

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

COREPHOTONICS LTD.,
Patent Owner.

IPR2020-00897
Patent 10,324,277 B2

Before BRYAN F. MOORE, GREGG I. ANDERSON, and
MONICA S. ULLAGADDI, *Administrative Patent Judges*.

ANDERSON, *Administrative Patent Judge*.

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

I. INTRODUCTION

Apple, Inc. (“Petitioner”) filed a Petition requesting *inter partes* review of claims 1–24 of U.S. Patent No. 10,324,277 (Ex. 1001, “the ’277 patent”). Paper 3 (“Pet.”). Corephotonics, Ltd. (“Patent Owner”) did not file a Preliminary Response. We instituted *inter partes* review on December 8, 2020. Paper 8 (“Inst. Dec.”). Patent Owner filed a Response (Paper 15, “PO Resp.”), Petitioner filed a Reply (Paper 22, “Reply”), and Patent Owner filed a Sur-Reply (Paper 23, “Sur-Reply”). A hearing was held on September 8, 2021, and a transcript is of record. Paper 33 (“Tr.”).

We have jurisdiction under 35 U.S.C. § 314. Upon considering the record, for reasons discussed below, we find claims 1–24 unpatentable.

II. BACKGROUND

A. *Real Parties in Interest*

The real parties in interest are Apple Inc. and Corephotonics, Ltd. Pet. 1.

B. *Related Matters*

Petitioner advises us that the ’277 patent is the subject of one pending civil action, *Corephotonics, Ltd. v. Apple Inc.*, Case No. 5-18-cv-02555 (N.D. Cal.) (“’2555 case”). Pet. 2. Patent Owner advises us of a separate civil action involving the same parties, *Corephotonics, Ltd. v. Apple Inc.*, Case No. 3:19-cv-04809 (N.D. Cal.) (“’4809 case”). Paper 6, 1. The ’2555 and ’4809 cases were found related to a previously filed case in the Northern District of California between the same parties, Case No. 17-cv-06457 (N.D.Cal.). See ’2555 case, Dkt. 14; ’4809 case, Dkt. 16.

Petitioner further advises us of two *inter partes* review proceedings between these same parties, IPR2018-01140 (“’1140 IPR”) and IPR2018-

01146 (“’1146 IPR”), which challenge respectively certain claims of U.S. Pat. Nos. 9,568,712 (“the ’712 patent”) and 9,402,032 (“the ’032 patent”).^{1, 2} Pet. 8, fn.2.

We identify the following related administrative matters, including every application and patent claiming the benefit of the priority of the filing date of patents in the priority chain of the ’277 patent. *See* Office Consolidated Trial Practice Guide³ at 18; *see also* 84 Fed. Reg. 64,280 (Nov. 21, 2019).

U.S. Patent No. 10,317,647 (“the ’647 patent”) and U.S. Patent No. 10,330,897 (“the ’897 patent”) claim priority to:

Application No. 15/817,235 (now the ’277 patent), which claims priority to Application No. 15/418,925 (now U.S. Patent No. 9,857,568, “the ’568 patent”), which claims priority to Application No. 15/170,472 (now the ’712 patent), which claims priority to Application No. 14/932,319 (now the ’032 patent), which claims priority to Application No. 14/367,924 (abandoned), which claims priority to PCT/IB2014/062465, which claims priority to Prov. No. 61/842,987.

With respect to AIA trial proceedings, we note the following:

IPR2020-00896 (challenges the ’647 patent);

¹ The ’277 patent is a continuation-in-part of the ’712 patent which is a continuation of the ’032 patent. Ex. 1001, at [63].

² The ’1140 and ’1146 IPRs have both terminated in final written decisions relating to certain claims of the challenged patents. ’1140 IPR, Paper 37 (claims 1, 13, 14, and 15 shown unpatentable); ’1146 IPR, Paper 37 (claims 15–17 shown unpatentable). Patent Owner has appealed both decisions to the United States Court of Appeals for the Federal Circuit. ’1140 IPR, Paper 38; ’1146 IPR, Paper 38.

³ Available at <https://www.uspto.gov/TrialPracticeGuideConsolidated>.

IPR2020-00878 (challenges the '897 patent);
IPR2019-00030 (challenges the '568 patent);⁴
IPR2018-01146 (challenges '712 patent); and
IPR2018-01140 (challenges the '032 patent), as identified by
Petitioner.

C. The Technology and '277 Patent

The application for the '277 patent was filed November 19, 2017. Ex. 1001, at [22]. A provisional application No. 61/842,987 was filed July 4, 2013.⁵ *Id.* at [60].

1. Technology

The '277 patent describes and claims an optical lens system used in a portable electronic product such as a cell phone. Ex. 1001, 1:24–29. A long effective focal length (EFL) relative to a short total track length (TTL) of the lens assembly enables good quality images. *Id.* at 1:31–45. The latest lens designs use five lenses but the TTL/EFL ratio is larger than desired. *Id.* at 1:41–45.

⁴ The '030 IPR terminated in a final written decision finding all challenged claims unpatentable. '030 IPR, Paper 32, 48; *see also Corephotonics, Ltd. v. Apple Inc. & Andrew Hirshfeld, Intervenor2* (Appeal No. 2020-1961 (Fed. Cir. Oct. 25, 2021) (affirming final written decision).

⁵ Because the effective filing date of this patent is March 16, 2013, or later, AIA § 103 applies to this proceeding. Ex. 1001, at [52], [60].

2. '277 Patent

Figure 1A of the '277 patent is reproduced below.

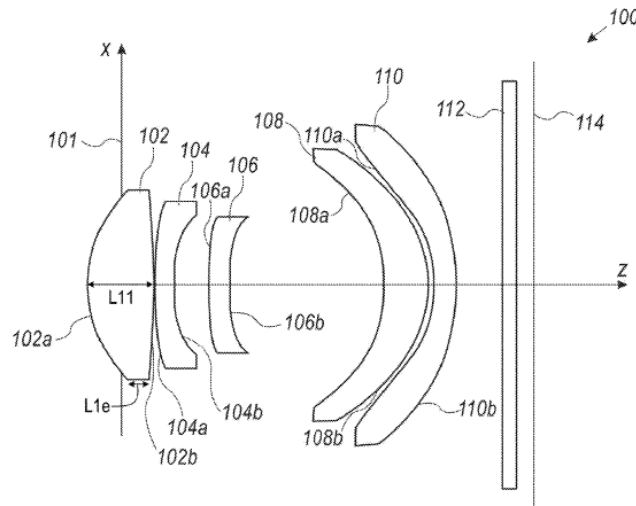


FIG. 1A

Figure 1A illustrates a first embodiment of the optical lens system.

Ex. 1001, 2:59–60. Referring to Figure 1A, optical lens system 100 includes five lenses 102, 104, 106, 108, and 110 arranged in order along optical axis z from the object side of the system (the x axis) to the image side (image plane 114). *Id.* at 3:25–46, 4:19 (discussing optical axis z). Each lens is of a specific refractive power and shape. *Id.* at 3:19–44. An “image sensor (not shown) is disposed at image plane 114 for the image formation.” *Id.* at 3:44–46.

Each of the five lenses of this embodiment has refractive powers and shapes shown in Figure 1A and further specified as follows:

first lens 102 has a positive refractive power and a convex object-side surface and a concave image side surface (Ex. 1001, 3:26–28);

second lens 104 has a negative refractive power of and a meniscus convex object-side surface (*Id.* at 3:28–31);

third lens 106 has a negative refractive power a concave object-side surface and a concave image-side surface (*Id.* at 3:31–33);

fourth lens 108 has a positive refractive power and a positive meniscus with a concave object-side (*Id.* at 3:34–38); and

fifth lens 110 has a negative refractive power having a negative meniscus, with a concave object-side surface (*Id.* at 3:38–41).

D. Illustrative Claim

All claims of the '277 patent, 1 through 24, are challenged. Pet. 9. Claims 1, 11, and 18 are independent apparatus claims to “a lens assembly.” Ex. 1001, 8:21–10:46. The remaining claims 2–10, 12–17, and 19–24 all depend directly or indirectly from one of the independent claims. Claim 1 is reproduced below as illustrative.

[1.0]⁶ A lens assembly, comprising:

[1.1] a plurality of refractive lens elements arranged along an optical axis, wherein at least one surface of at least one of the plurality of lens elements is aspheric,

[1.2] wherein the lens assembly has an effective focal length (EFL),

[1.3] wherein a lens system that includes the lens assembly plus a window positioned between the plurality of lens elements and an image plane has a total track length (TTL) of 6.5 millimeters or less,

[1.4] wherein a ratio TTL/EFL is less than 1.0,

⁶ Each claim and its limitations are bracketed in the Petition. *See, e.g.*, Pet. 20 ([1.0] is the preamble of claim 1). We adopt this format for purposes of this Decision.

[1.5] wherein the plurality of lens elements comprises, in order from an object side to an image side, a first lens element with positive refractive power,

[1.6] a second lens element with negative refractive power,

[1.7] and a third lens element,

[1.8] wherein a focal length f_1 of the first lens element is smaller than $TTL/2$ and

[1.9] wherein a lens assembly $F \#$ is smaller than 2.9.

Ex. 1001, 8:22–36.

E. Evidence

This proceeding relies on the following prior art references and expert testimony:

Ogino (Ex. 1005)⁷: Ogino et al., US 9,128,267 B2, filed Mar. 29, 2013, issued Sept. 8, 2015.

Bareau (Ex. 1012)⁸: Bareau et al., “*The Optics of Miniature Digital Camera Modules*,” SPIE Proceedings Volume 6342, International Optical Design Conference 2006; 63421F (2006), available at <https://doi.org/10.1117/12.692291>.

Petitioner also relies on the Declaration of José Sasián, PhD under 37 C.F.R. § 1.68 (“Sasián Dec.”, Ex. 1003) and the Declaration of José

⁷ Petitioner alleges Ogino “was filed on March 26, 2014 and claims priority to Japanese Application No. 2013-072282 filed on March 29, 2013.” Pet. 9. Thus, Petitioner alleges Ogino is prior art under 35 U.S.C. §102(a)(2) as of its Japanese filing date. *Id.* On this record, we find that Ogino is prior art.

⁸ Petitioner alleges Bareau “was both presented publicly and published in 2006 [Ex. 1003 ¶ 50] and is prior art under §102(a)(1).” Pet. 9. On this record, we find that Bareau is prior art.

Sasián, PhD under 37 C.F.R. § 1.68 in Support of Petitioner Reply (“Sasián Reply Dec.,” Ex. 1037).

Patent Owner relies, in part, on the Declaration of Tom D. Milster, Ph.D. Pursuant to 37 C.F.R. § 1.68 (“Milster Dec.,” Ex. 2001).

F. Asserted Grounds

Petitioner asserts that claims 1–24 would have been unpatentable on the following grounds (Pet. 9):

Claims Challenged	35 U.S.C. §⁹	Reference(s)/Basis
1–3, 5–8	103	Ogino Example 4, ¹⁰ Bareau
1–24	103	Ogino Example 5, Bareau

III. ANALYSIS

A. Level of Ordinary Skill in the Art

Petitioner alleges a person having ordinary skill in the art would have had “(i) a bachelor’s degree in Physics, Optical Sciences, or equivalent training, as well as (ii) approximately three years of experience in designing multi-lens optical systems.” Pet. 7 (citing Ex. 1003, 11¹¹). Petitioner further alleges a person of ordinary skill “would have known how to use lens design software such as Code V, Oslo, or Zemax, and would have taken a lens

⁹ The Leahy-Smith America Invents Act (AIA), Pub. L. No. 112-29, 125 Stat. 284, 285–88 (2011) revised 35 U.S.C. §§ 102 and 103, effective March 16, 2013. The ’277 patent has an effective filing date later than March 16, 2013 (*see* Section II.C, fn. 5). Thus, the grounds asserted are under the AIA version of 35 U.S.C. § 103.

¹⁰ Petitioner primarily relies on Examples 4 and 5, but also cites Example 6. *See, e.g.*, Pet. 27. We consider all cited portions of Ogino.

¹¹ Petitioner alternates its citations to the Sasián Declaration (Ex. 1003) between page numbers and paragraph numbers. *Compare* Pet. 7 (citing page) *with* Pet. 9 (citing paragraph). We refer to page numbers, which are used more often in the Petition, using paragraph cites when they are referenced.

design course.” *Id.* (citing Ex. 1003 ¶ 19). Patent Owner “does not disagree” with Petitioner’s proposed description of a person of ordinary skill in the art. PO Resp. 12 (citing Ex. 2001 ¶ 20). On this record, and to the extent relevant to our findings, we adopt Petitioner’s proposal which is consistent with the prior art of record.

B. Claim Construction

In an *inter partes* review for a petition filed on or after November 13, 2018, a claim “shall be construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b).” *See* Changes to the Claim Construction Standard for Interpreting Claims in Trial Proceedings Before the Patent Trial and Appeal Board, 83 Fed. Reg. 51,340 (Oct. 11, 2018) (amending 37 C.F.R. § 42.100(b) effective November 13, 2018) (now codified at 37 C.F.R. § 42.100(b) (2019)); *see also Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2005) (en banc) (citation omitted). The Petition here was accorded a filing date of May 4, 2020 (Paper 7), and the district court construction standard applies.

1. “effective focal length” and “total track length”

As Petitioner alleges, we construed “effective focal length” (EFL”) and “total track length” (“TTL”)¹² in the final decisions in the ’1140 and ’1146 IPRs. Pet. 8; *id.* at fn. 2. Specifically, our analysis concluded “effective focal length” is “the focal length of a lens assembly.” ’1140 IPR, Paper 37, 10; ’1146 IPR, Paper 37, 8. We further concluded “total track

¹² We also noted in the Institution Decision that Petitioner proposed a different construction of TTL in IPR2020-00877 (“’877 IPR”), which involves the same parties. Inst. Dec. 11. The parties were advised to “address during trial whether and why the construction of this term should differ.” *Id.* Neither party did so.

length” is “the length of the optical axis spacing between the object-side surface of the first lens element and one of: an electronic sensor, a film sensor, and an image plane corresponding to either the electronic sensor or a film sensor.” ’1140 IPR, Paper 37, 10–18; ’1146 IPR, Paper 37, 8–14. The challenged patents in the ’1140 and ’1146 IPRs share common subject matter with the ’277 patent. *See* Section II.B above.

Neither party disputes the constructions of EFL and TTL from the ’1140 or ’1146 IPRs as set forth above. Pet. 8; PO Resp. 13. There is no dispute as to the meaning of EFL or TFL. Accordingly, to the extent relevant and to complete the record, we maintain the above constructions of EFL and TTL for purposes of this Decision.

2. Remaining claim terms

In the Institution Decision, we determined no other claim term required construction. Inst. Dec. 10–11. Both parties agree that the remaining words of the claims do not require express construction and are given their ordinary and customary meaning as understood by a person of ordinary skill in the art. Pet. 8; PO Resp. 13.

C. Obviousness Legal Standard

A patent claim is invalid as obvious if the differences between the claimed invention and the prior art are “such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains.” 35 U.S.C. § 103.

The ultimate determination of obviousness is a question of law, but that determination is based on underlying factual findings. . . . The underlying factual findings include (1) “the scope and content of the prior art,” (2) “differences between the prior art and the claims at issue,” (3) “the level of ordinary skill in the

pertinent art,” and (4) the presence of secondary considerations of nonobviousness such “as commercial success, long felt but unsolved needs, failure of others,” and unexpected results.

In re Nuvasive, Inc., 842 F.3d 1376, 1381 (Fed. Cir. 2016) (citing *inter alia* *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966)).

“To satisfy its burden of proving obviousness, a petitioner cannot employ mere conclusory statements. The petitioner must instead articulate specific reasoning, based on evidence of record, to support the legal conclusion of obviousness.” *In re Magnum Oil Tools Int’l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016). Furthermore, in assessing the prior art, the Board must consider whether a person of ordinary skill would have been motivated to combine the prior art to achieve the claimed invention. *Nuvasive*, 842 F.3d at 1381.

As the Federal Circuit found, in quoting from the Supreme Court’s decision in *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418–419 (2007),

“because inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known,” “it can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does.”

Personal Web Technologies, LLC v. Apple, Inc., 848 F.3d 987, 991–992 (Fed. Cir. 2017).

D. Patent Owner’s Patentability Arguments on Design and Manufacturing Considerations

Patent Owner argues all claims of the ’277 patent remain patentable over all of Petitioner’s asserted grounds of unpatentability. PO Resp. 23–30

(first ground), 40–54 (second ground);¹³ Sur-Reply 4; *see* Sections III.E and F below. Patent Owner argues Petitioner’s unpatentability analysis is “incomplete and ignores how a [person of ordinary skill in the art] would have designed an optical lens assembly.” PO Resp. 23–30 (citing Ex. 2001 ¶¶ 76–79, 83). Patent Owner also argues Petitioner’s unpatentability analysis “does not address the tolerances and manufacturability of the design that would necessarily be considered by a [person of ordinary skill in the art].” *Id.* at 31 (citing Ex. 2001 ¶ 90). Patent Owner’s arguments on design and manufacturing considerations are found throughout Patent Owner’s briefs. *See generally*, PO Resp. 31–55 (grounds 1 and 2); Sur-Reply 8.

Patent Owner relies on the non-precedential opinion in the final decision in the ’030 IPR to argue that manufacturing concerns are relevant to whether a person of ordinary skill in the art would have modified the prior art in the manner Petitioner proposes. Tr. 36:15–23. The ’030 IPR final decision finds a lens designer of ordinary skill would have “taken into account manufacturing concerns.” ’030 IPR, Paper 32 at 18; *see also* Sur-Reply 8 (“manufacturability . . . is not directed toward the claim limitations, but rather to whether a [person of ordinary skill in the art] would have considered manufacturability”). We find that the knowledge of a lens designer of ordinary skill in the art includes familiarity with manufacturing and fabrication. *See* Section III.A above.

Notwithstanding the preceding finding, Patent Owner’s counsel was unable to cite authority reflecting how manufacturability is relevant to the

¹³ Patent Owner’s arguments for the first ground are very similar for the second ground. *Compare* PO Resp. 31 (ground 1) *with* PO Resp. 40 (both arguing “Petitioner ignores the manufacturability of the lenses”). For this Section III.D we discuss the first ground as representative.

ultimate conclusion of obviousness. Tr. 37:5–39:4.¹⁴ That a person of ordinary skill would consider manufacturing issues does not answer whether the claimed subject matter would have been obvious to that person. The level of ordinary skill in the art is only part of the obviousness inquiry. For example, neither Patent Owner nor its expert explain sufficiently how the manufacturing arguments show any “differences between the prior art and the claims at issue.” *See Graham*, 383 U.S. at 17–18. This is an unsurprising result because, as we find below, the claims do not recite any manufacturing requirements.

Patent Owner does not specifically argue that the Petition lacks a sufficient showing of reasons to combine Ogino Examples 4 or 5 and Bareau. *See generally* PO Resp. Patent Owner does argue that a person of

¹⁴ The colloquy from the cited portion of the transcript reads as follows:

JUDGE ANDERSON: Well, so that – that’s interesting, but is there any legal authority other than this non-precedential opinion, which is on appeal as I understand it, to support patent owner’s view that in some way manufacturing concerns are relevant to whether a person of ordinary skill in the art would make this modification?

MR. LINK: Well, Your Honor, I believe -- you know, going back to the very basics, in an obviousness analysis the person of ordinary skill in the art is required to look at the entire scope of the prior art. . . . And so a person of ordinary skill in the art would need to -- necessarily need to consider that to make sure that they could in fact create this lens assembly.

JUDGE ANDERSON: They need to consider what?

MR. LINK: They would need to consider the manufacturability. That is could a design that they created be manufactured?

JUDGE ANDERSON: So my question is do you have any legal authority to support that position?

MR. LINK: Well, beyond this -- you know, this prior holding here, no. . . .

ordinary skill would not combine the references based on various manufacturing considerations. *See, e.g., id.* at 37 (a person of ordinary skill “would not have modified Ogino Example 4” with Bareau because of relative illumination considerations). Patent Owner argues that “in some instances the prior art teaches away from the proposed combination.” *Id.* at 1, 10. At their core, all of Patent Owner’s arguments relate to physical combinability of the references based on manufacturing issues and are not reasons a person of ordinary skill would not have combined the references. *See* Sections III.E.5 and III.F.8 below (analyzing the reasons for combining the references).

Neither does Patent Owner identify any theory of patentability based on an alleged inability to manufacture the claimed invention. As noted above, problems in physically combining references are irrelevant to whether a person of ordinary skill would have had reason to combine the references. *See In re Keller*, 642 F.2d 413, 426 (CCPA 1981) (test for obviousness is not “whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference; nor is it that the claimed invention must be expressly suggested in any one or all of the references”).

We find that design and manufacturing considerations are not recited in any of the claims and cannot be imported into them. *See* Reply 9–10. On this record, manufacturing considerations would not have been a reason preventing a person of ordinary skill in the relevant field from combining the elements in the way the claimed new invention does. *See Personal Web Technologies*, 848 F.3d at 991–992; *see, e.g.,* PO Resp. 31 (arguing the Petition does not address “tolerances and manufacturability” in combining Ogino Example 4 and Bareau). This finding is supported by the claim

language, which does not recite any design and manufacturing consideration. *See, e.g.*, Ex. 1001, 8:22–36 (claim 1, reproduced above in Section II.D). Based on Patent Owner’s inability to articulate any legal theory supporting its position on manufacturability, we further find that a person of ordinary skill would “not wholly reject a design because it did not meet various manufacturing considerations.” *See* Reply 13 (citing Ex. 1037 ¶ 22).

The finding is also supported by testimony from Patent Owner’s and Petitioner’s experts. Relative to manufacturing, Dr. Milster testified the claims of the ’277 patent do not recite manufacturing considerations “other than what’s understood -- would be understood by a [person of ordinary skill in the art].” Milster Deposition (“Milster Dep.,” Ex. 1028, 90:13–91:4); *see also* Ex. 1037 ¶ 17 (relying on the above Milster Deposition testimony to assert the claims “do not recite **any** manufacturing requirements”).

In the ’030 IPR, Patent Owner’s expert, Dr. Moore, testified that “engineers on lens design teams ***do not know***, and ***do not care***, about the special manufacturing concerns that crop up during the production of polymer lens designs.” Ex. 1030,¹⁵ 56 (emphasis original). Petitioner argues Patent Owner inconsistently argues that manufacturing considerations are relevant here when they were argued as being irrelevant in the ’030 IPR. Reply 12.

Notwithstanding our overall conclusion regarding manufacturability, we analyze Patent Owner’s design and manufacturing arguments in Sections III.E.6 and III.F.9 below. Petitioner’s showing and any remaining arguments of Patent Owner are also discussed.

¹⁵ Declaration of Duncan Moore, Ph.D. Pursuant to 37 C.F.R. § 1.68 in ’030 IPR.

E. Obviousness of Claims 1–3 and 5–8 over Ogino Example 4 and Bareau

Petitioner alleges claims 1–3 and 5–8 would have been obvious over Ogino Example 4 and Bareau. Pet. 10. Petitioner also relies on the Sasián Declaration and the Sasián Reply Declaration. Ex. 1003 ¶¶ 44–62; Ex. 1037 ¶¶ 12–73. The Sasián Declaration includes a claim chart for this ground appended to paragraph 62. Ex. 1003, 34–60.

1. Ogino Example 4 (Ex. 1005)

Ogino discloses a five-lens system for use in portable devices. Ex. 1005, Abstract, 1:6–16. Ogino’s lens system is designed for use in “a digital still camera, a cellular phone with a camera, a mobile information terminal (PDA: Personal Digital Assistance), a smartphone, a tablet terminal, and a mobile game machine, on which the imaging lens is mounted to perform photography.” *Id.* at 1:11–16.

Figure 4 of Ogino is reproduced below.

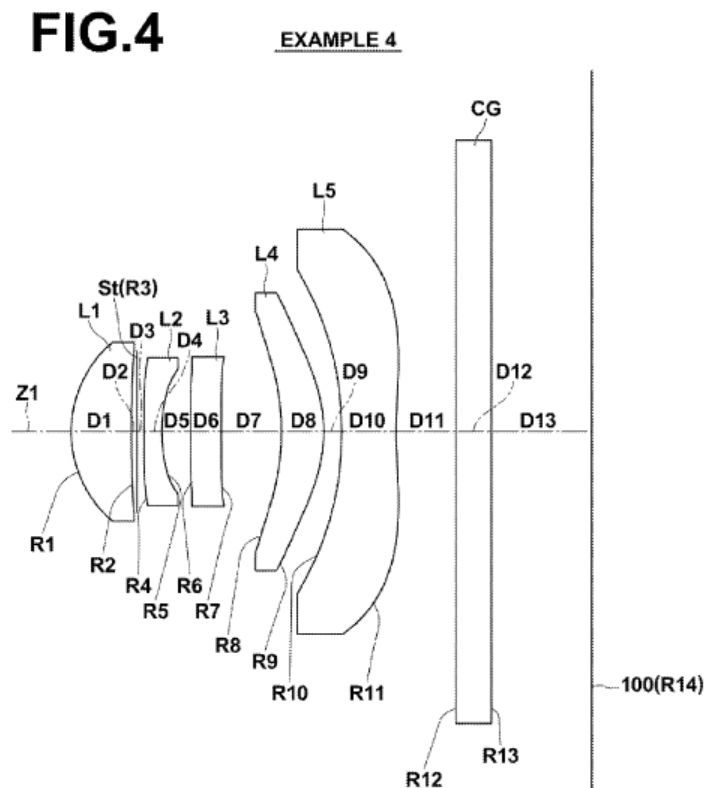


Figure 4 is a lens cross-sectional view of an imaging lens corresponding to Example 4.

Ex. 1005, 4:1–4. Ogino explains that there is a demand for five-lens systems in portable devices to “to enhance the resolution and performance of the imaging lens.” *Id.* at 1:30–31.

As shown in Figure 4 above, Ogino’s Example 4 includes five lenses in order from the object side, L1 through L5, each lens having an aspheric surface. Ex. 1005, 13:4–8. All embodiments, including the fourth embodiment disclosed in Ogino, which is shown above, include a “first lens L1 that has a positive refractive power and a meniscus shape which is convex toward the object side” and a second lens L2 that has a biconcave shape. *Id.* at 13:8–11. In the fourth embodiment, the third lens L3 has a negative refractive power. *Id.* at 13:44–50. Also common among all embodiments, “the fourth lens L4 . . . has a meniscus shape which is convex toward the image side; and the fifth lens L5 . . . has a negative refractive power and has at least one inflection point on an image side surface.” *Id.* at 13:5–16. The specific lens data for the lens system of Example 4 is described in Table 7. *Id.* at 15:18–22, 19:28–40, 20:28–40.

2. Bareau (Ex. 1012)

Bareau describes how “[d]esigning lenses for cell phone cameras is different from designing for traditional imaging systems.” Ex. 1012, 1. Bareau explains the “scale of cell phone camera systems creates particular challenges for the lens designer that are unique to this format.” *Id.*

Bareau explains that “initial cell phone cameras were based around VGA and QVGA modules with 5.6 μm pixels” with formats between 1/7” and 1/4” in size. Ex. 1012, 2. Bareau lists “typical lens specifications for a 1/4” sensor format” for use in cellular telephones, including an f-number of

2.8. *Id.* at 3–4. Bareau also indicates a TTL must be at least 0.050mm to protect the front of the lens. *Id.* at 3. Bareau states that “most camera module customers specify f/2.8, it is not uncommon to see lenses at f/3.0 and f/3.3 when the increased fno has a significant effect on performance or manufacturability.” *Id.* at 4.

3. Claim 1

Limitation 1.0, the preamble of claim 1, recites “[a] lens assembly, comprising: a plurality of refractive lens elements arranged along an optical axis.” Petitioner cites to Figure 4, Example 4, of Ogino, lenses L1 through L5, and optical axis Z1 as meeting the preamble. Pet. 20–22 (citing Ex. 1005, Fig. 4 (annotated at Pet. 21)). Petitioner alleges that all lenses are “refractive.” *Id.* at 21–22 (citing Ex. 1005, 9:11–12, 9:29, 7:51–53, 7:67–8:1, 8:8). That the lenses are arranged along the optical axis Z1 is further supported by the Sasián Declaration. *Id.* at 22–23 (citing Ex. 1003, 35–37, 115–118 (Figs. 2A–2D)).

Limitation 1.1 recites “wherein at least one surface of at least one of the plurality of lens elements is aspheric.” Ogino describes that in the imaging lenses in Examples 1 through 6, “both surfaces of each of the first to fifth lenses L1 to L5 are aspheric.” Pet. 23–24 (citing Ex. 1005, 15:22–24) (emphasis omitted). Table 7 of Ogino shows specific data for Example 4. Ex. 1005, 15:18–22. Table 7 specifically further identifies “surface numbers” 1, 2, and 4–11. *See id.* at 17 (Table 4 (“Surface Number”), 19:28–40, 20:28–40 (Table 7 (*1, *2, *4–*11 (“*ASPHERIC SURFACE”))). Petitioner relies on the preceding disclosures and alleges that lens surfaces 1, 2, and 4–11 are aspheric and correspond to lenses L1 through L5. Pet. 23–25 (citing Ex. 1005, 19:28–40, 20:28–40 (Table 7, annotated at Pet. 24)); Ex. 1003, 38).

Limitation 1.2 recites “wherein the lens assembly has an effective focal length (EFL).” Petitioner alleges a person of ordinary skill would “understand the term ‘effective focal length’ (EFL) to describe the focal length of the entire lens system. In that regard, Ogino states ‘**f is a focal length of a whole system.**’” Pet. 25 (citing Ex. 1005, 3:16; Ex. 1003, 38). Petitioner also cites to Table 7 and its disclosure of “ $f=4.555$ ” as teaching EFL. *Id.* at 26 (citing Ex. 1005, 19:28–40, 20:28–40 (Table 7, annotated at Pet. 26); Ex. 1003, 39).

Limitation 1.3 recites “wherein a lens system that includes the lens assembly plus a window positioned between the plurality of lens elements and an image plane has a total track length (TTL) of 6.5 millimeters or less.” Petitioner alleges cover glass (“CG”) is a “window” at 6.5 millimeters or less from the lens elements L1 through L5. Pet. 27–29 (citing Ex. 1005, 5:55–60, Fig. 4 (annotated at Pet. 28); Ex. 1003, 41–42). Petitioner calculates TTL by summing the distances (D_i) listed in Table 7 between lenses of Ogando as 4.362^{16} mm. *Id.* at 29 (citing Ex. 1005, 19:28–40, 20:28–40 (Table 7, annotated at Pet. 29); Ex. 1003, 43); *see also* Ex. 1005, Fig. 4 above (illustrating distances between lenses L1 to L5 as D_1 through D_{13}).

Limitation 1.4 recites “wherein a ratio TTL/EFL is less than 1.0.” Petitioner alleges “the EFL of Ogino’s Example [4] lens assembly is 4.555 mm, as shown in Table 7.” Pet. 30 (citing Ex. 1005, 19:28–40, 20:28–40).

¹⁶ While this is the sum of D_1 to D_{13} of Table 7, Table 7 specifically states “ $TL=4.260$.” *See* Pet. 29 (citing Ex. 1005, 19:28–40, 20:28–40 (Table 7, annotated at Pet. 29)). On this record, we accept the 4.362 mm calculation. *See* Ex. 1003, 40–44. We also note that if $TL=4.260$ that still falls within the recited “6.5 millimeters or less” recited in limitation 1.3. This is also the case for limitation 1.4 discussed immediately below.

Petitioner cites to its showing regarding limitation 1.3 to allege “the TTL of Ogino’s Example [4] lens assembly with the cover glass element is 4.362 mm.” *Id.* (citing Ex. 1005, 19:28–40, 20:28–40 (“summing distances from D1–D13”). Petitioner calculates the ratio of TTL/EFL as $4.362/4.555$, which equals 0.9576 and is less than 1.0. *Id.* (citing Ex. 1003, 44).

Limitation 1.5 recites “wherein the plurality of lens elements comprises, in order from an object side to an image side, a first lens element with positive refractive power.” Petitioner again cites Ogino’s Example 4 and its showing in connection with limitation 1.1. Pet. 31–32 (citing Ex. 1005, Fig. 4 (annotated at Pet. 32); Ex. 1003, 45). Petitioner starts with lens L1’s optical data for the Example 4 lens in Table 13, $f/f1 = 2.49$. *Id.* at 33 (citing Table 13, annotated at Pet. 33). Petitioner’s calculation next looks to the focal length of the entire system as shown for limitation 1.2, which is 4.555 mm. *Id.* (citing Ex. 1003, 46). Dividing the EFL of 4.555 into the $f/f1$ ratio the focal length for L1 alone is $4.555/2.49 = 1.829$ mm. *Id.* (citing Ex. 1003, 46). Relying on the Sasián Declaration, Petitioner alleges refractive power is the inverse of focal length or $1/1.829 \text{ mm} = 0.5467 \text{ mm}^{-1}$, which would have been understood by a person of ordinary skill to be a positive refractive power. *Id.* at 33–34 (citing Ex. 1003, 46–47 (citing Ex. 1010,¹⁷ 159)).

Limitation 1.6 recites “a second lens element with negative refractive power.” Petitioner cites to its showing with respect to limitation 1.5 for lens L2. Pet. 34. Petitioner calculates L2’s focal length ($f2$) starting with the “entire Example 4 lens system (f) and the data provided in Table 13 for

¹⁷ Born M. and Wolf E., *Principles of Optics*, (Pergamon Press, 6th Ed. 1980).

Example 4 showing $f/f_2 = -1.83$.” *Id.* at 34–35 (citing 1005, 23:25–40 (Table 13, annotated at Pet. 35); Ex. 1003, 47). Petitioner repeats the calculation method for limitation 1.5, $[f_2] = 4.55 \text{ mm} / -1.83 = 2.489 \text{ mm}$. *Id.* at 35 (citing Ex. 1003, 47). Petitioner then calculates refractive power as the inverse of focal length, $1 / -2.489 = -0.4017 \text{ mm}^{-1}$, which is a negative refractive power. *Id.* (citing Ex. 1003, 48).

Limitation 1.7 recites “and a third lens element.” Petitioner alleges Ogino teaches this limitation “because its Example 4 lens assembly includes a third lens L3.” Pet. 36–37 (citing Ex. 1005, Fig. 4 (annotated at Pet. 36); Ex. 1003, 48–49).

Limitation 1.8 recites “wherein a focal length f_1 of the first lens element is smaller than $TTL/2$.” Petitioner alleges Ogino’s L1 lens, as shown in connection with Example 4 and limitation 1.5, has a focal length f_1 of 1.829 mm. Pet. 37 (citing Ex. 1003, 49). Petitioner alleges, as it did in connection with limitation 1.2, that “the TTL of the Example 5 lens assembly with the cover glass element is 4.362 mm.” *Id.* Performing the calculation, Petitioner alleges the f_1 of 1.829 is less than TTL divided by 2 or $4.362 \text{ mm} / 2 = 2.181 \text{ mm}$. *Id.* (citing Ex. 1003, 49). Similarly, Petitioner contends that Ogino’s Example 4 lens assembly also meets the recited ratio because $f_1 = 1.829 \text{ mm}$ and $TTL/2 = 2.181 \text{ mm}$. *Id.* (citing Ex. 1003, 49).

Limitation 1.9 recites “and wherein a lens assembly F # is smaller than 2.9.” Petitioner relies on Bareau to show the $f\#$ limitation. Pet. 38. Petitioner alleges a person of ordinary skill “would have found this modification to be both predictable and desirable due to Ogino’s other disclosed embodiments supporting a lower f-number . . . [and] Bareau’s teaching of cell phones supporting f-numbers of 2.8 or less.” *Id.* (citing Ex. 1005, Figs. 8–13; Ex. 1003, 49); *see also* Section III.E.5 below (reasons for

combining Ogino Example 4 and Bareau). Petitioner also cites to a desire for faster lenses. *Id.* (citing Ex. 1013,¹⁸ 104). Petitioner relies on the Sasián Declaration to present Ogino’s Example 4 modified with an f-number of 2.8. *Id.* at 38–39 (citing Ex. 1003, 50, Fig. 2A).

Patent Owner does not dispute the argument and supporting evidence that limitations 1.0 through 1.9 are shown by the combination of Ogino Example 4 and Bareau. We find Petitioner’s argument and supporting evidence summarized above sufficient to show limitations 1.0 through 1.9.

4. Claims 2–3 and 5–8

We have reviewed Petitioner’s evidence and argument regarding claims 2–3 and 5–9. Pet. 39–51. We have also reviewed the evidence provided in the Sasián Declaration, including the claim chart appended. Ex. 1003, 50–60, 71–110 (claim chart). Patent Owner does not separately argue claims 2–3 and 5–8. PO Resp. 39.

Specifically, claim 2 depends from claim 1 and recites that “the third lens element has negative refractive power.” Petitioner cites to its showing regarding limitations 1.6 and 1.7 as teaching a third lens with a negative refractive power. Pet. 39 (citing Ex. 1005, 23:25–40 (Table 13, annotated at Pet. 40); Ex. 1003, 51).

Claim 3 also depends from claim 1 and recites five lens elements, as is shown in Ogino. Petitioner relies on Ogino’s five lens embodiment of Figure 4. Pet. 42 (citing Ex. 1005, Fig. 4 (annotated at Pet. 42)).

Claim 5 depends from claim 2 and recites five lens elements where the fourth and fifth lenses have “different refractive power signs.” As with

¹⁸ Kingslake, R., *Optics in Photography*, (The Society of Photo-Optical Engineering, 1992).

claim 3, Petitioner cites to Ogino's Figure 4 for the five lens elements. Pet. 43–44 (citing Ex. 1005, Fig. 4 (annotated at Pet. 44); Ex. 1010, 159, 161–162; Ex. 1003, 54). As to the recitation of different refractive powers, Petitioner cites to Ogino and the Sasián Declaration as showing “[t]he refractive power of lens elements L4 and L5 are calculated . . . by finding the reciprocal of their respective focal lengths calculated” as was done in limitation 1.5. *Id.* at 44–47 (citing Ex. 1005, 19:28–40, 20:28–40 (Table 7 annotated at Pet. 45), 23:25–40 (Table 13, annotated at Pet. 46); Ex. 1003, 55–57).

Claim 6 depends from claim 3 but otherwise recites the subject matter of claim 5 regarding different refractive powers of the fourth and fifth lenses. Petitioner relies on its showing made in connection with claim 5. Pet. 47.

Claim 7 depends from claim 3 and recites “a fourth lens element and a fifth lens element are separated by an air gap smaller than $TTL/20$.” Petitioner cites to Ogino's Table 7 to obtain the distance between lenses L4 and L5, the “air gap,” which is 0.151 mm. Pet. 48 (citing Ex. 1005, 19:28–40, 20:28–40 (Table 7, annotated at Pet. 48)). Petitioner takes its calculation of TTL from limitation 1.5, which is 4.362 mm, and calculates the recited “ $TTL/20$ ” as 0.218 mm, which is less than the air gap of 0.151 mm. *Id.* at 48–49 (citing Ex. 1003, 58–59).

Claim 8 depends from claim 3 and recites “one of a fourth lens element and a fifth lens element is characterized by an Abbe number smaller than 30 and wherein the other of the fourth lens element and the fifth lens element is characterized by an Abbe number greater than 50.” Petitioner again cites to Ogino's Table 7 and the Sasián Declaration. Pet. 49–51 (citing Ex. 1005, 19:28–40, 20:28–40 (Table 7, annotated at Pet. 50); Ex. 1003, 60).

Petitioner identifies the Abbe numbers for lenses L4 and L5 directly from Table 7 as the “vdj” numbers of 23.63 and 54.87 respectively. *Id.* at 50 (citing Ex. 1005, 14:45–47 (the vdj value is the Abbe number)).

Patent Owner does not dispute the argument and supporting evidence that the recitations of dependent claims 2–3 and 5–8 are shown by the combination of Ogino and Bareau. We find Petitioner’s argument and supporting evidence summarized above is sufficient to show the limitations recited in claims 2–3 and 5–8.

5. Reasons for Combining Ogino Example 4 and Bareau

Petitioner argues a person of ordinary skill would have reasons to combine Ogino and Bareau. Pet. 14–20. Specific to limitation 1.9, Petitioner argues the combination of Bareau teaches “a lens assembly F # is smaller than 2.8.” Pet. 14. Petitioner asserts the combination would have been

nothing more than applying Bareau’s specification for a brighter lens system for smaller image sensors, according to known lens design and modification methods (as taught in [Ex. 1017,¹⁹ 172]), to yield a predictable result of Ogino’s Example 4 lens assemblies likewise providing an f-number of 2.8 or lower.

Id. (citing Ex. 1003, 27 (citing Ex. 1012, 3–4)).

Petitioner argues several advantages of a cell phone lens with an “f-number of 2.8 or lower for ¼” or smaller sensors was common and it was at least expected that cell phone camera lenses would satisfy similar specifications.” Pet. 14 (citing Ex. 1012, 3; Ex. 1024 (“Wang”)²⁰, 1:38–42; Ex. 1025²¹, 4:54–57). Petitioner adds that designers and manufacturers of

¹⁹ Fischer, *Optical System Design*, (2d Ed. SPIE Press © 2008).

²⁰ Wang, US Patent No. 7,321,475 B2, issued Jan. 22, 2008.

²¹ Kubota, US Patent No. 8,508,648 B2, issued Aug. 13, 2013.

lenses desired to produce lenses of lower f-number, which result in “faster lenses.” *Id.* These objectives are “an indication of **the need that exists for brighter images and ‘faster’ lenses.**” *Id.* at 14–15 (citing Ex. 1015²², 104; Ex. 1025, 4:54–67).

Petitioner emphasizes Wang’s discussion of lens performance as based on “four main requirements,” the first of which is “a high brightness requirement, which means that the lens system should have a small F number (FNo.) **Generally, the FNo. should be 2.8 or less.**” Pet. 15 (citing Ex. 1024, 1:38–42). Petitioner contends Bareau’s lens specifications, including the importance of an f-number of 2.8 or less, would have been known to a person of ordinary skill in the art. *Id.* (citing Ex. 1003, 30).

According to Petitioner, a person of ordinary skill in the art would therefore have been “motivated to look to lens designs like Ogino’s that could support a lower, more desirable F number” in part, because “Ogino’s other embodiments support f-numbers values down to 2.45 (noting that the f-numbers of Ogino’s Examples 1–3 and 6, which all utilize a similar structure to Example 4, have a lower F number than 2.8 being respectively set at 2.47, 2.46, 2.45, and 2.64).” *Id.* at 15–16 (citing Ex. 1003, 29; Ex. 1005, Figs. 8–10, 13). Petitioner then argues “modifying Ogino’s Example 4 lens assembly to have an f-number of 2.8, as taught in Bareau, would have been nothing more than applying Bareau’s specification of an F# of 2.8 for a ¼” image sensor format according to known lens design methods (as taught in Fischer ([Ex.] 1017)) to allow Example 4 to likewise better support a ¼” sensor format in a thin cell phone.” *Id.* at 16.

²² Matsuzaka, JP 2013-106289, published May 30, 2013 (certified translation).

Petitioner notes that Bareau describes a wide angle lens with a field of view (FOV) of 60 degrees. Pet. 16 (citing Ex. 1005, Figs. 14, 15). However, Petitioner argues FOV is a design consideration and the specifications for f-number and TTL would also apply to “incorporating a telephoto lens,” as described in Example 4 of Ogino. *Id.* (citing Ex. 1003, 31; Ex. 1014²³, Fig. 16; Ex. 1012, 3–4). Petitioner also explains that a person of ordinary skill in the art “would have understood that one way of modifying Ogino’s Example 4 to decrease the f-number is to increase the diameter of one or more lens elements.” *Id.* at 17 (citing Ex. 1003, 30, 32; Ex. 1016²⁴, 59). Relying on Dr. Sasián’s explanation of Zemax lens design software, Petitioner shows one possible lens design of Ogino Example 4 with an f-number of 3.04 modified to an f-number of 2.8. *Id.* at 18–19 (citing Ex. 1003, 32 (Sasián Dec., 112, 115 (Figs. 1A and 2A “Ray Trace Diagram” compared side by side for F#=3.04 and F#=2.8)), (Sasián Dec. 113, 116 (Figs. 1B and 2B “Relative Illumination” compared side by side for F#=3.04 and F#=2.8))). Still relying on Dr. Sasián’s testimony and the Zemax software, Petitioner shows how the modification results in similar design and performance characteristics. *Id.* at 19 (citing Ex. 1003, 32 (Sasián Dec. 114, 117 (Figs. 1C and 2C “Analysis” compared side by side for F#=3.04 and F#=2.8))).

Patent Owner does not specifically dispute the argument and supporting evidence providing reasons for combining Ogino’s Example 4 with Bareau. To the extent Patent Owner argues some of Petitioner’s showing is related to design issues, they are discussed below. We find

²³ Parulski, US Patent No. 7,859,588 B2, issued Dec. 28, 2010.

²⁴ Walker, *Optical Engineering Fundamentals*, McGraw-Hill (1994).

Petitioner’s argument and supporting evidence summarized above sufficiently show reasons for combining Ogino’s Example 4 with Bareau.

6. *Patent Owner’s Arguments*

As stated in Section III.D, the panel finds that the knowledge of a lens designer of ordinary skill in the art includes familiarity with manufacturing and fabrication, which makes design and manufacture relevant to patentability (*e.g.* *Graham* factor 3, level of skill in the art). However, we determined Patent Owner’s arguments related to design and manufacture considerations are not recited in any of the challenged claim. Specifically, with respect to claim 1 on the first ground, Patent Owner leads its Response with this manufacturing argument. PO Resp. 31. Patent Owner states Petitioner “does not address the tolerances and manufacturability of the design that would necessarily be considered by a [person of ordinary skill in the art].” *Id.* (quoting Ex. 2001 ¶ 89).

Patent Owner attempts to make the design and manufacturing considerations relevant using deposition testimony from, Dr. Sasián. PO Resp. 31–32. Patent Owner alleges Dr. Sasián “admits that lenses in Ogino’s Example 4” are not oversized. PO Resp. 30–31 (citing “Sasián Dep.”,²⁵ Ex. 2003, 120:5–10); *see* Ex. 1005, Fig. 4 (illustrating Example 4)). The cited cross examination testimony by Dr. Sasián does not make the design and manufacturing evidence relevant to patentability.

Patent Owner argues the combination relied on by Petitioner uses Ogino’s “overlapping lenses.” PO Resp. 32 (citing Ex. 1003, 115). Further, Patent Owner argues Ogino’s lens elements touch and would not be used by

²⁵ The deposition is in an *inter partes* review concerning US Patent No. 10,317,647, but the testimony relates to the ’277 patent. Ex. 2003, 135:8–11.

a person of ordinary skill in the art, based on a summary of Exhibit 2006²⁶ indicating lenses “should be spaced at greater than the maximum tolerance.” *Id.* at 33–34 (citing Ex. 2006 (no pin cite); Ex. 2001 ¶ 94 (also citing Ex. 2006)). Patent Owner concludes by arguing Ogino’s overlapping lens design would “never be acceptable for an optical design, let alone for manufacturing, tolerances or desensitization.” *Id.* at 34 (citing Ex. 2001 ¶ 94).

Both parties’ showings regarding overlapping or touching lenses are based on expert testimony, which is, in turn, based on the drawings in the references. Ex. 2001 ¶¶ 93–94; Ex. 1037 ¶¶ 41–42. Patent Owner cites the Sasián Declaration as showing two lenses touching. PO Resp. 33 (citing Ex. 1003, 115). Patent Owner also cites Exhibit 1007²⁷ to allege design “rules of thumb” would result in “the distance separating the two at the closest point is so small as to be essentially touching.” PO Resp. 34–35; Sur-Reply 6. Patent Owner also argues a person of ordinary skill in the art “would not have two lenses touch each other.” PO Resp. 34–35 (citing Ex. 1007 (describing tolerances for lenses); Exhibit 2008²⁸, 95). Conversely, relying on Dr. Sasián’s testimony based on a Zemax analysis, Petitioner argues the L2 and L3 lenses of Ogino Example 4 do not touch or overlap. Reply 21 (citing Ex. 1037 ¶ 41 (Figs. 4A and 4B)).

²⁶ McGuire Jr et al., *Approaching direct optimization of as-built lens performance*, (Proceedings of SPIE) (October 2012).

²⁷ Beich et al., *Polymer Optics: A manufacturer’s perspective on the factors that contribute to successful programs*, (Society of Photo-Optical Instrumentation Engineers 2010).

²⁸ Symmons et al., *Field Guide to Molded Optics*, (Society of Photo-Optical Instrumentation Engineers (SPIE), copyright 2016).

Patent Owner argues that the enlarged drawing from the Sasián Declaration, which is reproduced at page 33 of the Response, arguably supports a finding that Ogino’s Example 4 lenses L4 and L5 touch. *See* PO Resp. 33. However, patent drawings “predicated, moreover, on a greatly enlarged section of a small drawing obviously never intended to show the dimensions of anything.” *Application of Wilson*, 312 F.2d 449, 454 (C.C.P.A. 1963) (finding an enlarged section of a small drawing unpersuasive).

We find that Dr. Sasián’s lens design software analysis using the Zemax software shows that L4 and L5 do not touch. *See* Reply 8–9 (citing Ex. 1037 ¶ 14 (Zemax ray analysis showing L4 and L5 do not touch)).²⁹ Patent Owner disputes the design process used by Dr. Sasián but does not rebut the ray analysis and did not provide a response from Dr. Milster. *See* Sur-Reply 5–7. In making our finding, we credit Dr. Sasián’s opinion testimony as supported by his ray analysis. Regardless, as we have already found, manufacturing considerations such as touching lenses do not provide a reason not to combine Bureau with Ogino Example 4.

²⁹ Dr. Sasián testified in other *inter partes* review proceedings, made of record here, that lenses L4 and L5 “may be touching.” *See* Ex. 2012 (Second Sasián Deposition taken in IPR2020-00877, 878, 897, and 906 on July 16, 2021), 91:20–92:3. Although Patent Owner relied on this testimony in IPR2020-00896, it does not cite this testimony in this proceeding, we thus do not consider it here in analyzing whether Ogino’s lenses L4 and L5 touch. Nevertheless, even if we were to consider this testimony, it would not alter our finding that the lenses do not touch. Dr. Sasián’s testimony is equivocal because he qualified the response by indicating “the resolution may not be enough to show they are separate or maybe they are touching.” *Id.* at 93:14–19. Dr. Sasián further testified that he would have to “reserve my answer” regarding the touching of the lenses until he could do “an analysis with the lens design program.” *Id.*

Patent Owner next argues “Bareau teaches against Modified Example 4.” PO Resp. 35 (citing Ex. 2001 ¶ 96). At page 36 of the Response, Patent Owner reproduces “Fig. 2B – Relative Illumination” from the Sasián Declaration and argues the relative illumination of Ogino Example 4 is less than 50% when Bareau teaches that for a “typical lens specifications for a 1/4” sensor format,” relative illumination is “>50%.” *Id.* at 36 (citing Ex. 1012, 7). According to Patent Owner, this disparity in relative illumination means a person of ordinary skill “would not have modified Example 4 of Ogino to arrive at the lens configuration of Modified Example 4.” *Id.* at 37 (citing Ex. 2001 ¶ 98).

As discussed above, design and manufacturing requirements, like relative illumination, are not limitations recited in any of the claims. *See* Reply 16–17; Ex. 1037 ¶ 22 (Milster Declaration paragraphs 92–98 re: relative illumination are manufacturing considerations); Sur-Reply 9–11. Bareau teaches that “Lens *specifications usually require* a value greater than 50% at the edge of the field.” Ex. 1012, 7 (emphasis added). This statement is limited to what “specifications usually require” and is not strong enough to discourage a person ordinary skill from using a lens with lower relative illumination. *See In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994); *see also* Ex. 1037 ¶ 25 (“Even in the case where certain manufacturing considerations are important for a particular design or purpose and are not met, it does not automatically mean that the design is impossible to make.” (citing Ex. 1007, 9)). The Milster Declaration does not add anything to Bareau, simply repeating Bareau’s 50% preference and concluding a person of ordinary skill would not look to Ogino Example 4 because its 30% relative illumination is “far less than the 50% or greater taught by Bareau.” Ex. 2001 ¶¶ 97–98.

We credit the Sasián Reply Declaration testimony and find that “various manufacturing considerations listed by Dr. Milster to be relevant to the lens design at issue . . . would have been understood to be *preferences* and not *requirements*.” Reply 13 (quoting Ex. 1037 ¶ 23). Patent Owner does not dispute Dr. Sasián’s reply testimony. Of course, showing unpatentability is Petitioner’s burden, and Patent Owner does not need to respond. Nonetheless, as an evidentiary matter we find Petitioner’s evidence and argument persuasive. Patent Owner broadly responds that relative illumination of greater than 50% is desired and is “an important criterion to consider.” Sur-Reply 9–10 (citing Ex. 2010, 49:2–60). For reasons already discussed, this manufacturing argument is not persuasive on the issue of obviousness.

Patent Owner argues that a person of ordinary skill would “have allowed spacing between lens surfaces to vary” to improve performance. PO Resp. 37 (citing Ex. 2001 ¶ 99). Patent Owner argues that the lens prescription in the Sasián Declaration for Ogino Example 4 varies only two parameters, not including lens spacing. *Id.* at 37–38 (citing Ex. 1003, App. 116 (reproducing Fig. 2D-Prescription Data); Ex. 2003, 135:8–22). Patent Owner alleges that “[p]rohibiting the spacing between lens surfaces from varying while designing a lens would have reduced the ability to improve the performance by limiting the direction along the optimization merit-function surface and might have prevented a [person of ordinary skill in the art] from finding the best performance result.” *Id.* at 38 (citing Ex. 2001 ¶ 100). According to Patent Owner not varying spacing means a person of ordinary skill would not have designed a lens assembly as modified in Ogino Example 4. *Id.* at 38–39 (citing Ex. 2001 ¶¶ 100–102). To the extent Patent Owner argues that Petitioner’s proposed combination would have prevented

a person of ordinary skill in the art from finding the best performance result, the claims do not require a particular performance result.

Patent Owner argues the “lens assembly [is] non-enabled.” PO Resp. 35 (citing *Nokia of Am. Corp. v. Oyster Optics, LLC*, IPR2018-00146, Paper No. [36] at 22 (PTAB April 29, 2019)).³⁰ The assertion is not supported by the cited decision or any expert testimony. As such, we are faced with an unsubstantiated allegation. Patent Owner does not explain sufficiently how or why an alleged lack of enablement should be considered in determining whether Petitioner has shown sufficient reasons for combining the references.

For the reasons summarized above, Patent Owner’s arguments are not persuasive.

7. Conclusion

Petitioner has sufficiently shown, and Patent Owner does not dispute, that each limitation above is taught or suggested by the combination of Ogino Example 4 and Bareau. We find that Petitioner has shown sufficient reasons for combining Ogino and Bareau. Patent Owner’s design and manufacturing arguments do not undercut Petitioner’s showings. Petitioner has shown by a preponderance of the evidence that claims 1–3 and 5–8 would have been obvious over Ogino Example 4 and Bareau.

F. Obviousness of Claims 1–24 over Ogino Example 5 and Bareau

Petitioner alleges claims 1–24 would have been obvious over Ogino Example 5 and Bareau. Pet. 51. Petitioner also relies on the Sasián Declaration and the Sasián Reply Declaration. Ex. 1003 ¶¶ 63–76; Ex. 1037

³⁰ Patent Owner’s citation to Paper 37 is incorrect. There is no Paper 37 in IPR2018-00146, and page 22 of Paper 36 (the Final Written Decision in that IPR) does not discuss enablement.

¶¶ 12–73. The Sasián Declaration includes a claim chart appended to paragraph 77. Ex. 1003 ¶ 77, 71–110.

1. Ogino Example 5 (Ex. 1005)

Ogino Figure 4, relating to “Example 4,” is discussed above in Section III.E.1. Ogino’s Figure 5, which relates to “Example 5,” is reproduced below.

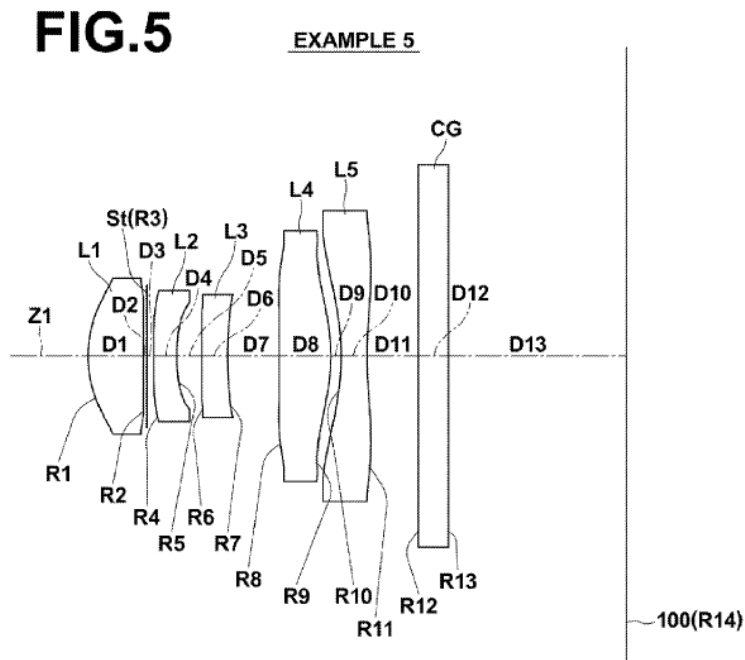


Figure 5 is a lens cross-sectional view of an imaging lens corresponding to Example 5.

Ex. 1005, 4:5–8. In Ogino’s fifth embodiment, which is shown in Figure 5, the “lens configurations of the first to fifth lenses L1 to L5 are common to the fourth embodiment,” Fig. 4. *Id.* at 13:58–63; *see* Section III.E.1 above. “Therefore, according to the respective lens configurations, it is possible to obtain the same effects as the respective corresponding configurations of the fourth embodiment.” *Id.* at 13:60–63.

In Example 5, the five lens elements are identified as L1–L5 and are aspheric. Ex. 1005, 13:4–5. Also included in Example 5 are “optical members CG [which] may be disposed between the fifth lens L5 and the imaging device,” and which may be “cover glass” acting as a filter. *Id.* at 5:66–6:2; *see* Fig. 5 above element CG. The Example 5 lens system is described with reference to the specific lens data shown in Table 9. *Id.* at 15:18–22, 21:10–35.

2. Claim 1

Much of Petitioner’s showing for Example 5 of Ogino is similar to the showing made above in Section III.E.3 for Example 4 of Ogino. *Compare* Pet. 21 (annotated Fig. 4 of Ogino), *with* Pet. 60 (annotated Fig. 5 of Ogino).³¹ Petitioner’s allegations regarding claim 1 are summarized below.

For limitation 1.0, the preamble of claim 1, Petitioner cites to Figure 5, Example 5, of Ogino, lenses L1 through L5, and optical axis Z1 (*see* Fig. 5 above) as meeting the preamble. Pet. 59–61 (citing Ex. 1005, Fig. 5 (annotated at Pet. 60)). Petitioner alleges that all lenses are “refractive.” *Id.* at 60 (citing Ex. 1005, 9:11–12, 5:13–15). That the lenses are arranged along the optical axis Z1 is further supported by the Sasián Declaration. *Id.* at 60 (citing Ex. 1003, 75).

Limitation 1.1 recites “wherein at least one surface of at least one of the plurality of lens elements is aspheric.” Ogino describes that in the

³¹ Petitioner refers to a “second modification” of Example 5 as also teaching certain limitations. *See, e.g.*, Pet. 62 (citing Ex. 1003, 76). The second modification is Example 5 “modified for an f-number of 2.8,” as taught by Bareau, but is otherwise the same as the showing made for Example 5. *Id.* at 59 (citing Ex. 1003, 70). For purposes of this Decision, unless specifically referenced, we do not include the showing made for the second modification.

imaging lenses in Examples 1 through 6, “both surfaces of each of the first to fifth lenses L1 to L5 are aspheric.” Pet. 61–62 (citing Ex. 1005, 15:22–24) (emphasis omitted). Table 9 of Ogino shows specific data for Example 5. *Id.* at 61; Ex. 1005, 15:18–22, 21:10–36 (Table 9, annotated at Pet. 62). Petitioner relies on the preceding disclosures and alleges that lens surfaces 1, 2, and 4–11 are aspheric and correspond to lenses L1 through L5. *Id.* at 61 (citing Ex. 1005, Table 9 annotated; Ex. 1003, 76).

Limitation 1.2 recites “wherein the lens assembly has an effective focal length (EFL).” Petitioner alleges a person of ordinary skill would understand “the term ‘effective focal length’ (EFL)’ is construed to mean ‘the focal length of a lens assembly.’ In that regard, Ogino states ‘f is a focal length of a whole system.’” Pet. 63–64 (citing Ex. 1005, 3:16, 14:47–53, 21:10–36 (Table 9, annotated at Pet. 63)); *see also id.* at 64 (citing Ex. 1003, 77). Petitioner also cites to Table 9 and its disclosure of “ $f=5.575$ ” as teaching the recited EFL. *Id.* at 64.

Limitation 1.3 recites “wherein a lens system that includes the lens assembly plus a window positioned between the plurality of lens elements and an image plane has a total track length (TTL) of 6.5 millimeters or less.” Petitioner uses the method discussed above in connection with Example 4 of Ogino to determine TTL. *See* Pet. 64. Ogino Example 5 is asserted to have a TTL of 5.273 mm. Pet. 64–67 (citing Ex. 1005, 5:55–60, 22:10–36 (Table 9, annotated at Pet. 66), Fig. 5 (annotated at Pet. 65); Ex. 1003, 81, App. Fig. 3A (testimony that the sum of distances D1 to D13 for Example 5 is 5.273 mm)).

Limitation 1.4 recites “wherein a ratio TTL/EFL is less than 1.0.” Petitioner alleges “the EFL of Ogino’s Example 5 lens assembly is 5.956 mm, as shown in Table 9.” Pet. 67 (citing Ex. 1005, 21:10–36). Petitioner

cites to its showing regarding limitation 1.3 to allege “the TTL of Ogino’s Example 5 lens assembly with the cover glass element is 5.273 mm.” *Id.* (citing Ex. 1005, 21:10–36). Petitioner calculates the ratio of TTL/EFL as $5.273/5.956$, which equals 0.8853 and is less than 1.0. *Id.* (citing Ex. 1003, 81).

Limitation 1.5 recites “wherein the plurality of lens elements comprises, in order from an object side to an image side, a first lens element with positive refractive power.” Petitioner again cites Ogino’s Example 5 and its showing in connection with limitation 1.1. Pet. 68–69³²; Ex. 1003, 82. Petitioner starts with lens L1’s optical data for the Example 5 lens in Table 13, $f/f1 = 2.88$. *Id.* at 70 (citing Table 13, annotated at Pet. 70). Petitioner’s calculation next looks to the focal length of the entire system as shown for limitation 1.2, which is 5.956 mm. *Id.* (citing Ex. 1003, 83). Dividing the EFL of 5.956 mm into the $f/f1$ ratio the focal length for L1 alone is $5.956 \text{ mm} / 2.88 = 2.068 \text{ mm}$. *Id.* (citing Ex. 1003, 83). Relying on the Sasián Declaration, Petitioner alleges refractive power is the inverse of focal length or $1/2.068 \text{ mm} = 0.4863 \text{ mm}^{-1}$, which would have been understood by a person of ordinary skill to be a positive refractive power. *Id.* at 70 (citing Ex. 1003, 83 (citing Ex. 1010, 159)).

Limitation 1.6 recites “a second lens element with negative refractive power.” Petitioner cites to its showing with respect to limitation 1.5 for lens L2. Pet. 71. Petitioner calculates L2’s focal length ($f2$) starting with the “entire Example 5 lens system (f) and the data provided in Table 13 showing $f/f2 = -1.88$.” *Id.* at 71–72 (citing 1005, 23:25–40 (Table 13, annotated at Pet.

³² The Petition cites Figure 5 but the annotation at page 69 is of Figure 4, Example 4. The showing is sufficient without the correct figure.

72); Ex. 1003, 84). Petitioner repeats the calculation method for limitation 1.5, $[f_2]=5.956 \text{ mm}/-1.88=-3.168 \text{ mm}$. *Id.* at 72 (citing Ex. 1003, 84). Petitioner then calculates refractive power as the inverse of focal length, $1/-3.168=-0.3157 \text{ mm}^{-1}$, which is a negative refractive power. *Id.* (citing Ex. 1003, 85).

Limitation 1.7 recites “and a third lens element.” Petitioner alleges Ogino teaches this limitation “because its Example 5 lens assembly includes a third lens L3.” Pet. 73–74 (citing Ex. 1005, Fig. 5 (annotated at Pet. 73); Ex. 1003, 85–86).

Limitation 1.8 recites “wherein a focal length f_1 of the first lens element is smaller than $TTL/2$.” Petitioner alleges Ogino’s L1 lens, as shown in connection with Example 5 and the showing for limitations 1.2 and 1.5, has a focal length f_1 of 2.068 mm and the TTL of the Example 5 lens assembly is 5.273 mm. Pet. 74–75 (citing Ex. 1003, 86). Performing the calculation, Petitioner alleges the f_1 of 2.068 mm is less than TTL divided by 2 or $5.273 \text{ mm}/2=2.6365 \text{ mm}$. *Id.* (citing Ex. 1003, 86).

Limitation 1.9 recites “and wherein a lens assembly F # is smaller than 2.9.” Petitioner relies on Bareau to show the $f\#$ limitation, requiring a combination of Ogino and Bareau. Pet. 74–76. Petitioner alleges a person of ordinary skill “would have found this modification to be both predictable and desirable due to Ogino’s other disclosed embodiments supporting a lower f-number [and] Bareau’s teaching of cell phones supporting f-numbers of 2.8 or less.” *Id.* at 75–76 (citing Ex. 1005, Figs. 8–13; Ex. 1003, 87); *see also* Section III.F.8 below (reasons for combining Ogino Example 5 and Bareau)). Petitioner also cites to a desire for faster lenses. *Id.* (citing Ex. 1013, 104). Petitioner relies on the Sasián Declaration to present Ogino’s

Example 5 modified with an f-number of 2.8. *Id.* at 38–39 (citing Ex. 1003, 87, Fig. 5A).

Patent Owner does not dispute the argument and supporting evidence that limitations 1.0 through 1.9 are shown by the combination of Ogino Example 5 and Bareau. We find Petitioner’s argument and supporting evidence summarized above is sufficient to show limitations 1.0 through 1.9.

3. Claims 2–10

Claims 2–10 depend directly or indirectly from claim 1. We have reviewed Petitioner’s evidence and argument regarding claims 2–10. Pet. 76–90. We have also reviewed the evidence provided in the Sasián Declaration. Ex. 1003, 87–100.

Claim 2 depends from claim 1 and recites that “the third lens element has negative refractive power.” Petitioner argues Ogino discloses this limitation because its Example 5 lens assembly includes a third lens L3 with negative refractive power. Pet. 76. Petitioner uses Table 13 of Ogino Example 5³³ to calculate the focal length of L3 (*i.e.*, f_3) of the entire Example 5 lens system as -6.926 mm. *Id.* (citing Ex. 1003, 88; Ex. 1004, 23:25–40). The refractive power is the inverse of the focal length or -0.1444 mm^{-1} . *Id.* at 77.

Claim 3 depends from claim 1 and recites “five lens elements.” Petitioner alleges Ogino’s recites five lens elements, as is shown in Ogino’s Figure 5. Pet. 78 (citing Ex. 1005, Fig. 5 (annotated at Pet. 78)).

Claim 4 depends from claim 1 and recites “wherein the focal length f_1 , a focal length f_2 of the second lens element and a focal length f_3 of the

³³ Page 77 of the Petition refers to “Example 4” but Table 13 is annotated for Example 5 and the numbers used correspond to Example 5.

third lens element fulfill the condition $1.2 \times |f_3| > |f_2| > 1.5 \times f_1$.”³⁴ Relying on its showings regarding limitations 1.5, 1.6, and claim 2, Petitioner alleges that Example 5 establishes that lens L1 has a focal length f_1 of 2.068 mm, L2 has a focal length f_2 of -3.168 mm, and L3 has a focal length of $[f_3]$ of -6.926 mm. Pet. 79. Substitution of these focal length values into the claimed expression, $1.2 \times |f_3| > |f_2| > 1.5 \times f_1$ results in $1.2 \times |-6.926| > |-3.168| > 1.5 \times 2.068$. *Id.* Performing the calculations for each part of the expression between the greater than symbols leads to $8.3112 > 3.168 > 3.102$. *Id.* at 79–80 (citing Ex. 1003, 90).

Claim 5 depends from claim 2 and recites five lens elements where the fourth and fifth lenses have “different refractive power signs.” Petitioner relies on its showing regarding claim 2. Pet. 80 (citing Pet. 76–78; Ex. 1003, 90).

Claim 6 depends from claim 3 but otherwise recites the subject matter of claim 5 regarding different refractive powers of the fourth and fifth lenses. Petitioner relies on its showing made in connection with claim 5. Pet. 84 (citing Pet. 80–84; Ex. 1003, 94).

Claim 7 depends from claim 3 and recites “a fourth lens element and a fifth lens element are separated by an air gap smaller than $TTL/20$.” Petitioner cites to Ogino’s Table 9 to obtain the distance between lenses L4 and L5, the “air gap,” which is 0.10 mm. Pet. 85 (citing Ex. 1005, 21:10–36, 20:28–40 (Table 9, annotated at Pet. 85)). Petitioner takes its calculation of TTL from limitation 1.3, which is 5.273 mm, and calculates the recited

³⁴ The mathematical notation $|X|$ indicates absolute values. *See also* Ex. 1005, 11:65–67 (describing a conditional expression, as is claimed here, in the context of “absolute value”).

“TTL/20” as 0.2637 mm, which is less than the air gap of 0.10 mm. *Id.* at 85–86 (citing Ex. 1003, 95).

Claim 8 depends from claim 3 and recites “one of a fourth lens element and a fifth lens element is characterized by an Abbe number smaller than 30 and wherein the other of the fourth lens element and the fifth lens element is characterized by an Abbe number greater than 50.” Petitioner cites to the second modification of Example 5 and Ogino’s Table 9 and the Sasián Declaration. Pet. 86–87 (citing Ex. 1005, 21:10–36 (Table 9, annotated at Pet. 87); Ex. 1003, 96). Petitioner identifies the Abbe numbers for lenses L4 and L5 directly from Table 9 as the “vdj” numbers of 23.63 and 54.87 respectively. *Id.* at 87 (citing Ex. 1005, 14:45–47 (the vdj value is the Abbe number)).

Claim 9 depends from claim 5 and includes limitation 9.1 which recites “the third lens element and the fourth lens element are separated by an air gap greater than TTL/5.” Petitioner cites to its showing regarding claim 7, which recites the same subject matter. Pet. 89 (citing Pet. 85–86); *see also* Section III.E.4 above (showing regarding claim 7 with respect to Example 4 of Ogino).

Limitation 9.2 recites “wherein one of the fourth lens element and the fifth lens element is characterized by an Abbe number smaller than 30, and wherein the other of the fourth lens element and the fifth lens element is characterized by an Abbe number greater than 50.” Petitioner cites to its showing regarding claim 8, which recites the same subject matter. Pet. 89–90 (citing Pet. 86–87); *see also* Section III.E.4 above (showing regarding claim 8 with respect to Example 4 of Ogino).

Claim 10 depends from claim 6 and includes limitation 10.1 which recites “wherein the third lens element and the fourth lens element are

separated by an air gap greater than $TTL/5$.” Petitioner cites to its showing regarding claim 7, which recites the same subject matter. Pet. 90 (citing Pet. 85–86); *see also* Section III.E.4 above (showing regarding claim 7 with respect to Example 4 of Ogino).

Limitation 10.2 recites “wherein one of the fourth lens element and the fifth lens element is characterized by an Abbe number smaller than 30, and wherein the other of the fourth lens element and the fifth lens element is characterized by an Abbe number greater than 50.” Petitioner cites to its showing regarding claim 8, which recites the same subject matter. Pet. 90 (citing Pet. 86–87); *see also* Section III.E.4 above (showing regarding claim 8 with respect to Example 4 of Ogino).

Patent Owner does not dispute the argument and supporting evidence that dependent claims 2–10 are shown by the combination of Ogino Example 5 and Bareau. We find Petitioner’s argument and supporting evidence summarized above are sufficient to show dependent claims 2–10.

4. Claim 11

Claim 11 is an independent claim which repeats the subject matter of claim 1. Claim 11 is similar to claim 1 with the exception of adding the subject matter of dependent claim 4 and omitting limitations 1.8 and 1.9. *See* Section II.D above. Patent Owner does not dispute the argument and supporting evidence that limitations of claim 11 are shown by the combination of Ogino Example 5 and Bareau. Petitioner’s showing is very similar to the showing made above in Sections III.E.3 as to claim 1. *See* Pet. 91–95. Petitioner has sufficiently shown that Ogino Example 5 in combination with Bareau teaches all the limitations of claim 11.

5. Claims 12–17

Claims 12–17 depend directly or indirectly from claim 11. Claim 12’s subject matter corresponds to that of claim 2, claim 13’s to claim 3, claim 14’s to claim 5, claim 15’s to claim 6, claim 16’s to claim 7, and claim 17’s to claim 8. Patent Owner does not dispute the argument and supporting evidence that limitations of claims 12–17 are shown by the combination of Ogino Example 5 and Bareau. Petitioner’s showing is very similar to the showing made above in Section III.E.4 as to claims 2–3 and 5–8. *See* Pet. 95–97. Petitioner has sufficiently shown that Ogino Example 5 in combination with Bareau teaches all the limitations of claims 12–17.

6. Claim 18

Claim 18 is an independent claim which, like claim 11, repeats the subject matter of claim 1. Claim 18 is similar to claim 1 with the exception of adding the subject matter of a fourth lens element with “an air gap greater than $TTL/5$,” recited in part in dependent claim 9, and omitting limitation 1.8. Patent Owner does not dispute the argument and supporting evidence that limitations of claim 18 are shown by the combination of Ogino Example 5 and Bareau. Petitioner’s showing is similar to the showing made above in Sections III.F.2 and III.F.3 as to claims 1 and 9. *See* Pet. 97–100. Petitioner has sufficiently shown that Ogino Example 5 in combination with Bareau teaches all the limitations of claim 18.

7. Claims 19–24

Claims 19–24 depend directly or indirectly from claim 18. We have reviewed Petitioner’s evidence and argument regarding claims 12–17. Pet. 100–102. We have also reviewed the evidence provided in the Sasián Declaration. Ex. 1003, 109–110.

Claim 19's subject matter corresponds to that of claim 2, claim 20's to claim 5, claim 21's to claim 7, claim 22's to claim 8, claim 23's to limitation 1.8, and claim 24's to claim 6. Accordingly, Petitioner's showing is very similar to the showing made above in Section III.F.2 as to limitation 1.8 and III.F.3 as to claims 2, 5, 7, and 8. *See* Pet. 100–102. Petitioner has sufficiently shown that Ogino Example 5 in combination with Bareau teaches all the limitations of claims 19–24.

8. *Reasons for combining Ogino Example 5 and Bareau*

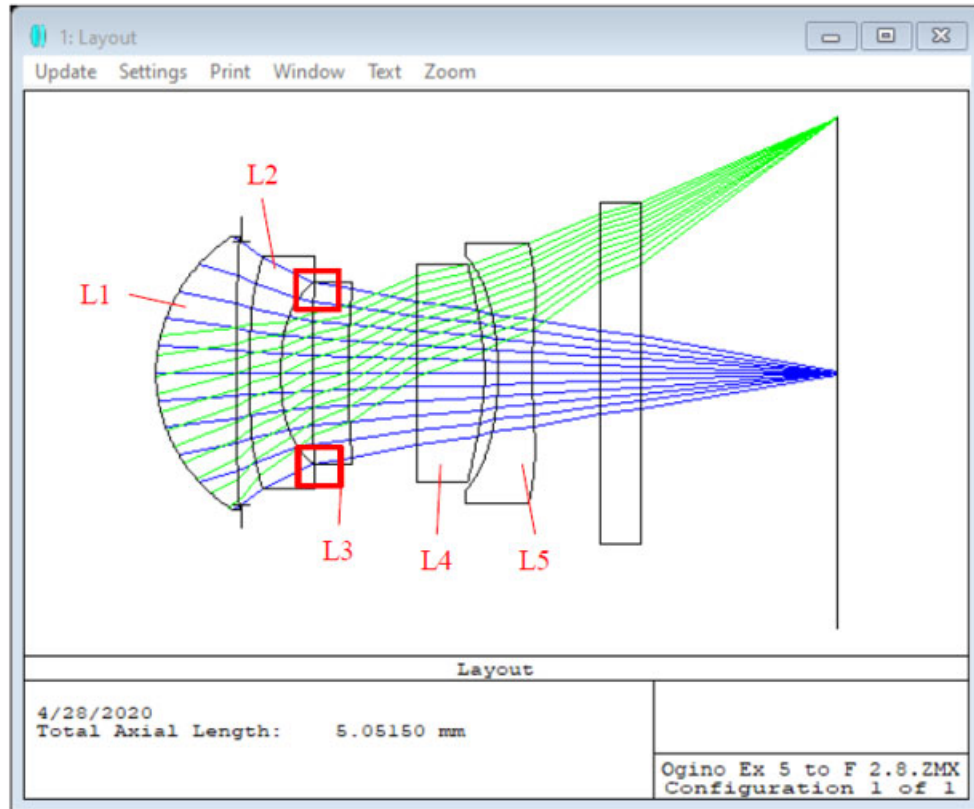
Petitioner argues a person of ordinary skill would have had reasons to combine Ogino Example 5 and Bareau. Pet. 53–59. Petitioner cites many of the reasons presented in connection with Example 4. *Compare* Pet. 14 (“Such a combination would have been nothing more than applying Bareau’s specification for a brighter lens system for smaller pixel image sensors, according to known lens design and modification methods”) *with* Pet. 53 (both citing Ex. 1017, 172). Petitioner also follows the Sasián Declaration applying well known lens design software, Zemax, to show how f-number could be modified from $f\#=3.94$ in Ogino Example 5 to $f\#=2.8$ from Bareau. Pet. 54 (citing Ex. 1003, 66 (Figs. 3A and 3B (compared side by side for $F\#=3.94$ and $F\#=2.8$))).

Patent Owner does not specifically dispute the argument and supporting evidence providing reasons for combining Ogino Example 5 and Bareau. To the extent Patent Owner argues some of Petitioner’s showing is related to design or manufacturing issues, they are discussed below. We find Petitioner’s argument and supporting evidence summarized above sufficiently shows reasons for combining Ogino Example 5 and Bareau.

9. Patent Owner's Arguments

Because independent claim 11 is similar to independent claim 1, Patent Owner's arguments on claims 11–17 substantially repeat the arguments it made in response to the challenge discussed above in Section III.F.2 for claim 1. Patent Owner states Petitioner does not consider “manufacturing, tolerances, or system desensitization, [and that] a [person of ordinary skill in the art] would certainly not have arrived at the lens configuration in the First Modified Example 5,” which is Petitioner's “alternative 1.” PO Resp. 40–41 (citing Ex. 2001 ¶ 106).

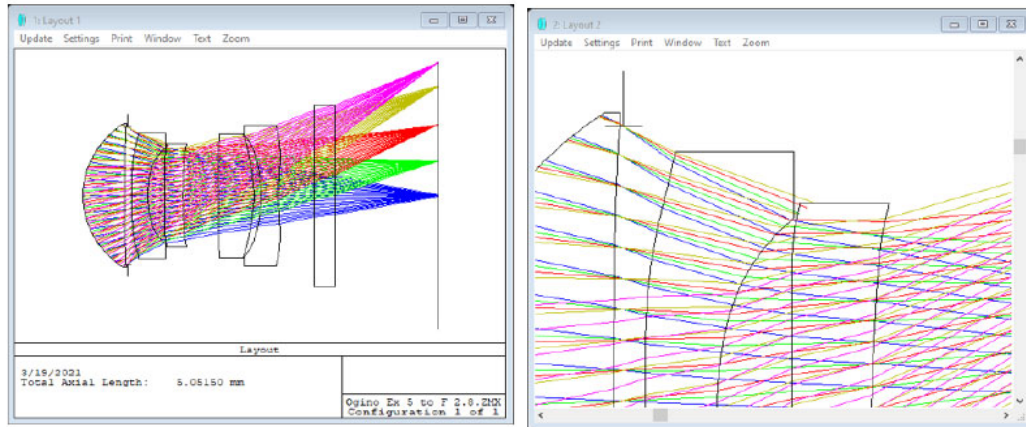
Patent Owner argues Ogino's lens elements as modified by Bareau to achieve an f-number of 2.8 touch and would not be used by a person of ordinary skill in the art. PO Resp. 41–42 (citing Ex. 2001 ¶ 109). This argument is based on the Sasián Declaration's Figure 4A, a “Ray Trace Diagram” reproduced below. *Id.* at 42.



Ray Trace Diagram Ogino Example 5 Alternative 1.

Exhibit 1003, 122. Patent Owner alleges Exhibit 1003 annotated above results from Dr. Sasián's "[m]odifying Ogino's Example 5 to achieve the Bureau's preferred f-number of 2.8 and using well-known lens design software to find the best solution." PO Resp. 41 (citing Ex. 1003 ¶ 71). Patent Owner repeats its arguments above relating to Ogino Example 4. *Id.* at 43 (citing Ex. 2001 ¶ 109).

Petitioner relies on the Sasián Reply Declaration and the Zemax analysis, which is reproduced below. Reply 21–22.



Dr. Sasián Reply Declaration Zemax Alternative 2 Analysis.

Ex. 1037 ¶ 41. Petitioner alleges alternative 2, which Patent Owner identifies as “Second Modified Example 5” (PO Resp. 40), meets Dr. Milster’s “manufacturing” requirements. Reply 25. Petitioner alleges alternative 2 showing “zoomed-in ray trace of lens elements L2 and L3 above clearly shows space between these lens elements.” *Id.* at 22 (citing Ex. 1037 ¶ 42). Patent Owner agrees that lenses L2 and L3³⁵ do not touch but the tolerance is so small a person of ordinary skill would not have used the arrangement. Sur-Reply 12 (citing Reply 21; Ex. 2012, 59:23–61:2³⁶).

Patent Owner alleges alternative 2 was not presented in the Petition or “applied against the claims 11–19 of the ’277 patent.” Sur-Reply 12–13. Though not stated, we understand Patent Owner to be arguing that alternative 2 should be disregarded. We decline to do so. First, as has been discussed exhaustively throughout this Decision, Patent Owner has not shown how these various design and manufacturing arguments are reasons a

³⁵ Patent Owner argues this point by referring to L4 and L5 which we find is a mistake because the cited Reply refers to L2 and L3. Reply 21. In addition, claim 11 recites three lenses which map to Ogino’s L2 and L3 in a three lens assembly. Ex. 1001, 9:35–39.

³⁶ Patent Owner mistakenly cites “Ex. 2010.”

person of ordinary skill would not have combined the references. Petitioner has responded to these design and manufacturing arguments while maintaining that they are not required by the claims. Reply 9–13. For example, Petitioner relies on the Sasián Reply Declaration to show a person of ordinary skill would have “incrementally” approached designing a lens with appropriate spacing between lenses. Reply 3 (citing Ex. 1037 ¶ 6; Ex. 1017, 168). Patent Owner argues the incremental approach is wrong without explanation beyond that it is a “predetermined process.” Sur-Reply 5. Second, we find alternative 2 is proper rebuttal to Patent Owner’s arguments that the lenses touch in alternative 1. *See* PO Resp. 42 (“First Modified Example 5 . . . results in two lens elements touching”).

Both parties argue whether or not the lenses of Ogino Example 5 overlap or touch. PO Resp. 41; Reply 21. Both arguments are based on expert testimony, which is, in turn, based on the drawings in the references. Ex. 2001 ¶¶ 108–109; Ex. 1037 (Sasián Reply Declaration) ¶¶ 41–42. As discussed in Section III.E.6 above, patent drawings are not intended to show dimensions. Regardless, we find that in the alternative 2 modification the lenses L2 and L3 do not touch. *See* Tr. 42:2–44:7 (the lenses “effectively” touch); Sur-Reply 12 (agreeing L2 and L3 do not touch). Moreover, even if L2 and L3 touch as a result of the alternative 1 modification that alone does not undercut Petitioner’s showing that the combination would have been obvious. *See Keller*, 642 F.2d at 426.

Patent Owner argues a person of ordinary skill “would have allowed the inputs of radius of the lenses, spacing between lens surfaces and the conic coefficients to vary.” PO Resp. 43 (citing Ex. 2001 ¶ 110). This argument was analyzed above in connection with Example 4 of Ogino. *See* Section III.E.5 above. This argument is another design and construction

argument and would not have discouraged a person of ordinary skill in the art from making the combination.

Patent Owner argues that Dr. Sasián has provided different graphs for relative illumination as between his declaration in *Apple, Inc. v. Corephotonics, Ltd.*, IPR2020-00896 and here. PO Resp. 46–47; Sur-Reply 14–15. The differences were a result of adjustments to vignetting and different starting points. PO Resp. 47 (citing Ex. 2003,³⁷ 152:2–13). We are not persuaded that the failure to explain why one set of inputs would be selected over another, as Patent Owner contends, has any bearing on whether a person of ordinary skill would have combined Bareau with Ogino Example 5. *See id.*

Patent Owner argues that alternative 1 of Example 5 includes dimensions that would have been unacceptable to a person of ordinary skill in the art. PO Resp. 47–49. Again, how a lens would actually be designed and manufactured is a separate question from whether what is taught by the references would not have discouraged a person of ordinary skill in the art from making the combination.

We are also not persuaded that Petitioner is precluded from relying on two separate modifications to Example 5 to show claim 11's limitations. PO Resp. 49–50. Fundamentally, Petitioner contends only the first modification of Example 5 is necessary to show all limitations of claim 11. *See* Pet. 91–95 (citing Ex. 1003, 102–103). The second modification is not required.

Patent Owner turns to claims 1–10 and 18–24. PO Resp. 50–51. Patent Owner again argues manufacturing requirements, performance factors, and differing results. *Id.* at 50–54. These arguments do not differ

³⁷ Dr. Sasián Deposition in IPR2020-00896, taken February 19, 2021.

materially from arguments addressed above in connection with claims 11–17 and do not change our prior determination.

Patent Owner’s arguments regarding alleged hindsight are based on “what a [person of ordinary skill in the art] would have actually done when designing a lens.” Sur-Reply 2–3. These arguments are unpersuasive for reasons previously stated concerning the difference between design and manufacture and obviousness. Additional arguments from the Sur-Reply are not relevant to the obviousness conclusion and are addressed above, including design and manufacturing considerations (Sur-Reply 4, 12), the design process (*id.* at 5–6), lenses “effectively” touching (*id.* at 6–7, 12), manufacturability of Ogino Example 4 (*id.* at 7–9), different input data (*id.* at 14–15), and the “Second Modification of Bareau” (*id.* at 15–16).

10. Conclusion

Petitioner has shown by a preponderance of the evidence that claims 1–24 would have been obvious over Ogino Example 5 and Bareau.

IV. ORDER³⁸

In consideration of the foregoing, it is hereby:

ORDERED that claims 1–24 are unpatentable; and

FURTHER ORDERED that, because this is a Final Written Decision, parties to the proceeding seeking judicial review of the decision must

³⁸ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner’s attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. § 42.8(a)(3), (b)(2).

comply with the notice and service requirements of 37 C.F.R. § 90.2.

Claims	35 U.S.C. §	Reference(s)/Basis	Claims Shown Unpatentable	Claims Not shown Unpatentable
1–3, 5–8	103	Ogino Example 4, Bareau	1–3, 5–8	
1–24	103	Ogino Example 5, Bareau	1–24	
Overall Outcome			1–24	

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