

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

COREPHOTONICS, LTD.,
Patent Owner.

IPR2020-00877
Patent 10,288,840 B2

Before BRYAN F. MOORE, MONICA S. ULLAGADDI, and
JOHN R. KENNY, *Administrative Patent Judges*.

ULLAGADDI, *Administrative Patent Judge*.

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

I. INTRODUCTION

Apple Inc. (“Petitioner”) filed a Petition to institute an *inter partes* review of claims 1–7, 11–13, 15, 16, 18, 20, and 21 (“the challenged claims”) of U.S. Patent No. 10,288,840 B2 (Ex. 1001, “the ’840 patent”). Paper 2 (“Petition” or “Pet.”). Patent Owner did not file a preliminary response. We instituted trial on all challenged claims and on all grounds set forth in the Petition. Paper 7 (“Institution Decision” or “Inst. Dec.”).

After institution, Patent Owner filed a Patent Owner Response (Paper 12, “PO Resp.”), Petitioner filed a Reply to Patent Owner’s Response (Paper 13, “Pet. Reply”), and Patent Owner filed a Sur-reply (Paper 18, “PO Sur-reply”). An oral hearing was held on August 3, 2021, and a copy of the transcript was entered in the record. Paper 25 (“Tr.”).

We have jurisdiction pursuant to 35 U.S.C. § 6. This Decision is a Final Written Decision under 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73 as to the patentability of the claims on which we instituted trial. Petitioner bears the burden of proving unpatentability of the challenged claims, and the burden of persuasion never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015). To prevail, Petitioner must prove unpatentability by a preponderance of the evidence. *See* 35 U.S.C. § 316(e) (2018); 37 C.F.R. § 42.1(d) (2019). Having reviewed the arguments and the supporting evidence, we determine that Petitioner has shown, by a preponderance of the evidence, that 1, 2, 5–7, 11–13, 15, 16, 18, 20, and 21 of the ’840 patent are unpatentable. We further determine that Petitioner has not shown, by a preponderance of the evidence, that claims 3 and 4 of the ’840 patent are unpatentable.

II. BACKGROUND

A. *Related Proceedings*

Petitioner and Patent Owner identify the following corresponding district court proceeding: *Corephotonics, Ltd. v. Apple Inc.*, No. 5:19-cv-04809-LHK (N.D. Cal.). Pet. 1; Paper 6, 1.¹ Pending U.S. Application No. 16/276,034 claims priority to the application underlying the '840 patent.

B. *The '840 Patent*

The '840 patent concerns a mobile electronic device having an integrated camera. Ex. 1001, code (57). The camera includes a wide camera unit having a wide lens unit, and a telephoto camera unit having a telephoto lens unit. *Id.* at 5:28–30. The telephoto lens unit has a total track length (TTL) to effective focal length (EFL) ratio smaller than 1 and the wide lens unit larger has a TTL/EFL ratio of larger than 1. *Id.* at 5:31–32. The wide and telephoto lens units provide respectively main and auxiliary optical/imaging paths. *Id.* at 17:46–47. Figure 1C, reproduced below, illustrates a telephoto lens unit. *Id.* at 7:1–2; 8:22–23.

¹ Patent Owner cites *Corephotonics, Ltd. v. Apple Inc.*, No. 3:19-cv-04809-LHK (N.D. Cal.) (Paper 6, 1), but this case number appears to reflect a typographical error. A PACER search of Case No. 5:19-cv-04809 reveals that Patent Owner's complaint in that case was erroneously identified as "Civil Action No. 3:19-cv-4809" on its cover page.

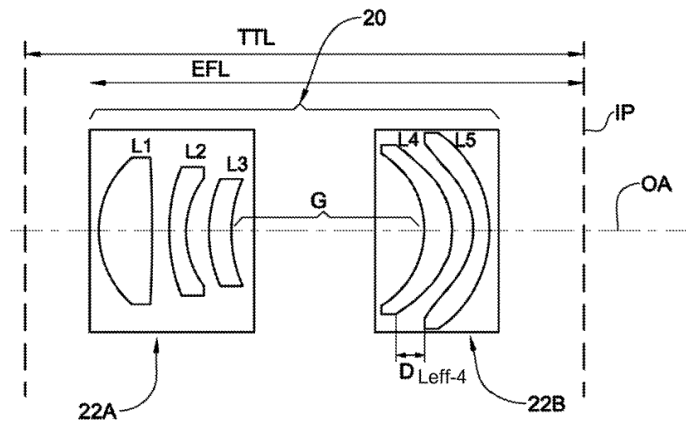


FIG. 1C

Figure 1C shows a telephoto lens unit. *Id.*

Telephoto lens unit 20 includes “multiple lens elements made of different polymer materials, i.e., materials having different Abbe numbers.” *Id.* at 8:22–26. The multiple lens elements define a telephoto lens assembly 22A and field lens assembly 22B on optical axis OA with gap G between assemblies, as shown in Figure 1C. *Id.* at 8:26–31. Gap G is larger than $1/5^{\text{th}}$ of the TTL of telephoto lens unit 22A, which corrects for “field curvature of telephoto lens assembly 22A by the field lens assembly 22B.” *Id.* at 8:43–47.

Telephoto lens assembly 22A has at least three lenses, L1, L2, and L3, in which lens L1 has positive optical power and lenses L2 and L3, combined, have negative optical power. *Id.* at 8:48–52. Lenses L2 and L3 are made of polymer materials having Abbe numbers selected to reduce chromatic aberrations of telephoto lens assembly 22A. *Id.* at 8:52–55. Field lens assembly 22B has at least two lenses L4 and L5 which are made of different polymer materials having different Abbe numbers. *Id.* at 8:55–58. Lenses L4 and L5 compensate for *residual* chromatic aberrations of telephoto lens assembly 22A that are dispersed when light passes through

gap G between telephoto lens assembly 22A and field lens assembly 22B.
Id. at 8:58–61.

C. Challenged Claims

Petitioner challenges claims 1–7, 11–13, 15, 16, 18, 20, and 21 of the '840 patent. Sole independent claim 1 is illustrative and reproduced below.

1. [1.0] A mobile electronic device comprising an integrated camera,

[1.1] wherein the camera comprises a Wide camera unit comprising a Wide lens unit and a Telephoto camera unit comprising a Telephoto lens unit,

[1.2] the Telephoto lens unit and the Wide lens unit having, respectively, total track length (TTL)/effective focal length (EFL) ratios smaller and larger than 1 and

[1.3] defining separate Telephoto and Wide optical paths,

[1.4] wherein the Telephoto lens unit comprises multiple lens elements made of at least two different polymer materials having different Abbe numbers,

[1.5] wherein the multiple lens elements comprise a first group of at least three lens elements configured to form a telephoto lens assembly and a second group of at least two lens elements,

[1.6] the second group of at least two lens elements spaced apart from the first group of at least three lens elements by a predetermined effective gap equal to or larger than 1/5 of the TTL of the Telephoto lens unit,

[1.7] wherein the first group of at least three lens elements comprises, in order from an object plane to an image plane along an optical axis of the Telephoto lens unit, a first lens element having positive optical power and

[1.8] a pair of second and third lens elements having together negative optical power such that the Telephoto lens assembly provides a Telephoto optical effect of the Telephoto lens unit and

[1.9] such that the second and third lens elements are each made of one of the at least two different polymer materials having a different Abbe number for reducing chromatic aberrations of the Telephoto lens,

[1.10] wherein the second group of lens elements includes a fourth lens element and a fifth lens element made of the different polymer materials having different Abbe numbers and

[1.11] is configured to correct a field curvature and to compensate for residual chromatic aberrations of the Telephoto lens assembly dispersed during light passage through the effective gap between the Telephoto lens assembly and the second group of at least two lens elements, and

[1.12] wherein the first, third and fifth lens elements have each an Abbe number greater than 50 and

[1.13] the second and fourth lens elements have each an Abbe number smaller than 30.²

Ex. 1001, 19:45–20:15.

D. Asserted Grounds of Unpatentability

Petitioner challenges claims 1–7, 11–13, 15, 16, 18, 20, and 21 as follows. *See* Pet. 10–11. In support, Petitioner relies on the First and Second Declarations of Dr. José Sasián (Ex. 1003, Ex. 1022).³

² Spacing and bracketed numbering are added for ease of readability.

³ Petitioner alternatively references pages and paragraphs when citing Dr. Sasián’s Declaration. We refer to pages or paragraphs, as appropriate.

Claim(s) Challenged	35 U.S.C. §⁴	Reference(s)/Basis
1, 2, 5, 7, 11–13, 15, 16, 18, 20, 21	103	Parulski ⁵ , Huang ⁶ , Tang ⁷
3, 4	103	Parulski, Huang, Tang, May ⁸
6	103	Parulski, Huang, Tang, Li II ⁹

III. ANALYSIS

A. Principles of Law

A claim is unpatentable under 35 U.S.C. § 103 if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) when available, objective evidence of

⁴ The Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (September 16, 2011) (“AIA”), included revisions to 35 U.S.C. § 103 that became effective on March 16, 2013. Because the ’840 patent issued from an application filed after March 16, 2013, we apply the AIA version of the statutory basis for unpatentability. *See* Ex. 1001, codes (22), (86).

⁵ U.S. Patent No. 7,859,588 B2, issued Dec. 28, 2010 (Ex. 1005, Parulski”).

⁶ U.S. Patent No. 9,726,858 B2, issued Aug. 8, 2017 (Ex. 1006, “Huang”). Petitioner asserts that Huang is entitled to an effective filing date of December 30, 2014, the filing date of the Taiwanese application from which Huang claims foreign priority, because the U.S. application underlying the Huang patent was filed in English and a certified copy of the Taiwanese application was received by the Patent Office. Pet. 10.

⁷ U.S. Patent No. 8,363,337 B2, issued Jan. 29, 2013 (Ex. 1009, “Tang”).

⁸ U.S. Patent No. 7,561,191 B2, issued July 14, 2009 (Ex. 1011, “May”).

⁹ U.S. Patent No. 8,189,100 B2, issued May 29, 2012 (Ex. 1018, “Li II”).

nonobviousness, i.e., secondary considerations. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

“In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)). The burden of persuasion never shifts to Patent Owner. *See Dynamic Drinkware*, 800 F.3d at 1378 (citing *Tech. Licensing Corp. Videotek, Inc.*, 545 F.3d 1316, 1326–27 (Fed. Cir. 2008)) (discussing the burden of proof in an *inter partes* review). Furthermore, Petitioner cannot satisfy its burden of proving obviousness by employing “mere conclusory statements.” *Magnum*, 829 F.3d at 1380.

Thus, to prevail in an *inter partes* review, Petitioner must explain how the proposed combinations of prior art render the challenged claims unpatentable.

We analyze the challenges presented in the Petition in accordance with the above-stated principles.

B. Level of Ordinary Skill in the Art

Petitioner contends

[A] person of ordinary skill in the art (“POSITA”) would include someone who had, as of the priority date of the ’840 Patent (i) a Bachelor’s degree in Physics, Optical Sciences, or equivalent training, as well as (ii) approximately three years of experience in designing miniature lens systems for mobile device applications. . . . Such a person would have had experience in analyzing, tolerancing, adjusting, and optimizing multi-lens systems, and would have been familiar with the specifications of lens systems, especially lenses configured for use in mobile

devices, such as cell phones. . . . In addition, a POSITA would have known how to use lens design software such as Code V, Oslo, or Zemax, and would have taken a lens design course. . . . Such a POSITA would have been familiar with photographic lenses and with mechanical and electronic devices. Lack of work experience can be remedied by additional education, and vice versa.

Pet. 6–7 (citing Ex. 1003, 10). Patent Owner “applies the level of ordinary skill in the art set forth in the petition and used by the Board in its Institution Decision.” PO Resp. 3 (Inst. Dec. 8).

We determine that the level of ordinary skill in the art proposed by Petitioner is consistent with the ’840 patent and the asserted prior art. We apply Petitioner’s definition in making the findings and conclusions rendered in this Decision.

C. Claim Construction

For *inter partes* reviews filed on or after November 13, 2018, we apply the same claim construction standard used by Article III federal courts and the ITC, both of which follow *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc), and its progeny. 37 C.F.R. § 42.100(b) (2019). Accordingly, we construe each challenged claim of the ’840 patent to generally have “the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.” *Id.*

We construe claim terms to the extent necessary for our analysis on whether to institute a trial. *See, e.g., Nidec Motor Corp. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (“[W]e need only construe terms ‘that are in controversy, and only to the extent necessary to

resolve the controversy.’” (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999))).

Independent claim 1 recites “the Telephoto lens unit and the Wide lens unit having, respectively, total track length (TTL)/effective focal length (EFL) ratios smaller and larger than 1 and defining separate Telephoto and Wide optical paths.” Ex. 1001, 19:48–52. Petitioner asserts that “a POSITA would find, in light of the specification, the term ‘total track length (TTL)’ to include ‘the length of the optical axis spacing between the object-side surface of the first lens element and the image plane.’” Pet. 8 (citing Ex. 1003, 20) (emphasis omitted). Petitioner further asserts that, although the Specification of the ’840 patent does not expressly define EFL, “its meaning is well known in the art, as exemplified in Li ([Ex.] 1007), which states that ‘[t]he focal length of a lens assembly [is] also referred to as the effective focal length[.]’” Pet. 8–9 (quoting Ex. 1007, 2:59–61) (alterations in the original). Patent Owner “does not believe that any terms require construction to resolve the disputes addressed in this response.” PO Resp. 3.

We do not discern a dispute as to the claim terms TTL and EFL in this proceeding and as such, we need not expressly construe these terms. *Nidec Motor Corp.*, 868 F.3d at 1017. .

D. Obviousness over Parulski, Huang, and Tang

Petitioner contends that claims 1, 2, 5, 7, 11–13, 15, 16, 18, 20, and 21 are unpatentable as obvious under 35 U.S.C. § 103 over Parulski, Huang, and Tang. Patent Owner did not dispute Petitioner’s challenge to these claims. *See* PO Resp. 1 (explaining that Patent Owner “limits this response to rebutting” only the ground for claims 3 and 4). For the reasons that follow, we determine that Petitioner’s showing establishes unpatentability by

a preponderance of the evidence with respect to the challenge to claims 1, 2, 5, 7, 11–13, 15, 16, 18, 20, and 21.

1. Overview of Parulski

Parulski concerns “a digital camera that uses multiple lenses and image sensors to provide an improved imaging capability.” *See, e.g.*, Ex. 1005, 1:7–10. In one embodiment, an image capture assembly includes two image capture stages. *Id.* at 12:36–45. For example, the image capture assembly can include a fixed focal length wide angle lens and a fixed focal length telephoto lens. *Id.* at 23:28–40. The two image capture stages can be contained within a single stage for a mobile phone camera, as seen in Figures 16A and 16B, reproduced below.

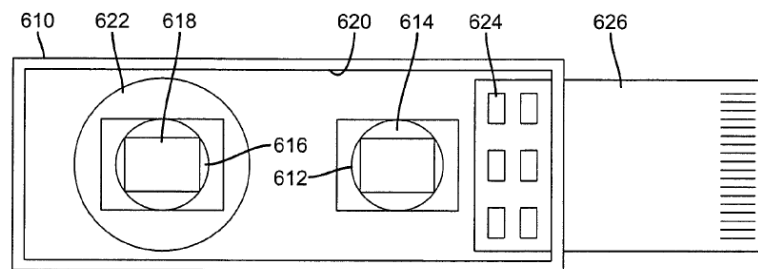


FIG. 16A

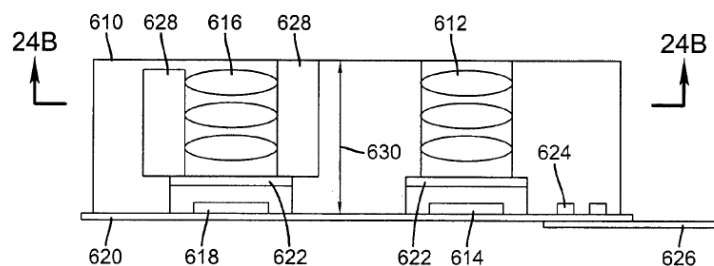


FIG. 16B

Figure 16A of Parulski is a top view of integrated capture assembly 610 taken along lines 24B-24B in Figure 16B. *Id.* at 23:29–30.

In both Figures 16A and 16B, integrated capture assembly 610 includes an integrated packaging of optical and imaging components on

common substrate 620. *Id.* at 23:31–32. Integrated capture assembly 610 includes first fixed focal length lens 612 and first image sensor 614, as well as second fixed focal length lens 616 and second image sensor 618. *Id.* at 23:33–36. First lens 612 is preferably a fixed focal length wide angle lens that forms an image on first image sensor 614, and second lens 616 is preferably a fixed focal length telephoto lens that forms an image on the second image sensor 618. *Id.* at 23:36–40. Lenses 612 and 616 are both “oriented in the same direction in order to form images of the same portion of the overall scene in front of them, albeit with different fields of view.” *Id.* at 23:40–43.

2. *Overview of Huang*

Huang concerns a compact photographing optical lens assembly and image capturing device. Ex. 1006, 1:16–17. Huang discloses a lens assembly that corrects astigmatism and balances refractive power to correct aberrations. *Id.* at 5:38–52. An exemplary lens assembly is depicted in Figure 1, reproduced below.

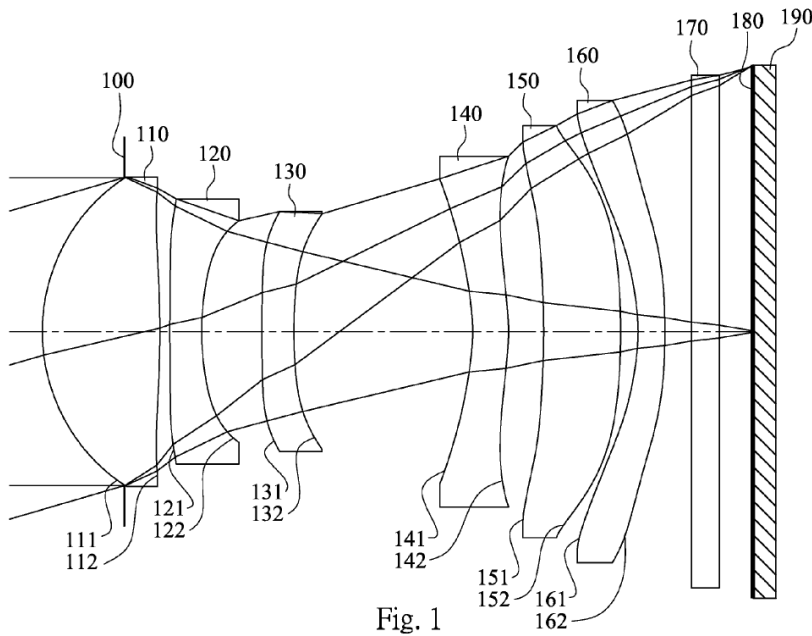


Figure 1 of Huang is a schematic view of an image capturing device according to a first embodiment. *Id.* at 9:19–20.

The lens assembly includes, from an object side to an image side, aperture stop 100, first through sixth lens elements 110, 120, 130, 140, 150, 160, IR-cut filter 170, image surface 180, and image sensor 190. *Id.* at 9:26–31. The optical data for the first embodiment is shown in Table 1, reproduced below.

TABLE 1

1st Embodiment								
$f = 6.60 \text{ mm}$, $Fno = 2.85$, $HFOV = 16.3 \text{ deg.}$								
Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal Length	
0	Object	Plano	Infinity					
1	Ape. Stop	Plano	-0.616					
2	Lens 1	1.401	ASP	0.885	Plastic	1.544	55.9	2.26
3		-7.705	ASP	0.074				

TABLE 1-continued

1st Embodiment f = 6.60 mm, Fno = 2.85, HFOV = 16.3 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
4	Lens 2	19.967	ASP	0.240	Plastic	1.640	23.3	-3.57
5		2.042	ASP	0.454				
6	Lens 3	55.581	ASP	0.240	Plastic	1.530	55.8	-8.42
7		4.126	ASP	1.345				
8	Lens 4	-1.523	ASP	0.270	Plastic	1.530	55.8	24.02
9		-1.444	ASP	0.264				
10	Lens 5	-7.396	ASP	0.581	Plastic	1.650	21.4	20.42
11		-4.895	ASP	0.131				
12	Lens 6	-1.157	ASP	0.200	Plastic	1.535	55.7	-2.61
13		-7.189	ASP	0.200				
14	IR-cut filter	Plano		0.210	Glass	1.517	64.2	—
15		Plano		0.254				
16	Image	Plano		—				

Note:

Reference wavelength is 587.6 nm (d-line).

Table 1 depicts optical parameters for the lens arrangement of Huang's first embodiment. *Id.* at 12:53–54.

Table 1 depicts, among other things, lens thicknesses, distances between lenses, Abbe numbers, and focal lengths. *Id.*

3. Overview of Tang

Tang concerns a compact imaging lens assembly. Ex. 1009, 1:7. An exemplary lens assembly is depicted in Figure 1A, reproduced below.

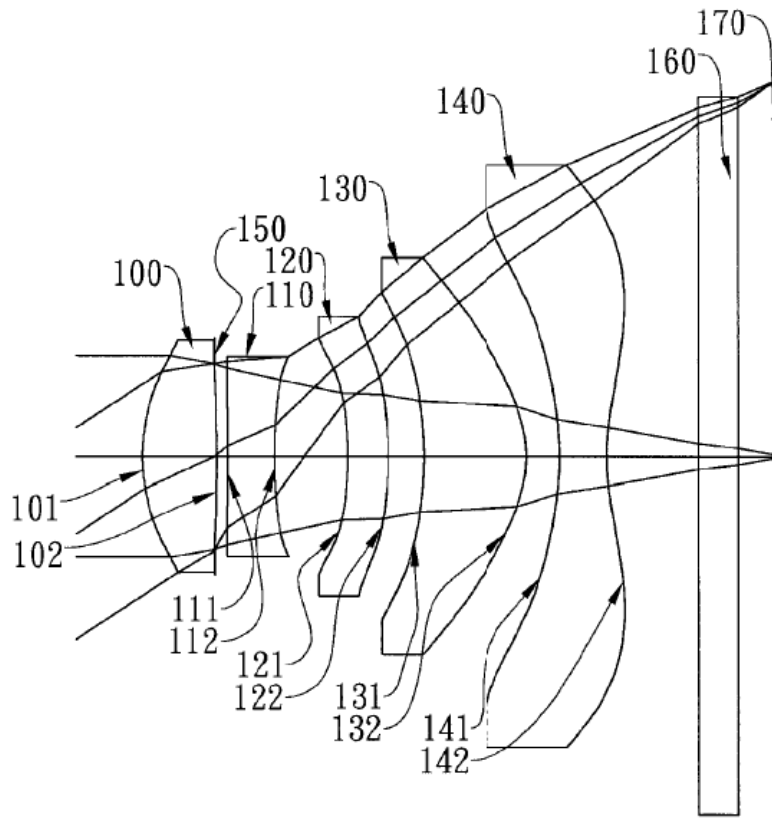


Fig. 1A

Figure 1A of Tang shows an imaging lens assembly in accordance with a first embodiment. *Id.* at 7:66–67.

The imaging lens assembly includes, from an object side to an image side, first through fifth lens elements 100, 110, 120, 130, 140, IR filter 160, and image plane 170. *Id.* at 8:2–29. The optical data of the first embodiment are depicted in Table 1 of Figure 7, reproduced below.

TABLE 1							
(Embodiment 1)							
$f = 4.34 \text{ mm}$, $F_{no} = 2.85$, $HFOV = 33.2 \text{ deg.}$							
Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal length
0	Object	Plano	Infinity				
1	Lens 1	1.424400 (ASP)	0.562	Plastic	1.544	55.9	2.55
2		-43.791100 (ASP)	-0.010				
3	Ape. Stop	Plano	0.096				
4	Lens 2	-15.543700 (ASP)	0.351	Plastic	1.632	23.4	-5.28
5		4.287000 (ASP)	0.559				
6	Lens 3	-3.112200 (ASP)	0.302	Plastic	1.632	23.4	-26.30
7		-3.973100 (ASP)	0.274				
8	Lens 4	-3.011300 (ASP)	0.790	Plastic	1.544	55.9	2.03
9		-0.881520 (ASP)	0.250				
10	Lens 5	-2.171820 (ASP)	0.360	Plastic	1.530	55.8	-1.73
11		1.674970 (ASP)	0.700				
12	IR-filter	Plano	0.300	Glass	1.517	64.2	-
13		Plano	0.334				
14	Image	Plano					

Fig.7

Figure 7 depicts the optical parameters for the lens arrangement of Tang's first embodiment. *Id.* at 4:5–6.

Figure 7 depicts, among other things, lens thicknesses, distances between lenses, Abbe numbers, and focal lengths.

4. Independent Claim 1

[1.0] “A mobile electronic device comprising an integrated camera”

Petitioner contends that Parulski discloses a “mobile phone camera with two image capture stages.” Pet. 26 (quoting Ex. 1005, 9:5–6).

According to Petitioner, an ordinarily skilled artisan would have understood

this disclosure to be a mobile electronic device that includes an integrated camera. *Id.* at 27–28 (citing Ex. 1003, 38; Ex. 1005, 23:4–20).

Parulski discloses that “[t]he concept of multiple lenses and multiple sensors, and the use of an integrated image capture assembly, may be adapted for use in a cell phone of the type having a picture taking capability.” Ex. 1005, 23:4–7.

Patent Owner does not dispute Petitioner’s showing as to this limitation. *See generally* PO Resp.

We have reviewed the record developed during trial, and find that Petitioner has shown that the cited portions of Parulski teach the preamble of independent claim 1.¹⁰

[1.1] “wherein the camera comprises a Wide camera unit comprising a Wide lens unit and a Telephoto camera unit comprising a Telephoto lens unit”

Petitioner contends that Parulski’s “integrated capture assembly 610 includes ‘a fixed focal length wide angle lens’ (612) and ‘fixed focal length telephoto lens’ (610).”¹¹ Pet. 28 (citing Ex. 1005, 23:28–43) (emphasis omitted). Petitioner further contends that “Parulski’s first lens 612 is a telephoto camera unit comprising a telephoto lens unit and Parulski’s second lens 614 is a wide camera unit comprising a wide lens unit.” *Id.* at 29 (citing Ex. 1005, 23:28–43; Ex. 1003, 40); *see also* n.11 (noting that Petitioner’s cites to element numbers are incorrect). Petitioner’s annotated Figures 16A and 16B, however, appear to point to wide angle lens 612 and first image

¹⁰ In light of this determination, the panel need not decide whether the preamble is limiting.

¹¹ In its discussion, Petitioner references the cited elements with inaccurate reference numbers. *See* Pet. 28–29.

sensor 614 as teaching the claimed wide camera unit, and telephoto lens 616 and second image sensor 618 as teaching the claimed telephoto camera unit.¹²

The cited portion of Parulski discloses, in relevant part,

[T]he assembly 610 includes a first fixed focal length lens 612 and a first image sensor 614, and a second fixed focal length lens 616 and a second image sensor 618. The first lens 612, preferably a fixed focal length wide angle lens (such as a 40 mm equiv. lens), forms an image on the first image sensor 614, and the second lens 616, preferably fixed focal length telephoto lens (such as 100 mm equiv. lens), forms an image on the second image sensor 618.

Ex. 1005, 23:33–40.

Patent Owner does not dispute Petitioner’s showing as to this limitation. *See generally* PO Resp.

We have reviewed the record developed during trial, and find that Petitioner’s annotated Figures 16A and 16B and the cited portion in column 23 of Parulski sufficiently support Petitioner’s contentions that Parulski teaches the claimed camera.

[1.2] “the Telephoto lens unit and the Wide lens unit having, respectively, total track length (TTL)/effective focal length (EFL) ratios smaller and larger than 1 and”

Petitioner contends that the combination of Parulski’s wide angle lens 612 and Tang’s optical parameters for a specific wide angle lens assembly renders obvious the claimed TTL to EFL ratio greater than one. *See* Pet. 29–34. Likewise, Petitioner contends that the combination of Parulski’s

¹² We note that Parulski uses different names for elements identified by the same reference number throughout its specification. *See* Ex. 1005. We similarly use Parulski’s element names as appropriate.

telephoto lens 616 and Huang's optical parameters for a specific telephoto lens assembly renders obvious the claimed TTL to EFL ratio smaller than one. *Id.* at 29, 34–39.

In particular, Petitioner contends that in Huang's Example 1, the TTL is 5.348 mm, which Petitioner calculates by “summing the distances between the object-side surface of the first lens 100 and the image surface 180 . . .” which are shown in the thickness column of Huang's Table 1. *Id.* at 30–32 (citing Ex. 1006, Table 1 (spanning columns 12–13); Ex. 1003, 43). Petitioner points to Huang's first embodiment focal length (f) of the lens assembly, 6.60 mm, and contends an ordinarily skilled artisan would have understood this to be the EFL of Huang's lens assembly. *Id.* at 33 (citing Ex. 1006, Table 1). Petitioner calculates Huang's ratio of TTL to EFL as $5.384/6.60 = 0.81$. *Id.* at 33–34. We presume Petitioner's calculation of the ratio includes a typographical error and should be a ratio of 5.348 to 6.60, which equates to 0.81 and is smaller than one. *See id.* at 32 (discussing 5.348 mm as the TTL).¹³

Petitioner further contends that in Tang's Embodiment 1, the “wide angle lens unit has a TTL of 4.878 mm and an EFL of 4.34 mm, thus yielding a ratio of $4.878/4.34$ which is larger than one.” *Id.* at 35. According to Petitioner, the TTL of Tang's Embodiment 1 lens can be determined by “summing the distances between the object-side surface of the first lens 100 and the image plane 170 . . .” using Tang's Table 1, and dividing by Tang's focal length (f), 4.34 mm, which Petitioner contends is the EFL. *Id.* at 35–37 (citing Ex. 1009, Figs. 1A, 7, 8:51). Petitioner

¹³ The ratio of 5.384 to 6.60 is also less than 1.

calculates the Tang's first embodiment to have a ratio of 4.878 to 4.34, which is 1.12. *Id.* at 38 (citing Ex. 1003, 47). Petitioner's calculations are undisputed. *See generally* PO Resp.

(1) Petitioner's Rationale for Combining

Petitioner presents the following reasons in support of combining the teachings of Parulski and Huang.

First, that Parulski generally teaches a wide angle lens and a telephoto lens, but “does not provide lens prescription data for either the wide or telephoto fixed-focal length lens in image assembly 610.” Pet. 20. According to Petitioner, “[s]ince Parulski offers nothing more, a POSITA looking to implement this embodiment would have sought a suitable telephoto lens unit to incorporate in the cell phone camera, like Huang's embodiment.” *Id.* (citing Ex. 1003, 31). *Second*, that Huang's lenses are “just one possible option” because they are applicable to mobile devices in general and smart phones in particular. *Id.* at 21 (citing Ex. 1003, 32; Ex. 1006, 8:44–51, 35:53–60). *Third*, that Parulski seeks to use lenses to reduce cell phone thickness, and Huang's telephoto lens “has the benefits of reducing both the manufacturing costs and the track length of the lens assembly (*i.e.*, thickness).” *Id.* at 22 (citing Ex. 1005, 24:20–27; Ex. 1006, 7:56–8:3). *Fourth*, that an ordinary skilled artisan would have had a reasonable expectation of success in making the combination, based on the similarity between the fields of view of Parulski and Huang's lenses. *Id.* at 23–24 (citing Ex. 1003, 35; Ex. 1006, Table 1; Ex. 1019, 9–10).

Petitioner presents the following reasons in support of combining the teachings of Parulski and Tang.

Fifth, that “Parulski does not provide lens prescription data for either the wide or telephoto fixed-focal length lens unit in image assembly 610,” and “[t]o create a working lens image assembly 610,” the ordinarily skilled artisan would have looked to Tang, “which provides not only a similar fixed-focal length wide-angle lens, but also provides lens data that specifies the properties and configuration” *Id.* at 24–25 (citing Ex. 1003, 35; Ex. 1009, Fig. 7). *Sixth*, that “Tang describes the use of its lens in ‘portable electronic devices’ such as smart phones and PDAs.” *Id.* at 25 (citing Ex. 1003, 35; Ex. 1009, 1:6–8, 1:37–38). *Seventh*, that “Tang further states that its lens ‘features better image quality, maintains a moderate total track length and is applicable to compact portable electronic products,’ thus satisfying Parulski’s desire for selecting lenses that offer reduced thickness compatible with a mobile device.” *Id.* at 25 (citing Ex. 1005, 24:20–27; Ex. 1009, 1:47–50).¹⁴

¹⁴ Petitioner also argues that that a “POSITA would have understood Tang’s wide-angle lens with a similar HFOV [half field of view] of 33.2 degrees to be essentially equivalent to Parulski’s wide-angle lens, based on the similarity between the fields of view of the lenses.” *Id.* (citing Ex. 1003, 36; Ex. 1005, 23:23–43; Ex. 1009, Fig. 7; Ex. 1019, 9–10 (“A wide-angle lens will cover an angular semifield of about 30° to 35°)). Petitioner calculates Parulski’s HFOV as 28.40 degrees for a 35 mm lens. *Id.* (citing Ex. 1016, 107). Petitioner misquotes Kingslake (Ex. 1019) and cites the wrong pages of Kingslake—we cite to the original page numbers of the Kingslake text. We do not address this eighth reason in light of Petitioner’s seven other reasons that we find persuasive and in light of the fact that Patent Owner does not dispute this reason, nor any of the seven reasons set forth in this section and discussed in the following section.

(2) *Discussion of Rationale for Combining*

We have reviewed the record developed at trial including the cited portions of Parulski, Huang, and Tang. We determine that Petitioner has supported its seven reasons for combining Parulski, Huang, and Tang with sufficient rational underpinning evidenced by the exhibits cited above.

Patent Owner does not dispute Petitioner's rationale for combining. *See generally* PO Resp. We determine that Petitioner has shown that an ordinarily skilled artisan would have been motivated to combine Parulski, Huang, and Tang, and that such motivation is supported by sufficient rational underpinning.

Based on the complete record developed at trial, we determine that cited portions of Parulski, Huang, and Tang sufficiently support Petitioner's contentions with respect to the telephoto lens unit and the wide lens unit as claimed.

[1.3] *“defining separate Telephoto and Wide optical paths”*

Petitioner provides annotated versions of Figures 16A and 16B of Parulski that add a dashed blue line through each of wide-angle lens unit 612 and telephoto lens unit 616 and contends “[a] POSITA would have understood that light passing through the Wide camera unit to the first sensor 614 defines a Wide optical path and the light passing through the Telephoto camera unit to the second sensor 618 defines a separate Telephoto optical path.” Pet. 40 (citing Ex. 1005, Figs. 16A, 16B; Ex. 1003, 50–51).

Patent Owner does not dispute Petitioner's showing as to this limitation. *See generally* PO Resp.

We have reviewed the record developed during trial, and find that the cited portions of Parulski sufficiently support Petitioner's contentions that Parulski teaches the claimed optical paths.

[1.4] "wherein the Telephoto lens unit comprises multiple lens elements made of at least two different polymer materials having different Abbe numbers"

Petitioner contends that "Huang's Example 1 lens is listed as plastic, which a POSITA would understand to be a polymer material." Pet. 44 (citing Ex. 1006, Table 1; Ex. 1003, 53). As identified by Petitioner, Huang's plastic lenses comprising its lens assembly are disclosed as having different Abbe numbers, ranging from 21.4 to 55.9. *Id.* at 44–45 (citing Ex. 1006, Table 1); *see* Ex. 1001, 8:25–27 ("lens elements made of different polymer materials, i.e., materials having different Abbe numbers.").

Patent Owner does not dispute Petitioner's showing as to this limitation. *See generally* PO Resp.

We have reviewed the record developed during trial, and find that the cited portions in Huang's Table 1 sufficiently support Petitioner's contentions that Huang teaches lenses of different polymer materials having different Abbe numbers.

[1.5] "wherein the multiple lens elements comprise a first group of at least three lens elements configured to form a telephoto lens assembly and a second group of at least two lens elements"

Petitioner contends that Figure 1 of Huang depicts a first group of lenses 110, 120, 130 and second group of lenses 140, 150, and 160. Pet. 45–46. According to Petitioner's first interpretation, the first group of lenses "form a telephoto lens assembly' because its TTL is less than its EFL (5.348 mm < 6.60 mm)." *Id.* at 46 (citing Ex. 1006, Table 1). Under this

theory, Petitioner appears to take the position that the *entire* telephoto lens unit, including the first group *and* the second group, forms a telephoto lens assembly.

Under an alternative theory, Petitioner contends that if the claim limitation is interpreted such that the first group of lenses *together* form a telephoto lens assembly with $TTL < EFL$, Huang also meets this limitation. *Id.* at 46–49. According to Petitioner, the TTL of the first group equals “[t]hicknesses of lenses and spaces for L1-L3 (1.893 mm) + Distance to image plane for L1-L3.” *Id.* at 47 (citing Ex. 1006, Table 1). Petitioner explains that

This value [1.893 mm] is then added to *the distance to the image plane* for a total TTL of 4.57583 mm, as calculated below in Zemax. . . . The EFL of Huang’s Example 1 first lens group was determined by Zemax to be 5.61 mm. Therefore, the TTL of Huang’s Example 1 first lens group (4.57583 mm) is smaller than the EFL (5.61 mm)

Id. at 48 (citing Ex. 1003, Appendix, Fig. 1) (emphasis added).¹⁵

Patent Owner does not dispute Petitioner’s showing as to this limitation. *See generally* PO Resp.

We have reviewed the record developed during trial, and find that, Huang sufficiently supports Petitioner’s contentions that Huang teaches the first group and the second group as claimed under either Petitioner’s primary theory or its alternative theory.

[1.6] “the second group of at least two lens elements spaced apart from the first group of at least three lens elements by a

¹⁵ Petitioner characterizes Zemax as a lens design software. *Supra* § III.B (citing Pet. 6–7).

predetermined effective gap equal to or larger than 1/5 of the TTL of the Telephoto lens unit”

Petitioner contends that Huang’s Table 1 discloses the distance between the image side of lens 3 and object side of lens 4 is 1.345 mm, and as discussed above, that the TTL is 5.348. Pet. 51. Based on these values, Petitioner calculates $5.348/5$ as 1.0696, and thus, asserts that Huang’s gap of 1.345 mm is larger than 1/5 of the TTL. *Id.* at 49–51 (citing Ex. 1006, Fig. 1; Ex. 1003, 56, 57).

Patent Owner does not dispute Petitioner’s showing as to this limitation. *See generally* PO Resp.

We have reviewed the record developed during trial, and find that the gap and thicknesses disclosed in Table 1 of Huang sufficiently support Petitioner’s contentions that Huang teaches the claimed predetermined effective gap and the claimed relation to the TTL of the telephoto lens unit.

[1.7] “wherein the first group of at least three lens elements comprises, in order from an object plane to an image plane along an optical axis of the Telephoto lens unit, a first lens element having positive optical power and”

Petitioner contends that lenses 110, 120, 130 are depicted in Figure 1 of Huang along an optical axis and provides an annotated version of this figure in the Petition. Pet. 53 (citing Ex. 1006, Fig. 1). Petitioner also contends that first lens element 110 has a positive optical power. *Id.* at 55 (citing Ex. 1006, 9:23–33, 42) (“The first lens element 110 with positive refractive power . . .”). According to Petitioner, “[a] POSITA would have understood ‘positive refractive power’ as stated by Huang to be equivalent to ‘positive optical power’ as recited in the claim.” *Id.* (citing Ex. 1003, 60).

Patent Owner does not dispute Petitioner's showing as to this limitation. *See generally* PO Resp.

We have reviewed the record developed during trial, and find that Figure 1 of Huang sufficiently supports Petitioner's contention that Huang teaches the lenses in the claimed arrangement, and the cited portion in column 9 of Huang sufficiently supports Petitioner's contention that Huang's first lens has positive optical power as claimed.

[1.8] "a pair of second and third lens elements having together negative optical power such that the Telephoto lens assembly provides a Telephoto optical effect of the Telephoto lens unit and"

Petitioner contends that "the second and third lens elements in Huang's first group both have negative optical power." Pet. 55 (citing Ex. 1006, 9:51–52 ("[t]he second lens element 120 with negative refractive power"); 9:58 ("[t]he third lens element 130 with negative refractive power")). According to Petitioner, an ordinarily skilled artisan would have understood that these lens elements together also have a negative optical power. *Id.* at 55–56 (citing Ex. 1003, 60). Petitioner also points to the negative focal lengths for Lens 2 and Lens 3 (i.e., -3.57 and -8.42 , respectively) in Huang's Table 1. *Id.* at 57. Petitioner supports its assertion that these lens elements together also have a negative optical power by substituting the negative focal lengths into a formula that evaluates to the combined focal length of two or more lenses, in this case, -0.3998 .¹⁶ *Id.* at 56–58.

¹⁶ Petitioner calculates the combined power of lenses 2 and 3 as -0.3998 , but also notes that the "negative optical power of the combined second and third lens elements is confirmed by Zemax, which calculates $1/f = -0.42$." Pet. 58

Under a first theory, Petitioner again contends that if the claim limitation is interpreted such that the first group of lenses *together* form the claimed telephoto lens assembly, then that assembly provides a telephoto optical effect as evidenced by a calculation from Zemax discussed above with respect to limitation 1.5. *Id.* at 58 (citing Ex. 1003, Appendix, Figs. 2 and 3). Specifically, “the optical data for Huang’s Example 1 lens assembly provides for a focal length of 4.57583 mm and a track length of 5.163 mm for lenses L1-L3 combined, as calculated by Zemax.” *Id.* According to Petitioner, “since the TTL is longer than the EFL for these lenses, the first lens group of Huang is a ‘Telephoto lens assembly [that] provides a Telephoto optical effect of the Telephoto lens unit’ as recited by the claim.” *Id.* at 58–59 (citing Ex. 1003, 62). We presume this is a typographical error on the part of Petitioner. The optical data that Petitioner presented above with respect to limitation 1.5 included a TTL of 4.57583 mm and an EFL of 5.61 mm, as calculated above by Zemax—with this correction, the TTL is still *less* than the EFL, and Huang meets this limitation.

Under a second theory, Petitioner further contends that “a POSITA would have understood that a Telephoto lens assembly would necessarily provide a Telephoto optical effect.” Pet. 59 (citing Ex. 1003, 62). According to the cited testimony of Dr. Sasián, “[a] POSITA would have also understood that telephoto lenses, such as those referenced by Huang, generally include a first positive lens followed by a second negative lens,

(citing Ex. 1003, 63, Appendix, Fig. 2) (emphasis omitted). Petitioner explains neither the reason for the difference between the value determined from the formula and the value calculated by Zemax, nor why these two values would have been considered equivalent.

providing a telephoto effect.” Ex. 1003, 62–63 (citing Ex. 1016, 155–156).¹⁷

Petitioner also points to portions of Huang that describe a “telephoto ability” with respect to “the arrangement of lens elements.” Pet. 59 (citing Ex. 1006, 5:58–60, 6:7–12) (emphasis omitted).

Patent Owner does not dispute Petitioner’s showing as to this limitation. *See generally* PO Resp.

We have reviewed the record developed during trial, and find that the lenses in the lens assembly of Huang’s first embodiment sufficiently support Petitioner’s contentions that Huang teaches the second and third lenses with negative optical power as claimed under either Petitioner’s first theory or its second theory.

[1.9] “such that the second and third lens elements are each made of one of the at least two different polymer materials having a different Abbe number for reducing chromatic aberrations of the Telephoto lens”

Petitioner contends that the second and third lens elements in Huang’s Table 1 are “made of plastic (polymer)” with different Abbe numbers and “different polymer materials (based on their being plastic and having different refractive indices).” Pet. 60–61 (citing Ex. 1003, 63). According to Petitioner, “[a] POSITA would have understood that the combination of two consecutive lenses with different Abbe numbers would help to correct

¹⁷ The cited reference, Katz (Ex. 1016), does not contain pages 155 and 156, and does not appear to relate to the subject matter for which it was cited.

chromatic aberration” *Id.* at 61 (citing Ex. 1017, 3:1–5 (Sverdrup patent); Ex. 1003, 63–64; Ex. 1019, 37).¹⁸

Petitioner’s annotated version of Huang’s Table 1 points out that the Abbe number of Lens 2 is 23.3 and the Abbe number of Lens 3 is 55.8. *Id.* at 60. Dr. Sasián testifies that “[a] POSITA would understand that both L2 and L3 are made of at least two different polymer materials (based on their being plastic and having different refractive indices).” Ex. 1003, 64. Based on the cited portions of Huang and Dr. Sasián’s testimony, we are persuaded that Huang’s Lens 2 and Lens 3 teach “second and third lens elements are each made of one of the at least two different polymer materials having a different Abbe number.”

With respect to reducing chromatic aberrations, Petitioner’s cited portion in Sverdrup (Ex. 1017) discloses not only that “[c]hromatic aberration can be addressed in lenses by combining two different materials with differing Abbe numbers,” as quoted by Petitioner, but also that “[o]ne of the materials is made into a positive lens, and the other into a negative lens,” and that “[t]he powers are not equal, so that the overall power is non-zero.” Ex. 1017, 3:1–5. Dr. Sasián testifies that “a POSITA would have understood that L1 of Huang’s Example 1 lens system introduces positive chromatic aberration and L2 reduces this chromatic aberration as is well known in the art.” Ex. 1003, 65 (citing Ex. 1017, 3:1–5; Ex. 1019, 37); *see* n.13. We understand Petitioner’s position to be that Huang’s Lens 1 teaches

¹⁸ Dr. Sasián’s testimony (Ex. 1003, 65) cites page 37 of Kingslake. The cited portion, page 37, of Kingslake (Ex. 1019) does not appear to exist.

the positive lens and Huang's Lens 2 teaches the negative lens to reduce chromatic aberrations.

Patent Owner does not dispute Petitioner's showing as to this limitation. *See generally* PO Resp.

We have reviewed the record developed during trial, and find that Huang's Lenses 2 and 3, as evidenced by Sverdrup, sufficiently support Petitioner's contentions that Huang teaches the second and third lenses reducing chromatic aberrations as claimed in this limitation.

[1.10] "wherein the second group of lens elements includes a fourth lens element and a fifth lens element made of the different polymer materials having different Abbe numbers and"

[1.11] "is configured to correct a field curvature and to compensate for residual chromatic aberrations of the Telephoto lens assembly dispersed during light passage through the effective gap between the Telephoto lens assembly and the second group of at least two lens elements, and"

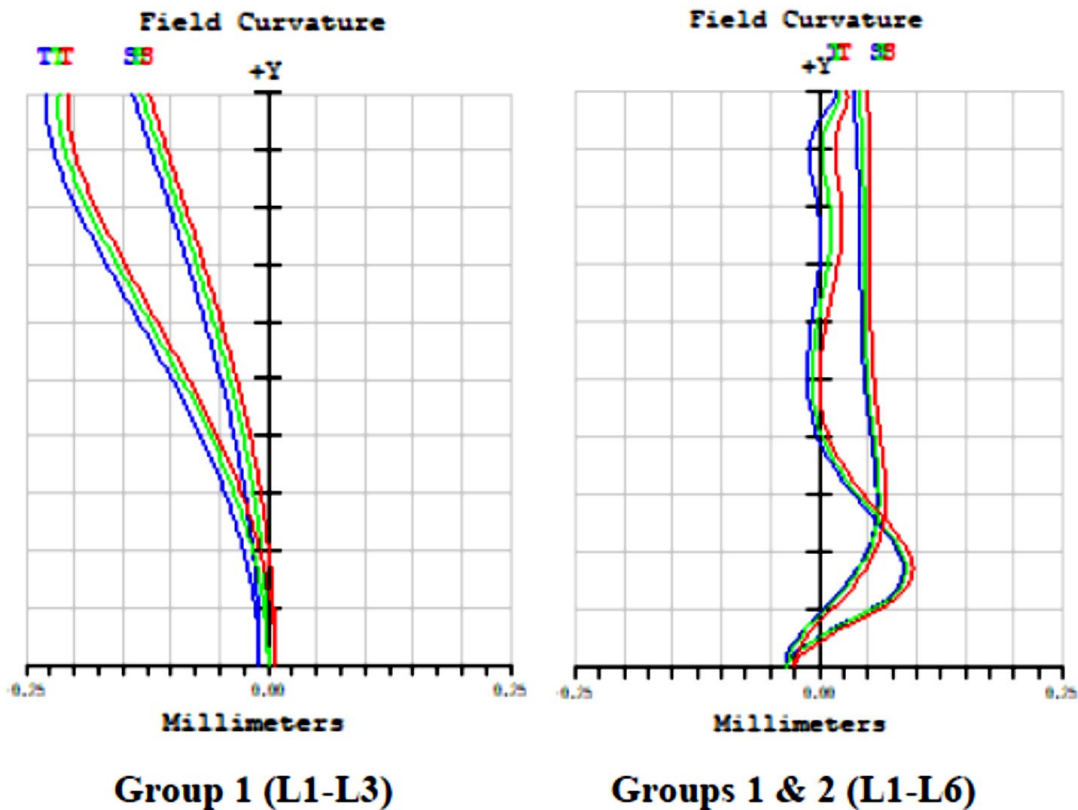
According to Petitioner, although Huang's lenses in the second group are numbered Lens 4 through Lens 6,

Huang's Lens 5 may be a "fourth lens element" and Lens 6 may be a "fifth lens element" because the claim language does not include any restriction requiring identification of each lens along the optical axis for lenses in the second group, and also indicates that the second group can have more than two lens elements.

Pet. 64 (citing Ex. 1003, 67–68). Huang's Lens 5, cited as teaching the claimed fourth lens element, has an Abbe number of 21.4. *Id.* at 63 (citing Ex. 1006, Table 1). Huang's Lens 6, cited as teaching the claimed fifth lens element, has an Abbe number of 55.7. *Id.*

Petitioner contends that "the field curvature of Huang's Example 1 lens assembly is corrected by the second group of lenses." *Id.* at 64.

Petitioner supports its contention with Zemax plots, which are reproduced below. *Id.* at 65.



Petitioner's Zemax plots depicting a reduction in field curvature in Groups 1 and 2 as compared with Group 1 alone, with respect to Huang's Example 1.¹⁹ *Id.* at 65.

In particular, Petitioner contends that

[T]he standard field curves show that lenses L1-L3 in the first group have some residual field curvature with a maximum of about -0.22 mm for the light beam at 16.3°, and that the field curves are curved. The field curves for the complete objective, L1-L6, show that the second group of lenses L4-L6 corrects for the residual field curvature of the first lens group L1-L3 as the

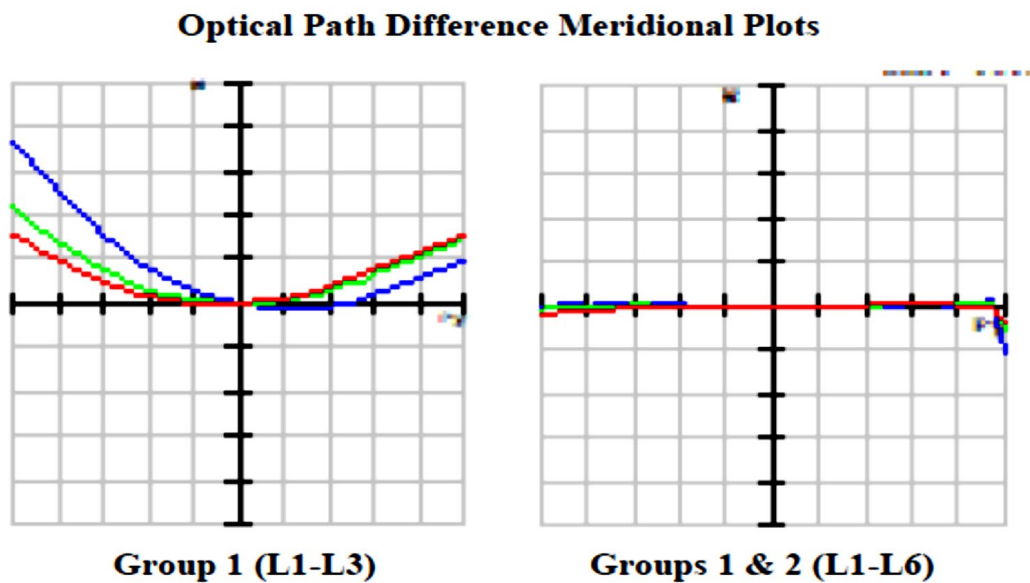
¹⁹ Petitioner's Zemax plots are reproduced with as much clarity as possible from the Petition and/or the Appendix of Dr. Sasián's Declaration.

field curves have a maximum of about 0.1 mm and are nearly straight.

Id. (citing Ex. 1003, 68). We determine that the Zemax plots reproduced above depict some change along the x-axis, which we understand to represent millimeters of field curvature. *See* Ex. 1003, Appendix (Figs. 1–8).

We accept as sufficient Dr. Sasián’s testimony that Figure 4 depicts the field curvature of Huang’s Example 1 lens assembly. Ex. 1003, 68.

Petitioner further contends that “a POSITA would have understood that lateral and longitudinal chromatic aberration can be shown by optical path difference meridional plots and chromatic focal shift curves.” Pet. 66. Petitioner contends that its Zemax plots, reproduced below, are representative of Huang’s Example 1 lens assembly. *Id.*



Zemax plots purportedly depicting optical path difference meridional plots. *Id.* (citing Ex. 1003, Appendix (Fig. 5)); *see supra* n.18.

According to Petitioner,

[T]he optical path difference meridional plot for the light beam at 16.3° shows lateral and longitudinal chromatic aberration for the first group of lenses L1-L3 as the plots for the F and C wavelengths are tilted and curved with respect to each other. The same plots for the complete lens assembly L1-L6 shows no tilt or curvature for the F and C wavelengths, indicating that the second group compensates for residual chromatic aberration from the first group.

Pet. 66–67 (citing Ex. 1003, 70).

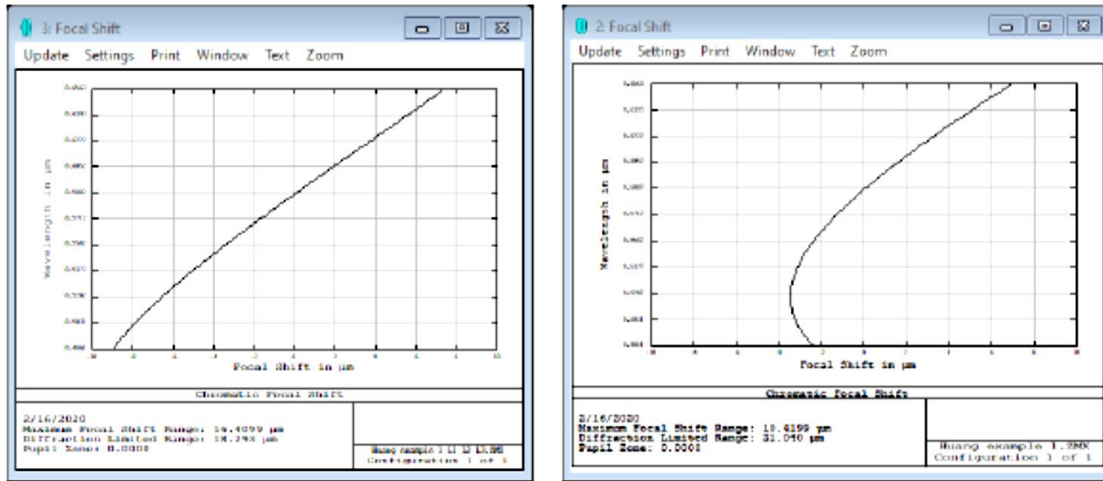
We accept as sufficient Dr. Sasián’s testimony that “lateral and longitudinal chromatic aberration can be shown by optical path difference meridional plots . . . for *Huang’s Example 1 lens assembly* as generated by Zemax” with respect to Figure 5. Ex. 1003, 69 (emphasis added). We determine that the Zemax plot for the complete lens assembly, Lens 1 through Lens 6, depicts a flattening as well as a reduction in tilt for the depicted curves, as Petitioner contends.

Lastly, Petitioner contends that

[T]he chromatic focal shift curve for the first group of lenses (L1-L3) shows longitudinal chromatic aberration, while the same curve for the complete lens assembly (L1-L6) shows that residual longitudinal chromatic aberration has been compensated as at least two wavelengths focused at the same focal distance. Thus, a POSITA would have known that the second group of lens elements is configured to “compensate for residual chromatic aberrations of the Telephoto lens assembly dispersed during light passage through the effective gap between the Telephoto lens assembly and the second group of at least two lens elements.”

Pet. 67–68 (citing Ex. 1003, 70). Reproduced below are Petitioner’s Zemax plots depicting chromatic focal shift curves representative of Huang’s Example 1 lens assembly.

Chromatic Focal Shift Curves



Group 1 (L1-L3)

Groups 1 & 2 (L1-L6)

Zemax plots depicting chromatic focal shift curves comparing Group 1 alone and Groups 1 and 2 together. *Id.* at 67 (citing Ex. 1003, Appendix (Fig. 6)); *see supra* n.18.

The Zemax plots reproduced above depict a focal shift that is more significant at lower wavelengths.

Patent Owner does not dispute Petitioner's showing as to this limitation. *See generally* PO Resp.

We have reviewed the record developed during trial, and find Dr. Sasián's testimony that "lateral and longitudinal chromatic aberration can be shown by . . . chromatic focal shift curves for *Huang's Example 1 lens assembly* as generated by Zemax" with respect to Figure 6 (Ex. 1003, 69 (emphasis added)) and text in Figure 6 that states "Huang example 1, configuration 1 of 1" (*id.*, Appendix) is sufficient.

We are also persuaded that Petitioner's Zemax plots and the cited portions of Huang sufficiently support Petitioner's contentions that Huang

teaches a second group that corrects a field curvature and compensates for residual chromatic aberrations as claimed.

[1.12] “wherein the first, third and fifth lens elements have each an Abbe number greater than 50”

[1.13] “and the second and fourth lens elements have each an Abbe number smaller than 30.”

Petitioner contends that Huang’s lenses have Abbe numbers greater than 50 because Huang’s Table 1 includes “lens elements annotated as L1, L3, and L5 hav[ing] Abbe numbers of 55.9, 55.8, and 55.7, respectively.” Pet. 69 (citing Ex. 1006, Table 1). Petitioner further contends that Huang’s lenses have Abbe numbers smaller than 30 because Huang’s Table 1 includes “lens elements annotated as L2 and L4 hav[ing] Abbe numbers of 23.3 and 21.4, respectively.” *Id.* at 71 (citing Ex. 1006, Table 1).

Patent Owner does not dispute Petitioner’s showing as to this limitation. *See generally* PO Resp.

We have reviewed the record developed during trial, and find that Huang’s disclosure of the Abbe numbers corresponding to Lenses 1 through 5 sufficiently supports Petitioner’s contentions that Huang teaches lenses with the claimed Abbe numbers.

For the foregoing reasons, and based on the entire record developed during trial, and find that the cited evidence sufficiently supports Petitioner’s contentions so as to establish unpatentability by a preponderance of the evidence with respect to the challenge to independent claim 1 over the combination Parulski, Huang, and Tang.

5. Dependent Claim 2

Claim 2 recites, “wherein light receiving outer surfaces of the Wide and Telephoto lens units are located substantially in the same plane, thereby

reducing shadowing and light blocking effects therebetween.” Ex. 1001, 20:17–20. Claim 2 depends from claim 1.

Petitioner annotates Figures 16A and 16B of Parulski to point out how “Telephoto and Wide camera units include light receiving outer surfaces (opposite image sensors 614 and 618) that lie along a same plane.” Pet. 73 (citing Ex. 1006, Figs. 16A, 16B).

Patent Owner does not dispute Petitioner’s showing as to this claim.
See generally PO Resp.

We have reviewed Petitioner’s annotated versions of Parulski’s Figures 16A and 16B and are persuaded that they sufficiently support Petitioner’s contentions so as to establish unpatentability by a preponderance of the evidence with respect to the challenge to dependent claim 2 over the combination Parulski, Huang, and Tang.

6. *Dependent Claim 5*

Claim 5 recites, “wherein the Wide and Telephoto camera units are mounted directly on a single printed circuit board.” Ex. 1001, 20:27–29. Claim 5 depends from claim 1.

According to Petitioner, “Parulski’s cell phone camera includes an integrated capture assembly that includes a Wide camera with a Wide lens unit and a Telephoto camera unit with a Telephoto lens unit.” Pet. 74 (citing Ex. 1005, 23:28–43). Petitioner contends that “[t]he Wide and Telephoto camera units of this integrated capture assembly are mounted directly on *a common substrate 620* as shown in Figs. 16A and 16B.” *Id.* (citing Ex. 1006, Figs. 16A and 16B) (emphasis added).

Patent Owner does not dispute Petitioner’s showing as to this claim.
See generally PO Resp.

We have reviewed Parulski's Figures 16A and 16B and are persuaded that they sufficiently support Petitioner's contentions so as to demonstrate unpatentability by a preponderance of the evidence with respect to the challenge to dependent claim 5 over the combination Parulski, Huang, and Tang.

7. *Dependent Claims 7, 12, and 18*

Claim 7 recites, "wherein the Telephoto lens unit has a TTL less than 6.5 mm." Ex. 1001, 20:33–34. Claim 12, "wherein the Telephoto lens unit TTL is less than 5.5 mm." *Id.* at 20:51–52. Claim 18 recites "wherein the Telephoto lens unit has an F# smaller than 3.2 and a TTL smaller than 6.2 mm." *Id.* at 20:65–67. Each of claims 7, 12, and 18 depends from claim 1.

With respect to the TTL requirements of claims 7, 12, and 18, Petitioner relies on Huang's Table 1 and calculates the TTL of Huang's first embodiment as 5.348 mm, as it did with respect to independent claim 1. Pet. 76–78, 81. Huang's Table 1 further indicates that the F# of Huang's first embodiment is 2.85. *Id.* at 81

Patent Owner does not dispute Petitioner's showing as to these claims. *See generally* PO Resp.

We have reviewed Huang's Table 1 and Petitioner's calculation and are persuaded that they sufficiently support Petitioner's contentions so as to establish unpatentability by a preponderance of the evidence with respect to the challenge to dependent claims 7, 12, and 18 over the combination Parulski, Huang, and Tang.

8. *Dependent Claims 11, 13, and 16*

Claim 11 recites "wherein the Telephoto lens unit TTL/EFL ratio is smaller than 0.9." Ex. 1001, 20:49–50. Claim 11 depends from claim 1.

According to Petitioner “Huang’s Example 1 lens system is a Telephoto lens unit with $TTL = 5.348$ mm and $EFL = 6.6$ mm,” and therefore, discloses a “ratio of $TTL/EFL = 5.348/6.6 = 0.81$, which is smaller than 0.9.” Pet. 78 (citing Ex. 1003, 78).

Claims 13 and 16 recite “wherein the Telephoto lens unit EFL is greater than 5.9 mm.” Ex. 1001, 20:53–54, 61–62. Claim 13 depends from claim 1. Claim 16 depends from claim 11, which in turn, depends from claim 1.

As discussed above, Petitioner contends “Huang’s Example 1 lens system is a Telephoto lens unit with $EFL = 6.6$ mm, which is greater than 5.9 mm.” Pet. 78.

Patent Owner does not dispute Petitioner’s showing as to these claims. *See generally* PO Resp.

We have reviewed Huang’s Table 1 and Petitioner’s calculation and are persuaded that they sufficiently support Petitioner’s contentions so as to establish unpatentability by a preponderance of the evidence with respect to the challenge to dependent claims 11, 13, and 16 over the combination Parulski, Huang, and Tang.

9. *Dependent Claim 15*

Claim 15 recites “wherein the Telephoto camera unit includes an image sensor and wherein an image captured by the Telephoto camera unit has a field of view that is no larger than 44 degrees.” Ex. 1001, 20:57–60. Claim 15 depends from claim 1.

Petitioner points to Huang’s image sensor 190 as teaching the claimed image sensor. Pet. 79. Petitioner also points out that Huang’s first embodiment has a half field of view (HFOV) that is depicted in Table 1 as

16.3 degrees, and contends that a “POSITA would have thus understood that the full Field of View of Example 1 lens assembly is twice the HFOV, or 32.6 degrees, which is $FOV = 2 * HFOV = 32.6$ degrees, which is ‘no larger than 44 degrees’ as claimed.” *Id.* at 80–81 (citing Ex. 1003, 79–80).

Patent Owner does not dispute Petitioner’s showing as to this claim. *See generally* PO Resp.

We have reviewed Huang’s Table 1 and Petitioner’s calculation and are persuaded that they sufficiently support Petitioner’s contentions so as to establish unpatentability by a preponderance of the evidence with respect to the challenge to dependent claim 15 over the combination Parulski, Huang, and Tang.

10. Dependent Claim 20

Claim 20 recites “wherein the first, second and third lens elements have respective focal lengths f_1 , f_2 and f_3 , and wherein the respective focal lengths satisfy the condition $1.2|f_3| > |f_2| > 1.5|f_1|$ and wherein the Telephoto lens unit has an $F\#$ smaller than 3.2, wherein the Telephoto lens unit TTL is smaller than 6.2 mm.” Ex. 1001, 21:4–9. Claim 20 depends from claim 1.

According to Petitioner, “in Table 1, Huang’s Example 1 lens system includes lenses L1, L2, and L3 having focal lengths of $f_1=2.26$ mm, $f_2=-3.57$ mm, and $f_3=-8.42$ mm, respectively.” Pet. 82–83. Petitioner sufficiently demonstrates that the focal lengths disclosed in Huang meet the condition recited in claim 20: $1.2|-8.42| > |-3.57| > 1.5(2.26) = 10.104 > 3.57 > 3.39$. *Id.* The second and third wherein clauses of claim 20 are the same as the limitations recited in claim 18. Petitioner points to its showing for claim 18 to meet the second and third wherein clauses, which

we consider persuasive for the same reasons as set forth above with respect to claim 18.

Patent Owner does not dispute Petitioner's showing as to this claim.
See generally PO Resp.

We have reviewed Huang's Table 1 and Petitioner's calculations and are persuaded that they sufficiently support Petitioner's contentions so as to establish unpatentability by a preponderance of the evidence with respect to the challenge to dependent claim 20 over the combination Parulski, Huang, and Tang.

11. Dependent Claim 21

Claim 21 recites "wherein the Telephoto camera unit includes an image sensor with an image sensor size $\frac{1}{4}$ " or $\frac{1}{3}$ ". Ex. 1001, 21:10–12. According to Petitioner,

Huang's Example 1 telephoto lens and Tang's Embodiment 1 wide-angle lens produce image heights of 2.0 mm and 2.86 mm, respectively. Using the formula provided by Smith as discussed above, Huang's Example 1 lens has a 4 mm diagonal and Tang's Embodiment 1 wide-angle lens has a 5.72 mm diagonal. A POSITA would have understood these diagonals to be compatible with sensor diagonals for $\frac{1}{4}$ " and $\frac{1}{3}$ " sensors, with diagonals of about 4.4 mm and 6 mm. Furthermore, a POSITA would have understood that the use of the lens assemblies of Huang and Tang with $\frac{1}{4}$ " and $\frac{1}{3}$ " sensors would avoid clipping the lens image, or providing many more unnecessary pixels as a $\frac{1}{2}$ " sensor would provide.

Furthermore, a POSITA would have understood that the lens assemblies of Huang and Tang are designed for electronic sensors such as a CCD or CMOS, and would therefore be motivated to provide a suitable sensor with these lenses. A POSITA would have been motivated to provide Huang's telephoto lens with an image sensor having a $\frac{1}{4}$ " or $\frac{1}{3}$ " format to

meet cost, size, and other design requirements of modern cell phones.

Pet. 84–85 (citing Ex. 1005, 7:28–31, 24:20–31; Ex. 1006, 1:20–30, Fig. 2; Ex. 1009, 1:10–19, Fig. 1B; Ex. 1015, 26; Ex. 1003, 84–85).²⁰

Patent Owner does not dispute Petitioner’s showing as to this claim.
See generally PO Resp.

Although Huang does not explicitly disclose the size of its sensor, we have reviewed the cited portions and determine that they sufficiently support Petitioner’s contentions so as to establish unpatentability by a preponderance of the evidence with respect to the challenge to dependent claim 21 over the combination Parulski, Huang, and Tang.

E. Obviousness over Parulski, Huang, Tang, and May

Petitioner contends that claims 3 and 4 are unpatentable as obvious under 35 U.S.C. § 103 over Parulski, Huang, Tang, and May. For the reasons that follow, we determine that Petitioner’s showing is not sufficiently supported so as to establish unpatentability by a preponderance of the evidence with respect to the challenge to claims 3 and 4.

1. Overview of May

May concerns “a digital camera that uses multiple lenses and image sensors to provide an extended zoom range.” Ex. 1011, 1:8–10. By providing a plurality of optical image capture modalities, each having a lens-sensor combination with a different focal length or combination of focal lengths (i.e., a zoom factor), “a large zoom ratio, e.g., 10:1, can be accomplished in a smaller scale space at lower cost with higher quality optical results than heretofore achieved.” *Id.* at 4:45–54.

²⁰ Smith (Ex. 1015) does not have a page 26 as cited by Petitioner.

An exemplary embodiment, a “folded lens assembly configuration,” is depicted in Figure 10D, reproduced below.

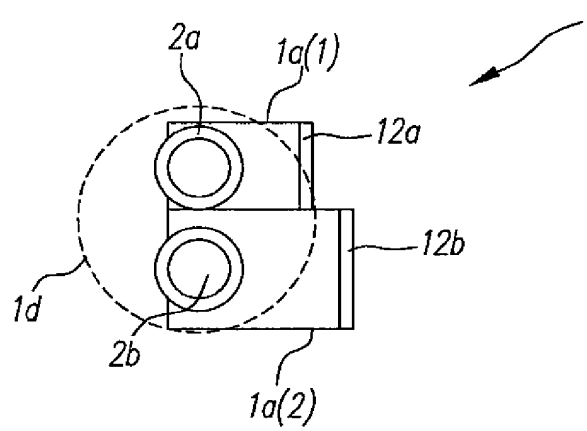


FIG. 10D

Figure 10A is an optical layout of an embodiment of image capture assembly 1. *Id.* at 7:4–8.

According to May,

in FIG. 10A, an image capture assembly 1 includes the first lens 2 and the first image sensor 12 mounted at opposing ends of a first optical relay subassembly 1a having a folded optical path arranged between the first image sensor 12 and the lens 2. The first lens 2, which preferably is a fixed focal length wide angle lens, forms a first image of a scene on the first image sensor 12. The image capture assembly 1 also includes the zoom lens 3 and the second image sensor 14 mounted at opposing ends of a second optical relay subassembly 1b having a folded optical path arranged between the second image sensor 14 and the zoom lens 3. The zoom lens 3, which has a range of focal lengths adjustable between a minimum focal length and a maximum focal length, forms a second image of the scene on the second image sensor 14. In this embodiment, the first lens 2 is a wide angle lens having a focal length less, and preferably substantially less, than the minimum focal length of the zoom lens 3.

Id. at 7:19–35.

Another exemplary embodiment, a “non-folded lens assembly configuration” is depicted in Figure 24A, reproduced below.

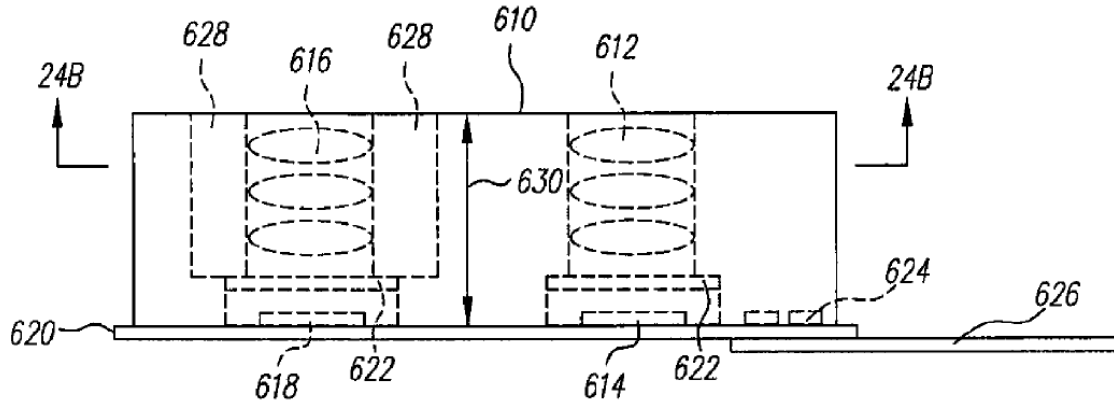


FIG. 24A

Figure 24A is a schematic sectional view of an image capturing assembly for a cell phone. *Id.* at 23:32–36.

“[A]ssembly 610 contains an integrated packaging of optical and imaging components on common substrate 620,” and includes first fixed focal length lens 612 and first image sensor 614, and second fixed focal length lens 616 and second image sensor 618. *Id.* at 23:35–40. The sensors in the image capture assembly may be positioned next to each other on a common circuit board assembly, or may be packaged in a common integrated circuit package. *Id.* at 10:14–17.

2. *Dependent Claims 3 and 4*

Claim 3 recites “wherein the Wide and Telephoto camera units are mounted on separate printed circuit boards.” Ex. 1001, 20:21–26.

Petitioner intermingles its contentions about how a POSITA would have understood May to teach the limitation of claim 3 and its rationale for combining May with Parulski, Huang, and Tang. We address these issues separately.

Petitioner's Initial Contentions Regarding May's Teachings

Petitioner cites elements from both May's folded configuration (*see, e.g.,* Ex. 1011, Figs. 10D–10F) and its non-folded configuration (*see, e.g., id.* at Fig. 24A).

Petitioner contends that “a POSITA would understand that each camera of the image capture assembly includes a sensor (i.e., 12a, 12b, 14, 16) mounted on a different printed circuit board,” as disclosed in May. Pet. 86 (citing Ex. 1011, Figs. 10D–10F, ¶¶ 48, 58), 91–92 (citing Ex. 1003, 92; Ex. 1011, Figs. 10D–10F, 7:4–15).²¹ Petitioner further contends that

May specifically describes embodiments with a telephoto lens and a wide-angle lens in reference to Fig. 10D: “[i]n a fourth embodiment, the digital camera employs a first fixed focal length lens 2a with a first image sensor 12a, and a second fixed focal length lens 2b with a second image sensor 12b . . . In this embodiment, the first fixed focal length lens 2a is preferably a wide angle lens and second fixed focal lens 2b is a telephoto lens.”

Id. at 87–88 (quoting Ex. 1011, 8:15–30). Petitioner also contends that “May additionally teaches that the cameras, including a wide-angle and telephoto lens, are mounted on different subassemblies 1a, 2a and ‘positioned next to each other on *a common circuit board assembly*.’” *Id.* at 89 (Ex. 1011, Figs. 10D–10F, 7:4–15, 10:14–17) (emphasis added).

Petitioner further contends

²¹ We understand Dr. Sasián's testimony to reference paragraph numbers in the pre-grant publication of the May patent (U.S. Patent Application Pub. 2006/0187338 A1). We have reviewed column 7, lines 4–15 and column 10, lines 6–23 in the May patent—the subject matter disclosed therein corresponds to the subject matter in paragraphs 48 and 58 of the pre-grant publication.

A POSITA would have also understood that each sensor is disposed on a printed circuit board extending along a plane (such as sensor 618 on substrate 620 above). For example, each of the camera subassemblies of May is mounted on a substrate that also carries other electronic components (e.g., an autofocus mechanism), including a flex connector (626) and therefore is understood to be a printed circuit board as claimed.

Id. at 87 (citing Ex. 1005, 23:28–40, Figs. 16A–16B; Ex. 1011, Figs. 24A–24B, 23:48–57). Petitioner points to “camera subassemblies including a lens, a lens barrel, and IR [infrared] filter, and an image sensor” and “flex connector 626” in both Parulski and May to support its contention that “a POSITA would have understood that both Parulski and May teach mounting Wide and Telephoto camera units on separate printed circuit boards.” *Id.* at 92–93 (citing Ex. 1005, Figs. 1, 16A–16B, 12:42–54, 23:28–40, 23:44–50, 23:48–54; Ex. 1011, Figs. 1, 24A–24B, 10:60–67, 23:48–57; Ex. 1003, 91–92).

To support its contentions, Petitioner asserts that “[t]he inclusion of a camera module on a printed circuit board in this fashion was well-known in the art, as evidenced by Ryu (APPL-1012).” *Id.* at 90 (citing Ex. 1003 ¶ 74; Ex. 1012, code (57), Fig. 8, 1:30–50).

*Petitioner’s Initial Contentions Regarding a Rationale for
Combining*

First and second, Petitioner contends that one of ordinary skill in the art would have combined May with Parulski, Huang, and Tang because May and Parulski share an inventor in common, “are in the same technical field,” “are analogous prior art,” and “are in the same field of endeavor.” Pet. 88–89 (citing Ex. 1003 ¶ 71; Ex. 1005, 9:8–10; Ex. 1006, 8:44–51; Ex. 1009, 1:6–8; Ex. 1011, 4:27–28).

Third, Petitioner contends that “a POSITA would have understood that Huang’s Example 1 lens assembly and Tang’s Embodiment 1 lens assembly have different track lengths, so the image sensors would naturally be placed at different planes.” *Id.* at 90 (citing Ex. 1003 ¶ 75; Ex. 1006, Table 1; Ex. 1009, Table 1).

Fourth, Petitioner contends that a POSITA would have understood that placing the wide and telephoto lens units of Parulski on different substrates with the ability to vary their layout would provide a greater range of optical performance and more economically produce camera lenses . . . [and] provide a cost savings as compared to a single zoom lens camera. *Id.* at 93 (citing Ex. 1003, 93; Ex. 1005, 6:20–44, 8:15–30, 10:37–59; Ex. 1011, 4:6–15, 45–54); *see also id.* at 90 (citing Ex. 1003 ¶¶ 76, 77) (collectively reiterating that the combination would “provide a greater range of optical performance and more economically produce camera lenses” and “would provide cost savings as compared to a single zoom lens camera”).

With respect to this reason, Petitioner elaborates that a POSITA would have been motivated to make the combination because: “May’s image capture assembly layout [] provide[s] additional flexibility for optical performance and camera lens arrangement” (Pet. 89 (citing Ex. 1003 ¶ 73; Ex. 1011, 4:19–24)); “May’s mounting, arrangement, and modularity of the camera subassemblies is desirable in designing and implementing a photographic camera” (*id.* (citing Ex. 1003 ¶ 74)); and “May states that the various embodiments of its image capture assembly with multiple cameras ‘can reduce the cost and size of the camera, and improve its optical performance’” (*id.* at 88 (citing Ex. 1011, 6:20–24)); *see also id.* at 90 (citing Ex. 1011, 4:6–15, 6:20–44, 10:37–59) (reiterating that “May’s

various image capture assemblies offer the additional benefit of reduction of size and cost of the camera and improvement of its optical performance”).

Patent Owner’s Contentions

Patent Owner contends that “Apple’s petition does not explain how it proposes using the Huang and Tang lenses in May’s layout for folded lenses.” PO Resp. 7. Patent Owner further contends that “[t]he description of the folded lens layouts that Apple quotes describes ‘a common circuit board assembly’” and “the non-folded Figure 24A layout is described as having a single ‘substrate 620’ with electronic circuit components ‘such as resistors, capacitors and power management components’ mounted on it.” *Id.* at 9 (citing Ex. 1011, 10:14–17, 23:48–57; Pet. 88–90).

Patent Owner also contends that the “cost and size benefits cited in May are not tied to the use of separate circuit boards.” *Id.* at 10. Patent Owner contends that “[t]he claims of reduced cost from using separate circuit boards also defy common sense,” and that, instead, “combin[ing] multiple components onto a single board [is] a way to reduce costs.” *Id.* at 11.

Patent Owner still further contends that “Dr. Sasián’s declaration and CV suggest that he is a highly experienced designer of lenses and teacher of lens design,” but that Petitioner “provide[s] no reason to believe that Dr. Sasián has any expertise in circuit board assembly or costs [thereof] that would be useful to this Board.” *Id.* at 12 (citing Ex. 1003 ¶¶ 6–17; Ex. 1004).

Petitioner’s Responsive Contentions

Pointing to May’s Fig. 24A with substrate 620 as teaching a printed circuit board, Petitioner contends that a “POSITA would have recognized

May's other optical assemblies would also include image sensors mounted on a PCB [printed circuit board]." Pet. Reply 8 (citing Pet. 90; Ex. 1003 ¶ 67; Ex. 1011, Fig. 17; Ex. 1022 ¶ 13). Petitioner more particularly contends that "a POSITA would have understood that the image sensors being in different planes in May's embodiments shows that the image sensor on each subassembly is mounted on its own PCB." *Id.* at 9 (citing Pet. 91–92; Ex. 1003 ¶¶ 66–67, 86; Ex. 1022 ¶ 15; Ex. 1005, Figs. 15A–15C, 16A–16B, 23:28–40; Ex. 1011, Figs. 10D–10F); *see id.* at 8–9 (citing Ex. 1003 ¶¶ 66, 74; Pet. 89–90; Ex. 1022 ¶ 14). Petitioner explains that "[s]ince each subassembly has a sensor mounted in a different orientation, a POSITA would have understood each sensor to be mounted on a different PCB due to the image sensors not being parallel and in the same plane." *Id.* at 11 (citing Ex. 1022 ¶ 18).

Petitioner explains that "a POSITA would have understood May's modular camera subassemblies (e.g., as shown in Figs. 10D–10F) to apply to both folded and non-folded fixed-lens configurations" and as such, "[a] POSITA would have been motivated to apply the teachings of May in a non-folded configuration to the wide-angle lens of Tang and the telephoto lens of Huang, at least because these lenses have nonfolded layouts." *Id.* at 20 (citing Pet 95; Ex. 1003, 96; Ex. 1006, Table 1; Ex. 1009, Table 1; Ex. 1011, 23:8–11; Ex. 1022 ¶ 30).

Petitioner further explains that "May's teachings that these camera subassemblies are modular would have indicated to a POSITA that the camera subassemblies in these embodiments use multiple printed circuit boards." *Id.* at 11 (citing Pet. 87, 92; Ex. 1022 ¶ 19). Petitioner asserts that "[b]ecause May shows that each of these camera subassemblies as separate

and oriented in different configurations, a POSITA would have understood that May teaches that its camera subassemblies are modular, and thus teaches the use of different circuit boards, distinct, and spaced apart.” *Id.* at 11–12 (citing Pet. 89–90; Ex. 1003 ¶¶ 66, 74, p. 93; Ex. 1011, Figs. 10A–15C, 9:54–59; Ex. 1022 ¶ 20); *see also id.* at 12 (citing Pet. 89–90; Ex. 1003 ¶¶ 66, 73–74; Ex. 1022 ¶ 21) (“May teaches independent, modular optical assemblies . . . [a] POSITA would have understood May to teach that the camera subassemblies are mounted on separate PCBs to maintain their modular nature.”).

Petitioner further contends that “May’s modular subassemblies would have made it easier to rearrange lenses to accommodate other components such as electronics, screens, and batteries within the ‘confined space of the digital camera.’” Pet. Reply 17 (citing Ex. 1011, 9:19–26; Ex. 1022 ¶ 26). Petitioner also contends that “[t]he use of modular subassemblies on different boards would also allow the use of wide-angle and telephoto lenses optimized for their specific purposes, without trying to align them on the same plane so that they are mounted on the same PCB [printed circuit board].” *Id.* (citing Pet. 90).

Petitioner contends that “[i]n a camera incorporating the lens designs of Huang and Tang (each with a different track length), sensors would be placed at different distances from the lens, as in the May examples” and that “[a] POSITA would look to May’s teachings of alternative ways of assembling those camera modules, including having them on the same plane or separate planes,” and further that “[i]n the case that the camera modules are on separate planes, they would also be on different PCBs [printed circuit boards].” *Id.* at 19 (citing Ex. 1022 ¶ 29).

Overview of Analysis of Dependent Claims 3 and 4

As to whether Petitioner is relying on May's embodiments individually, in the alternative, or in combination with each other, during the hearing, Petitioner clarified its position as follows:

MR. MAUCOTEL: Our combination combines May with the telephoto assemblies or the telephoto lens of Huang and the wide-angle lens of Tang. These are non-folded lenses and they have different track lengths. So, given this art that a POSITA would have in front of them, they would look to the *instructions of May that have to do with imaging assemblies that have different track lengths and can be placed at different orientations. So, that's why we rely on Figures 10D through F of May.*

Tr. 16:8–14 (emphasis added). Petitioner further clarified that:

MR. MAUCOTEL: And a POSITA would -- and May, in Figure 24A, showing non-folded lenses, it works in this case for two lenses mounted on a single PCB because the track length is the same for those imaging assemblies.

* * *

. . . what we're relying on for May, again, kind of going back to Figures 10E through F, we're not relying on the actual lenses of May. *In fact, we're relying on the lenses of Huang and Tang instead, which are non-folded lenses.* They are linear lenses that would extend straight down the page. We're using those imaging assemblies; however, what we're using for May is the teachings *that imaging assemblies are mounted on printed circuit boards and each imaging assembly would have its own printed circuit boards.* That's what we're using for May.

Id. at 15:4–6, 22:11–19 (emphases added). During the hearing, Petitioner further asserted that

MR. MAUCTOEL: We'd also like to point out that both May and Parulski include both folded and non-folded lens designs and use them interchangeably. So, there's no problem with jumping

between the folded and non-folded lens designs. They stand for the same proposition.

Id. at 24:4–8; *see also id.* at 15:1–3 (Mr. Maucotel arguing that “a POSITA would understand -- so, an interesting aspect of May is it uses folded and non-folded configurations interchangeably”).

Based on the Petition, Petitioner’s Reply, and arguments presented during the hearing, we understand Petitioner to rely on May’s non-folded configuration—because Huang and Tang have non-folded lens assemblies—to teach non-folded camera subassemblies on a printed circuit board, and May’s folded configuration to teach that there is a separate printed circuit board for each of the non-folded camera subassemblies.

Contrary to Petitioner’s assertion, whether May’s invention can interchangeably rely on its folded or non-folded configurations is not the relevant inquiry. Instead, we consider whether (1) given the teachings of May a POSITA would have understood that image sensors 12a through 12d of May’s Figures 10D–10F each have their own, separate printed circuit board and whether (2) a POSITA would have understood May or Parulski’s flex connectors to teach or suggest connecting one printed circuit board to another printed circuit board.

*Analysis of Whether a POSITA Would Have Understood
May to Teach or Suggest “separate printed circuit boards”
in Figures 10D through 10F*

We are not persuaded by Petitioner’s argument that, because May’s Figures 10D–10F depict image sensors 12a through 12d on different planes, each image sensor would have been understood by a POSITA to be connected to its own, separate printed circuit board and in a planar fashion. Initially, we find that Petitioner has not shown sufficient evidence that May

discloses separate printed circuit boards. Pet 91–92 (citing Ex. 1003, 92; Ex. 1011, 7:4–15, Figs. 10D–10F). The portions of May cited in the Petition do not teach or suggest more than one printed circuit board, let alone placing each different type of lens unit (i.e., the claimed Wide and Telephoto lens units) on separate printed circuit boards as claimed. *See* Ex. 1011, Figs. 10D–10F, Fig. 24A, 7:4–15. We have considered all of Dr. Sasián’s testimony (Ex. 1003 ¶¶ 65–73; Ex. 1022 ¶¶ 8–35; Ex. 2003) and supporting evidence, and it is not persuasive that May teaches or suggests placing different lens units on separate printed circuit boards. Although Dr. Sasián cites to evidence, we find that evidence does not support his position and thus is unavailing, for the reasons discussed below.

As Patent Owner observes, “[n]othing in May’s description of these figures says that there are printed circuit boards for each image sensor, as opposed to a single board that could be located behind the image capture assemblies shown in Figures 10A–10F that all of the image capture assemblies could be mounted on.” PO Sur-Reply 4; *id.* at 3 (Patent Owner disputing Petitioner’s contention ‘that the elements 12a–12d in these figures are ‘image sensors mounted on different printed circuit boards’” and arguing that May “expressly describes elements 12a–12d, as well as elements 14 and 16 as ‘image sensors.’”). There is insufficient evidence of record that would tend to support a finding that a POSITA would have understood May’s image sensors 12a through 12d to be *mounted in a planar fashion* to separate printed circuit boards. At most, Petitioner explains that “a POSITA would have understood that *the image sensors being in different planes* in May’s embodiments shows that the image sensor on each subassembly is mounted on its own PCB.” Pet. Reply 9 (citing Ex. 1003 ¶¶ 66–67, 86; Ex. 1005,

Figs. 15A–15C, 16A–16B, 23:28–40; Ex. 1011, Figs. 10D-10F) (emphasis added). Dr. Sasián does not explain why image sensors situated in different planes would have been understood to have a particular, e.g., planar, alignment with respect to a printed circuit board. *See, e.g.*, Ex. 1003, p. 93 (citing Ex. 1005, 23:44–50); *id.* ¶¶ 67, 74 (citing Ex. 1005, Figs. 16A–16B, 23:28–40; Ex. 1011, Figs. 24A–24B, 23:48–57).

With respect to May’s disclosure that “[w]hile not in an exactly coaxial arrangement with respect to each other, the multiple lenses *and sensors are generally aligned* with respect to each other so as to be viewing substantially the same object, albeit with different fields of view,” Petitioner has not sufficiently explained why May’s “generally aligned” lens assemblies, including image sensors, would have been understood to involve mounting the multiple lenses and sensors in a *planar* fashion which, in turn, would have been understood to lead to separate printed circuit boards. Ex. 1011, 6:26–30 (emphasis added); *see e.g.*, Tr. 13:11–16, 25:7–10.

*Analysis of Whether a POSITA Would Have Understood
May or Parulski’s flex connectors to Teach or Suggest
Connecting One Printed Circuit Board to Another*

Dr. Sasián testifies that, like May, “Parulski includes a flex connector 626 and a POSITA would have understood that this may be used to similarly connect different boards with lens units together” and thus, “a POSITA would have understood that both Parulski and May teach mounting Wide and Telephoto camera units on separate printed circuit boards.” Ex. 1003, 93 (Ex. 1005, 23:44–50). Dr. Sasián also testifies that “each of the camera subassemblies of May is mounted on a substrate that also carries other electronic components (*e.g.*, an autofocus mechanism), including a flex connector (626) and *therefore is understood to be a printed circuit board as*

claimed.” Ex. 1003 ¶¶ 67, 74 (Ex. 1005, Figs. 16A–16B, 23:28–40; Ex. 1011, Figs. 24A–24B, 23:48–57) (emphasis added). But we are not persuaded that Parulski’s flex connector or May’s flex connector would have been understood to connect to another printed circuit board with the other type (Wide or Tele) of lens unit.

There is nothing in May or Dr. Sasián’s testimony that indicates why a POSITA would have understood either Parulski’s or May’s flex connector to connect to another printed circuit board instead of, for example, “some other electronics.” *Cf.* Tr. 21:15–18. Neither does May or Dr. Sasián’s testimony explain why a POSITA would not have, instead, understood image sensors 12a through 12d could be connected, e.g., *in a non-planar fashion*, to a single printed circuit board that is parallel to fixed focal length lenses 2a through 2d via, for example, wires, “flex connectors or by some other electronics.” *Id.* at 20:18–21:2 (Petitioner’s counsel arguing that separate printed circuit boards would be connected by flex connectors or other electronics). Petitioner’s citation to Ryu does not support Petitioner’s position any further because the cited disclosure teaches “[a]n image sensor (not shown) is connected to one end of the upper surface of the PCB [printed circuit board] 12 by wire, and the header connector 14.” Ex. 1012, 1:34–36.

We are also not persuaded by Petitioner’s citation to May’s Figure 17 because that figure shows only one image sensor and does not explain how and why any component of the figure would have been understood to teach or suggest a printed circuit board. *See* PO Sur-Reply 6 (arguing that “May never says what these unlabeled structures [in Figure 17] are, and there is nothing in May to indicate that these are printed circuit boards, as opposed to some sort of connector, cable, or structural component”).

For the reasons discussed above, we determine that Petitioner fails to establish unpatentability of claim 3, and claim 4 which depends therefrom, by a preponderance of the evidence because Petitioner’s challenge does not sufficiently show that the combination of Parulski, Huang, Tang, and May, as evidenced by Ryu, teaches or suggests that “the Wide and Telephoto camera units are mounted on separate printed circuit boards.”

Petitioner’s challenge does not succeed for an *additional* reason—its rationale for combining May with Parulski, Huang, and Tang is not supported by sufficient rational underpinning, as discussed in detail below.

*Analysis of Rationale for Combining May with Parulski,
Huang, and Tang*

Petitioner’s reasons for combining May with Parulski, Huang, and Tang are too generic and factually unsupported. *See ActiveVideo Networks, Inc. v. Verizon Communications, Inc.* 694 F.3d 1312, 1328 (finding expert testimony about the “modular” nature of references “generic and bear[ing] no relation to any specific combination of prior art elements”). As discussed in further detail below, Petitioner’s reasoning “say[s] no more than that a skilled artisan, once presented with the two references, would have understood that they could be combined. And that is not enough; it does not imply a motivation to pick out those two references and combine them to arrive at the claimed invention.” *Pers. Web Techs., LLC v. Apple, Inc.*, 848 F.3d 987, 993–94 (Fed. Cir. 2017). “[O]bviousness concerns whether a skilled artisan not only *could have made* but *would have been motivated to make* the combinations or modifications of prior art to arrive at the claimed invention.” *Belden Inc. v. Berk–Tek LLC*, 805 F.3d 1064, 1073 (Fed. Cir. 2015); *see In re Nuvasive*, 842 F.3d at 1383 (holding conclusory statements

insufficient if not supported by a reasoned explanation) (citing *In re Lee*, 277 F.3d 1338, 1342 (Fed. Cir. 2002) (“The factual inquiry whether to combine references must be thorough and searching.”)).

Petitioner cites Tang’s optical parameters to specify the dimensions of a wide angle lens assembly. *See* Pet. 29–34. Likewise, Petitioner cites Huang’s optical parameters to specify the dimensions of a telephoto lens assembly. *Id.* at 29, 34–39. Petitioner contends that Tang’s wide optical parameters specify a lens assembly having a track length that differs from a lens assembly specified by Huang’s Tele optical parameters. *Id.* at 90 (arguing that a POSITA would have understood Tang’s Embodiment 1 lens assembly and Huang’s Example 1 lens assembly to have different track lengths and thus, “the image sensors would naturally be placed at different planes”).

Petitioner’s combination turns to May to determine how to mount lens units of differing track lengths. Pet. Reply 19 (“[I]n a camera incorporating the lens designs of Huang and Tang (each with a different track length), sensors would be placed at different distances from the lens,” a “POSITA would look to May’s teachings of . . . having them on the *same plane or separate planes.*”) (emphasis added). As Parulski, Huang, and Tang show wide lens assemblies and tele lens in non-folded configurations, Petitioner argues that “[a] POSITA would have been motivated to apply the teachings of May in a non-folded configuration [Fig. 24A] . . . at least because these lenses have non-folded layouts.” *Id.* at 20 (citing Ex. 1006, Table 1; Ex. 1009, Table 1; Ex. 1022 ¶ 30). Petitioner *also* relies on May’s folded configurations from Figures 10D–10F because, as it asserts, “May’s modular camera subassemblies (e.g., as shown in Figs. 10D-10F) to apply to both

folded and non-folded fixed-lens configurations.” *Id.* (citing Pet. 95; Ex. 1003, 96; Ex. 1022 ¶ 30; Ex. 1011, 23:8–11).

We are not persuaded that a POSITA would have looked to May’s folded configuration embodiments, given that May also discloses a non-folded configuration embodiment and each of Parulski, Tang, and Huang disclose non-folded configurations for their lens assemblies. Further, in May’s non-folded embodiment depicted in Figure 24A, reproduced below, May shows both a wide angle lens and telephoto lens on a single substrate 620.

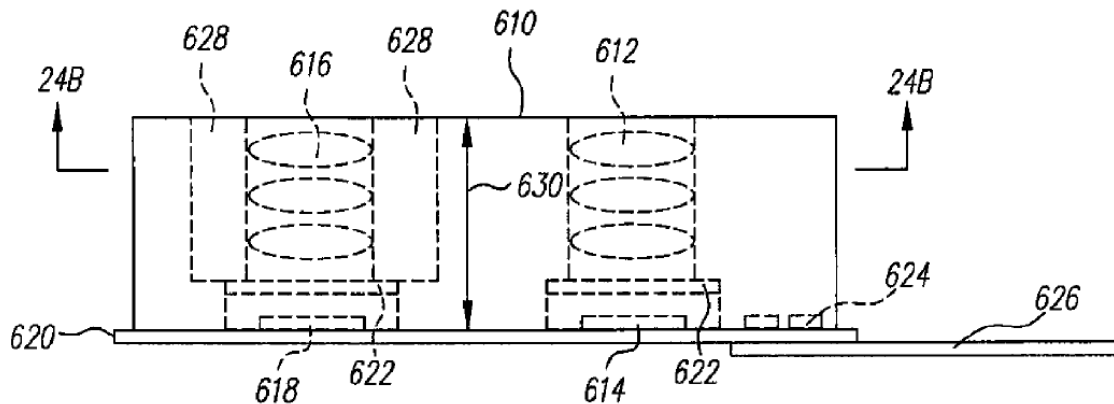


FIG. 24A

*Petitioner's Reasons Related to Modularity and Improvements
in Cost, Size, and Optical Performance*

We further determine that the record does not indicate that May is any more “modular” than any other lens assembly in the cited references. *See ActiveVideo Networks*, 694 F.3d at 1328. None of the lens assemblies in the cited references appear to share any elements with other lens assemblies and appear to be able to perform imaging independently of other lens assemblies and as such, are modular to the same extent May can be considered to be modular. Even if May does describe modularity in connection with its invention, that does not imply a POSITA would have understood its components to be interchangeable or any more capable of being rearranged than any other lens assembly in the cited references. Also, there is insufficient evidence of record to support a finding that May teaches the *desirability* of rearranging its camera subassemblies—particularly in light of May’s teaching, and Petitioner’s recognition, that “May gives specific reasons for the alignment of its subassemblies (as shown in the above figures), teaching that ‘multiple lenses and sensors are generally aligned with respect to each other so as to be viewing substantially the same object, albeit with different fields of view.’” Pet. Reply 23 (citing Ex. 1011, 6:28–30). We find that Patent Owner has the better position—that “[t]he Petition has no discussion of camera subassemblies that can be ‘reconfigured,’ ‘rearranged’ or swapped as if they were LEGO bricks.” PO Sur-Reply 9 (citing Pet. Reply 12, 17). At best, May states that “the spatial relationship of the components has been rearranged” in the examples shown in Figures 14A–14C. In other words, May states that it discloses different arrangements of subassemblies, but May does not indicate that camera

subassemblies can be readily ‘rearranged’ in a modular fashion during design or in a finished device or that such “modular” rearrangement would be desirable or any easier to do for May’s subassembly than it would be with the lens assemblies in the cited references. Ex. 1011, 9:54–59.

Even assuming, *arguendo*, that May teaches rearranging electronic components, there is insufficient evidence supporting Petitioner’s assertion that it is due to any “modular” quality of May’s invention. We disagree that camera assemblies that are modular, a term that could be used to describe any camera assembly and not just May’s, would have conveyed to a POSITA anything about a camera assembly’s mounting and connection to a printed circuit board, either a shared printed circuit board or its own, separate printed circuit board. The record does not contain specific evidence that would support a finding that placing image sensors on separate printed circuit boards would make May’s camera assemblies more able to be rearranged or interchanged as compared with mounting them, in some non-planar fashion, on a shared printed circuit board.

There is insufficient evidence of record that would tend to support a finding that placing wide-angle and telephoto lenses on separate printed circuit boards would “optimize” them for their specific purposes any more than aligning them on the same plane on a shared printed circuit board, contrary to Petitioner’s contentions. Pet. Reply 17 (citing Pet. 90). In this regard, Petitioner cites multiple portions of May in columns 4, 6, 9, and 10. In the cited portions, May states its objective to reduce the size and cost of its camera and produce higher-quality optical results. In a cited portion in column 6, May even states that the improvements in the cost, size, and optical performance of its dual-lens camera are relative to a camera having a

single sensor, and a large zoom lens. *See* Ex. 1011, 6:20–26. None of the statements in May suggest that any improvements in cost, size, or optical performance result from having a separate printed circuit board for each camera subassembly, which is what Petitioner relies on May to teach in its combination. *See also* Ex. 1005, 10:17–25 (Parulski generally describing a desire to reduce cost and size of a camera assembly). Also, there is insufficient evidence of record that would tend to support a finding that placing May’s different camera subassemblies on separate printed circuit boards would improve or increase the range of optical performance of its camera assemblies, as Petitioner contends. *See* Pet. 88–90, 93.

As such, we are not persuaded that “[a] POSITA would look to May’s teachings of alternative ways of assembling those camera modules, including having them on the same plane or separate planes.” *See* Pet. Reply (Ex. 1022 ¶ 29) (emphasis omitted).

As discussed above, Dr. Sasián’s testimony in his First and Second Declarations largely reiterates Petitioner’s contentions and cites to substantially similar portions of the references. *See e.g.*, Ex. 1003 ¶¶ 70–77; Ex. 1024 ¶¶ 26–31. As such, we find his testimony similarly unpersuasive.

For the foregoing reasons, we are not persuaded that Petitioner’s rationale for combining May with Parulski, Huang, and Tang is supported by sufficient rational underpinning. Accordingly, for this *additional* reason, we conclude that Petitioner does not establish unpatentability of claim 3 or claim 4, which depends from claim 3, by a preponderance of the evidence.

F. Obviousness over Parulski, Huang, Tang, and Li II

Petitioner contends that claim 6, which depends directly from claim 1, is unpatentable as obvious under 35 U.S.C. § 103 over Parulski, Huang,

Tang, and Li II. Patent Owner did not dispute Petitioner’s challenge to claim 6. *See* PO Resp. 1. For the reasons that follow, we determine that Petitioner’s showing is sufficiently supported so as establish unpatentability of claim 6 by a preponderance of the evidence.

1. Overview of Li II

Li II concerns a mobile device with dual digital camera sensors. Ex. 1018, 1:7–8. Sensor position controller of the mobile device 106 “may adjust locations and/or positions of the two sensors 102, 104, such as [by] rotating, shifting or sliding the sensors 102,104 in one or more directions.” *Id.* at 3:9–12. A mobile device with sensors is depicted in Figure 1, reproduced below.

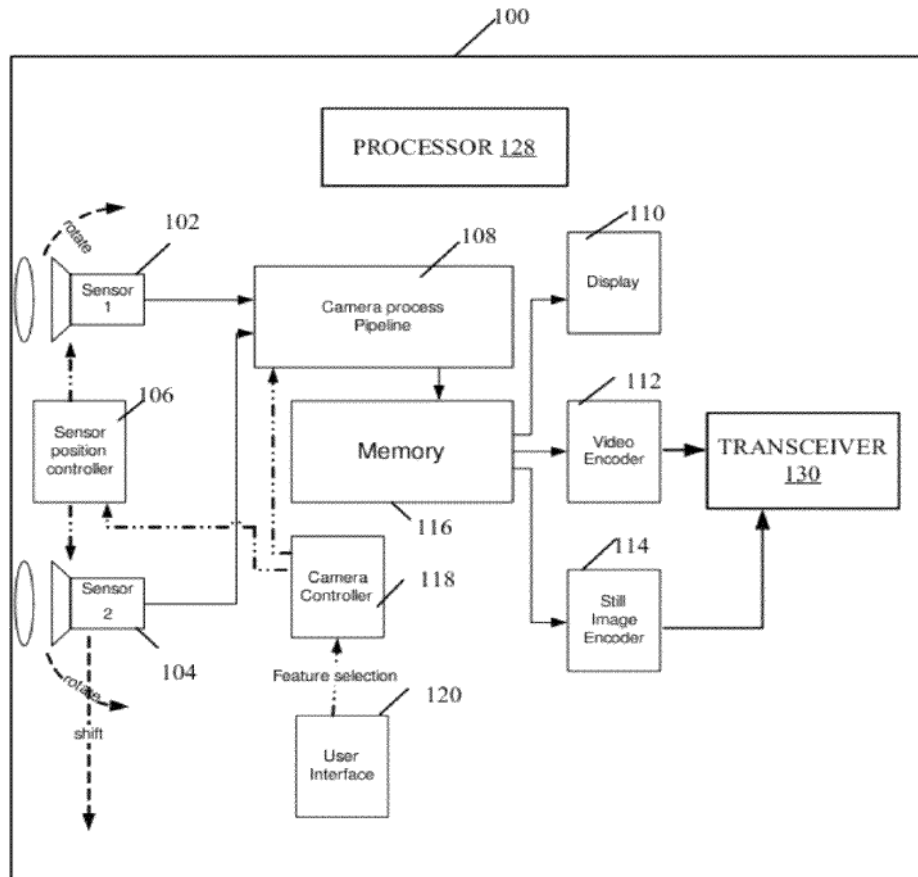


FIG. 1

Figure 1 of Li II illustrates a mobile device with two or more camera sensors. *Id.* at 1:36–37.

Li II explains “[a]djustable sensors 102, 104 may enable a number of advanced features, such as image quality improvement, 3-D image and video visualization, and 360-degree panoramic video generation.” *Id.* at 3:16–19.

2. Dependent Claim 6

Dependent claim 6 recites, “wherein the Wide and Telephoto camera units are spaced from one another a distance d of about 1 mm.” Ex. 1001, 20:30–32.

Petitioner contends that Li II discloses “a mobile device with dual digital camera sensors [102, 104]” that “are adjustable by ‘rotating, shifting or sliding the sensors 102, 104 in one or more directions.’” Pet. 100 (citing Ex. 1018, 1:7–8, 3:7–12, Fig. 1). According to Petitioner, “Li II states that the sensors may be adjusted to a range including 6 cm apart as well as closer together, such that ‘the distance between the two sensors 102, 104 approaches zero.’” *Id.* at 101 (citing Ex. 1018, 4:2–5, 4:56–57). Petitioner further contends that “[a] POSITA would have understood that this range includes ‘a distance *d* of about 1 mm’ as claimed, especially in the context of Li II’s discussion of sensors ‘positioned very close to each other,’ and considering the sizes of camera units.” *Id.* (citing Ex. 1018, 3:66–4:13).

As rationale for combining the teachings of Parulski, Huang, Tang, and Li II, Petitioner contends

[A] POSITA would have been motivated to modify Parulski’s mobile device with Li II’s method of varying the distance between imaging lenses to provide additional control over the imaging capabilities of the mobile device including increasing image dynamic range. For example, Parulski includes various embodiments with different spacing between lenses including a first embodiment that includes a first zoom imaging stage and a second imaging stage “for the purpose of autofocus of the first imaging stage.” In a second embodiment, “two image capture stages are used together to form a high resolution rangefinder similar to a dual lens rangefinder but with higher resolution, which is provided by the two high resolution image capture stages and a larger separation distance between the two lenses in the two image capture stages.”

Id. at 98 (citing Ex. 1003, 99, Ex. 1005, 10:26–37, 59–64; Ex. 1018, 4:12–36).

Patent Owner does not dispute Petitioner's showing as to this claim.
See generally PO Resp.

We have reviewed Petitioner's cited evidence and are persuaded that the rationale for combining is supported by sufficient rational underpinning and that the cited evidence sufficiently supports Petitioner's contentions so as to establish unpatentability by a preponderance of the evidence with respect to the challenge to dependent claim 6 over the combination of Parulski, Huang, Tang, and Li II. *See* Pet. 95–104.

IV. CONCLUSION

We conclude that Petitioner has established unpatentability by a preponderance of the evidence with respect to its challenge to claims 1, 2, 5–7, 11–13, 15, 16, 18, 20, and 21 over Parulski, Huang, and Tang and with respect to its challenge to claim 6 over Parulski, Huang, Tang, and Li II. We further conclude that Petitioner has not established unpatentability by a preponderance of the evidence with respect to its challenge to claims 3 and 4 over Parulski, Huang, Tang, and May.

Our conclusions regarding the challenged claims are summarized below:

Claims Challenged	35 U.S.C. §	References/ Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1, 2, 5, 7, 11–13, 15, 16, 18, 20, 21	103(a)	Parulski, Huang, Tang	1, 2, 5, 7, 11–13, 15, 16, 18, 20, 21	
6	103(a)	Parulski, Huang, Tang, Li II	6	

Claims Challenged	35 U.S.C. §	References/ Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
3, 4	103(a)	Parulski, Huang, Tang, May		3, 4
Overall Outcome			1, 2, 5–7, 11– 13, 15, 16, 18, 20, 21	3, 4

V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1, 2, 5–7, 11–13, 15, 16, 18, 20, and 21 are determined to be unpatentable;

ORDERED that claims 3 and 4 are determined to be not unpatentable;
and

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

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