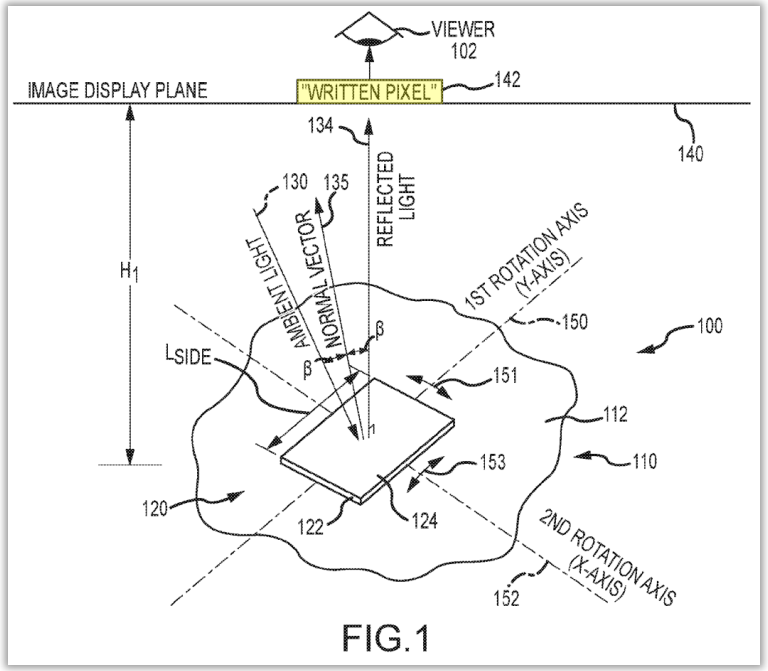

FIG.1

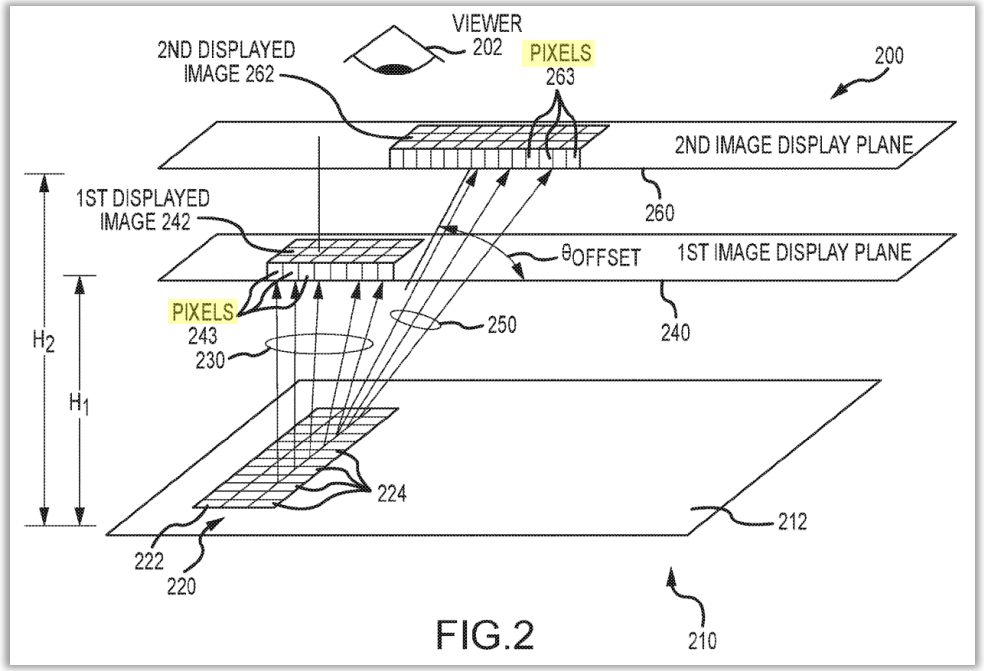

FIG.2

'836 IPR (EX1001, FIGs. 1-2); '838 IPR (EX1001, FIGs. 1-2)

'836 IPR (Pet., 31; Reply, 4); '838 IPR (Reply, 5)

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“Voxel” Was Added During Prosecution to Overcome Raber

system). Again, Applicant adds emphasis to stress that Raber teaches varying the focal length to sequentially display 2D images onto differing image planes to provide 3D and does not shown displaying 2D images concurrently and teaches focusing a whole 2D image onto different focal planes and not writing a plurality of voxels to create the 2D image.

’836 IPR (EX1002, 423)

’836 IPR (Pet., 31; Reply, 4)

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PO Improperly Requires Use of Identical Language

While those elements must be arranged or combined in the same way as in the claim, the reference need not disclose the elements in the very same terms used by the patent. *In re Gleave*, 560 F.3d 1331, 1334 (Fed. Cir. 2009) ("[T]he reference need not satisfy an *ipsissimis verbis* test." (citing *In re Bond*, 910 F.2d 831, 832–33 (Fed. Cir. 1990)). And "[e]ven if a reference's teachings are insuffi-

Adasa Inc. v. Avery Dennison Corp., 55 F.4th 900, 909 (Fed. Cir. 2022)

'836 IPR (Reply, 4-5); '838 IPR (Reply, 5-6)

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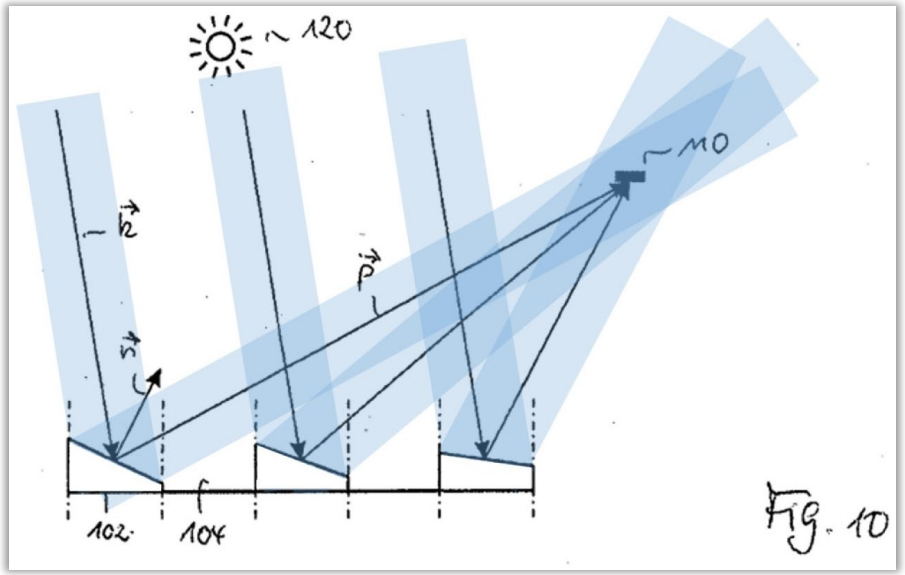
Undisputed Teachings of Fuhse262

PO does not dispute that Fuhse262 Teaches:

- Sets of micro mirrors in an array are assigned to a "pixels" / "light spots" with 3-D coordinates in space. Pet., 23-29 ([1b.3]).
- Incident ambient rays strike entire mirror surfaces, which are individually oriented to reflect beams of light towards assigned pixels. Pet., 18-20 ([1b.1]), 23-33 ([1b.3-1b.5]).
- The reflected beams for each micro mirror in a set intersect at the coordinates of the pixel. Pet., 23-33 ([1b.4-1b.5]).
- Pluralities of pixels form floating images in space. Pet., 20-23 ([1b.2]), 33-34 ([1b.6]).



'836 IPR (EX1003, ¶¶169-70; EX1006, FIG. 10, ¶¶95-97)

*citations refer to '836 IPR

'836 IPR (Reply, 8-9); '838 IPR (Reply, 8-10)

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PO Offers Unsupported Attorney Argument

Fuhse262 discloses that each pixel or image point P_j is formed at a specific ***point*** in space, *i.e.*, a specific point defined by its x, y, and x coordinates. *Id.* at ¶¶ [0095]-[0097]; Petition, p. 31. A POSITA would understand Fuhse262's consistent description of a pixel as an "image ***point***" as disclosure of a 2d pixel.

'836 IPR (POR, 15); '838 IPR (POR, 15)

'836 IPR (Reply, 5); '838 IPR (Reply, 6)

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Petitioners Do Not Allege Inherency for Fuhse262's Disclosure of "Voxel"

However, in considering the disclosure of a reference, it is proper to take into account not only specific teachings of the reference but also the inferences which one skilled in the art would reasonably be expected to draw therefrom. In re Shepard, 319 F.2d 194,

***In re Preda*, 401 F.2d 825, 826 (CCPA 1968) (J. Rich)**

'836 IPR (Reply, 6); '838 IPR (Reply, 7)

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PO Fails to Identify Additional Requirements of "Voxel"

use in displaying an image. A haphazard and unintentional overlapping of random light beams does not magically create an image pixel or voxel, and Petitioner has not presented any evidence to the contrary.

'836 IPR (POR, 16-17); '838 IPR (POR, 16)

'836 IPR (Reply, 6-9); '838 IPR (Reply, 7-10)

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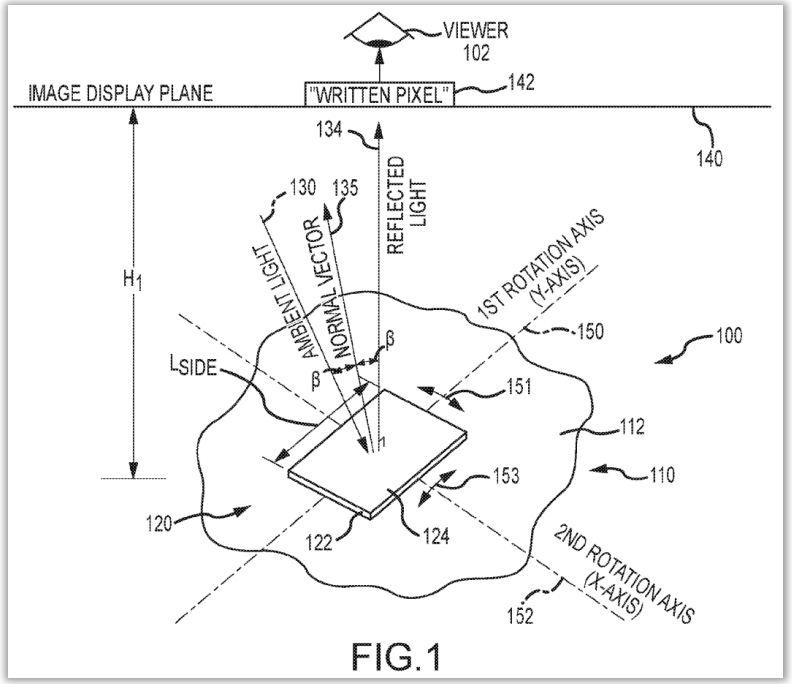
PO's Expert Confirms the Patent and Fuhse262 Teach the Same

- PO's expert confirmed how the '294 patent teaches forming a voxel, which includes no additional complexity from what Fuhse262 describes:
  - a micro-mirror (EX1055, 99:4-6; EX1001, 6:15-41)
  - "ambient light 130" strikes the micro mirror at angle β with the normal vector (EX1055, 99:11-16; EX1001, 6:41-50)
  - "reflected light 134" is reflected with the same angle β based on the law of reflection (EX1055, 105:15-107:14; EX1001, 6:41- 50), so as to coincide with the coordinate of a pixel (EX1055, 107:16-109:5; EX1001, 6:51-65), by orienting the normal vector of the micro mirror (EX1055, 108:1- 109:5; EX1001, 6:66-7:22)
  - This process is repeated for the set of micro mirrors for that pixel (EX1055, 108:1- 109:5; EX1001, 6:59-65).



'836 IPR (EX1001, FIG. 1); '838 IPR (EX1001, FIG. 1)

'836 IPR (Reply, 10-11); '838 IPR (Reply, 10-12)

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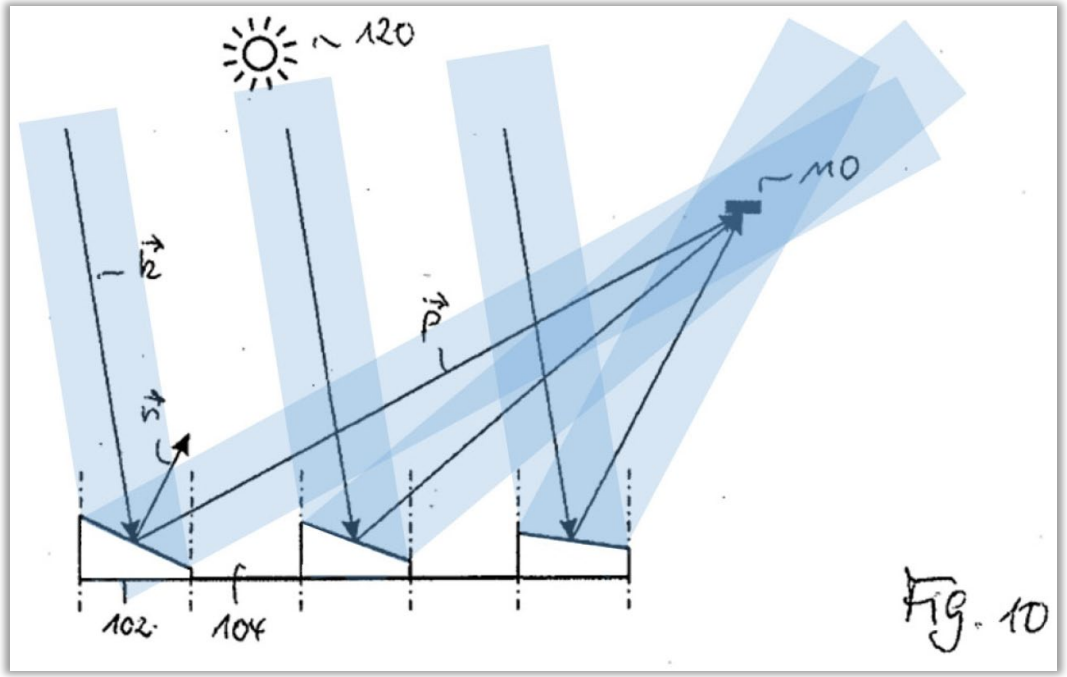
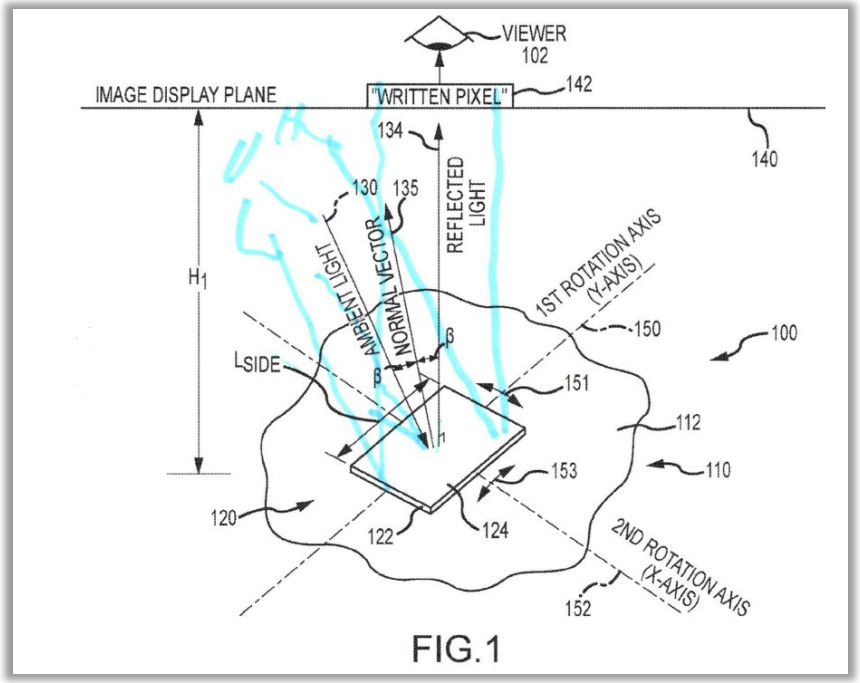
PO's Expert Confirms the Patent and Fuhse262 Teach the Same



'836 IPR (EX1003, ¶170 (annotation of EX1006, FIG. 10))
'838 IPR (EX1003, ¶178 (annotation of EX1006, FIG. 10))



'836 IPR (EX1054, 3); '838 IPR (EX1054, 3)

'836 IPR (Reply, 10-11); '838 IPR (Reply, 10-12)

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PO's "Technical Challenges" are Irrelevant and Unsupported

- **PO alleges "technical challenges" in creating a voxel (POR, 17-18):**
  - **Petitioners do not propose modification of Fuhse62 to achieve "voxels"**
  - **None described in asserted patents or Fuhse262**

'836 IPR (Reply, 12-13); '838 IPR (Reply, 12-13)

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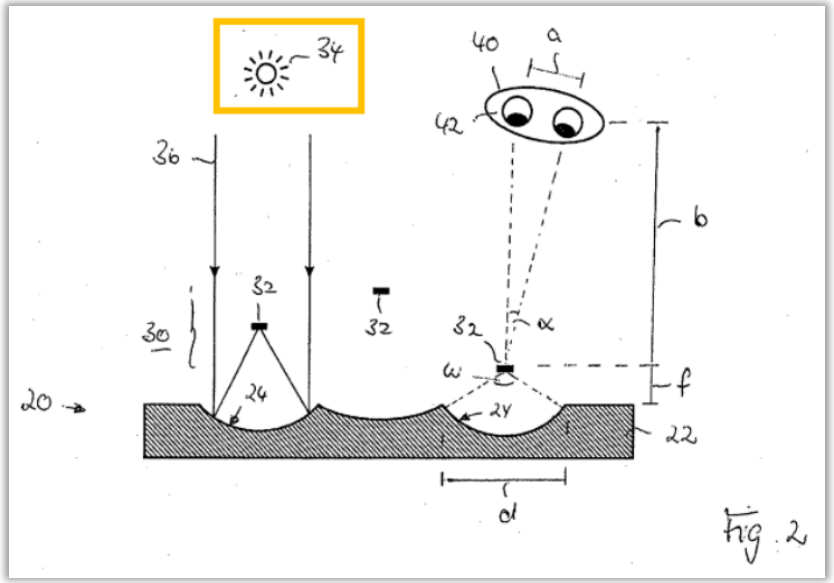
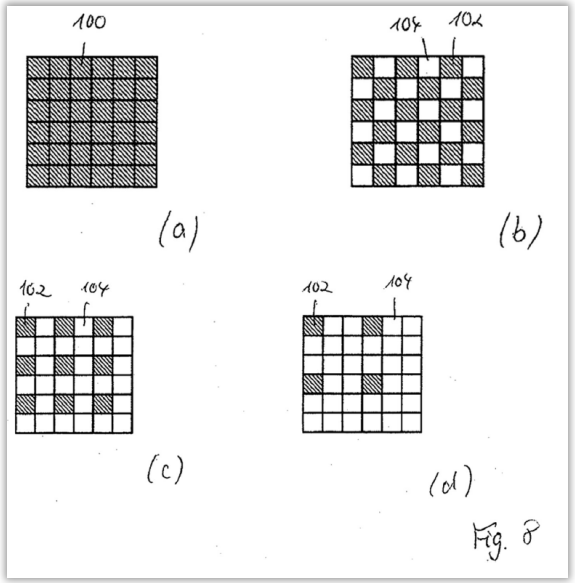
PO Does Not Dispute "Ambient Light"





[0054] When illuminated, for example by sunlight or a ceiling lamp, security element 12 produces a three-dimensional light-spot image for a viewer from a plurality of light spots, each of which appears to a viewer to float above or below the level of security element 12. Different light spots have different floating heights, so that the light spots together form a three-dimensional motif, for example a light pyramid protruding from the banknote.

'836 IPR and '838 IPR (EX1006, ¶54, FIGs. 2, 8)

'836 IPR (Pet., 20; Reply, 13); '838 IPR (Pet., 22-23; Reply, 13-14)

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Patent Owner Arguments: ’294 and ’191 Patents

Argument	Patents	Claims
“voxel”	’294 and ’191	All Independent Claims
“a second image in a second plane”	’294	Independent Claim 35

’836 IPR (POR, 21-24)

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE 38

Claimed "second image in a second plane" in the '294 Patent

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

a substrate; and

on a surface of the substrate, an array of micro mirrors receiving ambient light and, in response, displaying an image in a plane spaced a distance apart from the surface of the substrate,

wherein the image comprises a plurality of pixels,

wherein the array of micro mirrors includes for each of the pixels a different set of the micro mirrors each having a reflective surface oriented, differently from others of the micro mirrors in the different set, to reflect the ambient light away from the substrate and toward a point on the plane corresponding to one of the pixels, a first set of voxels concurrently being created at the points on the plane via intersection of two or more beams of the reflected ambient light at each of the points on the plane to concurrently display the pixels of the image,

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

wherein the second image comprises a plurality of pixels, and

wherein the array of micro mirrors includes, for each of the pixels of the second image, a different set of the micro mirrors each having a reflective surface oriented, differently from others of the micro mirrors in the different set, to reflect the ambient light away from the substrate and toward a point on the second plane corresponding to one of the pixels of the second image, a second set of voxels concurrently being created at the points on the second plane via intersection of two or more beams of the reflected ambient light at each of the points to concurrently display the pixels of the second image.

EX1001, Claim 35

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Independent Claims of the ’294 Patent

Claim	Claimed Image Plane	Claim Language	PO Disputes?
1	displaying an image in a plane	“displaying an image in a plane spaced a distance apart from the surface of the substrate” [1b.2]	**No**
28	displaying two images in a plane	“displaying a first image and a second image in a plane spaced a distance apart from the surface of the substrate” [28b.2]	**No**
35	displaying two images in *spaced apart* planes	“displaying an image in a plane spaced a distance apart from the surface of the substrate” [35b.2] and “displays a second image in a second plane spaced a distance apart from the plane displaying the image” [35b.5].	**Yes (35b.5)**

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Undisputed and Incorporated Disclosures

- **It is undisputed that:**
  - **(1) Fuhse262 discloses [1b.2]:** “displaying an image in a plane spaced a distance apart from the surface of the substrate”
  - **(2) Fuhse262 discloses [28b.2]:** “displaying a first image and a second image in a plane spaced a distance apart from the surface of the substrate”
  - **(3)** [1b.2] and [28b.2] are incorporated by reference into the [35b.5] position
- **All that [35b.5] mapping adds is that those multiple images may be spaced apart.**

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Fuhse262's Undisputed Disclosures in [1b.2]

- **Fuhse262's undisputed disclosures discussed in [1b.2] show images in planes spaced apart from the substrate**

[0010] According to the invention, a generic depiction element contains a substrate with a surface region in which a plurality of optical elements are arranged. The depiction element is designed and intended to produce, upon illumination, a light-spot image composed of a plurality of light spots, that for a viewer appear floating above or below the surface region and that are arranged in the form of a specified motif.

[0036] According to an advantageous method variant

- a desired three-dimensional motif having image points P_i and height values Z_i above an xy plane is specified, the image points corresponding to the light spots created upon illumination,

[0068] If the convex mirrors of a security element have several different focal lengths, i.e. if the light spots of the light-spot image have several different floating heights above and/or below the substrate surface, a truly three-dimensional motif is created. In some configurations, however, it may also be advisable to design all convex mirrors with the same focal length, so that all light spots in the light-spot image have the same floating height. In this way, a backdrop motif is created that floats at a certain height above or below the substrate surface.

EX1006, ¶¶10, 36, 68

Fuhse262's Undisputed Disclosures in [28b.2]

- **Fuhse262's undisputed disclosures discussed in [28b.2] incorporates [1b.2] and adds that *multiple* images may be in a plane.**

> [0111] In a further development of the invention, the security element can also produce a changing light-spot image when illuminated, in which different images become visible to the viewer from different directions. For example, the procedure for a reflective security element can be as follows; the procedure for a see-through security element is analogous:
> 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. First, the required optical elements that produce the light-spot images when illuminated are determined for both light-spot images. As described in connection with Figs. 8 to 10, each light spot is assigned a plurality of optical elements, here a plurality of micromirrors.
> EX1006, ¶111

- **Petitioners also presented an unrebutted obviousness argument (Pet., 36-37).**

'836 IPR (Reply, 15; Pet. 35-37; EX1003, ¶¶186-95; EX1006, ¶¶111-20)

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Element [35b.5]: Fushe262 Discloses Spacing Images

[0117] It may also be advisable to combine a three-dimensional motif with a two-dimensional motif in the light-spot image, in which all image points are at the same height, preferably at the height of the level of the security element, or after the plane of the security element. Such two-dimensional light spot motifs can still be easily recognized even under poor illumination conditions. For example, if a two-dimensional foreground motif is combined with a three-dimensional background motif, the light-spot image does not disappear completely, even in poor illumination conditions, but is simply reduced to the more robust two-dimensional foreground motif. An authenticity check is therefore still possible even in poor illumination conditions.

EX1006, ¶117

PO's Obviousness Position is Unrebutted

[28.b2] (Pet., 36-37)

To the extent it could be argued that Fuhse262 only explicitly discloses a three-dimensional image in the same place or next to a two-dimensional image (*see* ¶¶0027, 0118), it would have been obvious to provide two two-dimensional images.

[35.b5] (Pet., 43)

To the extent it could be argued that Fuhse262 only explicitly discloses a three-dimensional image in the foreground of a two-dimensional image (*see* ¶0117), it would have been obvious to provide two two-dimensional images. Based on

PO's Arguments Don't Apply to Petitioners' Obviousness Position

POR, 21

each other." Petition, p. 43 (citing Exhibit 1006, ¶¶ [0117]). The cited paragraph of Fuhse262 discloses a single light-spot image that contains both a 3-D motif and a 2-D motif. Exhibit 1006, ¶ [0117] ("It may also be advisable to ***combine*** a three-dimensional motif with a two-dimensional motif ***in the light-spot image***.") (emphasis added).

POR, 22

From Fuhse262's disclosure of a ***single light-spot image*** that ***combines*** a 3-D motif and a 2-D motif, a POSITA would understand that the 3-D motif and the 2-D motif are both displayed ***within the same three-dimensional plane***.

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PO's "three-dimensional plane" Argument

- **Doesn't rebut "foreground" and "background"**
- **Not based on any teaching of the '294 patent or disclosure of Fuhse262**
- **"hyper planes" not relevant**

noun
Mathematics.

1 a subspace of a vector space that has dimension one less than the dimension of the vector space.

Ex. 1052

A hyperplane is a flat affine subspace of one dimension less than its ambient space. In an n-dimensional space, a hyperplane has n−1 dimensions. It can be defined by a linear equation.

Ex. 1053

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Patent Owner Arguments: ’863 Patent

Issue	Claim	Limitation
“first object”	Independent Claim 1	Limitation [1a]: “assigning a first object in a starting digital image to a first image display plane and a second object in the starting digital image to a second image display plane.”
“design output file”	Independent Claim 12	Limitation [12b]: “generating a design output file including an angular orientation and location coordinates in the array for each of the micro mirrors.”
selected randomly	Dependent Claim 3 and Independent Claim 7	“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 Mapping	Dependent Claim 4	N/A

’839 IPR (*see* POR)

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Patent Owner Arguments: ’863 Patent

Issue	Claim	Limitation
“first object”	Independent Claim 1	Limitation [1a]: “assigning a first object in a starting digital image to a first image display plane and a second object in the starting digital image to a second image display plane.”
“design output file”	Independent Claim 12	Limitation [12b]: “generating a design output file including an angular orientation and location coordinates in the array for each of the micro mirrors.”
selected randomly	Dependent Claim 3 and Independent Claim 7	“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 Mapping	Dependent Claim 4	N/A

’839 IPR (POR, 14-18)

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Limitation [1a]

We claim:

1. A method of fabricating a security element, comprising:

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;

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;

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;

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

forming the array of the micro mirrors according to the design output file.

EX1001, claim 1

Limitation [1a]: PO Misconstrues Petitioners' Mapping

1. A method of fabricating a security element, comprising: 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;

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

Pet., 18

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**.

Pet., 18-19

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Fuhse847 Teaches First and Second Objects in a Starting Digital Image

1. A method of fabricating a security element, comprising:
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;

EX1001, claim 1

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.

Pet., 19

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PO Relies on Attorney Argument Regarding a POSITA's Knowledge

The Petition's attempts to remedy the deficiencies of Fuhse847 with expert testimony also fail.

POR, 17

Dr. Hesselink:

176. It would have been obvious that the second image is from **a second object in the starting digital image**. For example, in the case that the two images are two different "two-dimensional" images such as "a font or a logo" (*see* Fuhse847, pp. 5, 7, 26), those two fonts or logos represent two different objects. It would have been obvious that they were both provided in the same **starting digital image**. For example, it was well-known that formats like 3D-CAD, "computer-aided technical drawing," and "3D laser scanning of real three-dimensional bodies" could provide multiple objects in their images.

EX1003, ¶176

'839 IPR (Reply, 5-6)

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Patent Owner Arguments: ’863 Patent

Issue	Claim	Limitation
“first object”	Independent Claim 1	Limitation [1a]: “assigning a first object in a starting digital image to a first image display plane and a second object in the starting digital image to a second image display plane.”
“design output file”	Independent Claim 12	Limitation [12b]: “generating a design output file including an angular orientation and location coordinates in the array for each of the micro mirrors.”
selected randomly	Dependent Claim 3 and Independent Claim 7	“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 Mapping	Dependent Claim 4	N/A

’839 IPR (POR, 18-21)

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Limitation [12b]

12. A method of fabricating a security element useful on paper and coin currency and on product labels, comprising:

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;

generating a design output file including an angular orientation and location coordinates in the array for each of the micro mirrors; and

forming the array of micro mirrors according to the design output file,

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,

EX1001, claim 12

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Petitioners' and Dr. Hesselink's [12b] Position

- **[12b] Position is explained in [1c] mapping:**

c. [12b]:

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

Pet., 42

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**

Pet., 30-31

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.**

Pet., 27-28

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Petitioners' and Dr. Hesselink's [12b] Position

- **Fuhse847's normal vector $\vec{n}$ is *an angular orientation* of each micro mirror**

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**:

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

Pet., 28 (citing EX1022, 21-22; EX1003, ¶¶210-11)

'839 IPR (Reply, 7-9; Pet., 28)

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE 57

Petitioners' and Dr. Hesselink's [12b] Position

- **In the combined system of Fuhse847 and Rich, Rich's processor performs "orientation" calculations according to the *angular orientation* of Fuhse847**

> 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.
>
> Pet., 29

> 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.
>
> Pet., 30

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Petitioners' and Dr. Hesselink's [12b] Position: "Location Coordinates"

- **PO provides attorney argument that Rich's "map" would not include "location coordinates"**
- **It is undisputed that Rich teaches features in an ordered array on the surface of the master (*see* FIG. 3A), and a "map" to pattern them**

corresponding points. This data file **340** can be used as a map to generate the pattern of features F_1, F_2, . . . F_n on the surface **12** of the master **10**. An example data file is discussed with respect to FIG. **3**A.

Ex. 1039 (Rich), 17:4-7

file **240**. The pixels of the data file **340** can also correspond to one or more portions P_1, P_2, . . . P_n of the surface **12** of the master **10** in some embodiments. As shown in FIG. **2**B,

Ex. 1039 (Rich), 17:15-17

Patent Owner Arguments: ’863 Patent

Issue	Claim	Limitation
“first object”	Independent Claim 1	Limitation [1a]: “assigning a first object in a starting digital image to a first image display plane and a second object in the starting digital image to a second image display plane.”
“design output file”	Independent Claim 12	Limitation [12b]: “generating a design output file including an angular orientation and location coordinates in the array for each of the micro mirrors.”
selected randomly	Dependent Claim 3 and Independent Claim 7	“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 Mapping	Dependent Claim 4	N/A

’839 IPR (POR, 21-26)

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Claims 3/7: “selected randomly”

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.

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Fuhse925 Discloses Details Regarding Orientation Vector N

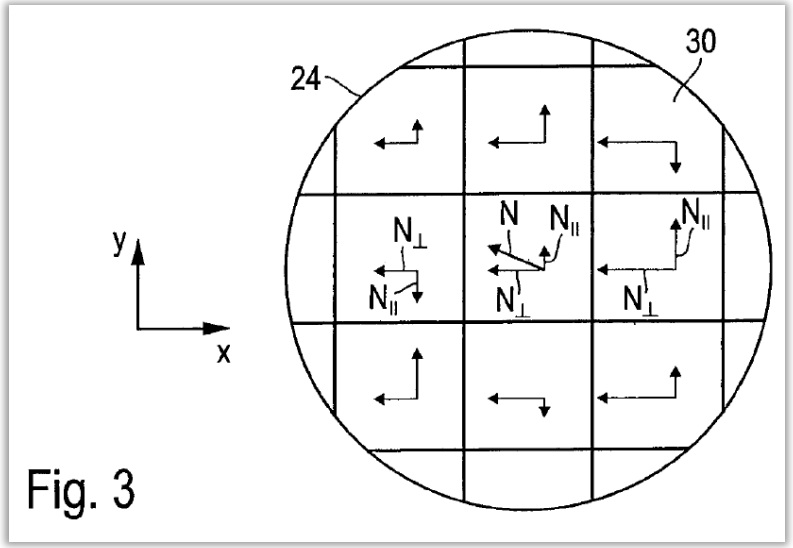

Fig. 3

As a distinctive feature, the inclination of the facets **30** of the areal motif region **20** has, in addition to the normal component $N_{\perp}$, also a non-vanishing parallel component $N_{||}$, parallel to the line **16**, whose value varies randomly in an angle range whose size is comparable with the size of the first angle range in the x-direction. Specifically, the inclination angle of a facet **30** in the position (x,y) parallel to the line **16** in the exemplary embodiment is given by:

$$\alpha_{||}(x,y)=A_y*\mathrm{rand}(-1,1), \quad (2)$$

Wherein rand(−1,1) is a function that yields a random number or pseudorandom number in the interval [−1,1], and A_y indicates the maximum parallel inclination angle.

’839 IPR (EX1008, FIG. 3, 9:1-13)

’839 IPR (Reply, 10-13)

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Fuhse925 Discloses Details Regarding Orientation Vector N

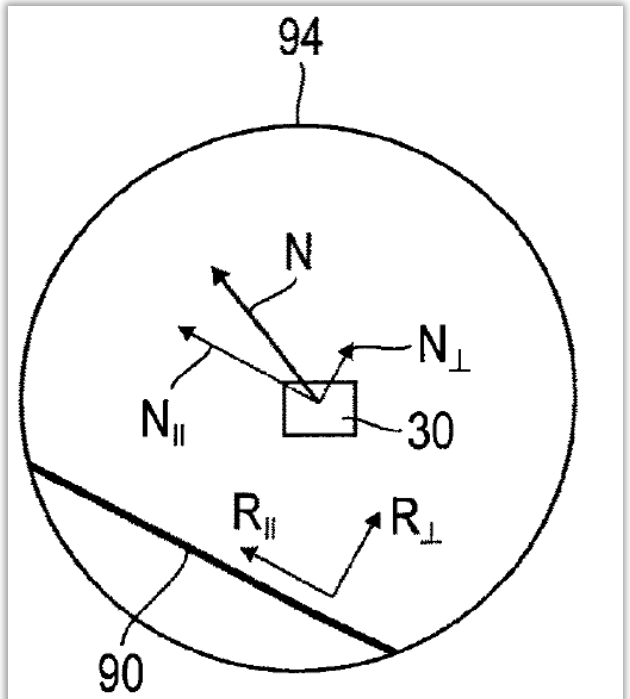

Fig. 7(b)

341. 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.*

’839 IPR (EX1003, ¶341; EX1008, FIG. 7b, 3:3-16, 9:1-31, 11:14-27)

’839 IPR (Reply, 10-13)

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PO Relies on Bodily Incorporation

¶ 77. Fuhse925 does not disclose the use of sets of mirrors that reflect light to a common point to create a pixel of an image and, again, the Petition does not argue otherwise. *Id*. The optical security assembly of Fuhse925 consists of a plurality of facets 30, i.e., mirrors:

POR, 22

PO's "Regular Grid" Argument Lacks Merit

As shown in FIG. 4, each of the mirrors of Fuhse925 are the same width and are arranged in even increments, one next to the other. This is also shown in FIG. 3, which shows facets 30 laid out in a regular grid with each facet 30 having identical lengths and widths of 15 micro meters.

POR, 25

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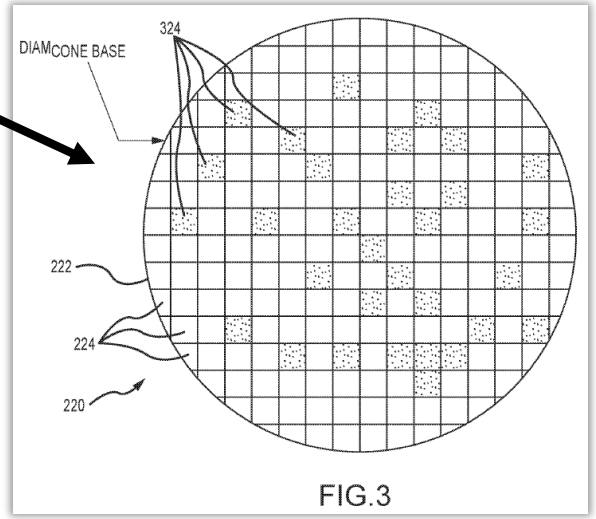
PO's "Regular Grid" Argument Lacks Merit

- **The specification exclusively shows regular grids**



'863 Patent, FIG. 3

- **Dr. Lindstrand acknowledges irrelevance:**

Q So is it your opinion that laying micro mirrors out in a regular grid indicates no random selection?

MR. ROZIER: Object to form. Relevance.

THE WITNESS: I would say that it indicates nothing with regard to the selection process, whether random or non-random. It doesn't tell.

EX1055, 143:11-144:7

'839 IPR (Reply, 14-16)

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PO's "Every" Mirror "is Used" Argument Lacks Merit

- **PO inserts a requirement that "every single one of the mirrors" of Fuhse925 must be used**

> Moreover, Fuhse925 cannot possibly disclose that the mirrors for producing a pixel or an image are selected randomly from the set of available mirrors, as required by claim 3, because every single one of the mirrors of Fuhse925 is used to reflect light for the images created by Fuhse925's optical security feature. Fuhse925 does not disclose any selection of a subset of the micromirrors, whether random or otherwise. *See generally* Exhibit 1008.

POR, 26

- **Dr. Lindstrand relies on this narrow interpretation:**

> every given pixel, the essential part is that you select the micro mirrors on the random basis and you don't use every micro mirrors -- micro mirrors for

EX1055, 149:9-12

'839 IPR (Reply, 16-17)

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Patent Owner Arguments: ’863 Patent

Issue	Claim	Limitation
“first object”	Independent Claim 1	Limitation [1a]: “assigning a first object in a starting digital image to a first image display plane and a second object in the starting digital image to a second image display plane.”
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selected randomly	Dependent Claim 3 and Independent Claim 7	“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 Mapping	Dependent Claim 4	N/A

’839 IPR (Reply, 17-19)

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Claim 4 Mapping

- **Claim 4 depends from claim 3 (addressed in Ground 2), but was listed in Ground 1.**
- **The Board's customary practice is to note the typographical error and evaluate the substance of the petition's contentions.**

> [3] Petitioner includes claims 16 and 17 in this ground even though these claims depend from claim 15, for which Petitioner additionally relies on Huang. We treat this as a typographical error and relist the grounds to account for the correct claim dependency.

Analog Devices, Inc. v. Xilinx Inc., IPR2020-01624, Paper 38, at 2 n.3 (May 3, 2022)

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Patent Owner Arguments: POSITA and Dr. Hesselink

Argument	Patents
POSITA Definition	’294, ’191, and ’863
Dr. Hesselink	’294, ’191, and ’863

’836 IPR (POR, 8-13), ’838 IPR (POR, 8-13), ’839 IPR (POR, 8-13)

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Patent Owner Arguments: POSITA and Dr. Hesselink

Argument	Patents
POSITA Definition	**’294, ’191, and ’863**
Dr. Hesselink	’294, ’191, and ’863

’836 IPR (POR, 8-11), ’838 IPR (POR, 8-10), ’839 IPR (POR, 8-10)

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POSITA Definition

Petitioners' 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, ¶¶68-74.

'836 IPR (Pet., 12)

PO's Level of Ordinary Skill:

In the opinion of Patent Owner's declarant, Dr. Lindstrand, a person of ordinary skill in the art (a "POSITA") in the relevant field, as of the date of alleged invention of the '294 patent, would have had an undergraduate degree in electrical engineering, mechanical engineering, physics, or a similar field and at least 2 years of experience with diffusive light micro-optic security features. *See* **Exhibit 2004**, ¶23.

'836 IPR (POR, 8)

'836 IPR (Reply, 21-26, Pet., 12), '838 IPR (Reply, 14-19, Pet., 15), '839 IPR (Reply, 19-24, Pet., 11)

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Ambient light is not Diffusive Light

- **PO presents a false dichotomy of all light as either "diffusive" or "collimated"**
- **Dr. Lindstrand admits ambient light has both parallel and diffuse components:**

Q So in sunlight, it's a combination of parallel light and diffusive light?

MR. ROZIER: Object to form.

THE WITNESS: I would say that it's a combination of parallel light and diffusive light. And we are talking about going away from theoretical experiments into practice, we are always combination of parallel light and diffusive light, in all conditions.

Ex. 1055, 97:21-98:8

zero. So shadows is a consequence that you -- you have parallel light including in all the energy or light emitted from the sun, including the bouncing around, the reflectances. So if you -- if you

Ex. 1055, 97:7-11

'836 IPR (Reply, 23), '838 IPR (Reply, 16-17), '839 IPR (Reply, 21-22)

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The ’294 Patent Relies on Parallel Light Rays

- **Ambient light 130 strikes micro mirror 120 *with a single angle β*.**

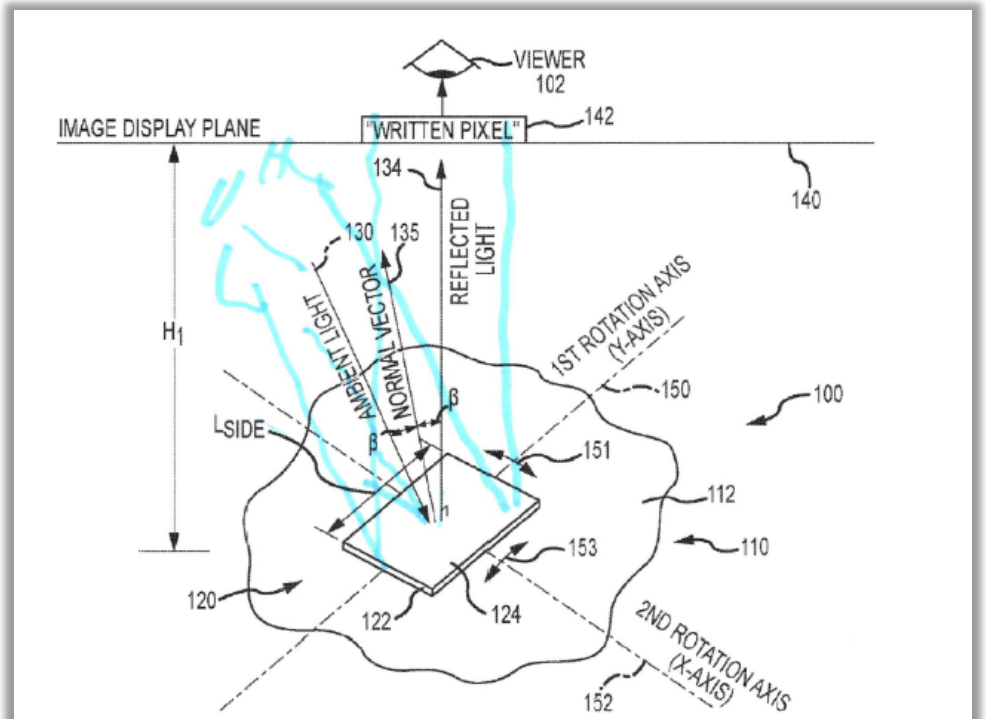


FIG. 1

EX1054, 3

Q Can you please draw some of those?

A I can give -- that is one stream and another stream here (indicating), all parallel. That is parallel with that (indicating) and parallel with that (indicating). And now we are discussing different examples of light rays with the exact same angle of incidence, beta.

Ex. 1055, 119:11-17

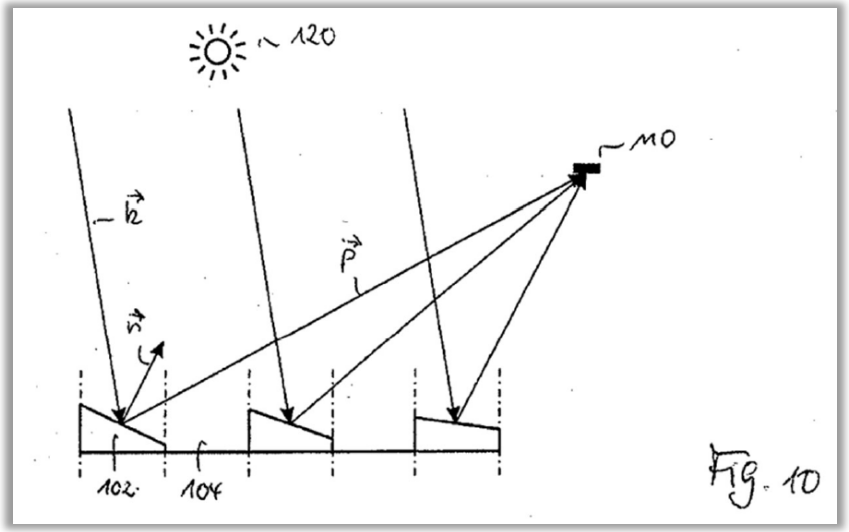
’836 IPR (Reply, 23-25), ’838 IPR (Reply, 17-19), ’839 IPR (Reply, 22-24)

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE 74

Fuhse262 Relies on Parallel Light Rays

- **Fuhse262 also discloses its incident light as parallel:**

[0097] The 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 $\vec{k}$ is reflected onto the focal point (x_0, y_0, z_0) for all micromirrors 102 assigned to light spot 110.



EX1006, ¶¶95-97, FIG. 10;

’836 IPR (Reply, 25-26), ’838 IPR (Reply, 19), ’839 IPR (Reply, 24)

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Giesecke+Devrient Currency Technology GmbH,
and Papierfabrik Louisenthal GmbH.
IPR2024-00839 - Ex. 1056

Patent Owner Arguments: POSITA and Dr. Hesselink

Argument	Patents
POSITA Definition	’294, ’191, and ’863
Dr. Hesselink	**’294, ’191, and ’863**

’836 IPR (POR, 11-13), ’838 IPR (POR, 10-13), ’839 IPR (POR, 10-13)

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Dr. Hesselink is a POSITA

- **PO only argues that Dr. Hesselink is not a POSITA under its "diffusive light" definition**
- **PO waived its objection to Dr. Hesselink**
- **Dr. Hesselink is a POSITA under either definition**