

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Jocelyn Parent, et al.
U.S. Patent No.: 10,795,120 Attorney Docket No.: 50095-0115IP1
Issue Date: October 6, 2020
Appl. Serial No.: 16/432,180
Filing Date: June 5, 2019
Title: MINIATURE WIDE-ANGLE IMAGING LENS

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**PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT
NO. 10,795,120 PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42**

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LIST OF EXHIBITS

EX1001	U.S. Patent No. 10,795,120
EX1002	File History for U.S. Patent No. 10,795,120
EX1003	Expert Declaration of Dr. David Kessler
EX1004	S. Thibault, J. Parent, H. Zhang, and P. Roulet, <i>Design, fabrication and test of miniature plastic panomorph lenses with 180° field of view</i> , Proceedings of SPIE, 2014 (“Thibault”)
EX1005	U.S. Patent Pub. No. 2010/0194853 to Matsusaka <i>et al.</i> (“Matsusaka”)
EX1006	Korean Patent No. 100677055B1 to Kim (“Kim”)
EX1007	Certified translation of Korean Patent No. 100677055B1 to Kim
EX1008	Complaint from <i>ImmerVision, Inc. v. Apple, Inc.</i> , Case No. 1:21-cv-01570 (D. Del.)
EX1009	Declaration of Patrick Franzen
EX1010	U.S. Patent No. 9,091,843 to Hudyma <i>et al.</i>
EX1011	Rebiai et al., “Image Distortion from Zoom Lenses: Modeling and Digital Correction,” 1992 IBC International Broadcasting Convention (July 1992) (“Rebiai”)
EX1012	“Fish Eye Lens” by K Miyamoto (Feb. 19, 1964) (“Miyamoto”)
EX1013	Zeljko Andreic, “Simple 180° field-of-view F-theta all-sky camera,” SPIE Proc. 1500 (Oct. 1, 1991) (“Andreic”)

EX1014	Abed Kassim et al., “Optical Performance of axial gradient and aspheric surface lenses: study and analysis,” SPIE’s 1994 International Symposium on Optics, Imaging, and Instrumentation, Vol. 2263 (Sept. 30, 1994) (“Kassim”)
EX1015	Susan Houde-Walter, “Recent Progress In Gradient-Index Optics,” SPIE Proc. 0935 (Apr. 8, 1988) (“Houde-Walter”)
EX1016	Paul K. Manhart et al., “Fundamentals of macro axial gradient index optical design and engineering,” SPIE Opt. Eng. 36(6), 1607-1621 (June 1997) (“Manhart”)
EX1017	U.S. Patent No. 5,686,957 to Baker (“Baker”)
EX1018	Zemax Output for Matsusaka’s Example 19
EX1019	Zemax Output for Kim’s First Embodiment
EX1020	Vidal, “Interim Procedure for Discretionary Denials in AIA Post Grant Proceedings with Parallel District Court Litigation” (USPTO, June 2021)
EX1021	<i>Curriculum Vitae</i> of Dr. David Kessler
EX1022	Joint Proposed Scheduling Order from <i>ImmerVision, Inc. v. Apple, Inc.</i> , Case No. 1:21-cv-01570 (D. Del.)

Apple Inc. (“Petitioner” or “Apple”) petitions for *Inter Partes* Review (“IPR”) of claims 1-7 (“the Challenged Claims”) of U.S. Patent 10,795,120 (“the ’120 Patent”). As explained in this Petition, there exists a reasonable likelihood that Petitioner will prevail.

I. PETITIONER HAS STANDING

Petitioner certifies that the ’120 Patent is available for IPR. Patent Owner served a complaint of infringement of the ’120 Patent in *ImmerVision, Inc. v. Apple, Inc.* (Case No. DDE-1-21-cv-0157) on January 18, 2022. Petitioner is not barred or estopped from requesting this review based on the grounds identified in Section IV.A.

II. SUMMARY OF THE ’120 PATENT

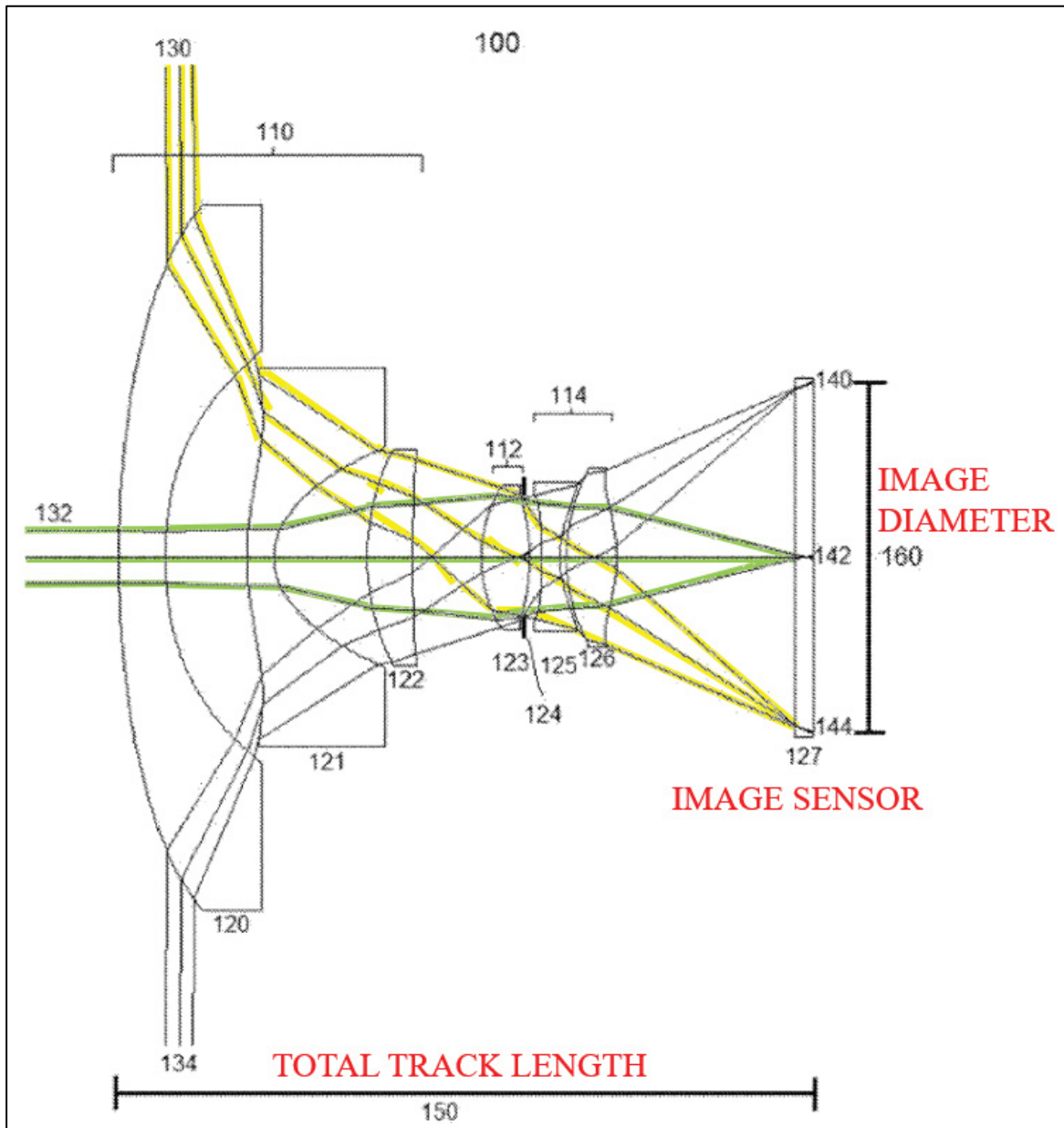
A. Brief Description

At a high level, the ’120 Patent is directed to “optical lenses and more particularly to miniature lenses having a wide-angle field of view.” EX1001, 1:20-22. The ’120 Patent explains that “[f]or most applications requiring wide-angle imaging, larger lens constructions having a miniaturization ratio (i.e., a total track length over an image circle diameter) greater than 3.0 are often used.” *Id.*, 1:23-26. With various consumer devices, such as mobile devices, however, “the trend is that the lens thicknesses are becoming thinner while the sensor sizes are becoming larger,” so “a new kind of wide-angle lenses with a miniaturization ratio less than

3.0 are required.” *Id.*, 1:26-30.

Responsive to this purported need, the ’120 Patent describes “miniature wide-angle imaging lenses having a miniaturization ratio (i.e., total track length from the center of the first surface to the focal plane over the image circle diameter) less than 3.0 while maintaining a good balance between image quality parameters, including MTF [modulation transfer function], relative illumination, and resolution.” *Id.*, 2:6-13.

With reference to Figure 1 (reproduced below), the ’120 Patent shows an “optical layout for a design having six optical elements in an asymmetric configuration.” *Id.*, 3:41-45. When light enters the lens 100, it hits a first surface of element 120 between an upper angle 130 and a lower angle 134, with a total field of view of 180°, “but any total field of view over 100° can be considered as a wide-angle lens according to the present invention.” *Id.*, 3:55-61. Light passes through elements 120, 121, 122, single lens 123, aperture stop 124, and elements 125 and 126 before reaching an IR filter and image sensor 127. For instance, a light beam from direction 130 (highlighted yellow) travels through the lens 100 and reaches the sensor 127 at position 144, while a light beam from direction 132 (highlighted green) travels through the lens 100 and reaches the sensor 127 at position 142. *Id.*, 3:66-4:3.



EX1001, FIG. 1 (highlighted; annotated)

The lens of Figure 1 has a total track length 150 as measured “from the first surface on the object side of the lens 120 to the image sensor,” forming an image with a diameter 160, which is “a distance on the sensor 127 between the position 140 and the position 144 where the light beams from the lower and the upper fields

130, 134 reach the sensor 127.” *Id.*, 4:14-20. The miniaturization ratio of the lens is obtained “by dividing the total track length 150 over the footprint diameter 160 and is less than 3.0 for any miniature lens according to the present invention and could even be less than 2.0 for an extreme miniature lens.” *Id.*, 4:20-24.

Figure 6 (reproduced below) shows a “targeted resolution curve 600 for a miniature wide-angle lens according to embodiments of the present invention where the targeted resolution is non-linear and a higher number of pixels per degree is intentionally present in a part of the image.” *Id.*, 6:9-13. In some instances, “the shape of the targeted resolution is intentionally designed to compensate for the drop of relative illumination seen in FIG. 4,” and in some instances, “the shape of the targeted resolution is intentionally designed to compensate for the drop of MTF seen in FIG. 5.” *Id.*, 6:13-19. In high resolution zones, more sensor pixels are used to image a given angle of the object space, which “compensates for the lower image quality in this zone either due to the lower relative illumination or the lower MTF.” *Id.*, 6:19-24.

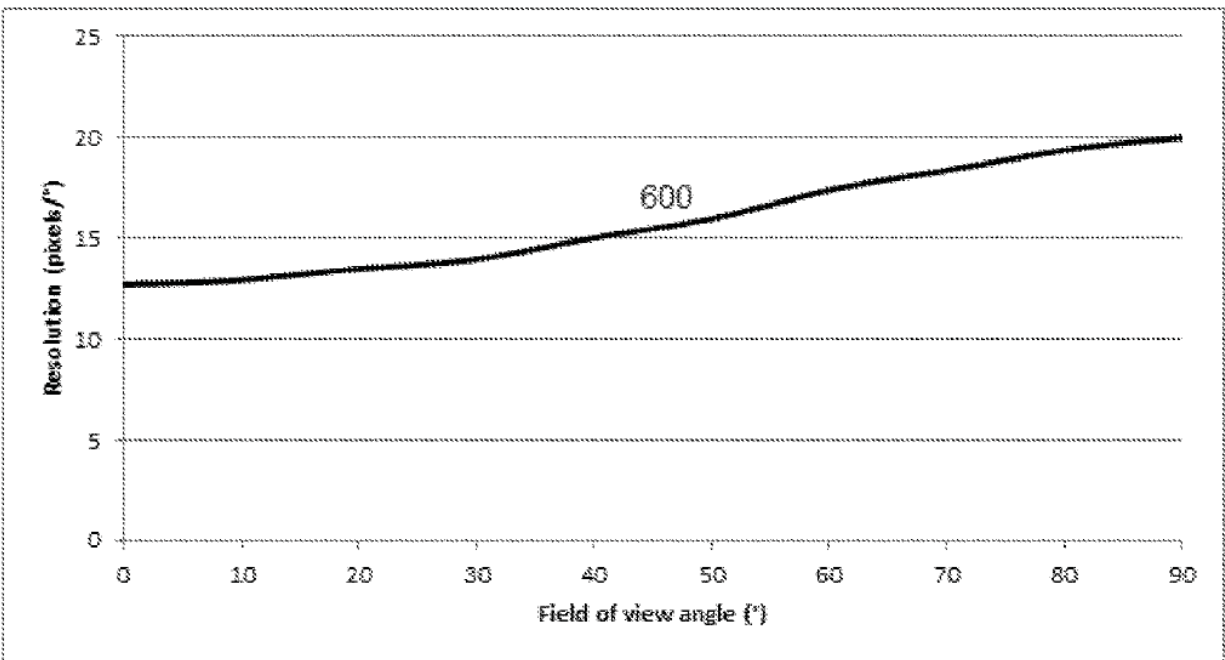


Figure 6

EX1001, FIG. 6

Figure 7 shows another non-linear targeted resolution curve 700, which has “an upward curve between the center resolution value 710 and a maximum 712 (number of pixels/degree), followed by a downward curve between the maximum 712 and a region near the edge of the field of view around position 714.” *Id.*, 6:28-35. The “downward curve between maximum value 712 and position 714 allows the lens system to have a higher relative illumination value toward the edge of the field of view by having a lower object to image magnification ratio in that region and hence redirecting the same quantity of light from an object to a smaller region in the image with more illumination.” *Id.*, 6:35-41. Figure 7 also shows a “change of direction at the edge of the field of view 716,” which “allows for a closer value

of resolution in the pixels/degree in the center 710 and at the edge 716, creating the best balance of MTF between the center 710 and the edge 716.” *Id.*, 6:42-50.

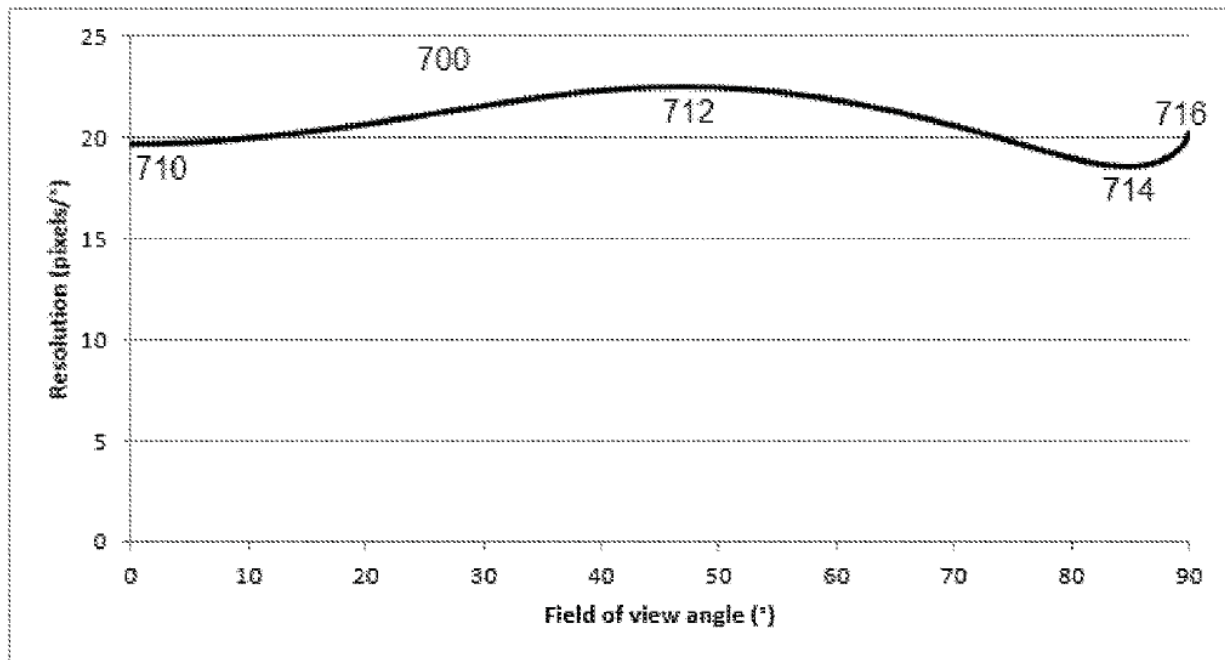


Figure 7

EX1001, FIG. 7

Despite its discussion in the '120 Patent as a purportedly “new kind of wide-angle lens[]”, the miniature lenses discussed in the '120 Patent were not new. *Id.*, 1:29-30. Notably, as discussed in more detail below, some of the inventors of the '120 Patent published a paper directed to this same concept before the Critical Date of the '120 Patent.

B. Summary of the Prosecution History of the '120 Patent

The '120 Patent issued on October 6, 2020, from U.S. Patent Application No. 16/432,180 (“the '180 application”), filed June 5, 2019, and claims priority to U.S.

provisional application No. 62/298,795, filed February 23, 2016, and U.S. provisional application No. 62/387,409, filed December 23, 2015. EX1001, 1.

The '120 Patent prosecution history is relatively short. The '180 application was filed with eight claims. In a non-final Office action, the examiner rejected all claims based on U.S. Pub. No. 2012/0314296 to Shabtay. *Id.*, 32-38. In a subsequent response, the applicant amended independent claim 1 to add “an opening angle of light entering the optical apparatus being over 100°,” which was recited in dependent claim 4. *Id.*, 24-30. With the amendment, the applicant argued that Shabtay’s disclosure of a lens with a field of view in the range of 30°-45° and as large as 54° does not qualify as “wide angle” or “come anywhere close to the 100° or greater field of view provided in claim 1.” *Id.*, 28-29. The Office responded with a Notice of Allowance that allowed the pending seven claims. *Id.*, 13.

While the applicant successfully argued that the Shabtay reference did not teach a “wide angle” lens with an opening angle of at least 100°, the Office did not rely on any other prior art to teach this feature. Notably, a number of prior art references, including the ones relied on in this petition, teach this and the other features recited in the claims of the '120 Patent, as discussed further in Section IV.

C. Effective Priority Date of the Claims of the '120 Patent

The '120 Patent issued from U.S. Application No. 16/432,180 filed June 4, 2019, which claims priority to U.S. provisional application No. 62/298,795, filed

February 23, 2016, and U.S. provisional application No. 62/387,409, filed December 23, 2015. EX1001, 1. For purposes of this proceeding, Petitioner applies a Critical Date of December 23, 2015.

D. Level of Ordinary Skill

For purposes of this IPR, Petitioner submits that a person of ordinary skill in the art at the time of the alleged invention (a “POSITA”) would have had at least a Bachelor’s degree in an academic area emphasizing physics, optical engineering, electrical engineering and/or a similar discipline, and at least five years of experience in developing and designing optical imaging systems and have familiarity with image processing algorithms and optical design software. EX1003 ¶15. Superior education could compensate for a deficiency in work experience, and *vice-versa*. *Id.*

III. CLAIM CONSTRUCTION

Petitioner submits that all claim terms should be construed according to the *Phillips* standard. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005); 37 C.F.R. § 42.100. Petitioner submits that no formal claim constructions are necessary.¹

¹ Petitioner is not conceding that each challenged claim satisfies all statutory requirements, such as 35 U.S.C. § 112. As this is an IPR petition, Petitioner is pursuing prior art-based grounds. Petitioner is not waiving any arguments concerning other grounds that can only be raised in district court.

Petitioner reserves the right to respond to any constructions offered/adopted by Patent Owner/Board.

A. Intended Use Language of Claim 1

The “non-linear targeted resolution” limitation of independent claim 1 includes an “intended use” limitation. In particular, the claim recites “the lower or higher object to image magnification *being used to* compensate, at least in part, for a lower image quality due to at least one of a drop of relative illumination or a drop of MTF in a zone of the image.” This limitation either inappropriately assigns intention to the claim’s optical apparatus—an inanimate object not capable of intention—or speaks to the intention of the designer/producer of the optical apparatus. Thus, for purposes of this proceeding in which grounds under 35 U.S.C. § 112 are not available, this limitation should not be given patentable weight beyond the structure that it defines.

It is well established that descriptions of use do not typically limit apparatus claims because the patentability of an apparatus depends on the claimed structure, not the use or purpose of that structure. *See Baldwin Graphic Systems, Inc. v. Siebert, Inc.*, 512 F.3d 1338, 1344 (Fed. Cir. 2008) (“Courts must generally take care to avoid reading process limitations into an apparatus claim.”); *Hewlett-Packard Co. v. Bausch & Lomb Inc.*, 909 F.2d 1464, 1468 (Fed. Cir. 1990) (“[A]pparatus claims cover what a device *is*, not what a device *does*.”) (emphasis in original); *In re Danly*,

46 C.C.P.A. 792, 263 F.2d 844, 848 (Cust. & Pat.App.1959) (“Claims drawn to an apparatus must distinguish from the prior art in terms of structure rather than function.”); *In re Michlin*, 256 F.2d 317, 320 (C.C.P.A. 1958) (“It is well settled that patentability of apparatus claims must depend upon structural limitations and not upon statements of function.”); *see also Cross Medical Products, Inc. v. Medtronic Sofamor Danek*, 424 F. 3d 1293, 1311-12 (Fed. Cir. 2005) (focusing on related concepts in infringement).

Indeed, to limit an apparatus claim, functional language must result in a structural difference in the claimed apparatus. *See K-2*, 191 F.3d at 1363-64 (holding “said non-rigid shoe portion being permanently affixed to said base portion at least at said toe area and said heel area for substantially preventing movement therebetween at least in a horizontal plane” was a claim limitation because it spoke to the structural requirements of the attachment); *In re Stencel*, 828 F.2d 751, 754 (Fed. Cir. 1987). Where the language does not structurally differentiate the claimed apparatus, the language is not limiting. *See In re Hack*, 44 C.C.P.A. 954, 245 F.2d 246, 248 (Cust. & Pat. App. 1957).

The clause of claim 1 that recites “the lower or higher object to image magnification ***being used to compensate, at least in part, for a lower image quality due to at least one of a drop of relative illumination or a drop of MTF in a zone of the image***” is an intended use that the ’120 Patent does not teach implicates the

structure of the claimed optical apparatus. EX1003, ¶79.

Rather, the '120 Patent describes that the claimed “compensation” is a necessary byproduct of the optical apparatus including the claimed “zone . . . with a lower or higher object to image magnification compared to linear targeted resolution.” EX1003, ¶80. Specifically, the '120 Patent describes that, “[i]n wide-angle lenses the relative illumination is usually maximum in the center and drops continuously toward the edge of the field of view.” EX1001, 1:56-58. Similarly, the modulation transfer function (MTF) also drops “from the center to the edge of the field of view.” EX1001, 1:63-2:3. Examples of these drops are illustrated in FIGS. 4 and 5. EX1001, 5:57-6:8. The '120 Patent describes that either increasing or decreasing the image magnification (*i.e.*, pixels per degree) in regions of the image away from the center compensates for these natural drops in relative illumination and/or MTF. *See* EX1001, 6:9-50. For example, with respect to FIG. 6, the '120 Patent explains that increasing resolution in a region away from the center of the image “compensates for the lower image quality in this zone either due to the lower relative illumination or the lower MTF.” EX1001, 6:21-24. On the other hand, with respect to FIG. 7, the '120 Patent explains that decreasing resolution further from the center of the image “allows the lens system to have a higher relative illumination value toward the edge of the field of view by having a lower object to image magnification ratio in that region and hence redirecting the same quantity of

light from an object to a smaller region in the image with more illumination.”
EX1001, 6:35-41.

Accordingly, by implementing the otherwise claimed “zone in an image captured by the miniature wide-angle optical apparatus with a lower or higher object to image magnification compared to linear targeted resolution,” the ’120 Patent teaches that the optical apparatus compensates, at least in part, for a lower image quality due to at least one of a drop of relative illumination or a drop of MTF in a zone of the image. EX1003, ¶81. Regardless of whether this is actually true—and therefore definite and/or enabled for purposes of infringement—for purposes of this proceeding, the claims should be construed to be met if the prior art anticipates or renders obvious the claimed “zone.” EX1003, ¶81.

IV. APPLICATION OF PRIOR ART TO THE CHALLENGED CLAIMS

A. Grounds

The Challenged Claims are unpatentable over the 35 U.S.C §102 (anticipation) or § 103 (obviousness) grounds in the table below. Accompanying explanations and support are provided in Dr. Kessler’s Declaration (EX1003).

Ground	Claim(s)	Prior Art Basis
1	1-7	§§102/103 – Thibault
2	1, 3-6	§§102/103 – Matsusaka
3	1, 4, 5, 7	§§102/103 – Kim

As shown below, each reference pre-dates the December 23, 2015 “Critical

Date,” which is the earliest date to which the ’120 Patent claims priority. Petitioner does not concede that the ’120 Patent is entitled to the claimed priority.

Reference	Date	Section
Thibault (EX1004)	December 17, 2014 ²	102(a)(1)
Matsusaka (EX1005)	September 22, 2008 (filed) August 5, 2010 (published)	102(a)(1)-(2)
Kim (EX1006/EX1007)	February 2, 2007	102(a)(1)-(2)

B. Ground 1 (Claims 1-7)

1. Overview of Thibault (EX1004)³

Thibault is a paper titled “Design, fabrication and test of miniature plastic panomorph lenses with 180° field of view” authored by four of the six inventors listed on the ’120 Patent. EX1004, 1. It was published and publically accessible on December 17, 2014, more than a year before the Critical Date, and therefore not subject to the exceptions of 35 U.S.C. § 102(b). EX1009, ¶¶9-10; EX1003, ¶83.

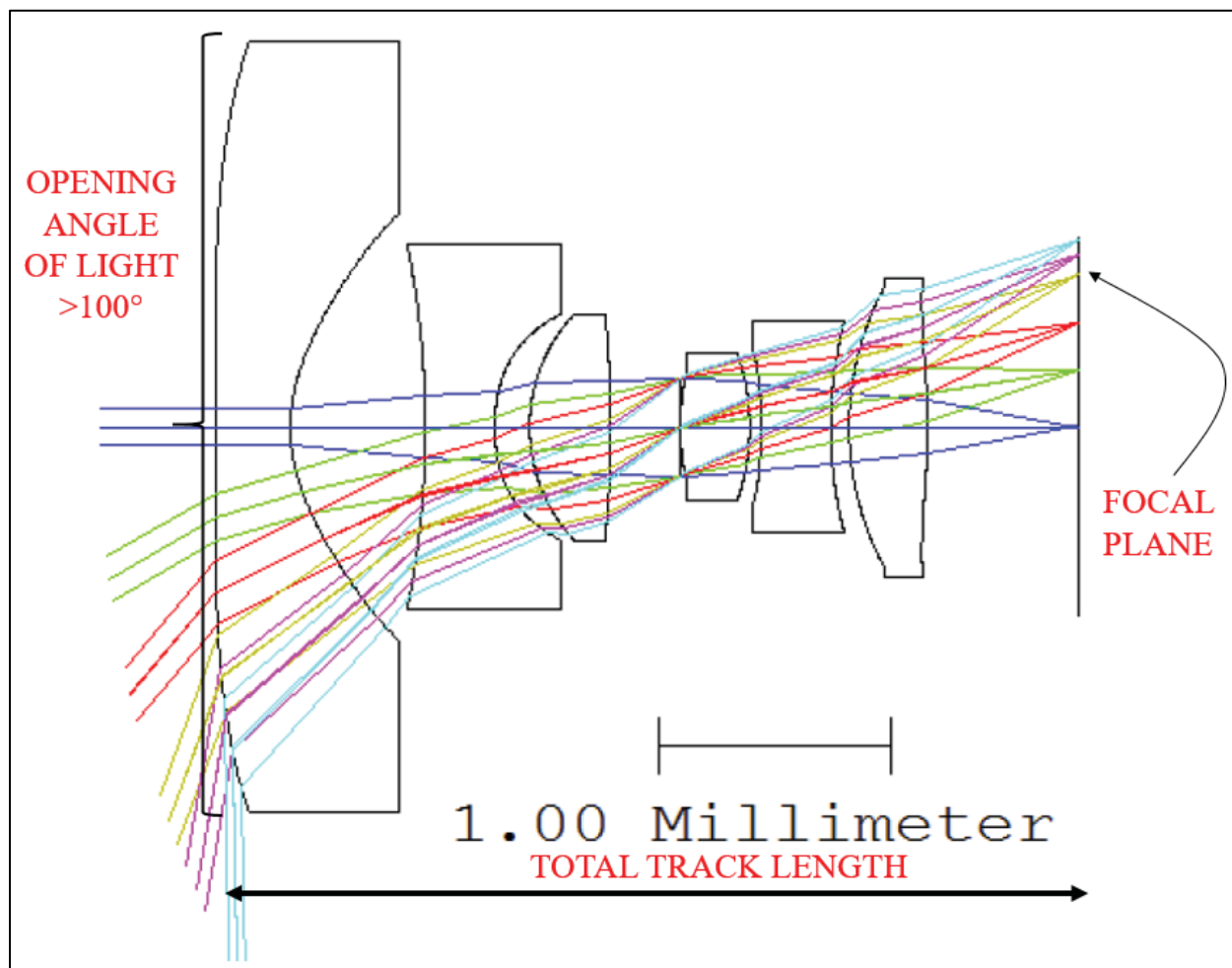
² EX1009 (explaining EX1004 was publically available on December 17, 2014).

³ General descriptions provided for this and other references and combinations thereof are incorporated into each subsection and mapping of the claims that includes citations to these references.

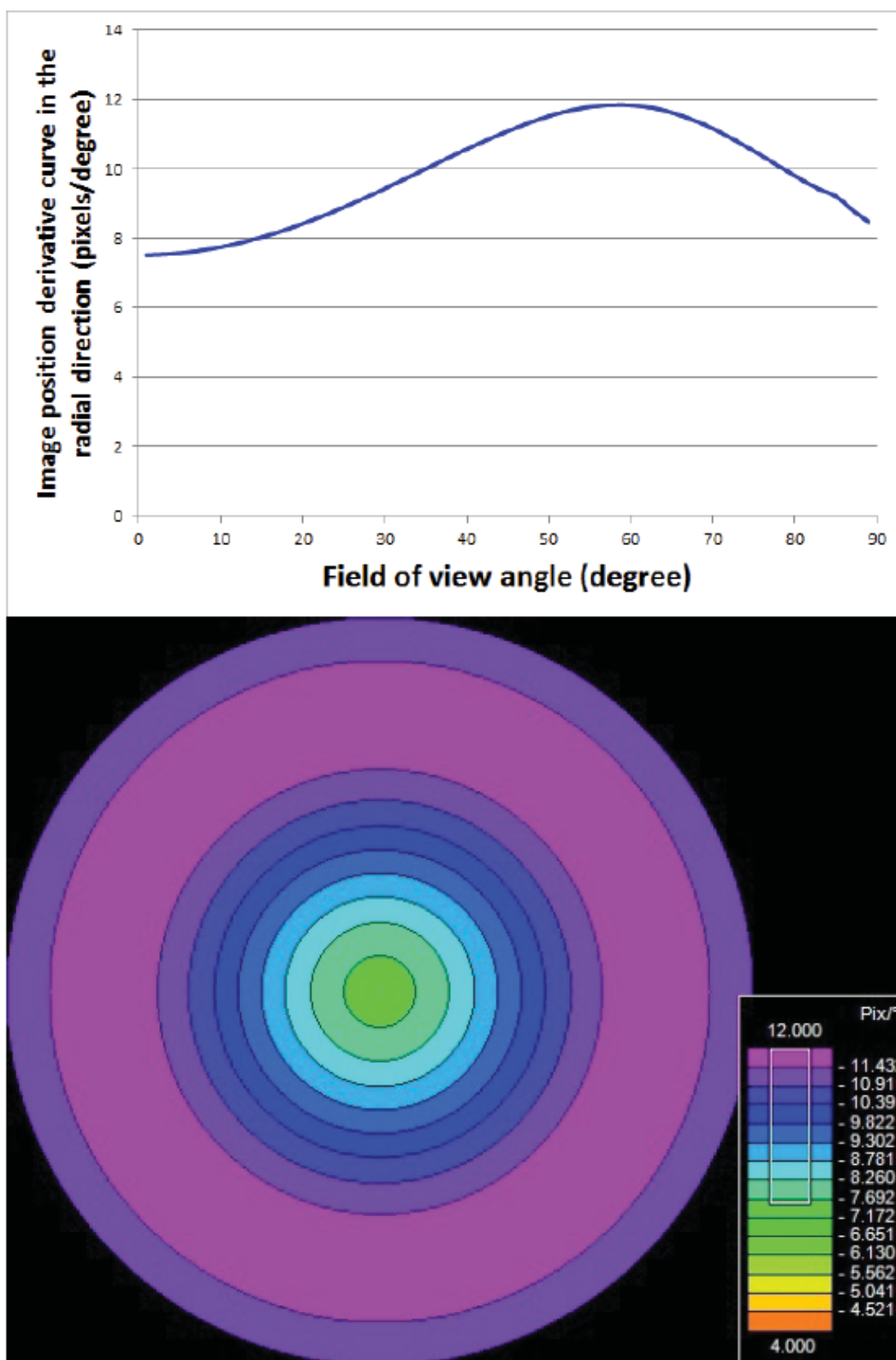
Like the '120 Patent, Thibault describes miniature wide-angle lenses. EX1004, Abstract. Thibault further recognizes “the challenges of designing and manufacturing miniature panomorph lenses suitable for state of the art megapixels sensor.” *Id.*, 2.

Thibault explains that panomorph lenses are wide-angle lenses with a field of view over 120° that use “particular elements to increase the number of pixels in an area of interest.” *Id.*, 2. The “particular elements” used to increase the number of pixels are “an anamorphic ratio to match the sensor optical format” and “controlled distortion to selectively stretch or compress the number of pixels in areas of interest in the field of view.” *Id.*

Figure 5 (reproduced below) show a miniature panomorph lens “designed at the end of 2013 for mobile device applications” with a requirement of a smaller TTL and diameter. *Id.*, 6. The resulting lens has a TTL of 3.80 mm with a 0.2 mm cover glass and six elements. *Id.* The “f/2.8 lens has a 1:1 anamorphic ratio and use[s] targeted distortion to increase the number of pixels in the zone of interest for mobile video chat applications,” shown in Figure 6 (reproduced below). *Id.* The panomorph footprint is 2.01 x 2.01 mm and is designed for the full 360° image to fit the height on a 5.04 MPx 4.3 sensor with 2592 x 1944 pixels of 1.12 μm.” *Id.*

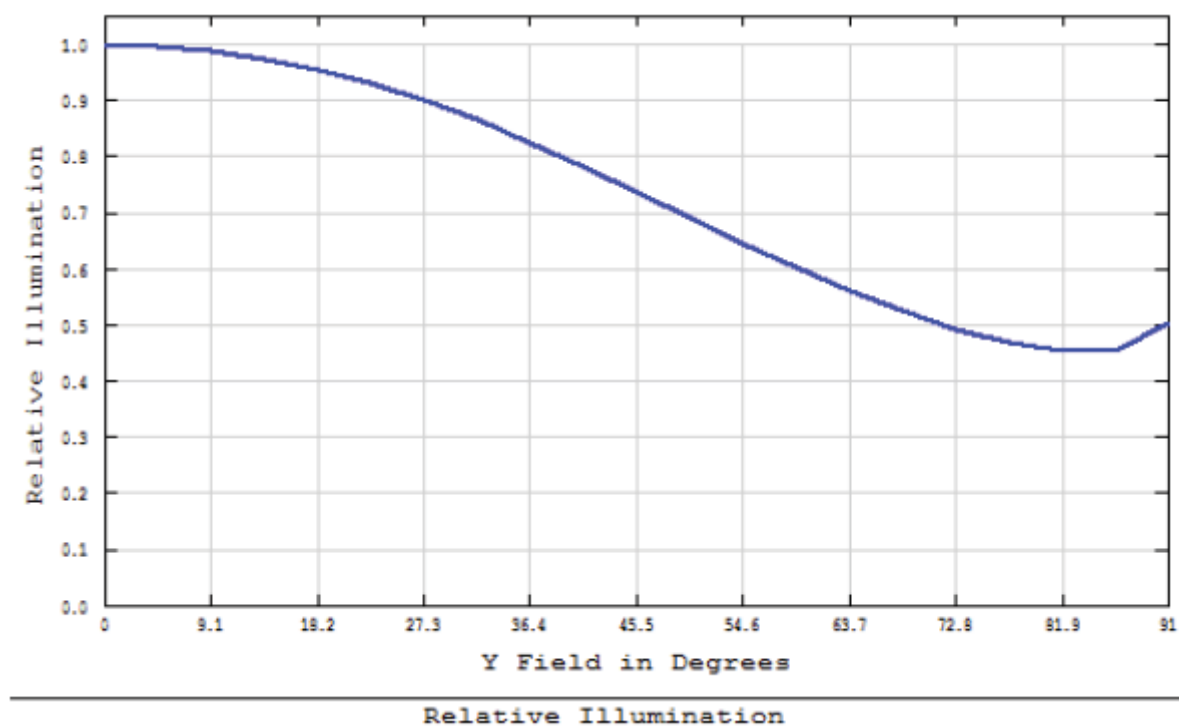


EX1004, FIG. 5 (annotated)



EX1004, FIG. 6

The top graph of Figure 6 shows the image position derivative curve in the radial direction (pixels/degree), and the bottom image shows the resolution over the full circular panomorph image. *Id.*, 7; EX1003, ¶87. Collectively, Figure 6 shows an increase in the number of pixels in various zones of the resulting image. *Id.* Figure 7 (reproduced below) shows the relative illumination of the panomorph lenses with a TTL of 3.80 mm. *Id.*



EX1004, FIG. 7

Thibault further discusses using de-warping to “exploit the increase of resolution in a region of interest created by the panomorph lens design while removing the distortion to provide human brain friendly views tailored for specific applications or use cases.” EX1004, 10. In consumer electronic and mobile devices,

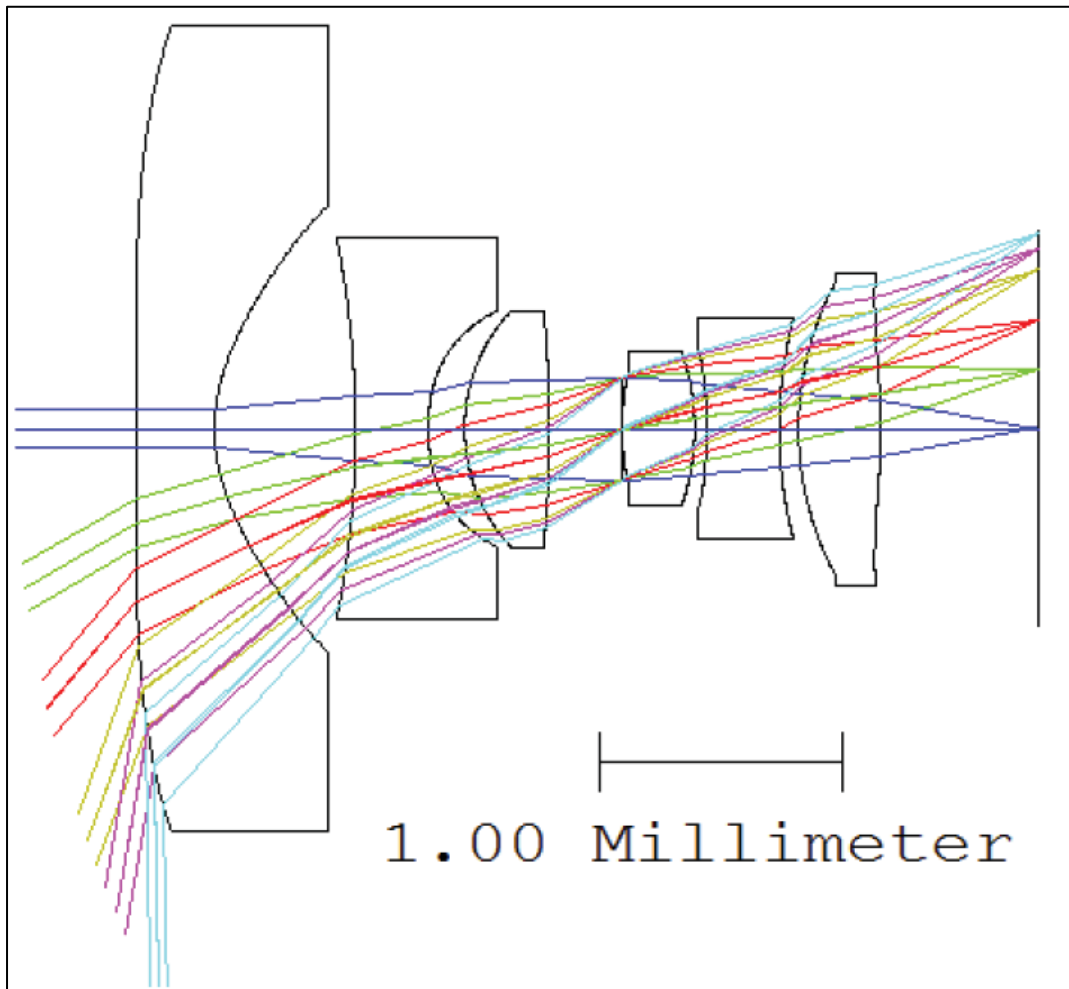
these techniques are often used for 360° live video chat or selfies. *Id.* In the case of selfies, “de-warping is also used to correct the viewpoint to a vertical orientation based on orientation information extracted directly from the device.” *Id.*

2. Analysis of the Claims

[1pre] A miniature wide-angle optical apparatus comprising:

To the extent the preamble is limiting, Thibault discloses this element. EX1004, 2, 6, FIG. 5; EX1003 ¶108. Thibault “present two ***miniature*** all plastic megapixel panomorph lenses for consumer electronics.” EX1004, 2⁴. Thibault describes “[p]anomorph lenses” as “***wide-angle lenses*** with a field of view of 120°, usually 180° and beyond, using particular elements to increase the number of pixels in an area of interest.” EX1004, 2. Thibault’s Figure 5 (reproduced below) is a “miniature panomorph lens was designed at the end of 2013 for mobile device applications.” EX1004, 6. Thibault describes itself as “introduc[ing] the two smallest panomorph ***wide-angle lenses*** with fields of view of 180°.” EX1004, 10.

⁴ Emphasis added throughout, unless otherwise noted.



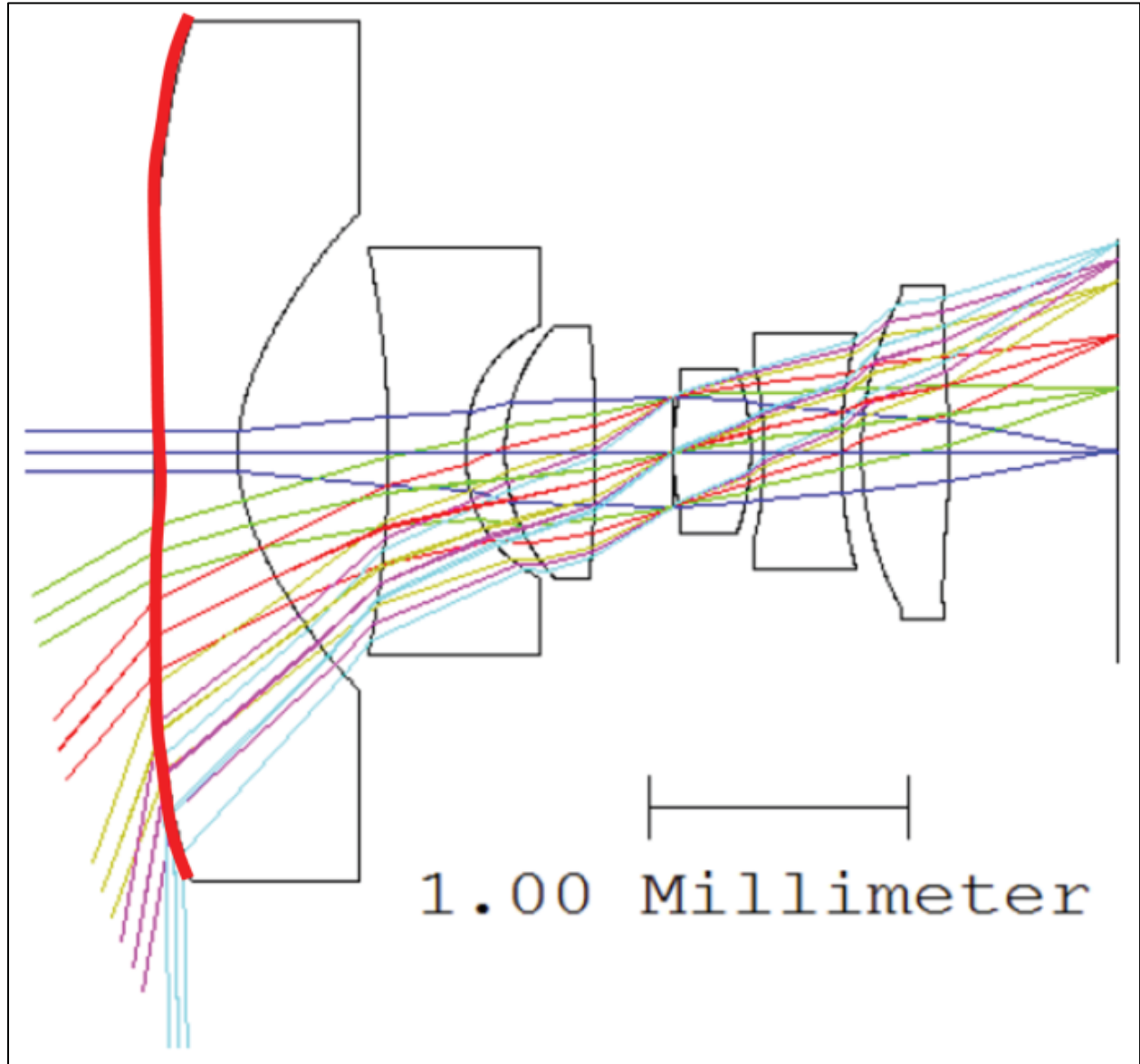
EX1004, FIG. 5

[1a] a light-receiving first surface;

Thibault discloses this element. EX1004, 6, FIG. 5; EX1003 ¶¶109-112. “As shown at figure 5, the layout still consist of 6 plastic elements, the shorter TTL being obtained by further compressing every air spaces and lens thickness to their manufacturing limits and placing the IR filter on the sensor cover glass.” EX1004, 6. The first element (from the left, object-side) includes a light-receiving surface

(highlighted red), where various rays of light are shown as multi-colored lines.

EX1004, FIG. 5; EX1003 ¶109.



EX1004, FIG. 5 (highlighted)

While Thibault does not explicitly describe the multicolored lines passing through the panomorph lens of FIG. 5 as “light,” a POSITA would have understood

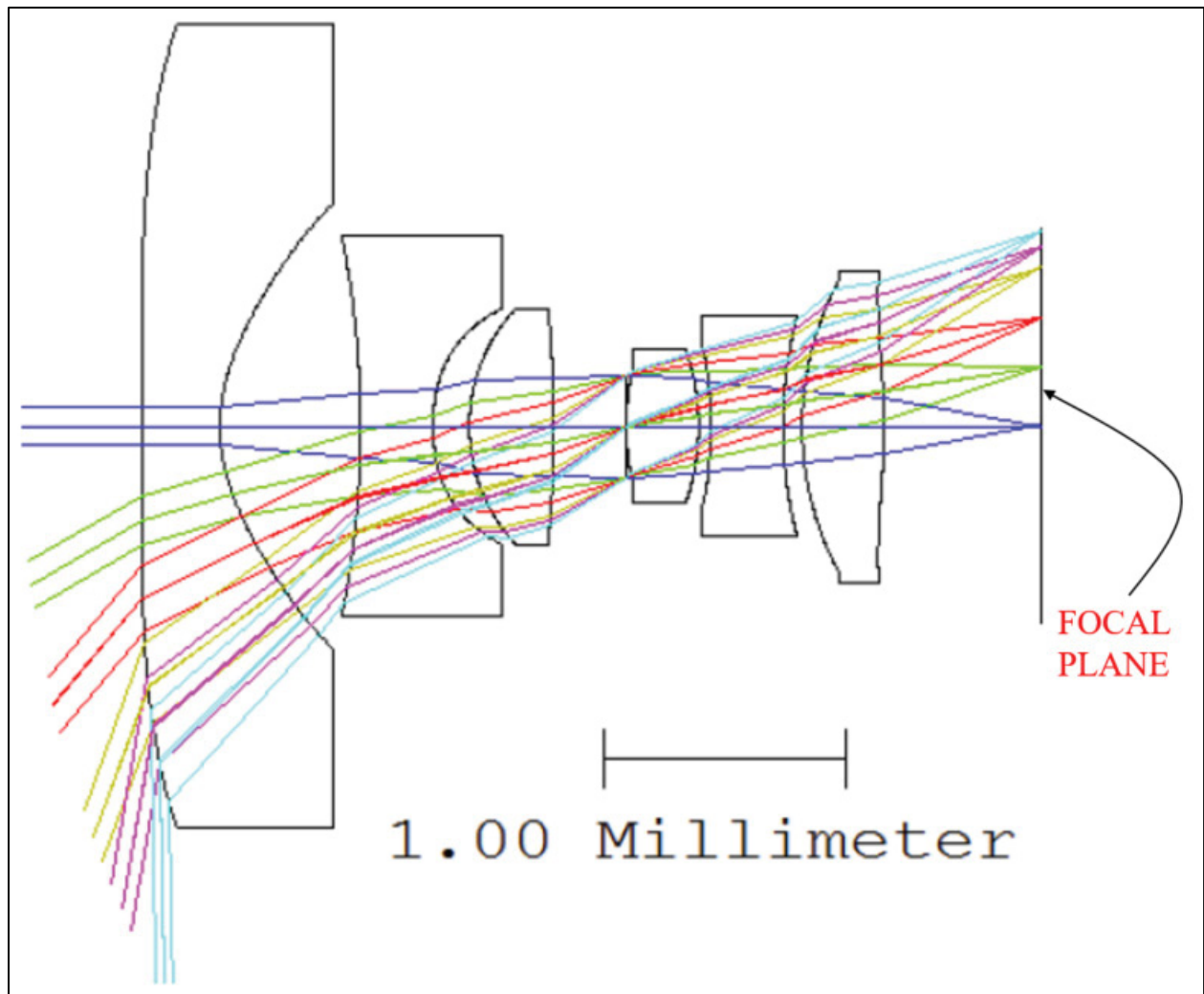
the multi-colored lines as representing rays of light that enter the lens at the light-receiving first surface highlighted red below. EX1003 ¶110.

Thibault teaches that FIG. 5 does not show “the 0.20 mm cover glass of the sensor which is included in the TTL measurement of 3.80 mm.” EX1004, 6. A POSITA would have understood that the “0.20 mm cover glass” is an optional optical element positioned on the object-side of the panomorph lens that helps protect the system. EX1004, 3 (“the front lens vortex can be leveled with the mechanical surrounding or the lens can be behind a thin cover-glass”); EX1003 ¶111. The “0.20 mm cover glass” would have been positioned on the object-side of the lens assembly illustrated in FIG. 5 (*i.e.*, to the left of the above red highlighting). *Id.* The “0.20 mm cover glass” described by Thibault is necessarily an optical element because it would have to pass light through to the remainder of the panomorph lens assembly for the assembly to operate. EX1003 ¶111.

Thus, in those implementations that include the “0.20 mm cover glass,” the object-side of cover glass would have been the claimed “light-receiving first surface.” EX1003 ¶112. On the other hand, where the “0.20 mm cover glass” is omitted, the above red highlighted object-side of the first element of the panomorph lens would have been the claimed “light-receiving first surface.” *Id.*

[1b] a focal plane;

Thibault discloses this element. EX1004, FIG. 5; EX1003 ¶113. In particular, Figure 5 of Thibault shows a lens design where various rays of light are shown as multi-colored lines. EX1004, FIG. 5. The convergence of light rays at the line at right, annotated “FOCAL PLANE,” indicates that the lens has a focal plane at the annotated location. EX1003 ¶113.

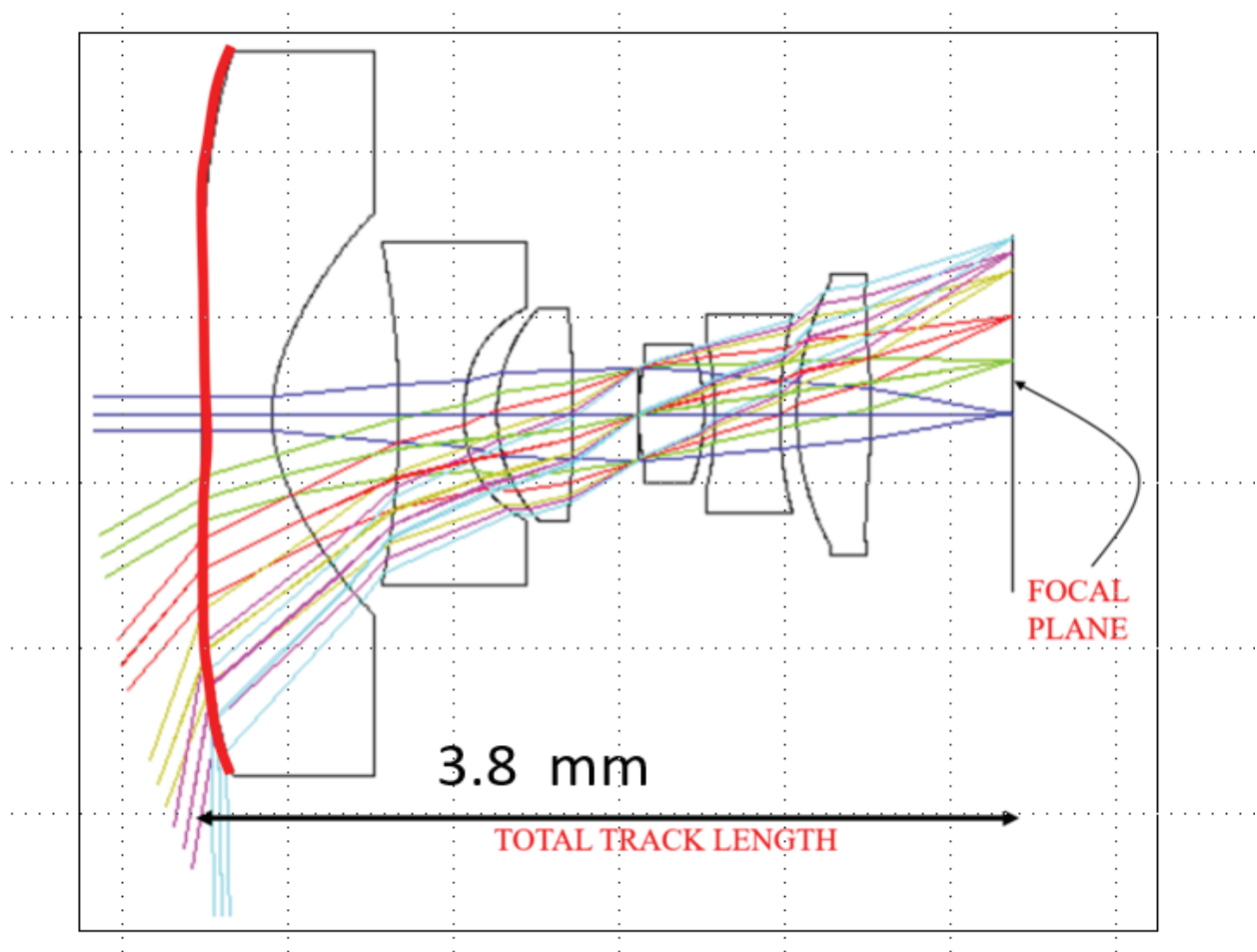


EX1004, FIG. 5 (annotated)

[1c] a total track length measured from a center of the first surface to the focal plane;

Thibault discloses this element. EX1004, FIG. 5; EX1003 ¶114. Thibault describes “two miniature all plastic megapixel panomorph lenses for consumer electronics (***total track length (TTL)***)⁵ of 6.56 mm) and mobile devices (TTL of 3.80 mm).” EX1004, 1. In particular, Thibault states that the miniature wide-angle lens design illustrated in FIG. 5 (an annotated version of which is included below) “achieved a TTL of 3.80 mm including a 0.2 mm cover glass (3.72 mm in air).” EX1004, 6. As noted with respect to limitation [1b], the “0.2 mm cover glass” is optional, so the TTL of the lens design illustrated in FIG. 5 is “3.72 mm in air” (i.e., without the “0.2 mm cover glass”). *Id.*; EX1003 ¶114.

⁵ The “total track length (TTL)” was a known term of art to POSITAs and was known to be measured from “from a center of the first surface to the focal plane,” as claimed. EX1003 ¶114, n. 3 (citing EX1010, 40:7-9). This is particularly true for Thibault, where the authors are four of the six inventors of the ’120 Patent, which suggests that the same authors would use the same language consistently. *Id.*



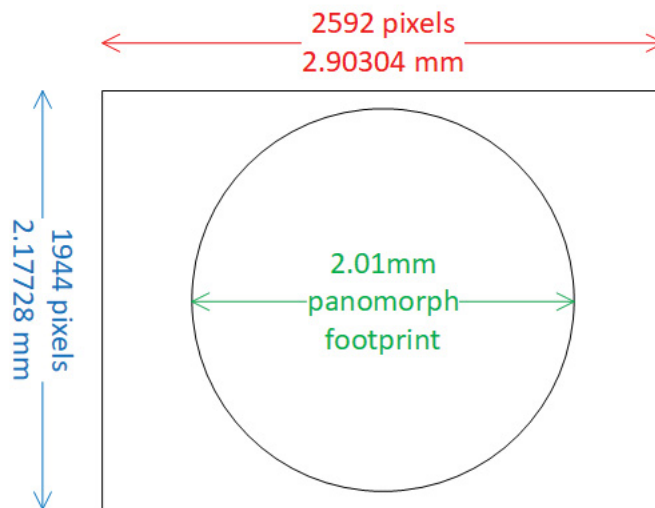
EX1004, Figure 5 (excerpted and annotated)

[1d] a miniaturization ratio with a value less than 3.0, the miniaturization ratio being a ratio of the total track length divided by an image circle diameter; and

Thibault discloses this element. EX1004, 6; EX1003 ¶¶115-116. In particular, as stated with respect to element [1c], the lens design shown in Figure 5 has a total track length of 3.80 mm with the cover glass and “3.72 mm in air” (i.e., without the “0.2 mm cover glass”). EX1004, 6. Thibault additionally describes that the “*panomorph footprint is 2.01 x 2.01 mm* and is designed for the full 360° image to fit the height on a 5.04 MPx 4:3 sensor with 2592 x 1944 pixels of 1.12 μm .”

EX1004, 6. As illustrated below, a POSITA would have understood that the “panomorph footprint” described by Thibault is the claimed “image circle diameter.”

EX1003 ¶115.



As such, with the cover glass, the miniaturization ratio of the lens design is the TTL of 3.80 mm divided by the image circle diameter of 2.01 mm, or 1.89, which is less than 3.0. EX1003 ¶116. Similarly, without the cover glass, the miniaturization ratio of the lens design is the TTL of 3.72 mm divided by the image circle diameter of 2.01 mm, or 1.85, which is less than 3.0. EX1003 ¶116.

[1e] a non-linear targeted resolution to intentionally create a zone in an image captured by the miniature wide-angle optical apparatus with a lower or higher object to image magnification compared to linear targeted resolution, the lower or higher object to image magnification being used to compensate, at least in part, for a lower image quality due to at least one of a drop of relative illumination or a drop of MTF in a zone of the image,

Thibault discloses or at least renders obvious this element. EX1004, 6, 7, 10, FIGS. 6-7; EX1003 ¶¶117-124. The only place where the '120 Patent describes

“image magnification” and “resolution” is with respect to FIG. 7. EX1003 ¶117.

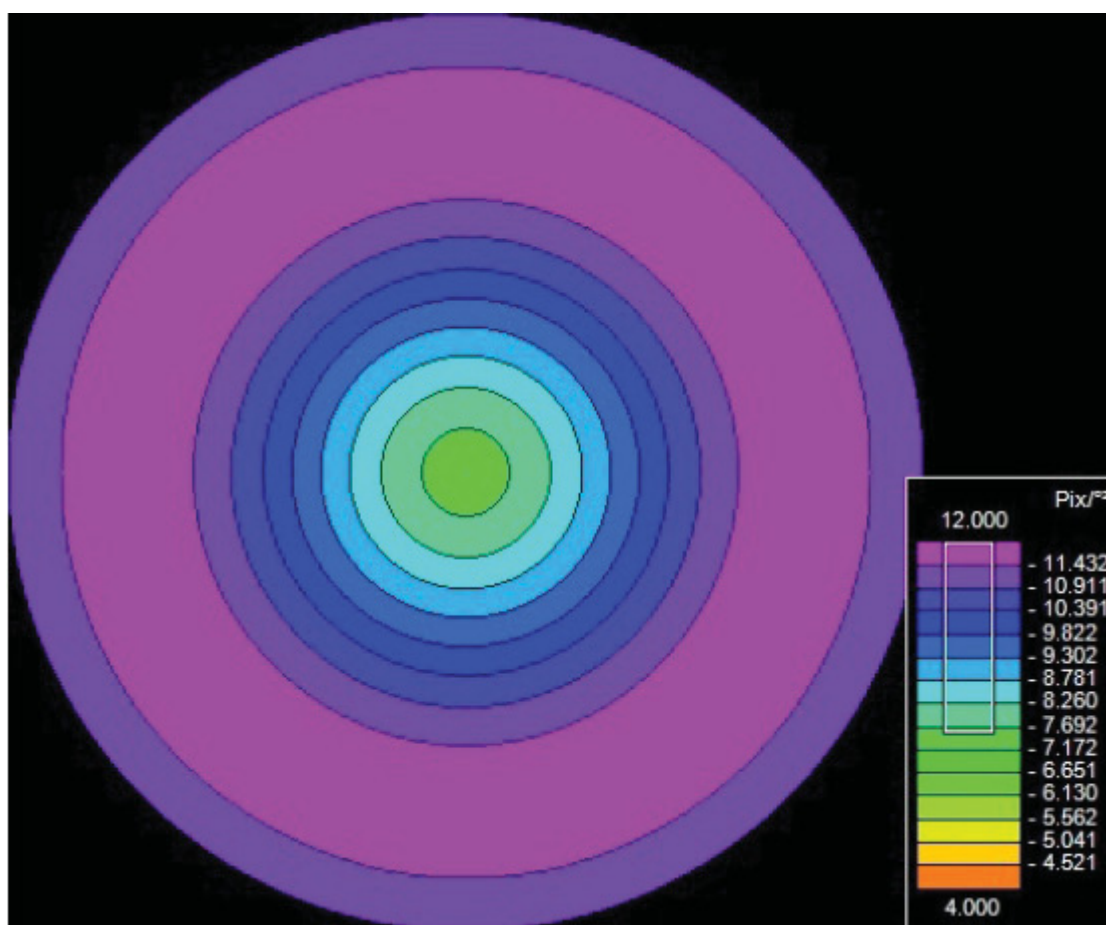
Specifically, the '120 Patent describes:

FIG. 7 shows another example embodiment of a *non-linear targeted resolution curve 700* for a miniature wide-angle lens according to the present invention. The targeted resolution curve is chosen to have an upward curve between the center *resolution value 710* and a maximum *712 (number of pixels/degree)*, followed by a downward curve between the maximum *712* and a region near the edge of the field of view around position *714*. *This downward curve between maximum value 712 and position 714 allows the lens system* to have a higher relative illumination value toward the edge of the field of view *by having a lower object to image magnification ratio in that region* and hence redirecting the same quantity of light from an object to a smaller region in the image with more illumination.

EX1001, 6:28-41. In other words, the '120 Patent conflated a negative or downward sloped resolution curve as having lower object to image magnification ratio. *Id.*; EX1003 ¶¶117. For the same reasons, a POSITA would understand the '120 Patent to teach that a positive or upward sloped resolution curve as having higher object to image magnification ratio. *Id.*

Thibault similarly describes that the lens assembly of FIG. 5 is a “f/2.8 lens [that] has a 1:1 anamorphic ratio and use[s] *targeted distortion to increase the number of pixels in the zone of interest* for mobile video chat applications as shown at figure 6.” EX1004, 6. In particular, the bottom portion of Figure 6 (reproduced

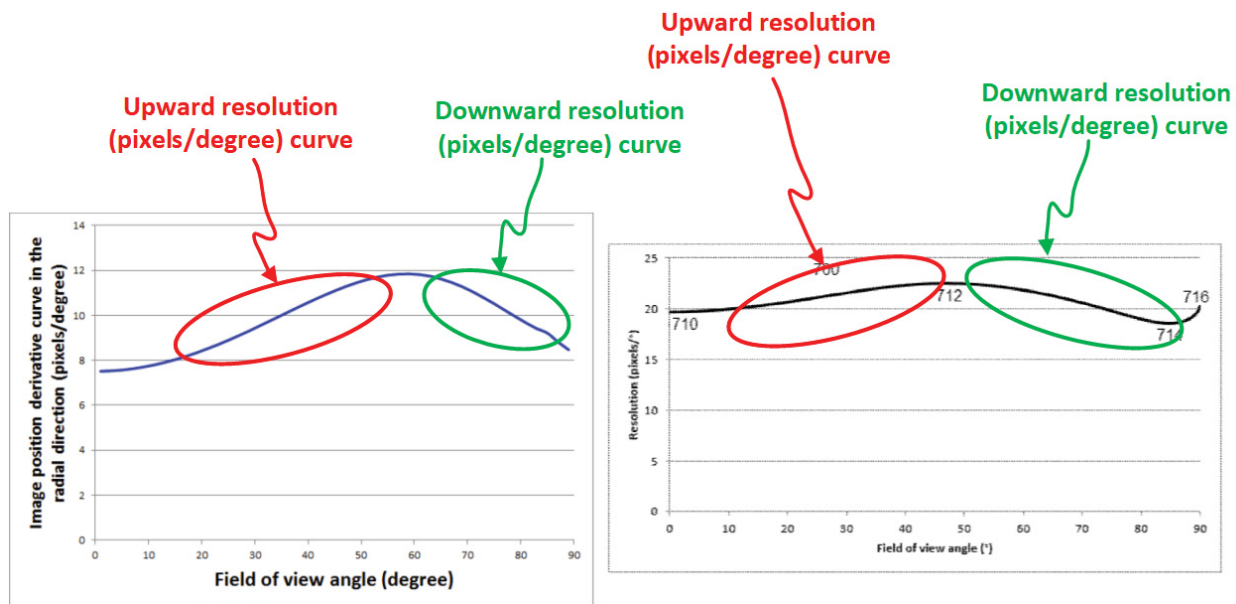
below) shows the surface resolution over the full circular panomorph image. EX1004, 7, FIG. 6. As shown in the resolution graph, the lens design has non-linear targeted resolution such that some zones have higher resolution (e.g., purple and magenta zones) and other zones have a lower resolution (e.g., green and cyan zones). *Id.*, FIG. 6; EX1003, ¶118.



EX1004, Excerpt of Figure 6

The top portion of Thibault's Figure 6 (reproduced below) shows curves with areas of increasing and decreasing values, just as in FIG. 7 of the '120 Patent. EX1003 ¶119. Thibault refers to the Y-axis of its Figure 6 graph as "image position

derivative curve in the radial direction” and it labels it as “pixels/degree.” EX1004, 6-7. Thibault describes this graph as illustrating the “the distortion profile ratio from minimum to maximum number of pixels/degree.” EX1004, 6.



EX1004, Annotated Figure 6

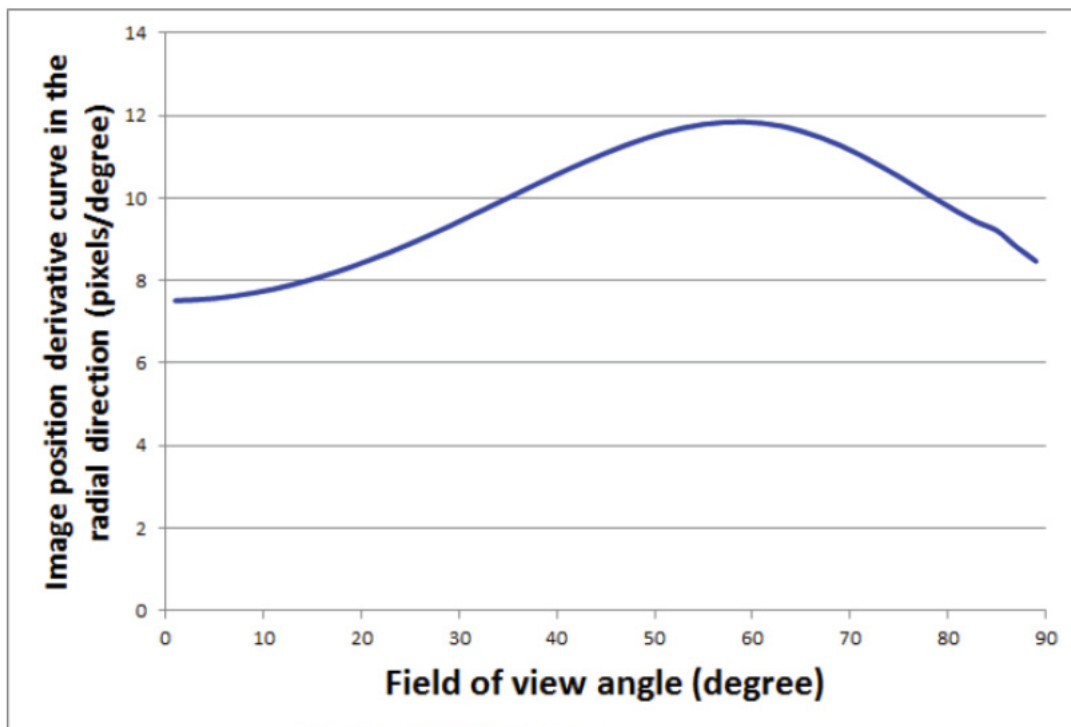
EX1001, Annotated FIG. 7

A POSITA would have understood from Thibault that this “distortion profile ratio” is the resolution of the image projected onto the focal plane in pixels/degree. EX1003 ¶120. That is, the image of the object is being distorted such that portions of the object are magnified and therefore imaged at a higher resolution than other portions. *Id.* This is illustrated in Thibault’s Figure 11, where an image/picture was taken using a testing setup in which the object/target “consist[s] of alternating black and white rectangles each 2° wide.” EX1004, 8-9. That is, each black rectangle would have the same width in an undistorted lens, but the lens of Figure 5 causes the

black rectangles at approximately 60° to be magnified (i.e. wider horizontally) and therefore have a greater resolution (i.e., pixels/degree) and perceived size in the image than the black rectangles nearer the center or edges of the image, where the magnification drops (i.e. the images are thinner horizontally) and therefore the resolution (i.e., pixels/degree) decreases. EX1003 ¶120.

**Lower magnification and
fewer pixels/degree, so
black rectangle is narrower**

**Higher magnification and
greater pixels/degree, so
black rectangle is wider**



EX1004, Annotated Excerpts of FIGS. 11 and 6

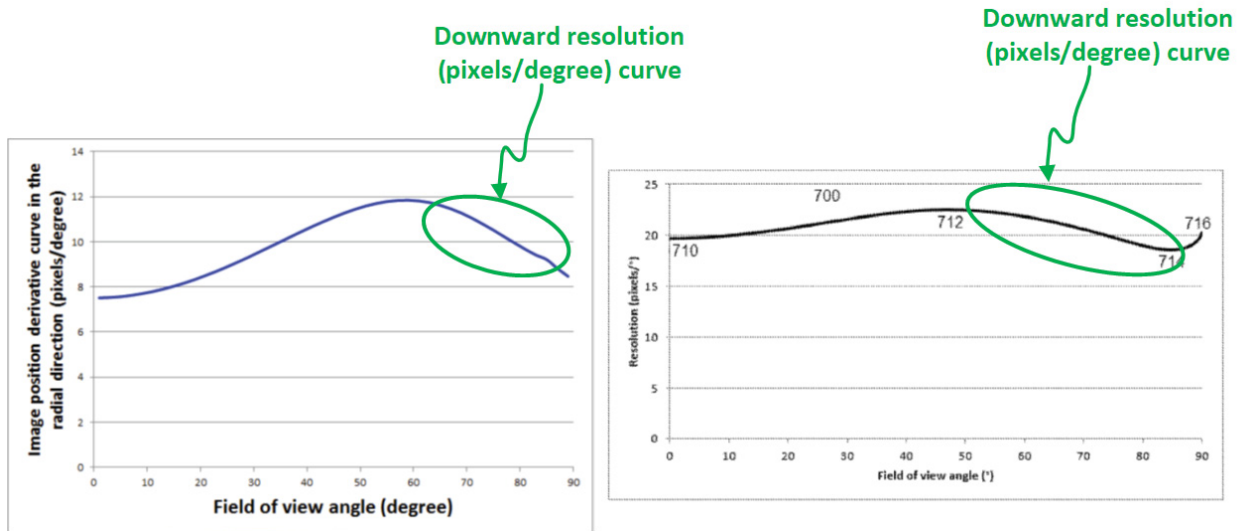
Thus, the lens' non-linear targeted resolution creates a zone in a captured image with a higher or lower object to image magnification compared to linear targeted resolution. EX1003 ¶121.

Further, Thibault teaches or at least renders obvious that the distortion described above is introduced "intentionally."⁶ As noted above, Thibault teaches that the lens of Figure 5 "use[s] **targeted** distortion to increase the number of pixels in the zone of interest." EX1004, 6. A POSITA would have understood or at least found it obvious that, by "target[ing] . . . the zone of interest" with distortion, the designers of the Figure 5 lens "intentionally create[d] a zone in an image captured by the miniature wide-angle optical apparatus with a higher object to image magnification compared to linear targeted resolution," as claimed. EX1003 ¶122.

As noted in Section III.A, *supra*, the final clause of limitation [1e] (i.e., "the lower or higher object to image magnification being used to compensate, at least in part, for a lower image quality due to at least one of a drop of relative illumination

⁶ As Apple has asserted in district court, this claim limitation is independently invalid as indefinite. Because of the statutory restrictions on the grounds that may be presented to the Board, Apple is pursuing its indefiniteness arguments in district court. However, the claims at issue are unpatentable for the reasons set forth herein regardless of the district court's ruling on the issue of indefiniteness.

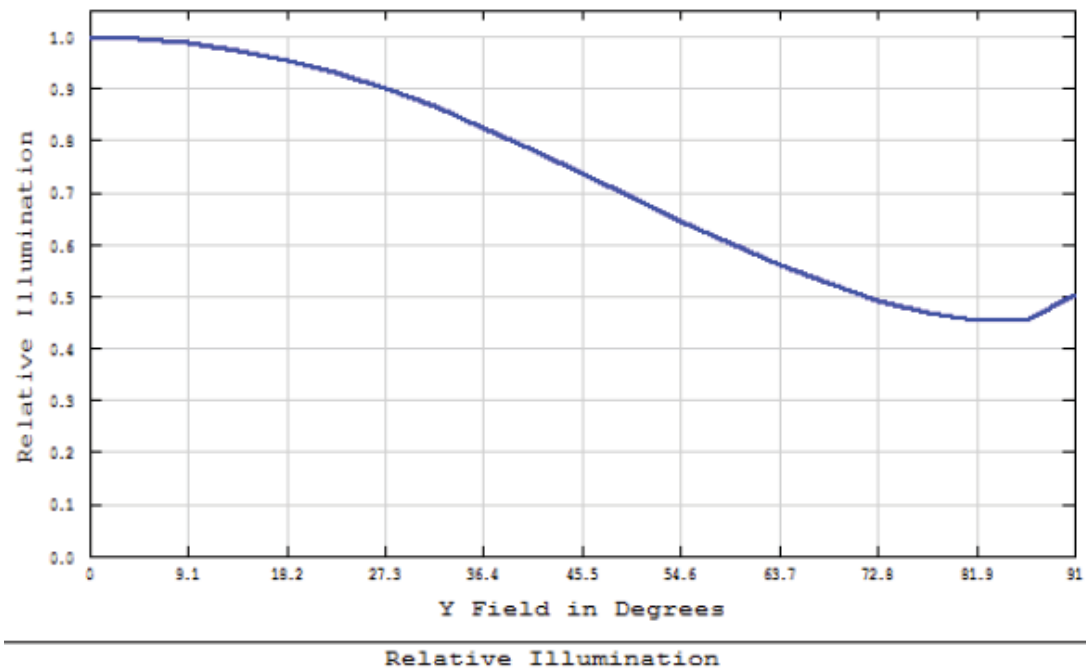
or a drop of MTF in a zone of the image”) should not be given patentable weight. However, to the extent that the final clause is given patentable weight, the curvature of the resolution curve in Thibault’s Figure 6 will “compensate, at least in part, for a lower image quality due to at least one of a drop of relative illumination or a drop of MTF in a zone of the image” for the same reasons as described in the ’120 Patent. EX1003 ¶123. The ’120 Patent describes that the “downward curve between maximum value 712 and position 714 allows the lens system to have a higher relative illumination value toward the edge of the field of view by having a lower object to image magnification ratio in that region and hence redirecting the same quantity of light from an object to a smaller region in the image with more illumination.” EX1001, 6:36-41. The resolution curve in Thibault’s Figure 6 has a similar downward slope to Figure 7 of the ’120 Patent as annotated below, and would therefore have the same impact on relative illumination as described in the ’120 Patent. EX1003 ¶123.



EX1004, Annotated Figure 6

EX1001, Annotated FIG. 7

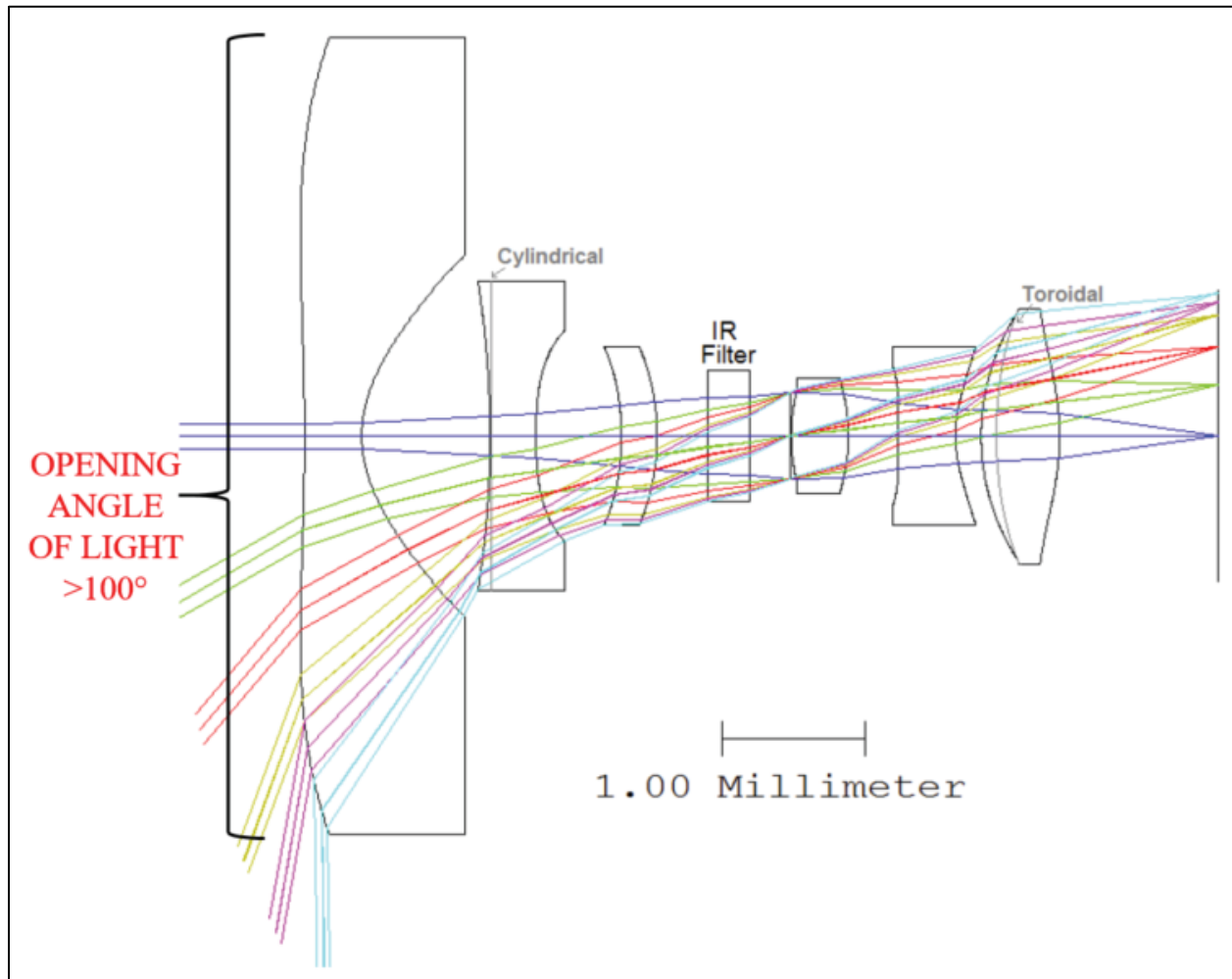
Indeed, Thibault's Figure 7 (reproduced below) illustrates an increase in relative illumination toward the edge of the field of view, just as predicted by the '120 Patent. EX1003 ¶124.



EX1004, FIG. 7

[1f] an opening angle of light entering the optical apparatus being over 100°.

Thibault discloses this element. EX1004, FIG. 5; EX1003 ¶125. Thibault describes itself as introducing “the two smallest panomorph wide-angle lenses ***with fields of view of 180°.***” EX1004, 10. This is illustrated in Thibault’s Figure 5, where various rays of light are shown as multi-colored lines. EX1004, FIG. 5. A POSITA would have understood from these light rays that the opening angle of light of the lens design is 180°, which is over 100°. EX1003 ¶125. This is clear at least from the bottom-most set of rays in cyan, which, given the symmetrical nature of the lens element, would have a counterpart top-most set of rays (not shown), forming a 180° opening angle of light. *Id.*; EX1004, 6 (“symmetric”). Indeed, the ’120 Patent also refers to the claimed 100° of light entering the optical apparatus as the “field of view,” consistent with Thibault. *See* EX1001, 3:55-61, 4:38-44, 5:16-22.



EX1004, FIG. 5 (annotated)

[2] The miniature wide-angle optical apparatus of claim 1, wherein the optical apparatus is configured to create a resulting image with a constant image quality across a whole field of view.

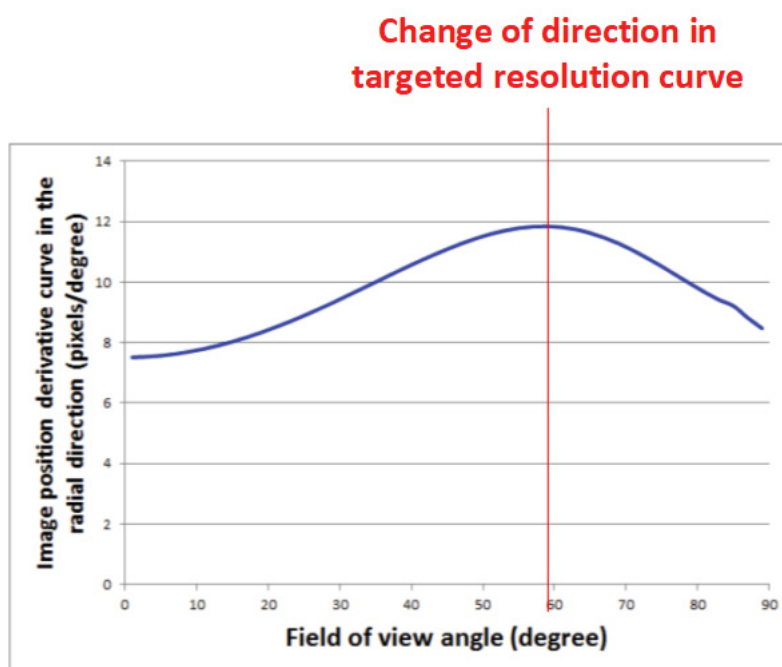
Thibault renders obvious claim 2. EX1004, 3, 10; EX1003 ¶¶127-128.

Thibault teaches that, “[t]o **control the image quality** in production so that it remains in the specification, special optimization to make sure that the MTF stays within a range of a few % from the nominal MTF for all fields are required. To achieve that, desensitization of the several worst offenders was done during the optical design

optimization using typical tolerance guidelines from mobile industry.” EX1004, 3. From this teaching, a POSITA would have understood that Thibault’s lens designs were intended to achieve “constant image quality across a whole field of view,” or that it would have been obvious to achieve such an outcome using known “guidelines” within the industry. EX1003 ¶128. Furthermore, as Dr. Kessler describes, there are many criteria that a POSITA would have known could be used to assess image quality, but no matter what criteria the POSITA used, a POSITA’s aim in whatever optical system he/she is designing is to obtain a constant image quality across a whole field of view. EX1003, ¶127. Thus, claim 2 would have been obvious based on the teachings of Thibault and a POSITA’s knowledge.

[3] The miniature wide-angle optical apparatus of claim 1, wherein a targeted resolution curve has a change of direction near an edge of a field of view.

Thibault discloses claim 3. EX1004, FIG. 6; EX1003 ¶¶130-136. As described above with respect to limitation [1e], the image position derivative curve in the radial direction in the top-portion of Thibault’s Figure 6 is a target resolution curve, as it plots the pixel/degree resolution with respect to the field of view angle of the 3.80 mm TTL lens illustrated in Figure 5. EX1003 ¶130. The top-portion of Thibault’s Figure 6 shows a change of direction of the targeted resolution curve at approximately 60°, which is annotated in red below. EX1003 ¶130.



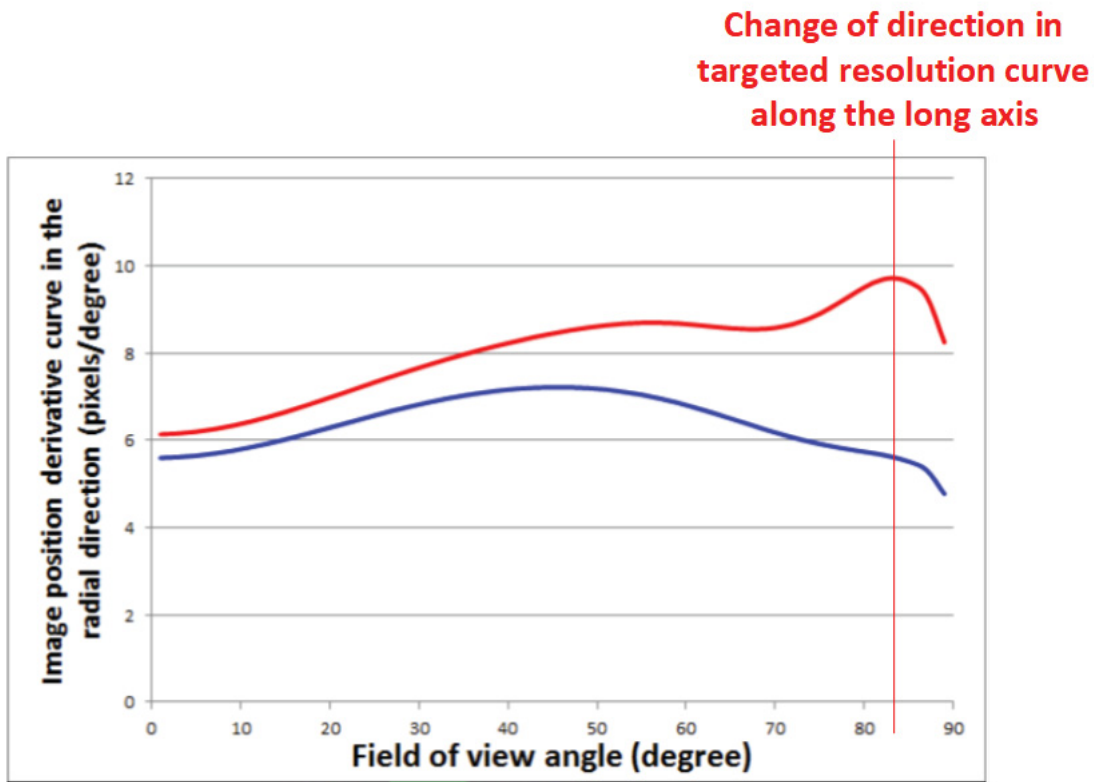
EX1004, FIG. 6 (cropped; annotated)

The '120 Patent does not define the word “near.” EX1003, ¶131. Rather, the only place that the specification uses the word “near” is when it describes that FIG. 7 includes “a downward curve between the maximum 712 and a region *near* the edge of the field of view around position 714.” EX1001, 6:30-35. This contrasts the change of direction between positions 714 and 716 of FIG. 7, which the '120 Patent describes as “a change of direction *at* the edge of the field of view 716” (as opposed to “near” the edge). EX1001, 6:42-44. Because the change of direction in the top-portion of Thibault’s Figure 6 happens nearer to the edge of the field of view (i.e., 90°) than to the center (i.e., 0°) and the resulting downward sloping portion of the resolution curve is in a similar range of the field of view as the downward sloping

portion between positions 712 and 714 of the '120 Patent, a POSITA would have found it reasonable to consider the change of direction at 60° to be “near an edge of a field of view,” as that term is loosely used in the '120 Patent. EX1003, ¶131.

However, if Patent Owner argues that claim 3's use of the phrase “near an edge of a field of view” is intended to refer to the change of direction nearer the positions 714 and 716 of FIG. 7 of the '120 Patent (*e.g.*, somewhere approximately between 80-90°), a POSITA would have found it obvious to modify the lens assembly to include such a change in direction based on Thibault's overall teachings, and particularly those with respect to the 6.56 mm TTL lens illustrated in Figure 2. EX1003, ¶132.

As shown in the top-portion of Figure 3, the targeted resolution curve of the 6.56 mm TTL lens has a change of direction between 80-90°, which is annotated in red below. EX1003 ¶133.



EX1004, Figure 3 (annotated)

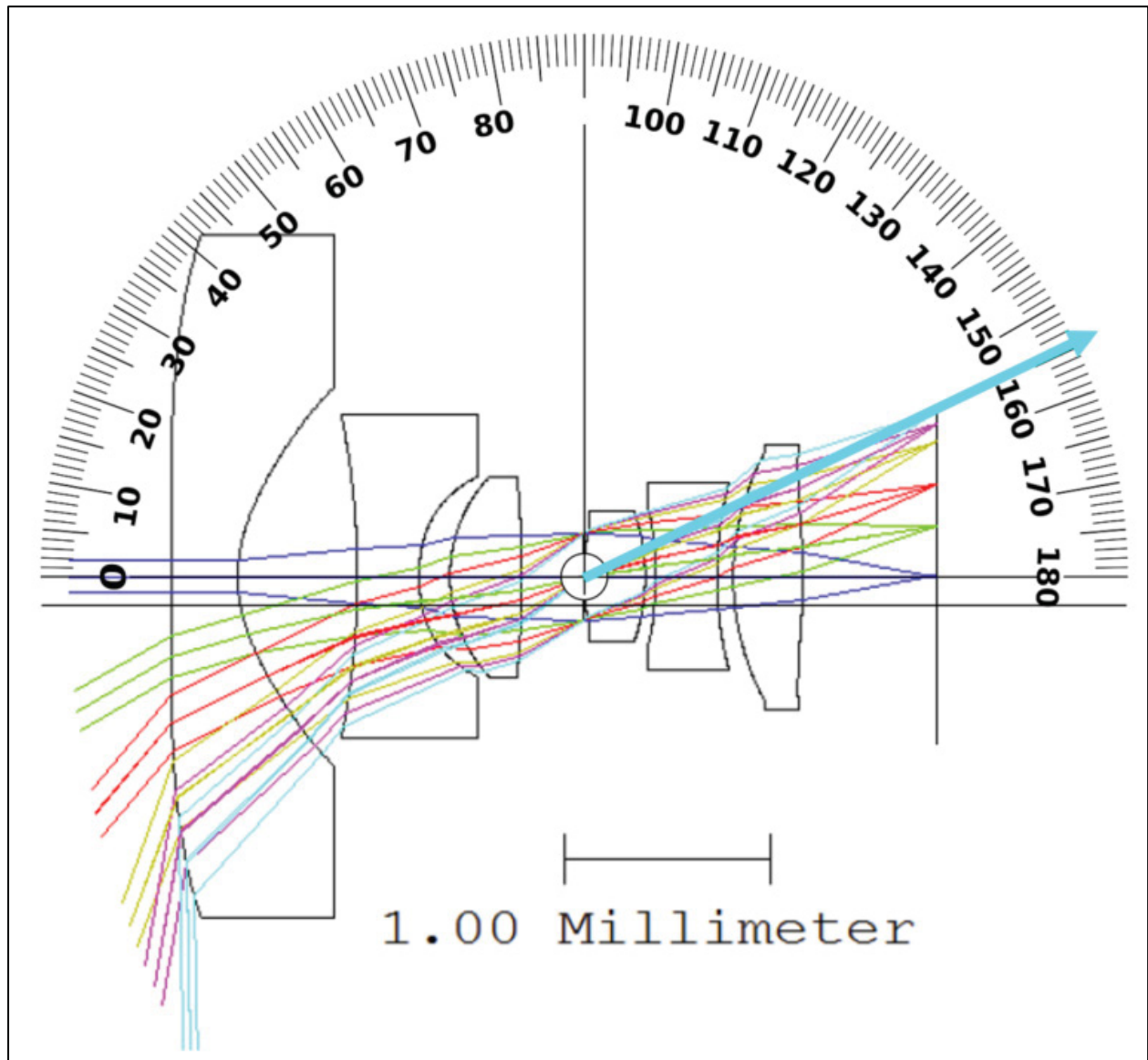
Thibault generally teaches a POSITA that there is a benefit to designing a lens so that the resulting image includes an “increase [in] the number of pixels in an area of interest.” EX1004, 2. This is achieved in part through “controlled distortion to selectively stretch or compress the number of pixels in areas of interest in the field of view.” EX1004, 2. With respect to the 6.56 mm TTL lens, Thibault acknowledges that there are at least a subset of use cases where it is desirable to design the targeted distortion of the lens “to increase the number of pixels/degree *toward the edge of the FoV* as shown in figure 3.” EX1004, 4; EX1003 ¶134. This

is consistent with the maximum value of pixels/degree being between 80-90°, as annotated above with respect to Figure 3. EX1003 ¶134.

Based on these teachings, a POSITA would have found it obvious to modify the design of the 3.80 mm TTL lens illustrated in Figure 5 such that the area of interest is closer to the edge of the field of view, similar to where it is shown in the top portion of Thibault's Figure 3. EX1003 ¶135. This would have resulted in a lens that has a peak pixels/degree resolution between 80-90° of the field of view, as opposed to at 60°, where it is shown in Figure 6. *Id.* For example, in the context of video chat, as shown in Thibault's Figure 3, a POSITA would have recognized that moving the area of interest and targeted distortion closer to edge of the field of view would beneficially allow the users to position themselves closer to edge of the field (e.g., by sitting back more comfortably from the lens) and would allow more users to be positioned within the field of view at the area of interest with the increased resolution. *Id.* Further, Thibault provides at least as much teaching regarding the properties of its 6.56mm and 3.80mm TTL lenses as the '120 Patent teaches regarding the claimed lens. EX1003, ¶136. Thus, if the '120 Patent contains an enabling disclosure, the disclosure of Thibault is sufficient to enable a POSITA to make this obvious modification. *Id.*

[4] The miniature wide-angle optical apparatus of claim 1, wherein an angle of chief-rays reaching the focal plane is over 20° from an optical axis of the optical apparatus.

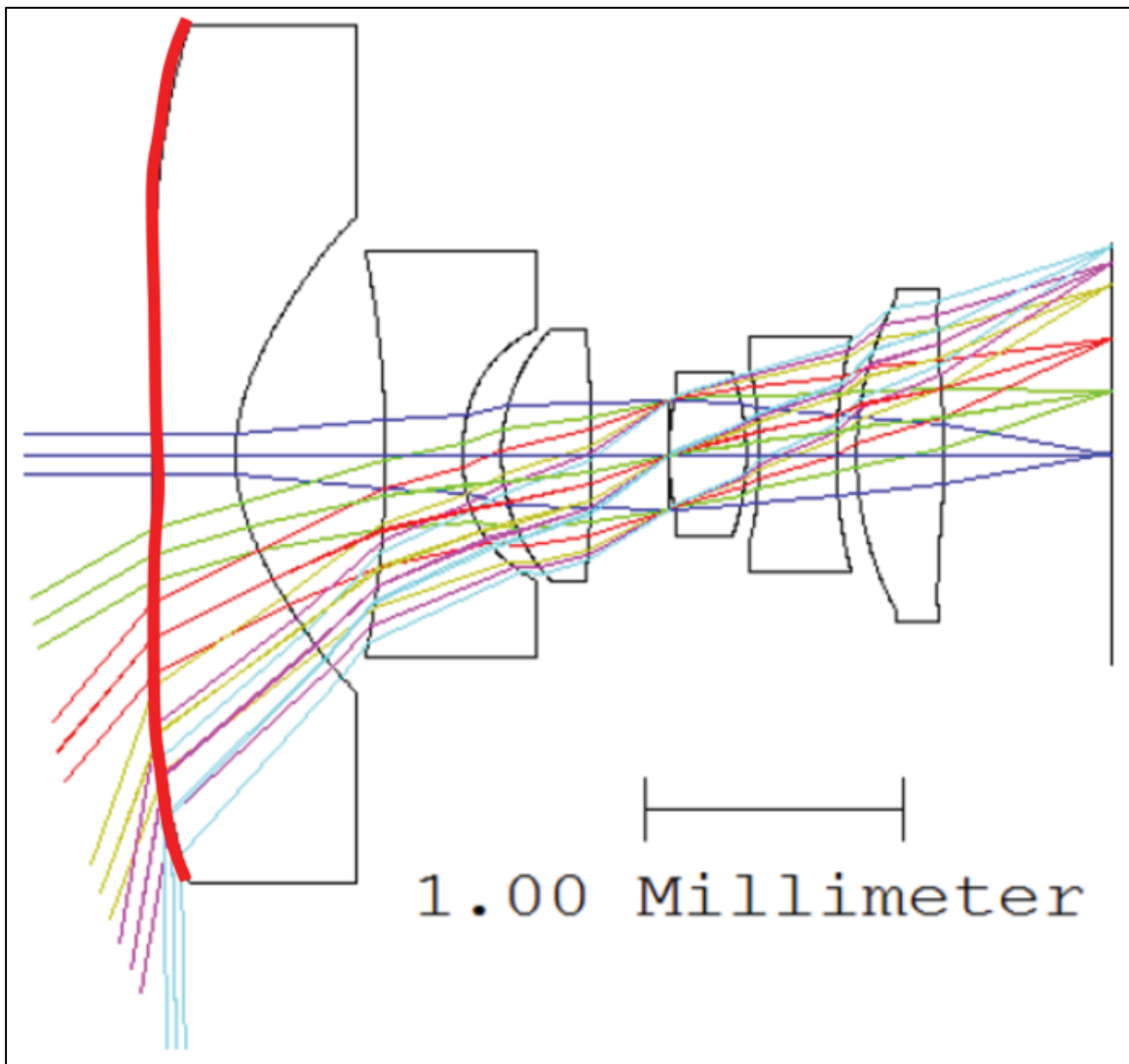
Thibault discloses claim 4. EX1004, FIG. 5; EX1003 ¶138. In particular, as illustrated in the modified image of Figure 5 below, the chief-rays reaching the focal plane are over 20° (approximately 26°) from the optical axis of the lens. *Id.*



EX1004, FIG. 5 (modified)

[5] The miniature wide-angle optical apparatus of claim 1, further comprising a plurality of optical elements, at least one of the plurality of optical elements defining the first surface.

Thibault discloses claim 5. EX1004, 6, FIG. 5; EX1003 ¶¶140-141. As shown in Thibault's Figure 5, the lens design having a TTL of 3.80 mm has a plurality of optical elements ("6 plastic elements" and a "0.2 mm cover glass"). EX1004, 6-7; EX1003 ¶140.



EX1004, FIG. 5 (highlighted)

As described with respect to limitation [1a], a POSITA would have understood that, for this lens design, the “0.20 mm cover glass” is an optional optical element positioned on the object-side of the panomorph lens that helps protect the otherwise plastic lens assembly. EX1004, 3 (“the front lens vortex can be leveled with the mechanical surrounding or the lens can be behind a thin cover-glass”); EX1003 ¶141. Thus, in those implementations that include the “0.20 mm cover glass,” the object-side of cover glass would have been the claimed “light-receiving first surface.” EX1003 ¶141. On the other hand, where the “0.20 mm cover glass” is omitted, the above red highlighted object-side of the first element of the panomorph lens would have been the claimed “light-receiving first surface.” *Id.*

[6] The miniature wide-angle optical apparatus of claim 5, wherein at least one of the optical elements is made of glass.

Thibault discloses claim 6. EX1004, 6; EX1003 ¶143. In particular, the optical apparatus of Thibault having a TTL of 3.80 mm may include an optional “0.2 mm cover glass.” EX1004, 6. Thibault describes that “the front lens vortex can be leveled with the mechanical surrounding or the lens can be behind a thin cover-glass,” which means that the cover glass would be positioned on the object-side of the lens (i.e., on the left side of the six plastic elements shown in Figure 5). EX1004, 3, 6-7; EX1003 ¶143. As described above with respect to limitation 1[a], the “0.20 mm cover glass” described by Thibault is necessarily an optical element because it

would have to pass light through to the remainder of the panomorph lens assembly for the assembly to operate. EX1003 ¶143. Thus, in those implementations that include the “0.20 mm cover glass,” at least one of the optical elements is made of glass, as claimed.

[7] The miniature wide-angle optical apparatus of claim 1, wherein the miniaturization ratio value is less than 2.0.

Thibault discloses claim 7. EX1004, 6; EX1003 ¶145. As discussed with respect to element [1d], with the cover glass, the miniaturization ratio of the lens design is the TTL of 3.80 mm divided by the image circle diameter of 2.01 mm, or **1.89**, which is less than 2.0. EX1003, ¶145. Similarly, without the cover glass, the miniaturization ratio of the lens design is the TTL of 3.72 mm divided by the image circle diameter of 2.01 mm, or **1.85**, which is less than 2.0. *Id.*

C. Ground 2 (Claims 1 and 3-6)

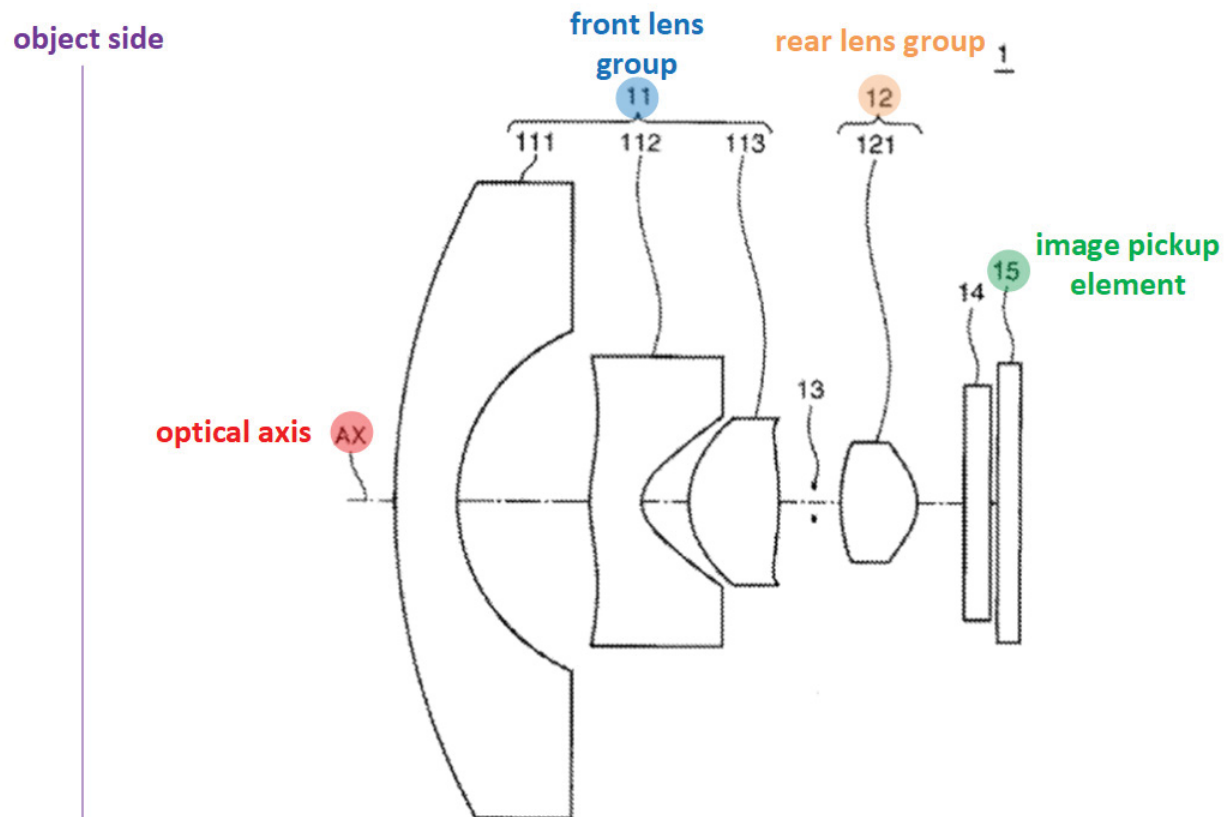
1. Overview of Matsusaka (EX1005)

Matsusaka is a U.S. patent publication titled “Wide-angle optical system, image pickup lens device, monitor camera, and digital apparatus.” EX1005, 1. Like the ’120 Patent, Matsusaka is directed to a “wide-angle optical system that is compact and copes with a wide angle of view, and in particular, relates to a wide-angle optical system that is suitable to a super wide-angle optical system that copes with a super wide angle and has a total angle of view of 90° or more.” *Id.*, ¶0002; EX1003, ¶89.

Matsusaka describes that there was a known recognition for the usefulness, across a variety of uses cases, of “wide-angle optical systems having a large angle of view for taking images (wide angle of view).” EX1005, ¶¶0003-0004; EX1003, ¶90. There existed prior art wide-angle optical systems that (1) prevented “shading that is a problem caused when the optical system has a super wide angle and is formed of a small number of lenses,” and (2) controlled “fluctuations of an image forming position under various temperature environments by employing glass members arranged at proper positions.” EX1005, ¶¶0005-0008. However, Matsusaka recognized that these prior art wide-angle optical systems failed to correct “chromatic aberrations which are caused because of downsizing of the optical system,” and resulted in lower “contrast over the entire image area.” EX1005, ¶0008. Thus, Matsusaka sought to “provide a wide-angle optical system which is compact and has more excellent optical propert[ies],” as compared to the prior art wide-angle optical systems and their observed failures. *Id.*

Matsusaka describes a general wide-angle optical system 1 with respect to FIG. 1. EX1005, ¶¶0144-0145. Matsusaka teaches certain structural specifications for the wide-angle optical system 1 and a series of thirteen (13) conditions that the wide-angle optical system 1 should meet in order to exhibit the improved optical properties that Matsusaka sought. *See generally*, EX1005, ¶¶0144-0208; EX1003, ¶91.

FIG. 1



EX1005, FIG. 1 (annotated)

Matsusaka goes on, in FIGS. 5-50B and their associated descriptions, to provide twenty three (23) examples of “[s]pecific constructions of wide-angle optical system 1 shown in FIG. 1” that each “satisfy the required conditions relating to the present invention,” and therefore “have more excellent optical properties, achieve to be compact sufficiently for being mounted on digital apparatus, especially for being mounted on an onboard monitor camera or on a mobile terminal, and are capable of achieving cost reduction.” EX1005, ¶¶0234, 0449-0450; EX1003, ¶92.

A number of the lenses taught by Matsusaka prove that claims 1 and 3-6 of

the '120 Patent are anticipated and/or obvious, including, *e.g.*, Examples 6, 8, 18, 19, 20, 22, and 23. EX1003, ¶93. However, for simplicity of explanation, the below analysis focuses primarily on Example 19, which is illustrated in and described with respect to FIGS. 23, 43A, and 43B. EX1003, ¶93.

Using the construction data provided by Matsusaka for Example 19, Dr. Kessler was able to model the lens in a program called Zemax to evaluate various of its properties. *See* EX1003, ¶¶94-99. Zemax is an optical design software program, and has been commercially available since at least 1990. *Id.* Those of ordinary and above-ordinary skill in the art of optical system design are usually familiar with Zemax or equivalent optical design software. *Id.* These programs allow those of skill in the art, such as Dr. Kessler, to evaluate properties of an optical system. *Id.*

2. Analysis of the Claims

[1pre] A miniature wide-angle optical apparatus comprising:

To the extent the preamble is limiting, Matsusaka discloses this element. EX1005, abstract, ¶¶0002, 0009, 0082, 0149, 0188, 0224, 0233, 0450; EX1003 ¶¶148-149. Matsusaka is directed to a “***wide-angle optical system*** that is ***compact*** and copes with a wide angle of view, and in particular, relates to a wide-angle optical system that is ***suitable to a super wide-angle optical system that copes with a super wide angle and has a total angle of view of 90° or more.***” *Id.*, ¶0002. As described in the Overview, Matsusaka provides twenty three (23) examples of “[s]pecific

constructions of *wide-angle optical system* 1 shown in FIG. 1” that each “satisfy the required conditions relating to the present invention.” EX1005, ¶¶0234, 0449-0450. Matsusaka describes that each of “Examples 1 to 23 are capable of achieving a *super wide angle* which is a total angle of view of 180° or more.” EX1005, ¶0450.

Matsusaka describes that “the wide-angle optical system having such [] structure can provide a wide-angle optical system that has more excellent optical efficiency and *is made to be compact (downsized)*.” EX1005, ¶0233. Like the ’120 Patent, Matsusaka describes that its optical system is sufficiently compact “for being mounted on . . . a mobile terminal.” EX1005, ¶0450; EX1001, 1:26-30; EX1003, ¶149. As will be described in further detail with respect to limitation [1d], *infra*, Matsusaka’s optical system has a miniaturization ratio that is smaller than the threshold set in the ’120 Patent, and is therefore “miniature,” as that term is used in the ’120 Patent. *See* EX1001, 1:26-30; EX1003, ¶149.

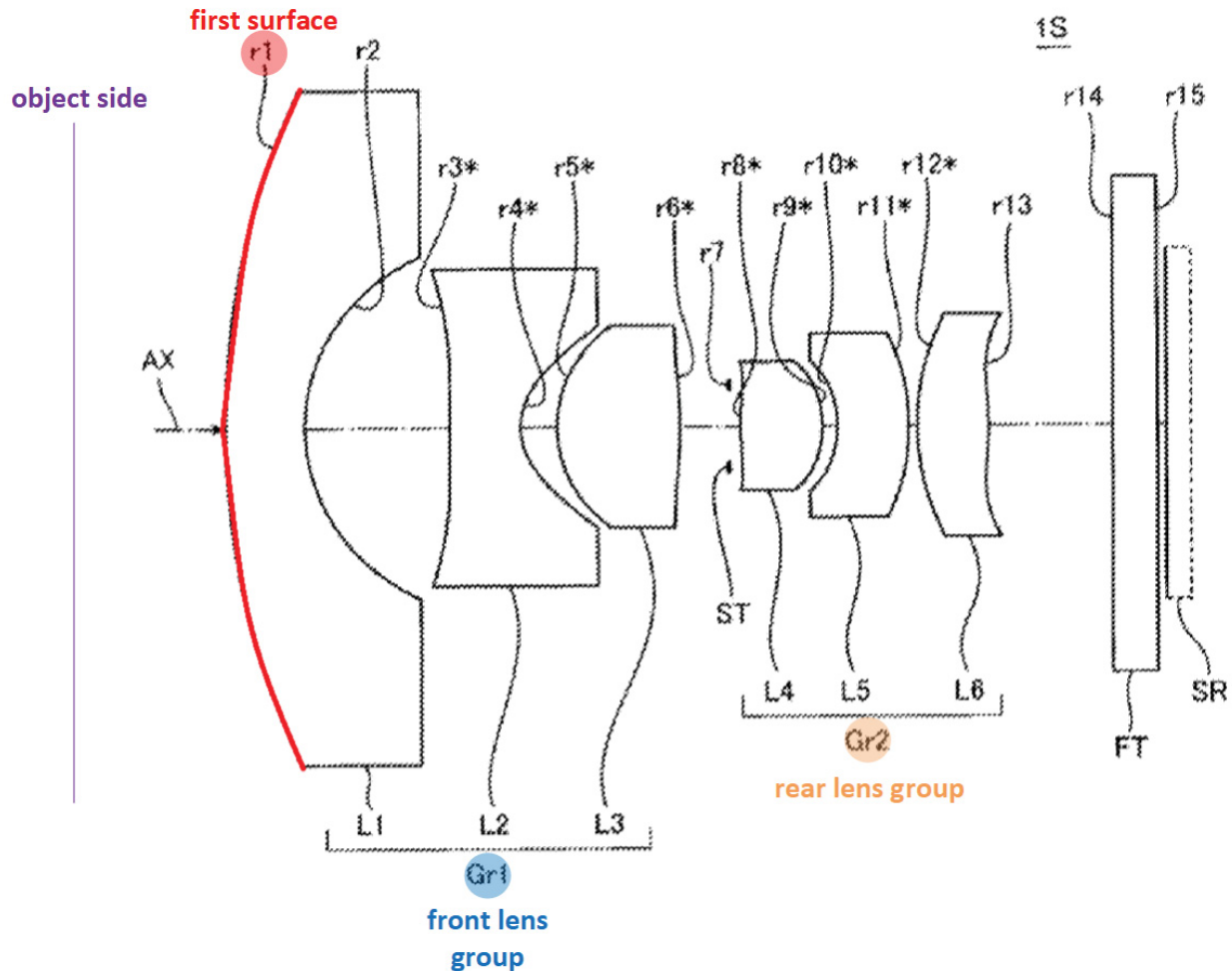
[1a] a light-receiving first surface;

Matsusaka discloses this element. EX1005, FIG. 23, ¶¶0404-0410; EX1003 ¶¶150-151. “FIG. 23 is a sectional view showing an arrangement of lens groups in a wide-angle optical system of Example 19.” EX1005, ¶0404. “Wide-angle optical system 1S of Example 19 has a two-component structure of negative-positive components which includes, as shown in FIG. 23, a front lens group (Gr1) having a negative optical power as the whole lens group, aperture stop ST for adjusting a light

amount, and a rear lens group (Gr2) having a positive optical power as the whole lens group, which are arranged in order from the object side to the image side.”

EX1005, ¶0405.

FIG. 23



EX1005, FIG. 23 (annotated)

“The first lens group (Gr1) is composed of a negative meniscus lens (first lens L1) whose convex surface faces the object side.” EX1005, ¶0407. A POSITA would have understood that surface r1 of first lens L1 (highlighted in red above) is

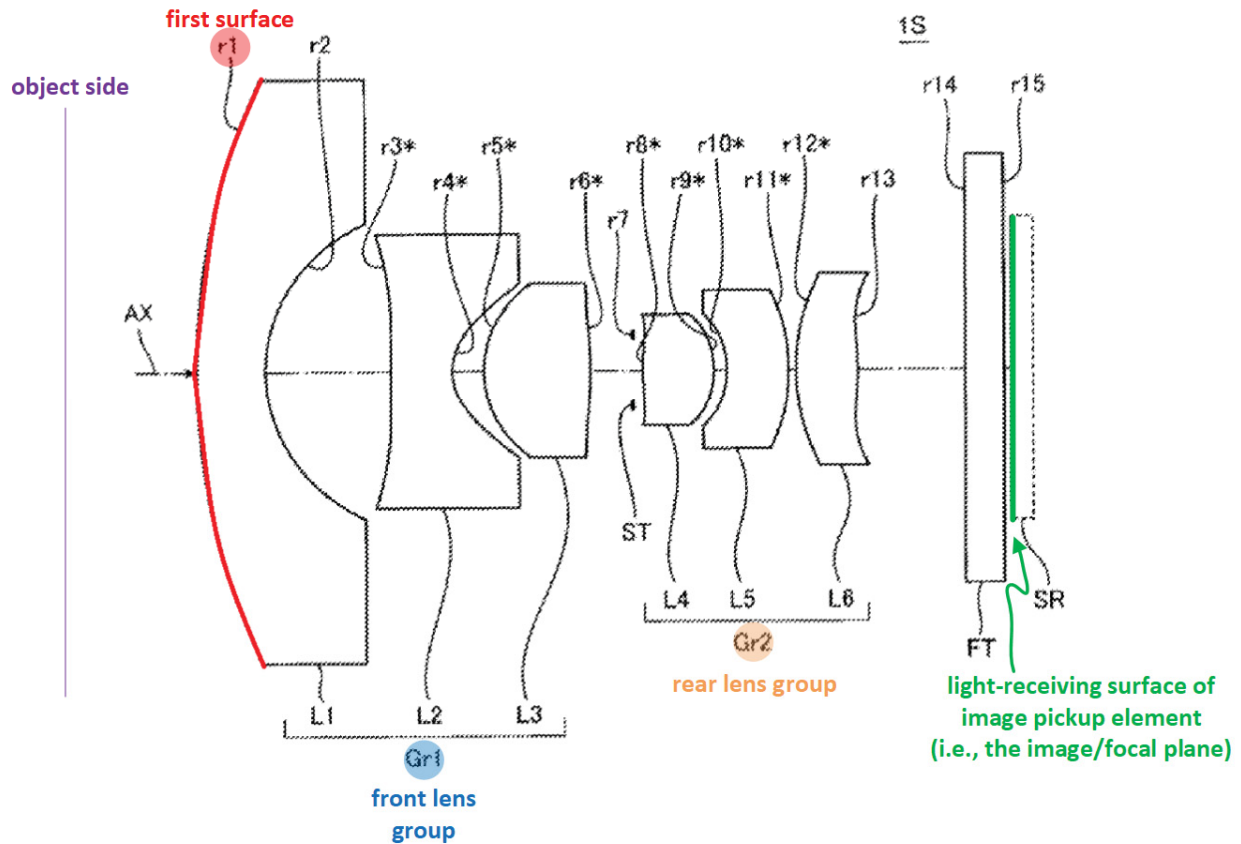
a “first surface,” as claimed. EX1003, ¶151. Surface r1 is the surface of exemplary optical system 1S that is closest to the object and furthest from the image plane, which is the “light-receiving surface of image pickup element SR.” EX1005, FIG. 23, ¶¶0404-0410; EX1003, ¶151. In order for light to be received on the surface of the image pickup element SR, as described by Matsusaka, it would necessarily have to pass through each surface of the exemplary optical system 1S (including the first surface r1) on its path from the object from which the light originates to the light-receiving surface of image pickup element SR. *See* EX1005, ¶¶0151 (“the optical image of a photographic object at the object side are guided to a light-receiving surface of image pickup element 15 by wide-angle optical system 1 along the optical axis AX, and the optical image of the photographic object is picked up by image pickup element 15.”), 0211; EX1003, ¶151.

[1b] a focal plane;

Matsusaka discloses this element. EX1005, FIG. 23, ¶¶0404-0410; EX1003 ¶¶152-153. Specifically, Matsusaka describes that the wide-angle optical system 1 of FIG. 1 (and thus all of the examples) “is equipped favorably on an image pickup lens device whose structure [is] capable of forming an optical image of an object (photo graphic object) on a predetermined image forming surface, for example, on a light-receiving surface (image plane) of image pickup element 15 that converts an optical image into electric signal.” EX1004, ¶0145; *see also id.*, ¶¶0221, 0232

(describing that the wide-angle optical system 1 focuses an image of an object on the light-receiving surface of image pickup element).

FIG. 23



EX1005, FIG. 23 (annotated)

The '120 Patent treats the light receiving surface of image sensor 127 as the “focal plane,” and uses these concepts interchangeably. See EX1001 4:15-21 (“lens 100 has a **total track length** 150, which is a measure from the first surface on the object side of lens 120 **to the image sensor 127**”); 7:14-15 (“a **total track length** measured from a center of the first surface **to the focal plane**”); EX1003 ¶153.. Thus, a POSITA would have understood that the light-receiving surface, *i.e.*, image

plane, of image pickup element SR (highlighted in green above) is the claimed “focal plane.” EX1003 ¶153.

[1c] a total track length measured from a center of the first surface to the focal plane;

Matsusaka discloses this element. EX1005, FIG. 23, ¶¶0404-0411; EX1003 ¶¶154-157. For wide-angle optical system 1S of Example 19, Matsusaka provides the following data:

Unit mm				
Surface data				
Surface Number	r	d	nd	vd
Object plane	∞	∞		
1	10.286	0.900	1.83481	42.72
2	2.300	1.638		
3*	38.903	0.800	1.53048	55.72
4*	0.812	0.416		
5*	1.623	1.392	1.63200	23.41
6*	-4.562	0.561		
7 (Stop)	∞	0.132		
8*	6.361	0.921	1.53048	55.72
9*	-1.232	0.171		
10*	-1.225	0.800	1.63200	23.41
11*	-3.876	0.100		
12*	3.352	0.800	1.53048	55.72
13*	-3.490	1.400		
14	∞	0.500	1.51680	64.20
15	∞	0.100		
Image plane	∞			

Distance from surface r1 to surface r2

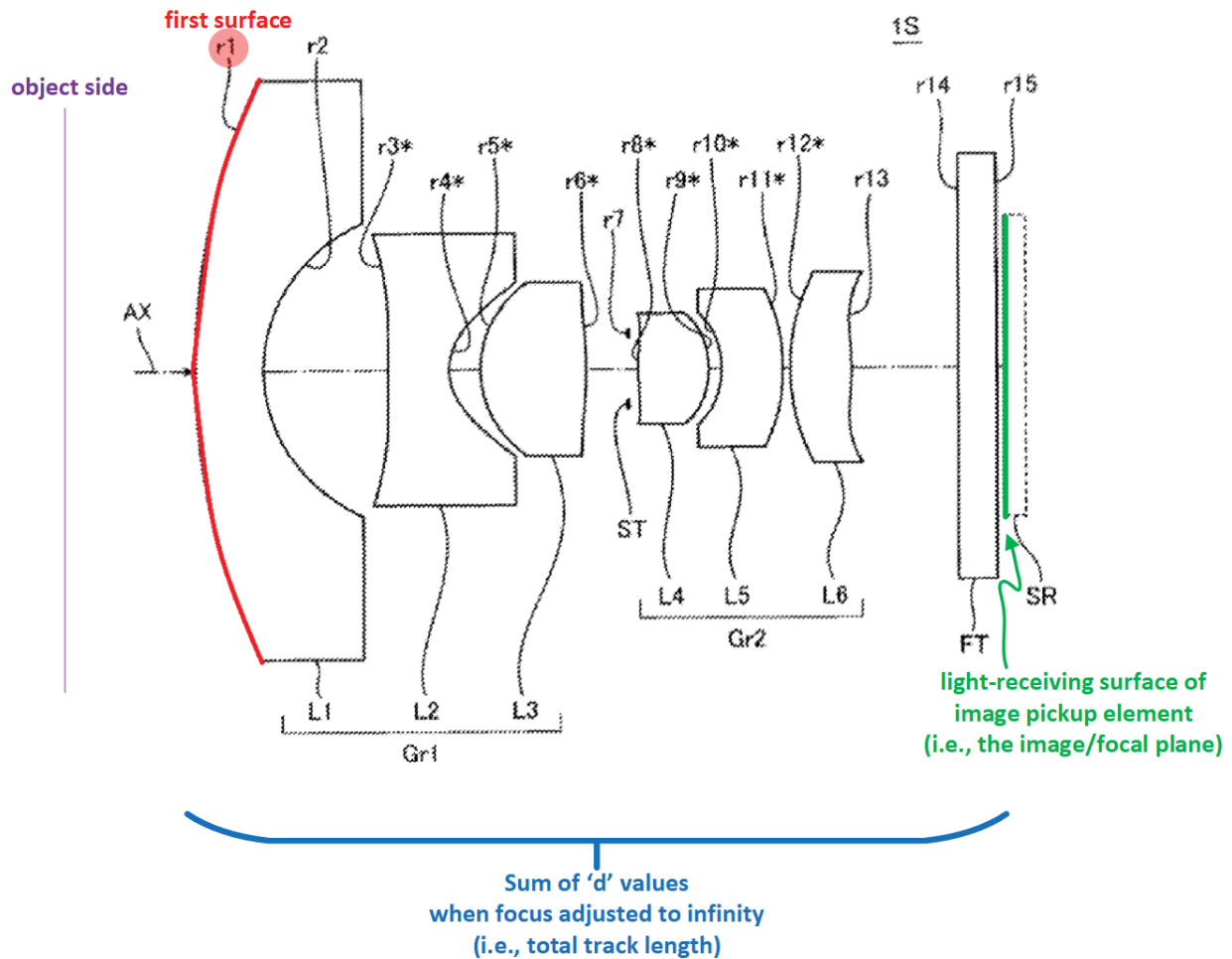
Distance from surface r15 to the image/focal plane

EX1005, ¶0411 (highlighted and annotated). Matsusaka describes that “‘d’ represents a space between lens surfaces on the optical axis (an axial surface distance) under the condition that the focus is adjusted to infinity.”⁷ EX1005, ¶0246. For example, the first value of ‘d’ associated with surface r1 (demarked by a red box) is the distance between the surface r1 of first lens L1 and surface r2 of first lens L1 on the optical axis. *See* EX1005, ¶¶0246, 0411; EX1003, ¶156. Similarly, the last value of ‘d’ associated with surface r15 (demarked by a blue box) is the distance between the surface r15 of parallel flat plate FT and the surface of the image/focal plane. *See id.* Thus, adding up all the ‘d’ values listed in ¶0411 would represent the distance from a center of surface r1 (i.e., the claimed “first surface”) to the image plane (i.e., the claimed “focal plane”) under the condition that the focus is adjusted

⁷ For a given lens assembly, the total track length may change depending on the focus condition, because focusing may change the distance between individual lenses included in the optical apparatus and/or the distance between the lenses and the image sensor. EX1003, ¶155. Matsusaka’s description of the condition being “that the focus is adjusted to infinity” means that the lenses are positioned with respect to one another such that the depth of field of the image created by the optical apparatus is at its maximum, and the maximum number of object are in focus regardless of their distance from the optical apparatus. *Id.*

to infinity. *See id.* Using this method of calculation, the total track length of the wide-angle optical system 1S of Example 19 is 10.631 mm under the condition that the focus is adjusted to infinity. EX1003, ¶156.

FIG. 23



EX1005, FIG. 23 (annotated)

Matsusaka also discloses the following additional data about wide-angle optical system 1S of Example 19:

Various types of data	
Focal length	1.010
F number	2.828
Half angle of view	104.183
Image height	2.110
Total lens length	10.503
BF	1.872

EX1005, ¶0411 (highlighted). As highlighted in yellow, Matsusaka describes the “total lens length” as 10.503 mm. *Id.* Based on the teachings of Matsusaka and their general knowledge, a POSITA would have understood the “total lens length” disclosed by Matsusaka the distance from a center of surface r1 (i.e., the claimed “first surface”) to the image plane (i.e., the claimed “focal plane”) under the condition that the focus is adjusted to less than infinity. EX1003, ¶157. This stands to reason because the “total lens length” disclosed by Matsusaka (i.e., 10.503 mm) is slightly less than 10.631 mm, which a POSITA would have understood accounts for the case where the optical elements are moved with respect to the image plane in order to focus on a closer object. *Id.* Accordingly, Matsusaka discloses different total track lengths under different conditions. *Id.*

[1d] a miniaturization ratio with a value less than 3.0, the miniaturization ratio being a ratio of the total track length divided by an image circle diameter; and

Matsusaka discloses this element. EX1005, ¶¶0161, 0246, 0411; EX1003 ¶¶158-160. As described with respect to limitation [1c], a POSITA would have understood that the “total track length” of Matsusaka’s wide-angle optical system

1S of Example 19 is either 10.631 mm or 10.503 mm, depending on the adjustment of the lens' focus. *See* EX1005, ¶¶0246, 0411; EX1003, ¶158.

Matsusaka also discloses the following additional data about the wide-angle optical system 1S of Example 19:

Various types of data	
Focal length	1.010
F number	2.828
Half angle of view	104.183
Image height	2.110
Total lens length	10.503
BF	1.872

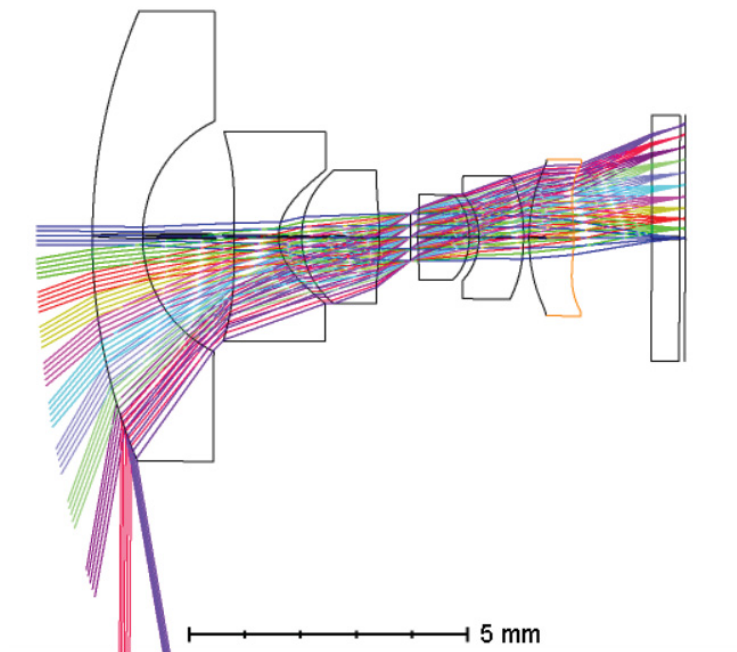
EX1005, ¶0411. As shown, Matsusaka teaches that the “image height” of the wide-angle optical system 1S of Example 19 is 2.110 mm (highlighted in green above). *Id.* Based on the teachings of Matsusaka and their knowledge, a POSITA would have understood that Matsusaka’s disclosed “image height” is a distance from the optical axis to the extent of the image circle. *See* EX1005, ¶0161 (explaining “height” as “distance from the optical axis”); EX1003, ¶59. Thus, the “image circle diameter” would be twice the image height disclosed by Matsusaka, since the optical axis is at the center of the circle. EX1003, ¶159. Accordingly, for the wide-angle optical system 1S of Example 19, the image circle diameter is 4.220 mm.

Under either of the disclosed total track lengths, the miniaturization ratio of the wide-angle optical system 1S of Example 19 is less than 3.0 (10.631 mm divided

by 4.220 mm is **2.519** and 10.503 mm divided by 4.220 mm is **2.489**). EX1003, ¶160.

[1e] a non-linear targeted resolution to intentionally create a zone in an image captured by the miniature wide-angle optical apparatus with a lower or higher object to image magnification compared to linear targeted resolution, the lower or higher object to image magnification being used to compensate, at least in part, for a lower image quality due to at least one of a drop of relative illumination or a drop of MTF in a zone of the image,

Matsusaka discloses this element or at least renders it obvious. EX1005, FIGS. 23, 43A, 43B, ¶¶0404-0412; EX1003 ¶¶161-167. As described above, Dr. Kessler modeled the wide-angle optical system 1S of Example 19 in Zemax. EX1003, ¶¶161. By entering the values provided in the table “Numerical Example 19” in paragraph 0411, Dr. Kessler was able to create the following model:

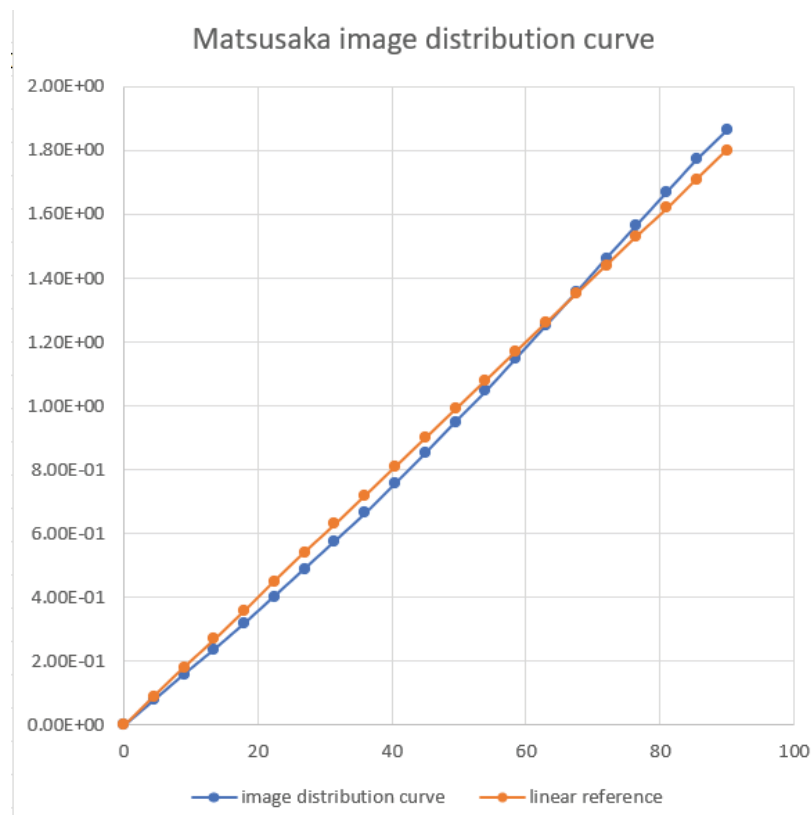


Zemax Model of Matsusaka's Optical System 1S of Example 19

(EX1003, ¶¶95, 161)

Through various comparisons and considerations known to a POSITA, Dr. Kessler was able to confirm that this model matches the description provided in Matsusaka of the wide-angle optical system 1S of Example 19, and meets the expectations of a POSITA for such a lens. EX1003, ¶¶95-99.

Zemax provides the image height at the sensor as a function of the field angle (reproduced below), as known as an “image distribution curve,” corresponding to the model of Matsusaka’s wide-angle optical system 1S of Example 19. EX1003, ¶162.



As shown in this “image distribution curve,” there is deviation in the image height at the sensor compared to the orange linear reference line. EX1003, ¶163. Dr. Kessler explains that where the slope of the blue image distribution curve differs from the slope of the orange linear reference line, there is a change of magnification such that these areas of deviation are “zone(s) in an image captured by the miniature wide-angle optical apparatus with a lower or higher object to image magnification compared to linear targeted resolution,” as claimed. *Id.*

From this data, a POSITA would have been able to derive the derivative of the image height and convert it to resolution in terms of pixels/degree (reproduced below). EX1003, ¶164. For a linear f-theta lens, the equivalent curve will just be a straight line as shown with the pixels evenly spread over 100 degrees. *Id.*



Areas where the blue curve are above the red curve are areas of increased magnification with respect to the linear targeted resolution, and areas where the blue

curve are below the red curve are areas of decreased magnification with respect to the linear targeted resolution. EX1003, ¶165.

Matsusaka does not explicitly describe that these areas or zones of increased and decreased magnification with respect to the linear targeted resolution are “intentional.” EX1003, ¶166. Nonetheless, based on the teachings Matsusaka and a POSITA’s ability to analyze the lens examples using an optical CAD such as Zemax, it would have been obvious to a POSITA to intentionally utilize the areas or zones of increased and decreased magnification, depending on the relevant use case. *Id.* For example, Matsusaka describes using its lenses in “an onboard camera for monitoring rear view of a vehicle.” EX1005, ¶¶0004, 0229-0233. Based on the teachings of Matsusaka and their own knowledge of the art, a POSITA would have recognized that there may be areas or zones of the image that are more important for a user of such a vehicle-mounted camera (e.g., the portion of the image where obstacles are often present), and that these areas or zones may benefit from increased magnification, while other areas or zones are not as important and may have decreased magnification. EX1003, ¶166.

As described in Section III.A, the “used to compensate” language of this limitation should not be given patentable weight. Yet, even if it was, Matsusaka teaches or at least renders obvious that claim language based on the fact that Matsusaka’s lens includes the claimed “zones.” EX1003 ¶167. The ’120 Patent

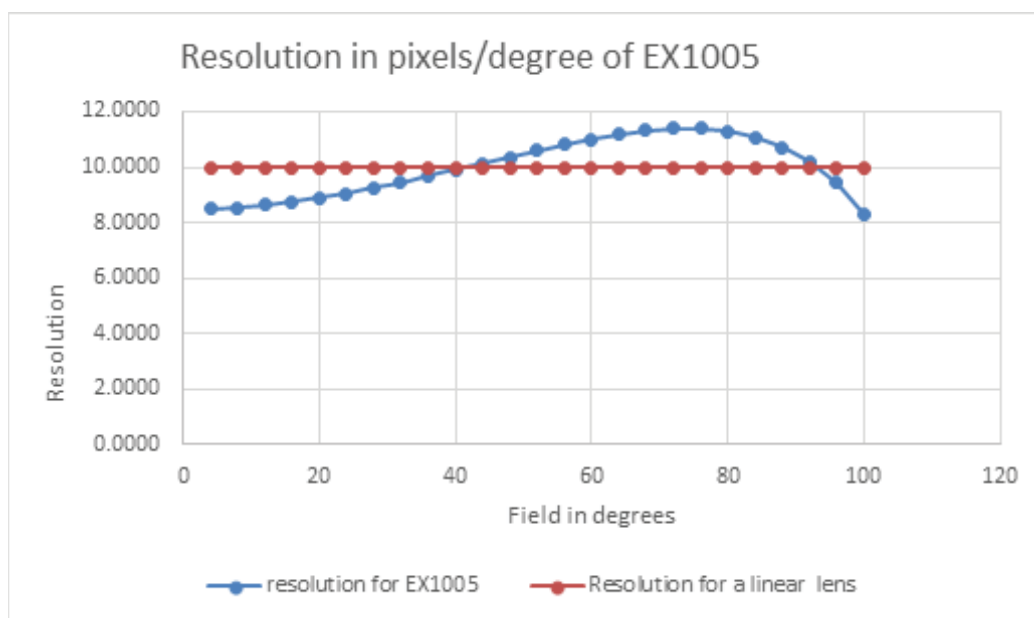
describes that the “downward curve between maximum value 712 and position 714 allows the lens system to have a higher relative illumination value toward the edge of the field of view by having a lower object to image magnification ratio in that region and hence redirecting the same quantity of light from an object to a smaller region in the image with more illumination.” EX1001, 6:36-41. The resolution curve of Matsusaka’s wide-angle optical system 1S of Example 19 has a similar downward slope to Figure 7 of the ’120 Patent, and would therefore have the same impact on relative illumination as described in the ’120 Patent. EX1003, ¶167.

[1f] an opening angle of light entering the optical apparatus being over 100°.

Matsusaka discloses this element. EX1005, ¶0450; EX1003 ¶168. Specifically, Matsusaka describes that each of “Examples 1 to 23 are capable of achieving a super wide angle which is *a total angle of view of 180° or more.*” EX1005, ¶0450.

[3] The miniature wide-angle optical apparatus of claim 1, wherein a targeted resolution curve has a change of direction near an edge of a field of view.

Matsusaka discloses claim 3. EX1005, FIG. 2; EX1003 ¶¶170-171. As described with respect to limitation [1e], a POSITA would have been able to derive the derivative of the image height from the image distribution curve provided by Zemax and convert it to resolution in terms of pixels/degree, which results in the following plot. EX1003, ¶170.



As shown in this graph, there is a change of direction of the targeted resolution curve between approximately 75° and 80°. EX1003, ¶171. For reasons similar to those noted in Section IV.B with respect to the Thibault ground, a POSITA would have found it reasonable to consider the change of direction between approximately 75° and 80° to be “near an edge of a field of view,” as that term is loosely used in the ’120 Patent. Furthermore, for the same reasons described with respect to Thibault (*see* Section IV.B.2.[3], *supra*), a POSITA would have found it obvious to modify Matsusaka’s wide-angle optical system 1S of Example 19 such that the area of interest is closer to the edge of the field of view. EX1003, ¶171.

[4] The miniature wide-angle optical apparatus of claim 1, wherein an angle of chief-rays reaching the focal plane is over 20° from an optical axis of the optical apparatus.

Matsusaka discloses this element or at least renders it obvious. EX1005, FIGS. 23, 43A, 43B, ¶¶0404-0412; EX1003 ¶¶173-174. Zemax provides the following “single ray trace” corresponding to Dr. Kessler’s model of Matsusaka’s wide-angle optical system 1S of Example 19. EX1003, ¶173.

Ray Trace Data							
Units	:	Millimeters					
Wavelength		5.876E-01	μm				
Real Ray Trace Data:							
Surf	Y-coordinate	Y-cosine	Y-normal	Angle in	Path length	Comment	
OBJ	Infinity	9.848E-01					
1	-1.03E+01	9.85E-01	-5.16E-01	6.90E+01	-1.65E+01		
2	-3.74E+00	8.05E-01	-3.64E-01	7.87E+01	6.67E+00	1st element	
3	-1.97E+00	7.58E-01	-8.56E-01	5.21E+00	2.20E+00		
4	-1.45E+00	3.95E-01	1.99E-01	6.07E+01	6.90E-01	2nd element	
5	-8.68E-01	1.66E-01	-7.22E-01	2.30E+01	1.46E+00		
6	-8.34E-01	3.33E-01	-5.65E-01	2.49E+01	2.04E-01	3rd element	
7	-4.37E-01	6.02E-01	7.78E-02	2.39E+01	1.19E+00		
8	6.85E-12	6.02E-01	0.00E+00	3.70E+01	7.26E-01	STOP	
9	1.00E-01	3.87E-01	1.58E-02	3.79E+01	1.66E-01	4th element	
10	4.51E-01	3.97E-01	-3.69E-01	1.13E+00	9.06E-01		
11	5.13E-01	4.08E-01	-4.26E-01	1.86E+00	1.56E-01	5th element	
12	8.60E-01	4.51E-01	-3.38E-01	4.33E+00	8.51E-01		
13	1.08E+00	1.33E-01	3.69E-01	4.85E+01	4.83E-01	7th element	
14	1.17E+00	4.51E-01	3.69E-01	2.93E+01	6.67E-01		
15	1.85E+00	2.98E-01	0.00E+00	2.68E+01	1.50E+00	filter	
16	2.00E+00	4.51E-01	0.00E+00	1.73E+01	5.24E-01		
17	2.05E+00	4.51E-01	0.00E+00	2.68E+01	1.12E-01	sensor	

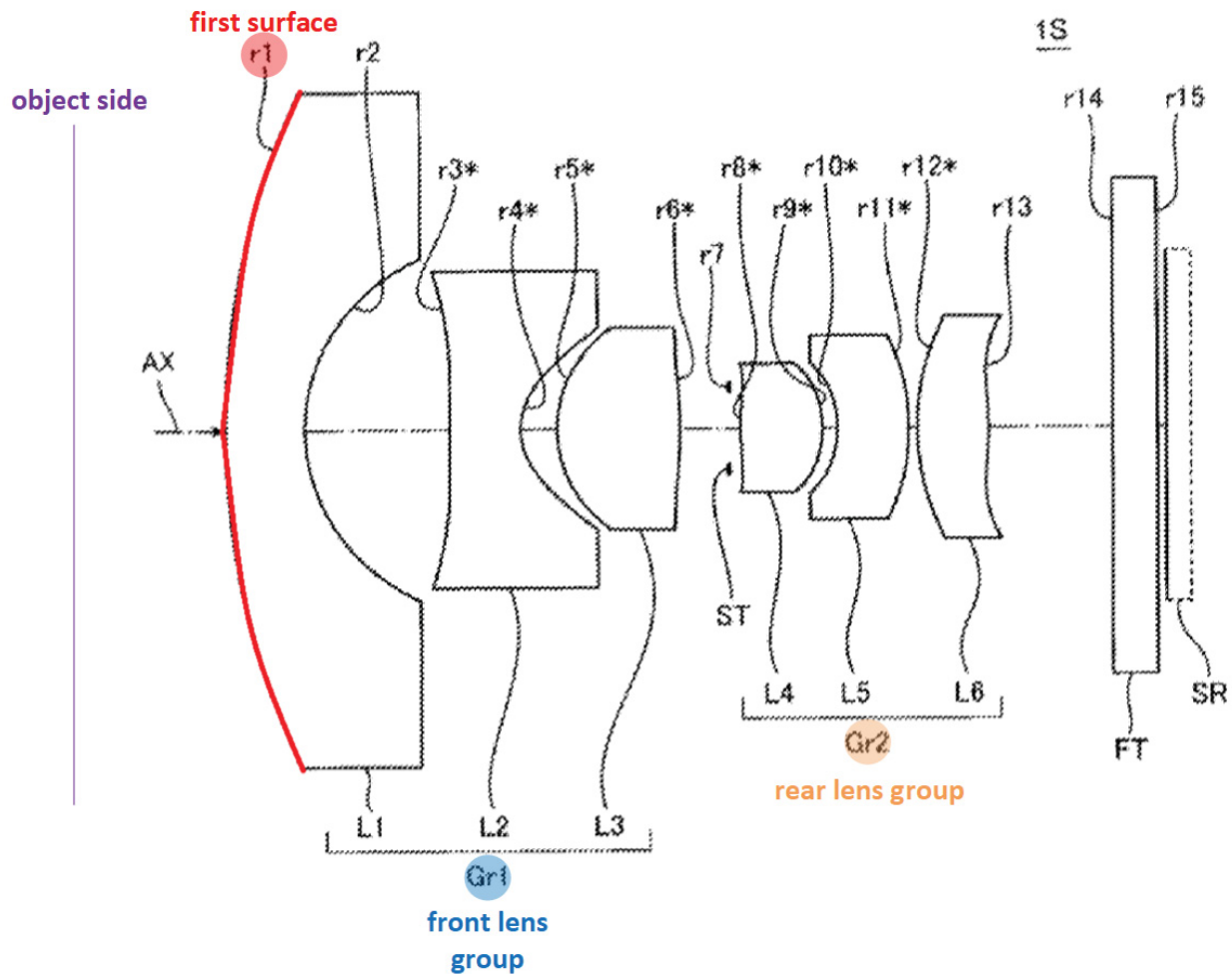
In this “single ray trace,” the ray is the chief ray for 100 degrees off axis (the lens actually can go up to 104 degrees). EX1003, ¶174. As shown, the angle of this

chief-ray reaching the focal plane is 26.8 degrees (over 20°) from an optical axis of the optical apparatus. Also shown on the single trace is the image semi-size at the sensor for 100 degrees off axis field of 2.05 mm (at 104 degrees it is 2.1 mm), as shown in Matsusaka's Fig 23. *Id.*

[5] The miniature wide-angle optical apparatus of claim 1, further comprising a plurality of optical elements, at least one of the plurality of optical elements defining the first surface.

Matsusaka discloses claim 5. EX1005, FIG. 23, ¶¶0404-0410; EX1003 ¶¶176-177. As described with respect to limitation 1[a], a POSITA would have understood that surface r1 of first lens L1 (highlighted in red above) is a “first surface,” as claimed. EX1003, ¶176.

FIG. 23



EX1005, FIG. 23 (annotated)

Surface r1 is the object-side surface of first lens L1 of the first lens group (Gr1). EX1005, FIG. 23, ¶0406; EX1003 ¶177. Matsusaka describes that there are three lenses (L1-L3) that are part of the first lens group (Gr1) and three lenses (L4-L6) that are part of the second lens group (Gr2). EX1005, FIG. 23, ¶¶0406-0408. Thus, Matsusaka's wide-angle optical system 1S of Example 19 comprised a

plurality of optical elements (*e.g.*, L1-L6), at least one of the plurality of optical elements (L1) defining the first surface (r1). EX1003, ¶177.

[6] The miniature wide-angle optical apparatus of claim 5, wherein at least one of the optical elements is made of glass.

Matsusaka discloses claim 6. EX1005, FIG. 23, ¶¶0180, 0404-0407; EX1003 ¶179. In particular, Matsusaka describes that, “[i]n the wide-angle optical system 1, it is preferable that a lens arranged at the closest position to the object *is made of glass.*” EX1005, ¶0180. Thus, in the wide-angle optical system 1S of Example 19 the first lens L1 of the first lens group (Gr1) is preferably made of glass. *See* EX1005, FIG. 23, ¶¶0180, 0234, 0404-0407; EX1003 ¶179. Matsusaka describes “[w]hen the lens closest to the object side . . . is composed of a glass lens as state[d] above, the lens is high in strength, and its anti-scratch property can be improved.” EX1005, ¶0180.

D. Ground 3 (Claims 1, 4, 5, 7)

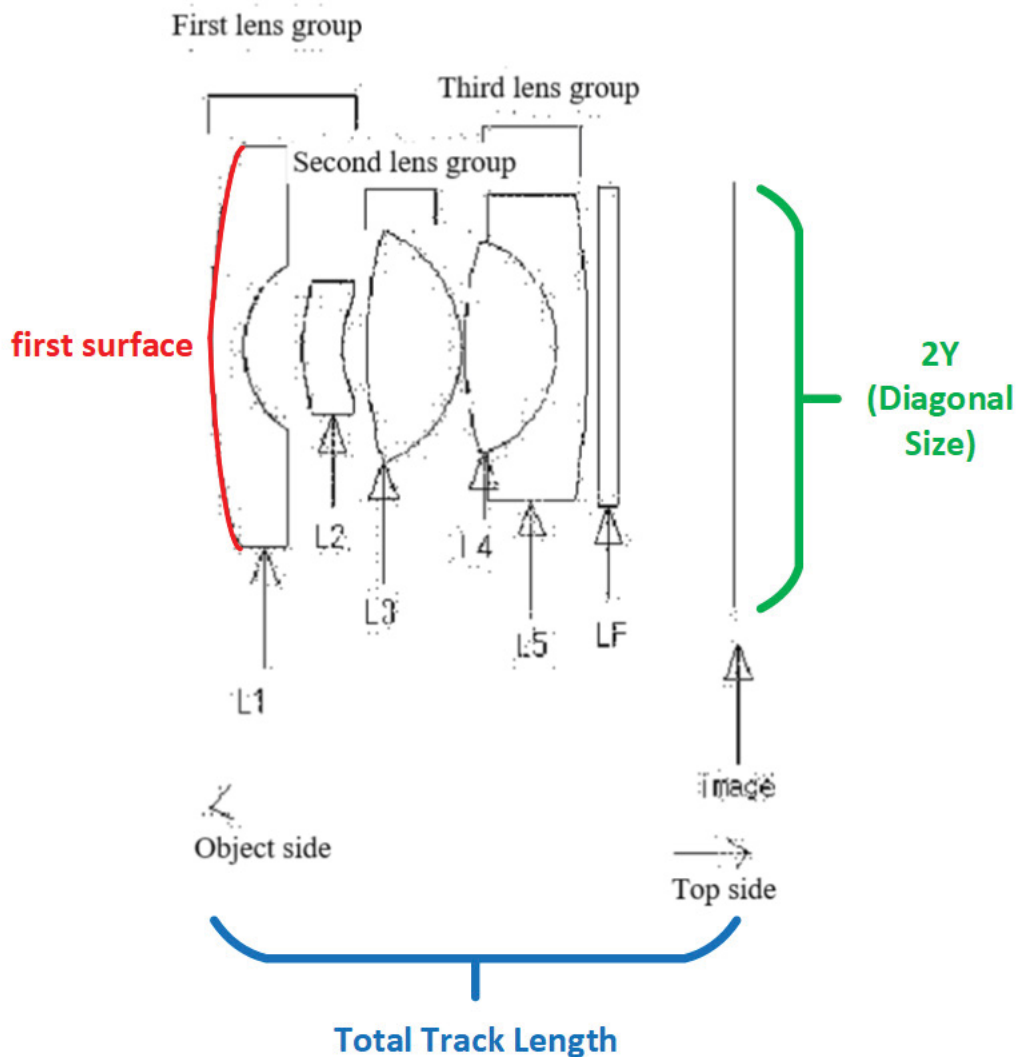
1. Overview of Kim (EX1006/EX1007)

Kim is a Korean patent titled “Compact Superwide Angle Optical System.” EX1007, 1. Like the ’120 Patent, Kim is directed to a “compact super-wide angle optical system.” EX1007, 1, Summary.

With reference to Diagram 1A (reproduced below), Kim discloses a “lens optical system” with a first lens group having lenses L1 and L2, a second lens group having lens L3, and a third lens group having lenses L4 and L5. *Id.*, 4-5, Diagram

1A. A filter, LF, is included after the fifth lens L5. *Id.*, 8, Diagram 1A. The optical system includes an image plane, labeled “image.” *Id.*, 5, Diagram 1A.

Diagram 1a



EX1009, Diagram 1A (annotated)

The lens of Diagram 1A has the specifications shown in Table 1 (below) under the “Example 1” column. *Id.*, 6 (Table 1). The angle of view, diagonal size (twice

the image height Y), and total track length TL are annotated in Figure 1 above.

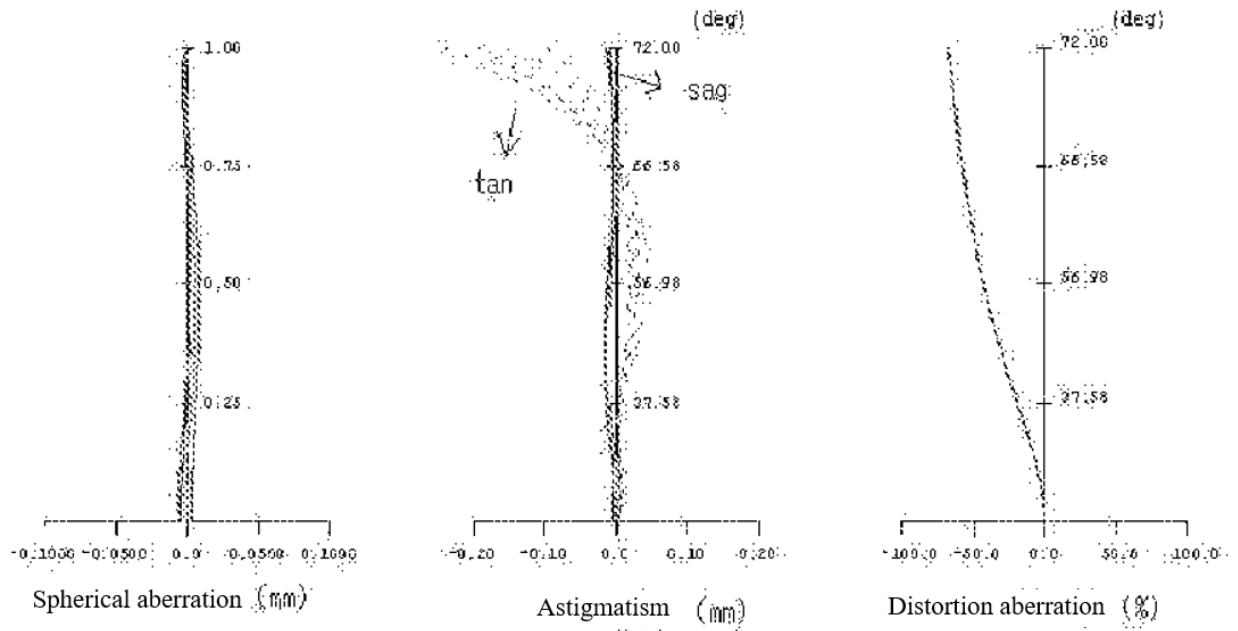
EX1003, ¶102. Kim explains that the examples shown in Table 1 “assume a lens system in which the image height Y value is 1 (in other words, the image diagonal size is 2).” EX1006, 6. “ $TTL/2Y$ is the total length of the lens divided by the diagonal size of the image, and represents information on the total length of the lens,” where “ TTL is the distance from the first surface of the lens to the image sensor, and $2Y$ is the diagonal size of the image sensor.” *Id.* Kim further states that “the values of $TTL/2Y$ related to the size of the optical system are all less than 2, and therefore, according to the embodiment of the invention, it can be shown that the optical electric field can be configured to be less than twice the diagonal size of the image sensor.” *Id.*

	Embodiment 1	Embodiment 2	Embodiment 3
FNO	1.7916	1.7916	1.8200
Angle of view	144	148	154
$TTL/2Y$	1.9189	1.9750	1.9415
Image height - Y	1	1	1
Total length of the lens	0.97760	0.97730	0.96280
ϕ_{12}/ϕ_t - Conditional Expression 1	0.62729	0.70657	0.61669
ϕ_3/ϕ_t - Conditional Expression 2	0.22170	0.15353	0.20317
$V4/V5$ - Conditional Expression 3	2.18726	2.18726	2.18726

EX1007, 6 (Table 1) (highlighted)

Diagram 1B (reproduced below) shows various graphs relating to the lens system shown in Diagram 1A. EX1007, 7, Diagram 1B.

Diagram 1b



EX1007, Diagram 1B

There are three lenses taught by Kim that prove that claims 1, 4, 5, and 7 of the '120 Patent are anticipated and/or obvious. However, for simplicity of explanation, the below analysis focuses primarily on the first embodiment, the detailed characteristics of which are included on page 6. EX1007, 6. As with Matsusaka, Dr. Kessler was able to model the lens based on these characteristics in a program called Zemax to evaluate various of its properties. See EX1003, ¶¶104-105.

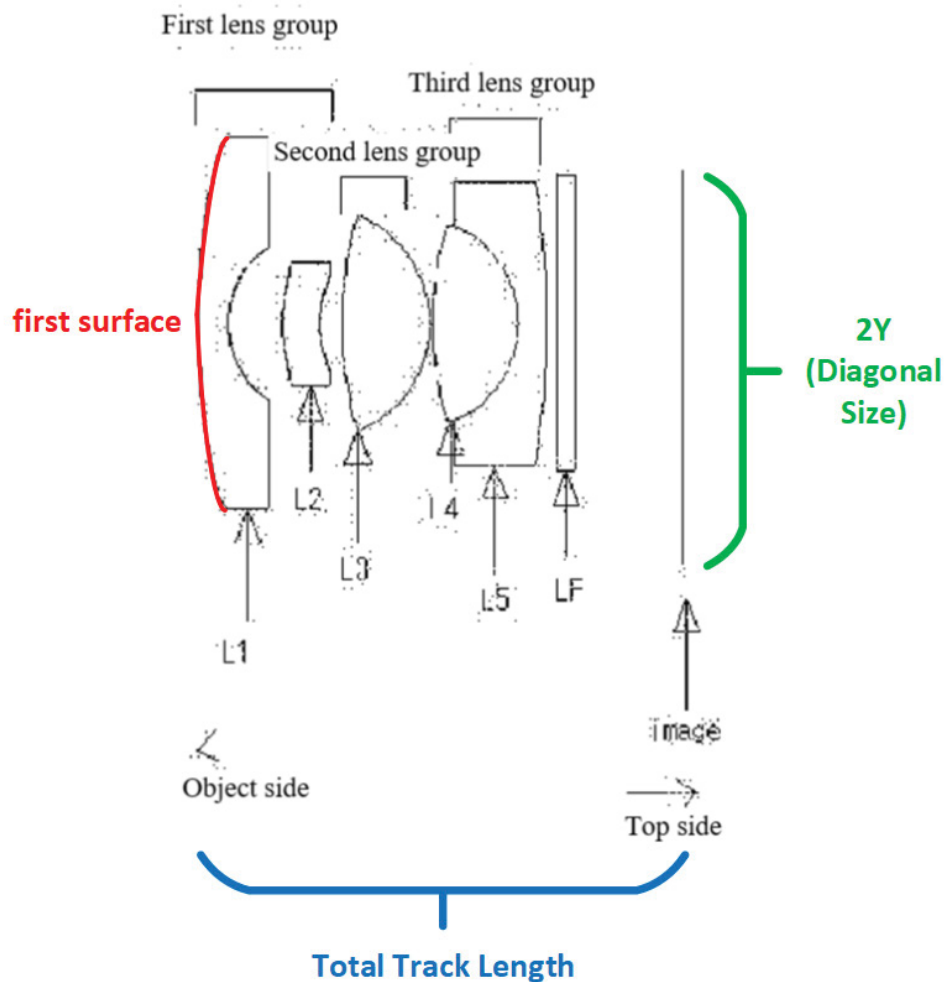
2. Analysis of the Claims

[1pre] A miniature wide-angle optical apparatus comprising:

To the extent the preamble is limiting, Kim discloses this element. EX1007, 4, 6; EX1003 ¶¶182-184. In particular, Kim discloses “compact superwide angle optical system[s].” EX1007, Summary. Diagram, 1A (reproduced below) is an example of Kim’s compact superwide optical system. *Id.*, 5, FIG. 1A. Kim describes that its “***superwide angle optical system*** that drastically improves the lens brightness and resolution performance compared to conventional methods and ***significantly reduces the overall size.***” EX1007, 4.

With respect to a “wide-angle lens,” the ’120 Patent states that “***any total field of view over 100°*** can be considered as a wide-angle lens according to the present invention.” EX1001, 4:38-44 (emphasis added); *see also* EX1002, 28. The lens shown in Diagram 1A of Kim is such a wide-angle lens. EX1003, ¶183. The lens system of Diagram 1A has an angle of view, or total field of view, of 144°, which is greater than 100°, so Kim discloses a wide-angle optical apparatus. EX1007, 6 (Table 1); EX1003, ¶183.

Diagram 1a



EX1007, Diagram 1a (annotated)

With respect to “miniature,” the ’120 patent states that “a miniature wide-angle imaging lens *has a miniaturization ratio*, of a total track length from the center of a first surface to a focal plane by an image circle diameter, *with a value less than 3.0.*” EX1001, Abstract, 1:26-30. As will be described in further detail with respect to limitation [1d], *infra*, Kim’s optical system has a miniaturization ratio that is

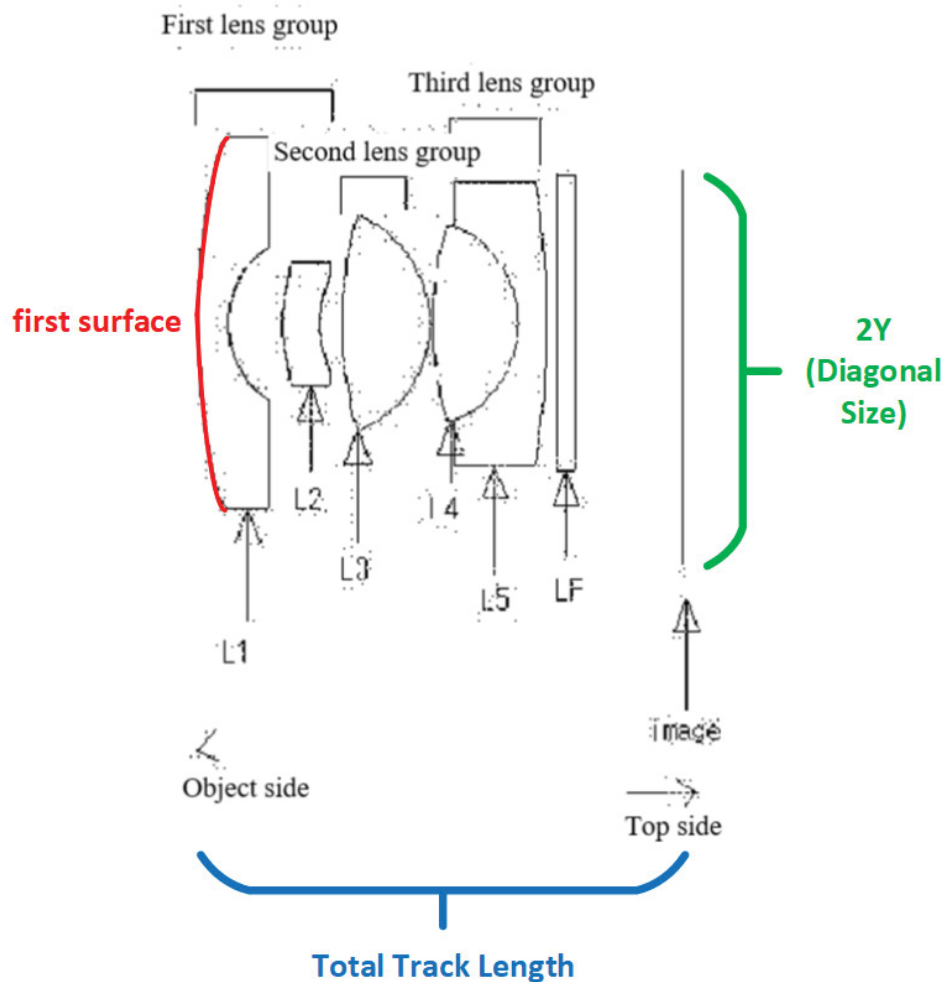
smaller than the threshold set in the '120 Patent, and is therefore “miniature,” as that term is used in the '120 Patent. EX1007, 6 (Table 1); EX1003, ¶184.

[1a] a light-receiving first surface;

Kim discloses this element. EX1007, Diagram 1A; EX1003 ¶¶185-186. Kim describes three examples of its compact superwide-angle optical system, each of which include a first lens group (from the object side) having a negative refractive power as a whole, second lens group having positive refractive power, an aperture provided between the first lens group and the second lens group, and third lens group having a positive refractive power as a whole. EX1007, 4-5; EX1003, ¶185.

In the first embodiment, illustrated in Diagram 1A, “the first lens group in front of the aperture has a strong negative refractive power, making it possible to construct a superwide angle system.” EX1007, 4. The first element L1 (from the left, object side) is “a meniscus-shaped lens having a convex object side . . . so as to be suitable for incident light in the superwide angle areas.” EX1007, 4. As illustrated below, includes a light-receiving first surface (highlighted red). EX1007, Diagram 1A; EX1003, ¶186.

Diagram 1a



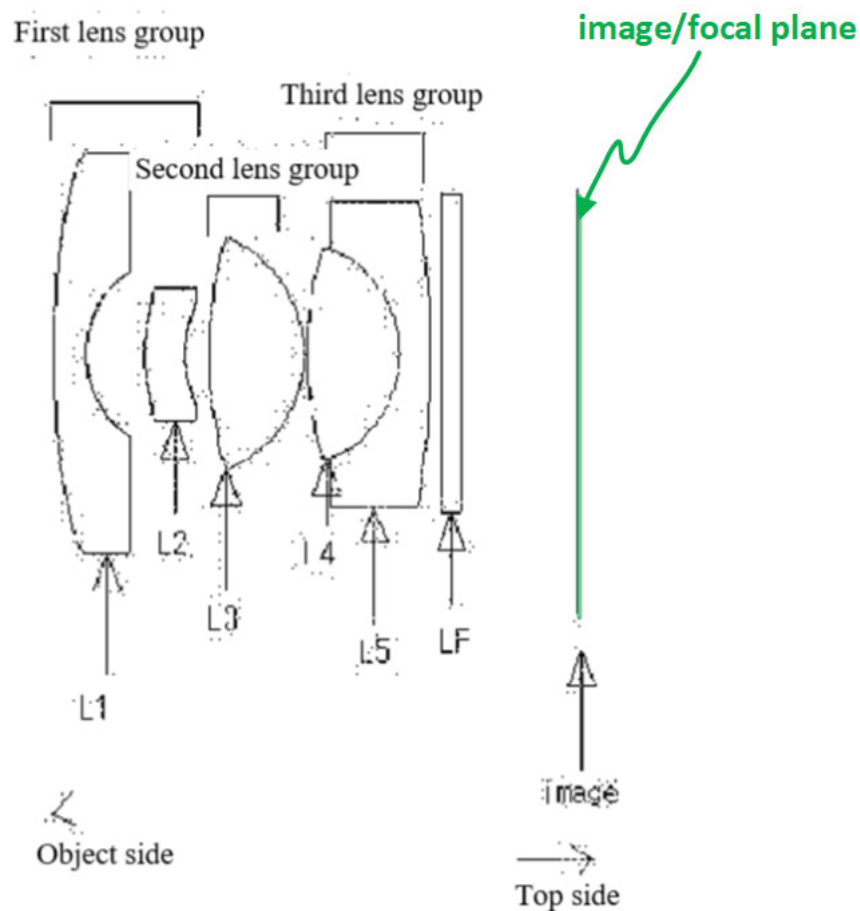
EX1009, FIG. 1A (highlighted).

[1b] a focal plane;

Kim discloses this element. EX1007, Diagram 1A; EX1003 ¶187. In particular, Diagram 1A of Kim shows a plane labeled “image” that is a focal plane. EX1007, 6, 8, Diagram 1A. Given that the total track length (TTL) is considered the distance “from the center of a first surface to a focal plane,” and Kim refers to the TTL as “the distance from the front surface of the lens to the image sensor,” a

POSITA would have understood that the image plane is where the image sensor is located and also the focal plane. EX1001, Abstract; EX1007, 6, 8; EX1003 ¶187. Indeed, Kim describes that “even if the total length of the optical system is shortened, a sufficient margin for the back focal length (the distance from the last lens surface to the image sensor) can be secured.” EX1007, 4. In other words, the image sensor is the point of focus. EX1003 ¶187.

Diagram 1a



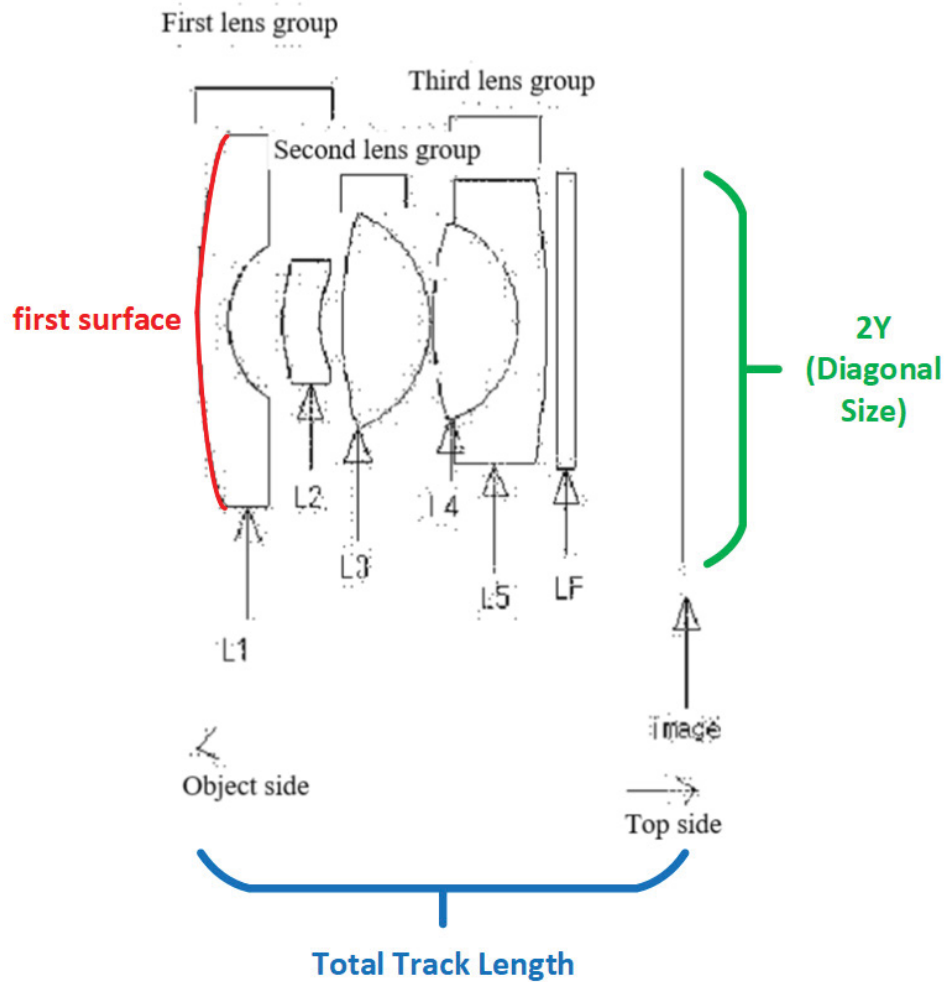
EX1007, Diagram 1A (annotated)

[1c] a total track length measured from a center of the first surface to the focal plane;

Kim discloses this element. EX1007, 6, Diagram 1A; EX1003 ¶¶188-189. In particular, Kim teaches that “TTL/2Y is the ***total length of the lens*** divided by the ***diagonal size of the image***, and represents information on the total length of the lens.” EX1007, 6. Kim further teaches that “TTL is the ***distance from the first surface of the lens to the image sensor***” *Id.*

Kim teaches that “[a]ll of the three embodiments shown in Table 1 assume a lens system in which the image height Y value is 1 (in other words, the image diagonal size is 2).” EX1007, 6. Kim further teaches that the lens of Diagram 1A has a TTL / 2Y of 1.9189, and since the value of Y (image height) is 1, the total track length is 1.9189 multiplied by 2, which is 3.8378. EX1007, 6 (referring to the TTL as the “total length of the lens” and “the distance from the first surface of the lens to the image sensor”) (Table 1); EX1003, ¶189. The TTL is shown below in Figure 1.

Diagram 1a



EX1007, Diagram 1a (annotated)

[1d] a miniaturization ratio with a value less than 3.0, the miniaturization ratio being a ratio of the total track length divided by an image circle diameter; and

Kim discloses this element. EX1009, 6 (Table 1); EX1003 ¶¶190-191. In particular, as discussed with respect to element [1c], the lens system of Diagram 1A has a total track length (TTL) / image circle diameter (2Y), of 1.9189. EX1007, 6. Kim describes that “2Y is the diagonal size of the image sensor.” EX1007, 6. A

POSITA would have understood that 2Y is the image circle diameter, because optical designers often design their systems such that the image sensor covers as much of the “image circle” created by the lens as possible. EX1003, ¶190. Thus, the miniaturization ratio of the lens system of FIG. 1A is 1.9189, which is less than 3.0. EX1003, ¶191.

	Embodiment 1	Embodiment 2	Embodiment 3
FNO	1.7916	1.7916	1.8200
Angle of view	144	148	154
TTL/2Y	1.9189	1.9750	1.9415
Image height - Y	1	1	1
Total length of the lens	0.97760	0.97730	0.96280
$\phi 12 / \phi t$ - Conditional Expression 1	0.62729	0.70657	0.61669
$\phi 3 / \phi t$ - Conditional Expression 2	0.22170	0.15353	0.20317
V4/V5 - Conditional Expression 3	2.18726	2.18726	2.18726

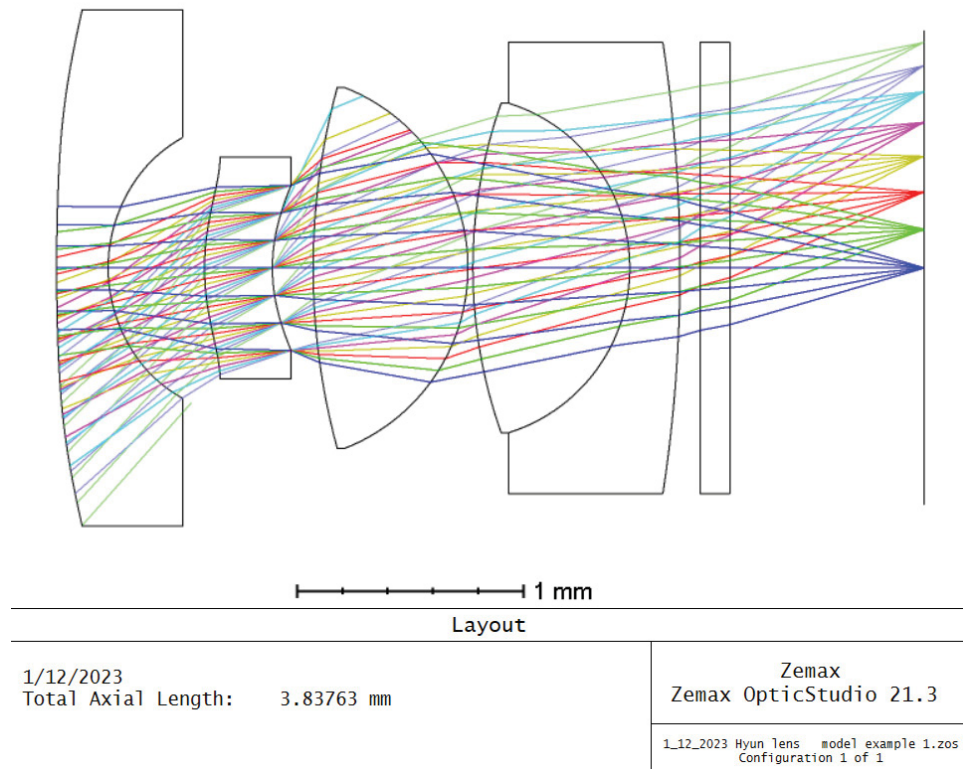
EX1007, 6 (Table 1).

[1e] a non-linear targeted resolution to intentionally create a zone in an image captured by the miniature wide-angle optical apparatus with a lower or higher object to image magnification compared to linear targeted resolution, the lower or higher object to image magnification being used to compensate, at least in part, for a lower image quality due to at least one of a drop of relative illumination or a drop of MTF in a zone of the image,

Kim discloses this element. EX1007, Diagrams 1A-1B; EX1003 ¶¶192-198.

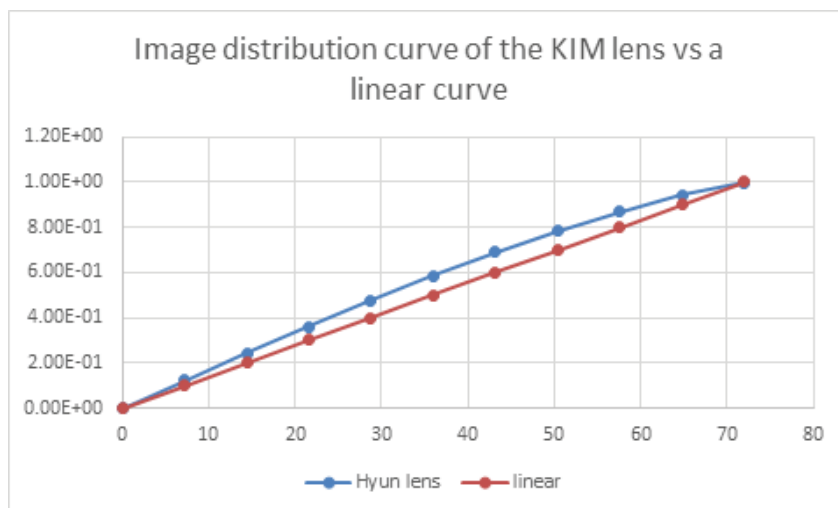
As described above, Dr. Kessler modeled the first embodiment illustrated in Diagram 1A in Zemax. EX1003, ¶192. By entering the values provided in the

detailed table of parameters for the first embodiment included on page 6 of Kim, Dr. Kessler was able to create the following model. EX1003, ¶192.



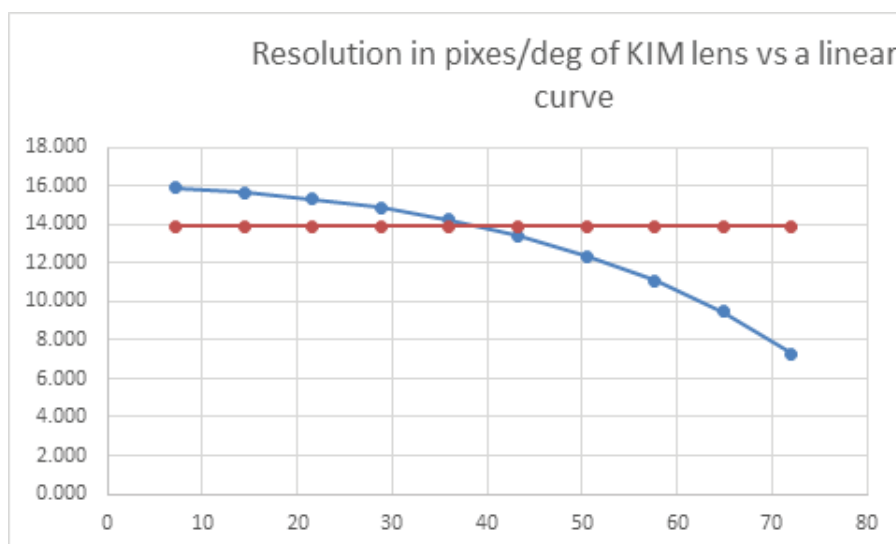
Zemax Model of Kim's First Embodiment

Zemax provides the image height at the sensor as a function of the field angle, also called the “image distribution curve” (reproduced below). EX1003, ¶193. Following is the image distribution curve corresponding to the model of Kim's first embodiment. *Id.*



As shown in this “image distribution curve,” there is deviation in the image height at the sensor compared to the red linear reference line. EX1003, ¶194. Where the slope of the blue image distribution curve differs from the slope of the orange linear reference line, there is a change of magnification such that these areas of deviation are “zone(s) in an image captured by the miniature wide-angle optical apparatus with a lower or higher object to image magnification compared to linear targeted resolution,” as claimed. *Id.*

From this data, a POSITA would have been able to derive the derivative of the image height and convert it to resolution in terms of pixels/degree (a plot of which is reproduced below). EX1003, ¶195. For a linear f-theta lens, the equivalent curve will just be a straight line as shown evenly spread over 70 degrees. *Id.*



Areas/zones where the blue curve are above the red curve are areas of increased magnification with respect to the linear targeted resolution, and areas/zones where the blue curve are below the red curve are areas of decreased magnification with respect to the linear targeted resolution. EX1003, ¶196.

Kim does not explicitly describe that these areas or zones of increased and decreased magnification with respect to the linear targeted resolution are “intentional.” EX1003, ¶197. Nonetheless, based on the teachings Kim and a POSITA’s ability to analyze the lens examples using an optical CAD such as Zemax, it would have been obvious to a POSITA to intentionally utilize the areas or zones of increased and decreased magnification, depending on the relevant use case. *Id.* For example, Kim describes that its “superwide angle optical system ha[s] an angle of view of about 140 to 160 degrees is used in surveillance cameras *for vehicles*.” EX1007, 3. Based on the teachings of Kim and their own knowledge of the art, a

POSITA would have recognized that there may be areas or zones of the image that are more important for a user of such a vehicle-mounted camera (e.g., the portion of the image where obstacles are often present), and that these areas or zones may benefit from increased magnification, while other areas or zones are not as important and may have decreased magnification. EX1003, ¶197. Indeed, Kim describes that its goal is to “provide a superwide angle optical system that *drastically improves the lens brightness and resolution performance* compared to conventional methods.” EX1007, 4.

As described in Section III.A, the “used to compensate” language of this limitation should not be given patentable weight. Yet, even if it was, Kim teaches or at least renders obvious that claim language based on the fact that Kim’s lens includes the claimed “zones.” EX1003 ¶198. The ’120 Patent describes that the “downward curve between maximum value 712 and position 714 allows the lens system to have a higher relative illumination value toward the edge of the field of view by having a lower object to image magnification ratio in that region and hence redirecting the same quantity of light from an object to a smaller region in the image with more illumination.” EX1001, 6:36-41. The resolution curve of Kim’s first embodiment has a downward slope, and would therefore have the same impact on relative illumination as described in the ’120 Patent. EX1003, ¶198.

[1f] an opening angle of light entering the optical apparatus being over 100°.

Kim discloses this element. EX1007, 6 (Table 1); EX1003 ¶199. In particular, as discussed with respect to element [1pre], the lens system of Diagram 1A has an angle of view, or total field of view, of 144°, which is greater than 100°. EX1007, 6 (Table 1).

[4] The miniature wide-angle optical apparatus of claim 1, wherein an angle of chief-rays reaching the focal plane is over 20° from an optical axis of the optical apparatus.

Kim discloses this element or at least renders it obvious. EX1007, Diagram 1A, p. 6; EX1003 ¶¶201-205.

The '120 Patent provides two definitions for the “chief ray.” EX1001 4:3-5, 4:54-59. The first definition of “chief ray” is “the middle ray of the three rays drawn because it passes through the center of the aperture stop 124.” EX1001 4:3-5. The second definition “chief ray” is the center of the cone of light reaching the image sensor at the max image height (positions 140 and 144 on Fig. 1). EX1001 4:54-59. The two definitions coincide for systems where there is no vignetting. EX1003, ¶202. Vignetting is intentionally cutting rays at the periphery of the aperture for large field angles, and is a known and useful way of improving image quality at large field angles. *Id.* The center of the cone of light no longer goes through the center of the aperture stop. *Id.* In these situation the CRA is center of the cone of light reaching the edge of the sensor, but the ray going through the center of the iris stop

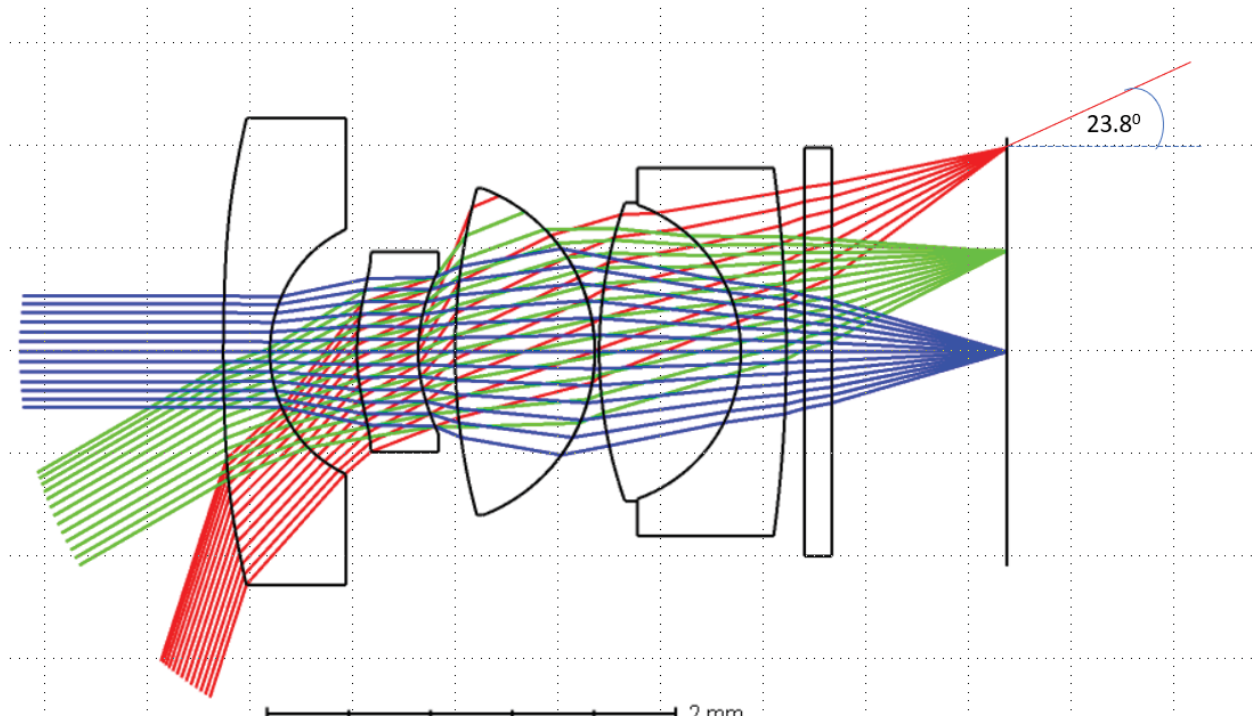
is no longer at the center of the cone, and if vignetting is cutting half of the unvignetted beam it may not even reach the sensor. *Id.*

Kim is using vignetting in his design as shown on his first embodiment reproduced below. EX1003, ¶203.

surface #		R value	D value	N d	V d		aperture
	Sphere	infinity	infinity			Refract	
1	Asphere	6.94734	0.22838	1.48749	70.41	Refract	
2	Asphere	0.65740	0.42632			Refract	0.57765
3	Asphere	1.02110	0.30019	1.75520	27.58	Refract	
STOP	Asphere	0.75068	0.18040			Refract	
5	Sphere	3.04316	0.68443	1.66545	52.89	Refract	
6	Sphere	-0.85763	0.02222			Refract	0.59987
7	Sphere	2.18749	0.69376	1.62041	60.32	Refract	
8	Sphere	-0.76481	0.22217	1.75520	27.58	Refract	
9	Sphere	-6.64485	0.08887			Refract	
10	Sphere	infinity	0.13330	1.48749	70.41	Refract	
11	Sphere	infinity	0.00000			Refract	
12	Sphere	infinity	0.85781			Refract	
image	Sphere	infinity	0.00000			Refract	1

EX1007, 6.

The vignetting apertures on surfaces 2 and 6 are highlighted. With this vignetting in place, Zemax demonstrates that the beams through the lens for three field positions. EX1003, ¶204. Specifically, Zemax provides the following cone angle directions corresponding to Dr. Kessler's model of Kim's first embodiment illustrated in FIG. 1A. *Id.*

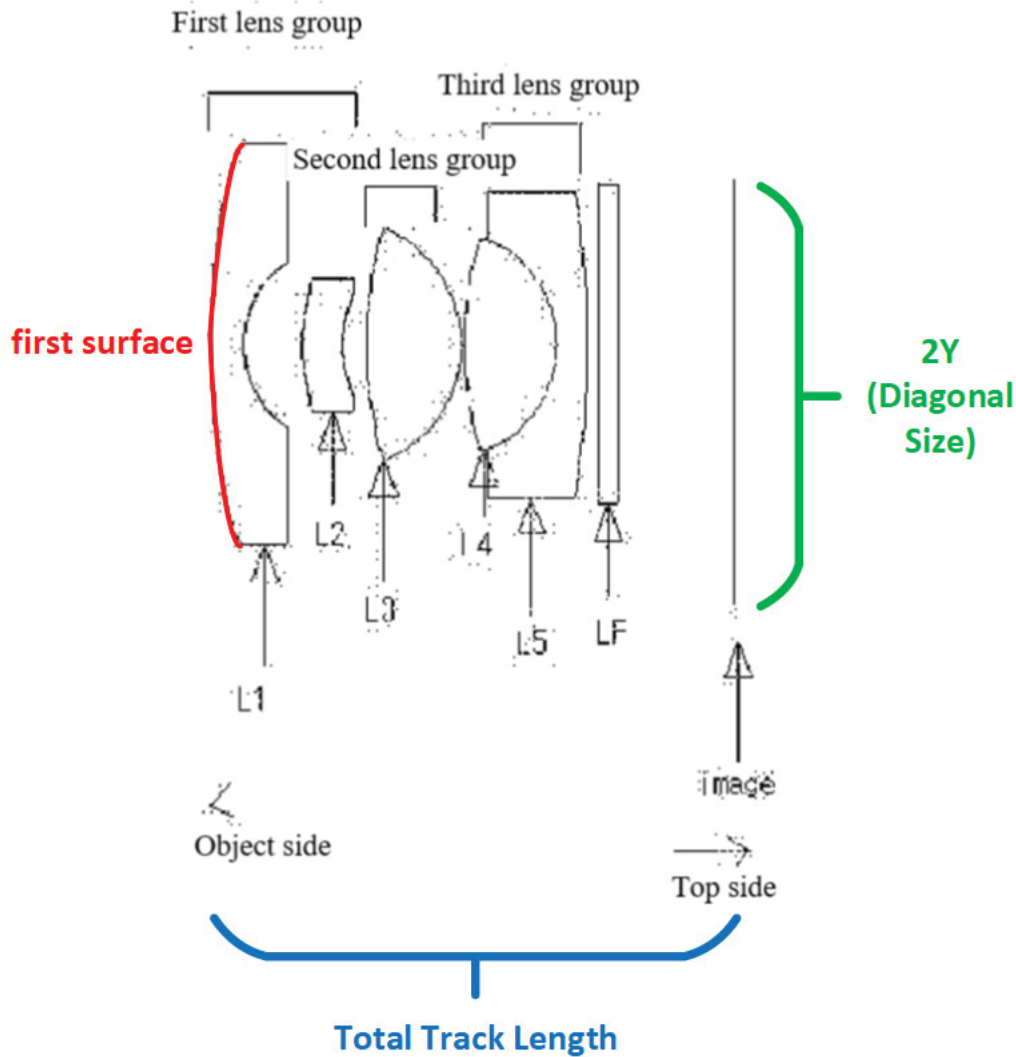


The chief ray angle, the center of the red cone of light is at 23.4 degrees at the sensor, which is larger than 20 degrees in claim 4. EX1003, ¶205.

[5] The miniature wide-angle optical apparatus of claim 1, further comprising a plurality of optical elements, at least one of the plurality of optical elements defining the first surface.

Kim discloses claim 5. EX1007, 7, Diagram 1A; EX1003 ¶207. As shown in Figure 1A, the lens has a plurality of optical elements (e.g., lenses L1-L5), where the first element on the object side, 1 (at left), defines the first surface (highlighted red). *Id.*

Diagram 1a



EX1007, Diagram 1A (annotated)

[7] The miniature wide-angle optical apparatus of claim 1, wherein the miniaturization ratio value is less than 2.0.

Kim discloses claim 7. EX1007, 6 (Table 1); EX1003 ¶209. As discussed with respect to element [1d], the lens system of Diagram 1A has a miniaturization

ratio, total track length (TTL) / image circle diameter (2Y), of 1.9189, which is less than 2.0. EX1007, 6 (Table 1).

**V. DISCRETIONARY DENIAL IS NEITHER APPROPRIATE
NOR EQUITABLE**

Patent Owner (“ImmerVision”) filed an infringement action against Apple involving the ’120 Patent. *See* EX1008. The action, assigned Case No. 1:21-cv-01570 (“the Related Litigation”), is concurrently pending in the District of Delaware.

Pursuant to the Interim Procedure For Discretionary Denials In AIA Post-Grant Proceedings (EX1020), the “PTAB will not rely on *Fintiv* factors to discretionarily deny institution in view of parallel district court litigation where a petition presents compelling evidence of unpatentability.” EX1020, 2. As explained above (*see* §§IV.A-D *supra*), this Petition and Dr. Kessler’s accompanying declaration present compelling evidence of unpatentability of the Challenged Claims. Accordingly, the *Fintiv* factors do not support discretionary denial of institution based on the co-pending district court actions. Even if the *Fintiv* factors were considered, these factors weigh against discretionary denial.

A. Factor 1: Institution Will Increase Likelihood of Stay

Each companion litigation is at an early stage. Petitioner served preliminary invalidity contentions a little over a month ago, and claim construction issues are still being identified and have yet to be briefed. EX1022, 19-20. Moreover,

institution would enable the Board to resolve invalidity issues, and an invalidity finding would advance judicial efficiency by freeing the district court from having to conduct trial on the '120 Patent. Accordingly, Petitioner will move to stay the district court cases, upon institution.

The proceedings' relatively early stage and the potential for simplification of issues increases the likelihood that the district court will grant a stay based on IPR institution. *See 454 Life Sciences Corp. v. Ion Torrent Systems, Inc., et al.*, C.A. No. 15-595-LPS, 5-11 (D. Del. Nov. 7, 2016) (Judge Stark). Stay of the litigations pending the final written decision ("FWD") weighs strongly in favor of institution.

B. Factor 2: The Final Written Decision will Issue Before Any Foreseeable Trial

Trial is currently scheduled for October 2024. EX1022, 19-20. Based on the 18-month IPR schedule, a FWD in an IPR arising from this Petition would issue as early as July or August 2024, which would be at least two months before any potentially foreseeable court trial date. Thus, *Fintiv* factor two favors institution.

C. Factor 3: Early Stage of Parallel Proceedings

As noted above, each litigation is in an early stage, with the vast majority of work relating to invalidity (e.g., preparing expert reports, preparing final invalidity contentions, discovery relating to third party prior art references and systems) yet to come. Beyond the exchange of prior art references associated with Apple's invalidity contentions, substantive discovery related to invalidity has not begun, and

claim construction issues have not yet been briefed; these facts weigh strongly in favor of institution.

D. Factor 4: Under the Current Trial Schedule, No Overlap is Possible

As noted above, based on the 18-month IPR schedule, a FWD in an IPR arising from this Petition would issue as early as July or August 2024, which would be at least two months before any potentially foreseeable court trial date. Because a FWD will issue before the trial date, the estoppel that would attach from the FWD pursuant 35 U.S.C. § 315(e) would prevent grounds that were raised or reasonably could have been raised in this IPR to be raised in the trial. Thus, under the current schedule, there is no possibility for overlap between the IPR and the related litigation.

E. Factor 5: Apple’s involvement in Parallel Proceedings

With respect to Factor 5, the *Fintiv* decision “says nothing about situations in which the Petitioner is the same as, or is related to, the district court defendant.” *Cisco Systems, Inc. v. Ramot at Tel Aviv University Ltd.*, IPR2020-00122, Paper 15, 10 (May 15, 2020) (“the factor is neutral.”).

F. Factor 6: Other Circumstances Support Institution

As evidenced from the above analysis (*see supra* §IV), Apple’s patentability challenge is unusually strong, which favors institution regardless of the other factors. IPR2020- 00156, Paper 10, 20–21.

VI. CONCLUSION

Accordingly, Petitioner respectfully requests institution of an IPR for those claims of the '120 Patent for each of the grounds presented herein.

VII. PAYMENT OF FEES – 37 C.F.R. § 42.103

Apple authorizes the Patent and Trademark Office to charge Deposit Account No. 06-1050 for the fee set in 37 C.F.R. § 42.15(a) for this Petition and further authorizes payment for any additional fees to be charged to this Deposit Account.

VIII. MANDATORY NOTICES UNDER 37 C.F.R § 42.8(a)(1)

Real Party-In-Interest Under 37 C.F.R. § 42.8(b)(1)

Apple Inc. is the real party-in-interest.

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

The '120 Patent is involved in the following litigation: *ImmerVision, Inc. v. Apple, Inc.*, D. Del. 1-21-cv-01570. Petitioner is not aware of any disclaimers, reexamination certificates or petitions for *inter partes* review for the '120 Patent.

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

Apple provides the following designation of counsel.

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Service Information

Please address correspondence/service to the above-listed address.

Petitioner consents to email service at IPR50095-0115IP1@fr.com.

Respectfully submitted,

Dated: January 18, 2023

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CERTIFICATION UNDER 37 CFR § 42.24

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for *Inter partes* Review totals 13,994 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated: January 18, 2023

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CERTIFICATE OF SERVICE

Pursuant to 37 CFR §§ 42.6(e)(4)(i) *et seq.* and 42.105(b), the undersigned certifies that on January 18, 2023, a complete and entire copy of this Petition for *Inter partes* Review and all supporting exhibits were provided via Federal Express, to the Patent Owner, by serving the correspondence address of record as follows:

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