

Apple Inc. (Petitioner)
v.
ImmerVision, Inc. (Patent Owner)

Petitioner's Demonstratives

Case No. IPR2023-00472
U.S. Patent No. 10,795,120

Before Hon. Kristina M. Kalan, John D. Hamann, Stephen E. Belisle
Administrative Patent Judges

FISH.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

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Appendix



Background of Independent Claim 1 of the '120 Patent

'120 Patent: Challenged Indep. Claim 1

1. A miniature wide-angle optical apparatus comprising:
a light-receiving first surface;
a focal plane;
a total track length measured from a center of the first surface to the focal plane;
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
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, an opening angle of light entering the optical apparatus being over 100°.

'120 Patent: Challenged Indep. Claim 1

1. A miniature wide-angle optical apparatus comprising:
a light-receiving first surface;
a focal plane;
a total track length measured from a center of the first surface to the focal plane;
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
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, an opening angle of light entering the optical apparatus being over 100°.

'120 Patent: Claim Constructions

Claim Term	Petitioner Construction	Patent Owner Construction
“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”	If given patentable weight, satisfied if either of the relevant feature of FIG. 6 (“zone . . . with a higher object to image magnification” aligned with a drop in relative illumination or MTF) or FIG. 7 (“a downward curve between the maximum 712 and a region near the edge of the field of view around position 714”) is present in resolution curve	Satisfied only if the relevant feature of FIG. 6 (“zone . . . with a higher object to image magnification” aligned with a drop in relative illumination or MTF) is present in resolution curve

Ground 1

Thibault Renders Claim 1 Obvious Under
Either Construction of the “Compensate”
Limitation Based on Evidence Presented in the
Petition

'120 Patent Inventors Published "Thibault" Reference One Year and Six Days Before Priority Date

Design, fabrication and test of miniature plastic panomorph lenses with 180° field of view

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^bImmerVision, 2020 University, Suite 2320, Montréal, QC, Canada, H3A 2A5

Ex. 1004 (Thibault), 2;
Paper 2 (Petition), 13

(12) United States Patent Parent et al.

(10) Patent No.: **US 10,795,120 B2**
(45) Date of Patent: **Oct. 6, 2020**

(54) MINIATURE WIDE-ANGLE IMAGING LENS
(71) Applicant: **6115187 Canada, Inc.**, Montreal (CA)

(72) Inventors: **Jocelyn Parent**, Montreal (CA); **Simon Thibault**, Quebec (CA); **Patrice Roulet**, Montreal (CA); **Hu Zhang**, Montreal (CA); **Pascal Nini**, Montreal (CA); **Pierre Konen**, Saint-Bruno (CA)

(73) Assignee: **ImmerVision, Inc.**, Montreal, Quebec (CA)

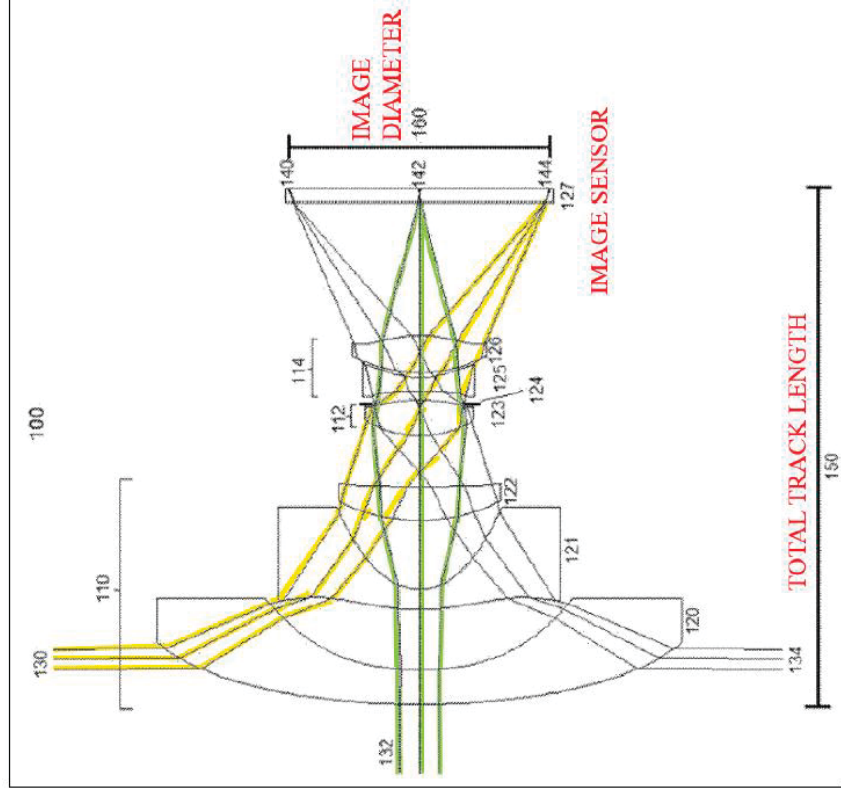
(52) U.S. Cl.
CPC **G02B 13/001** (2013.01); **G02B 5/005** (2013.01); **G02B 5/208** (2013.01); **G02B 9/62** (2013.01); **G02B 9/64** (2013.01); **G02B 13/0045** (2013.01); **G02B 13/06** (2013.01)

(58) Field of Classification Search
CPC **G02B 13/001**; **G02B 5/005**; **G02B 5/208**; **G02B 9/64**
See application file for complete search history.

(56) References Cited
U.S. PATENT DOCUMENTS
Ex. 1001 ('120 Patent), 1;
Paper 2 (Petition), 13

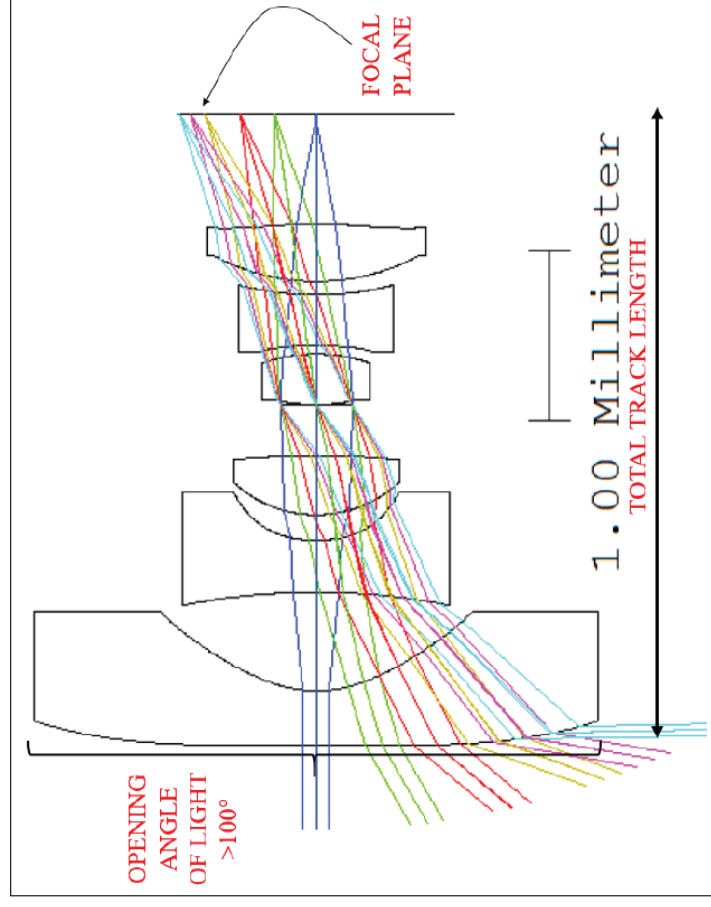
'120 Patent and Thibault Lenses Share All Claimed Features

'120 Patent's Lens



EX1001, FIG. 1 (highlighted; annotated)

Thibault's Lens



EX1004, FIG. 5 (annotated)

Issue 1A

Thibault Renders Claim 1 Obvious Under
Patent Owner's Narrow Construction

POR's Only Argument Is Petition Did Not "Identify The Magnification Zones"

From POR

41; Ex. 2004 at ¶¶ [0076]-[0077]. Since Petitioner does not even bother to identify the magnification zones, it has not demonstrated how such zones correlate to any portion of the relative illumination curve illustrated in Thibault's Fig. 7. Ex. 2001 at ¶¶ 79, 92. Petitioner and Dr. Kessler simply offer no evidence in this regard.

Paper 10 (POR), 27

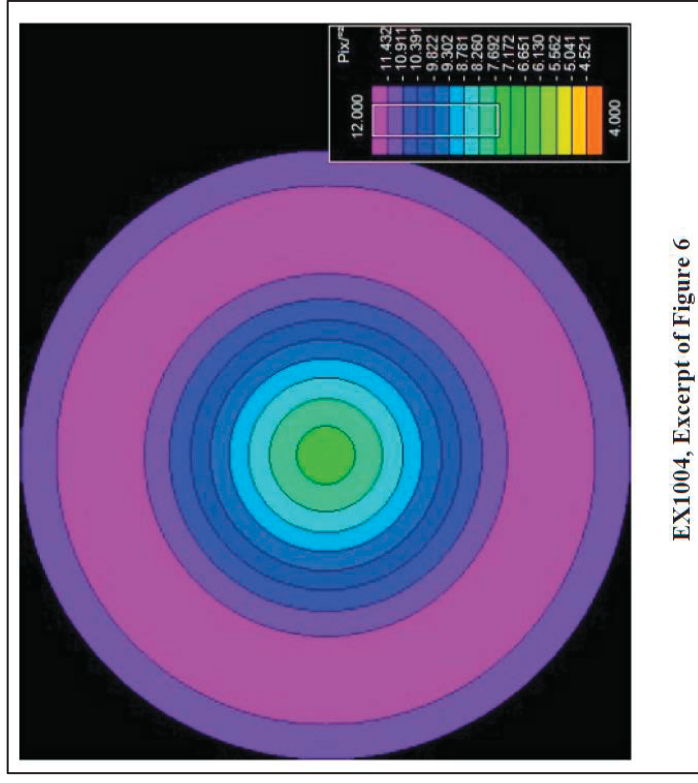
Petition Identified Thibault's Disclosure of Claimed "zone...with a lower or higher object to image magnification"

From Petition

2. Analysis of the Claims

[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 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.



Paper 2 (Petition), 26-27

Petition Identified Thibault's Disclosure of Claimed "zone...with a lower or higher object to image magnification"

2. Analysis of the Claims

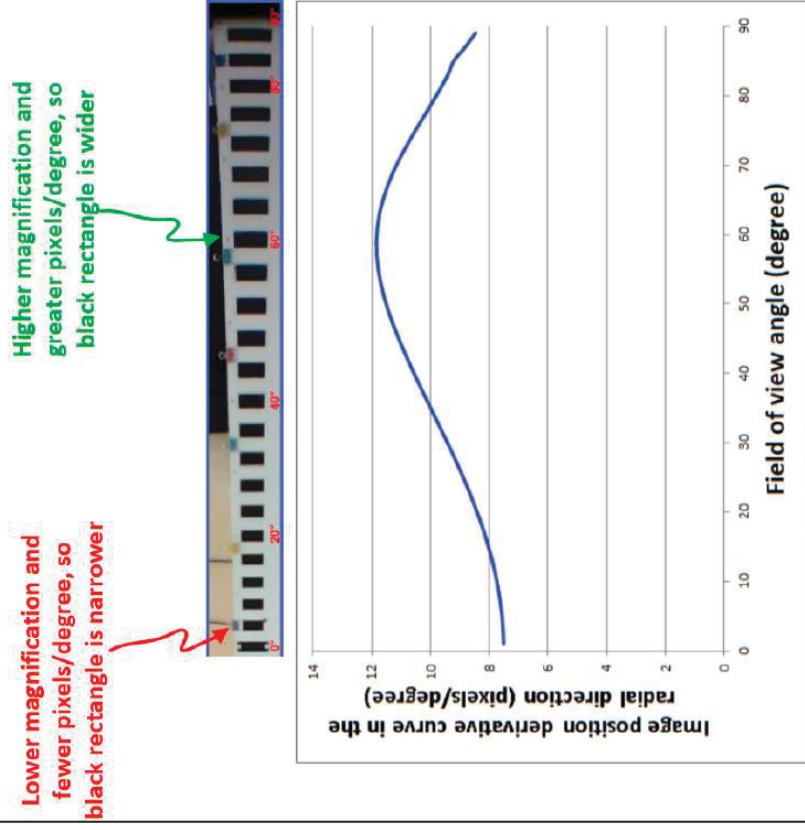
[1e] a non-linear targeted resolution to intentionally create a zone in an image captured by the miniature wide-angle optical apparatus with a lower or higher object to image magnification compared to linear targeted resolution, the lower or higher object to image magnification being used to compensate, 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,

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.

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.

From Petition

(Red and Green Annotations in Petition)



EX1004, Annotated Excerpts of FIGS. 11 and 6

Petition Identified Thibault's Disclosure of Claimed "zone...with a lower or higher object to image magnification"

From Petition

B. Ground 1 (Claims 1-7)

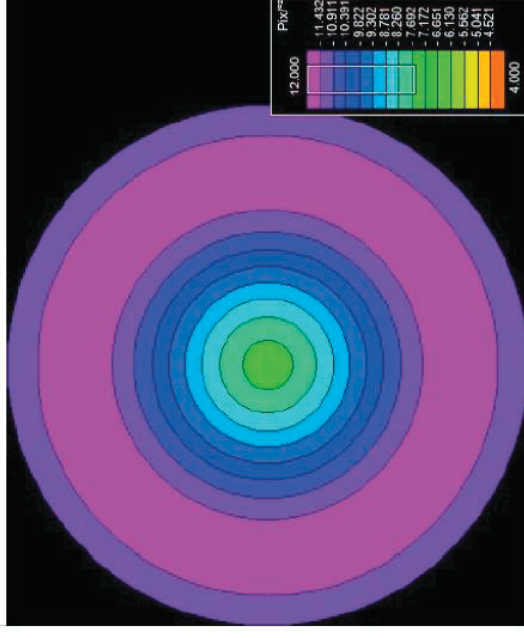
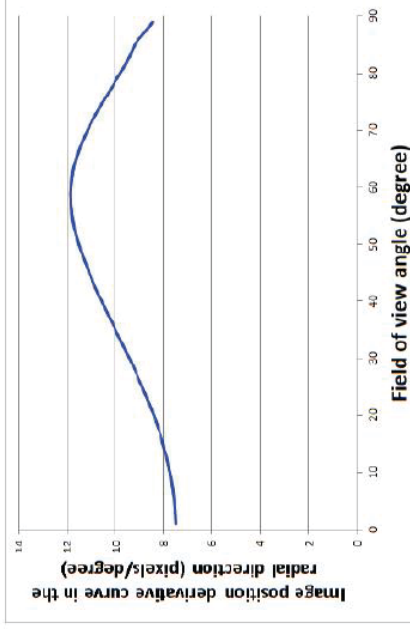
1. Overview of Thibault (EX1004)³

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.*

Paper 2 (Petition), 16-17



EX1004, FIG. 6

Patent Owner Argues That Proper Identification of the Claimed “Zone” Required Insertion of A Horizontal Line by Dr. Kessler to Thibault’s Fig. 6

From POR

exact image height and pixel size. Ex. 1004 at 6; Ex. 2001 at ¶¶ 56, 82. Dr.

Kessler would have only needed to place the line at the appropriate height on

Thibault’s Fig. 6 to identify the low and high resolution zones. Ex. 2001 at ¶ 82.

But Dr. Kessler omitted this analysis and provides *no* evidence regarding a location of any particular magnification zone in Thibault with respect to Thibault’s relative illumination curve. *Id.*

Paper 10 (POR), 26

In Reply, Dr. Kessler Explains How Petition's Identification Aligns With Claimed "zone...with a lower or higher object to image magnification" and Horizontal Line

From Petition

87. The top graph of Figure 6 shows the image position derivative curve in the radial direction (pixels/degree), and the bottom image shows the surfacic resolution² over the full circular panomorph image. *Id.*, 7. In Figure 6, the zone shown in magenta has the highest number of pixels per degree associated with it. 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.*

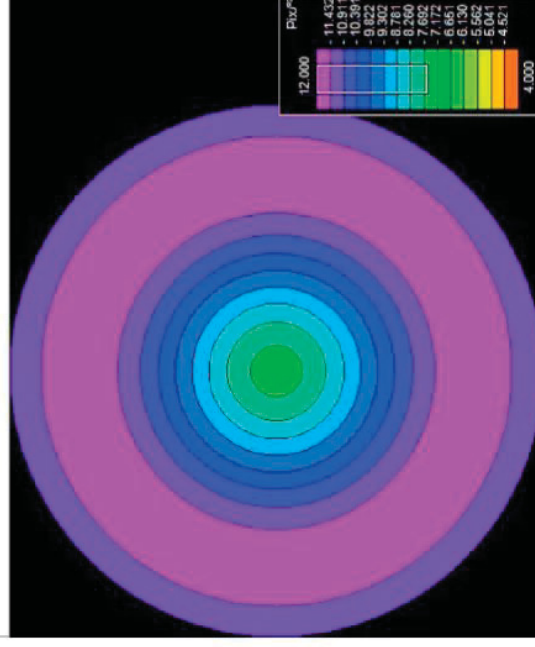
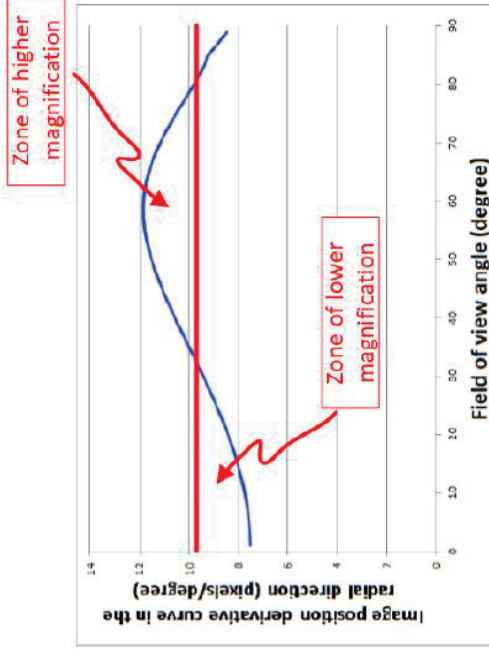
EX1004, 7, FIG. 6. As shown in the resolution graph, the lens design has non-linear targeted resolution such that some zones have higher resolution (e.g., purple and magenta zones) and other zones have a lower resolution (e.g., green and cyan zones).

Id., FIG. 6.

Ex. 1003 (Kessler Orig. Decl.), ¶ 87;
Paper 2 (Petition), 17

From Reply

24. As shown above, applying Dr. Lebby's horizontal line method to the image position derivative curve shown at the top of FIG. 6 confirms that the magenta zone that I identified in my original declaration corresponds to a zone of higher magnification. See EX1003, ¶87. Thus, even under Dr. Lebby's alternative

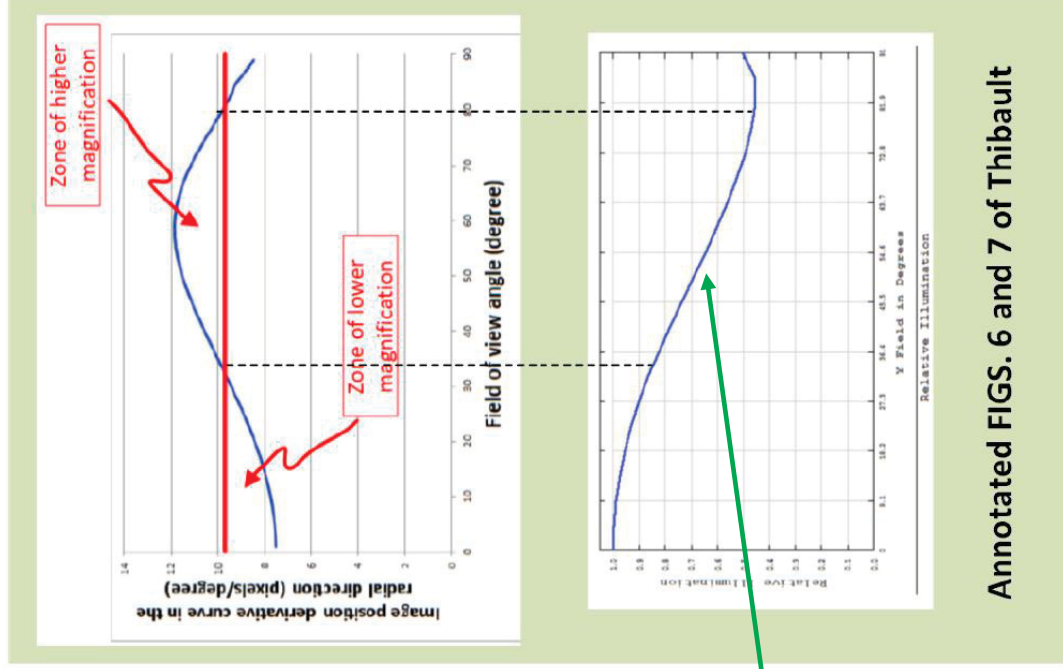


Annotated FIG. 6 of EX1004

Ex. 1023 (Kessler Supp. Decl.), ¶ 24
Paper 13 (Pet. Reply), 14-15

Thibault Shows a Drop In Relative Illumination Corresponding to the Claimed “zone...with a lower or higher object to image magnification”

Thibault

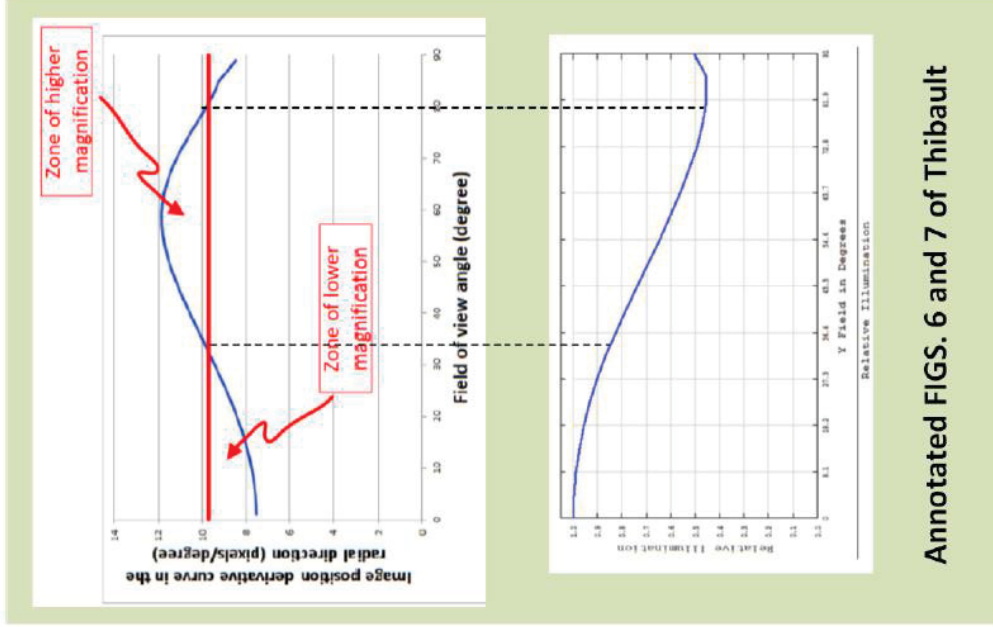


A Drop Of Relative Illumination In a Zone of the Image
(Ex. 1023, ¶¶ 25-26)

Annotated FIGS. 6 and 7 of Thibault

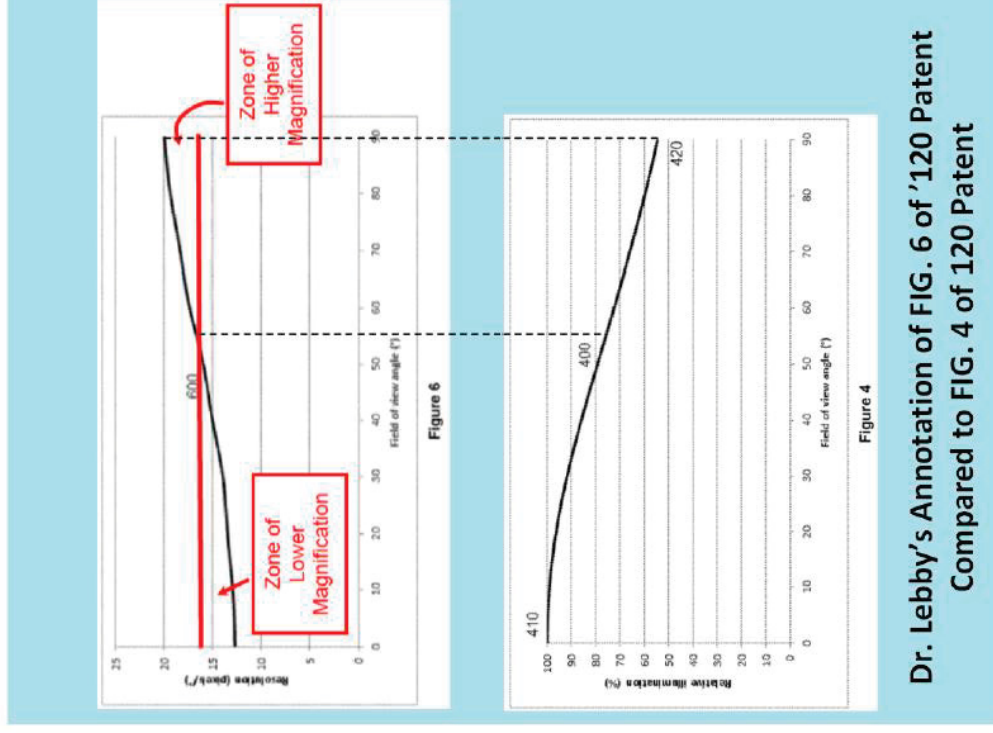
Thibault Shows a Drop In Relative Illumination Corresponding to the Claimed “zone...with a lower or higher object to image magnification”

Thibault



Annotated FIGS. 6 and 7 of Thibault

'120 Patent



Dr. Leiby's Annotation of FIG. 6 of '120 Patent Compared to FIG. 4 of 120 Patent

Sur-Reply's New, Unsupported Argument That Claimed Zone Must Be "Worst Relative Illumination"

From Sur-Reply

the edge of the field of view. Reply at 16. Leaving aside whether Dr. Kessler's belated demarcation of zones is accurate, the comparison with the relative illumination curve shows a misalignment. Specifically, the worst relative illumination area of Thibault's lens occurs between about 80-85° in the field of view. *Id.*; Ex. 1023 at ¶ 25; Ex. 2001 at ¶ 70; POR at 11-12. This *coincides with a low magnification zone* as shown in Dr. Kessler's annotated Thibault resolution plot. Reply at 16; Ex. 1023 at ¶ 25.

Paper 15 (PO Sur-Reply), 15

Claim Requires the “lower or higher object to image magnification” to Compensate For “a drop relative illumination,” Which Thibault Does

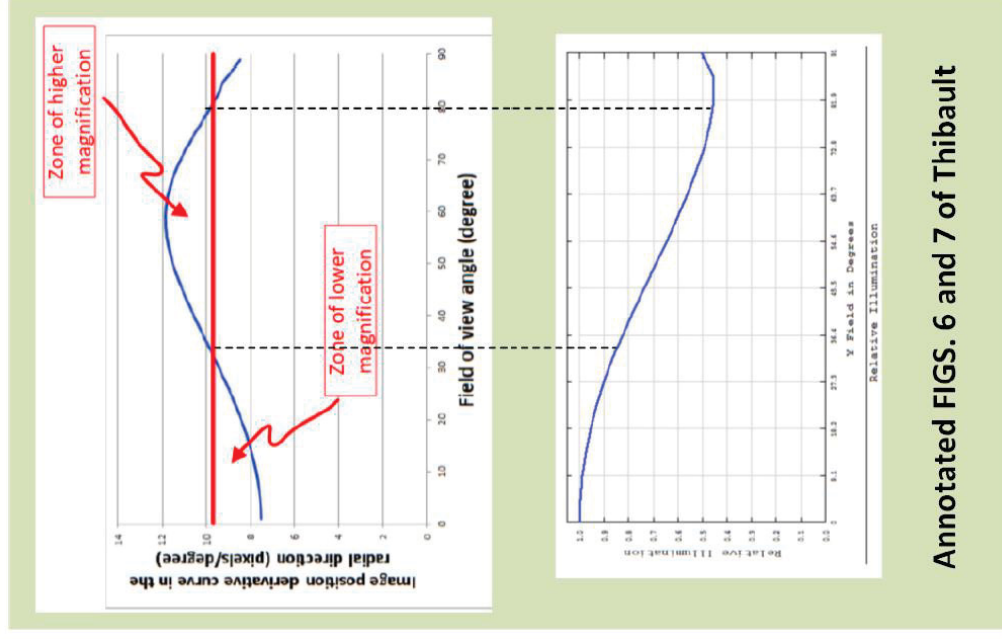
Claim Language

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,

Sur-Reply

69; Ex. 2005 at 3:43-4:10; POR at 11. Accordingly, Petitioner has not adequately demonstrated that Thibault teaches or suggests the claimed correlation between magnification and compensating for a lower image quality due to a drop in relative illumination.

Paper 14 (PO Sur-Reply), 16



Annotated FIGS. 6 and 7 of Thibault

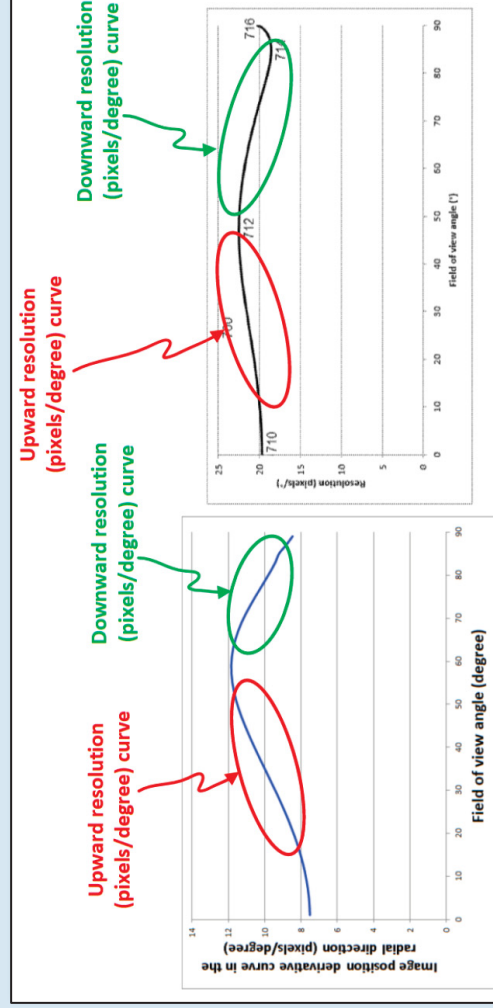
Paper 13 (Pet. Reply), 16-17

Issue 1B

Thibault Renders Claim 1 Obvious Under
Petitioner's Construction

Undisputed that Thibault Discloses FIG. 7's "Downward Curve" and "Higher Relative Illumination"

From Kessler Original Decl.



EX1004, Annotated Figure 6

EX1001, Annotated FIG. 7

for the claimed optical apparatus. However, to the extent that the final clause of this limitation is considered further limiting, 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. The '120 Patent

Ex. 1003 (Kessler Orig. Decl.), ¶ 123;
Paper 2 (Petition), 30-31

Undisputed that Thibault Discloses FIG. 7's "Downward Curve" and "Higher Relative Illumination"

From Kessler Original Decl.

for the claimed optical apparatus. However, to the extent that the final clause of this limitation is considered further limiting, 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. The '120 Patent

Ex. 1003 (Kessler Orig. Decl.), ¶ 123;
Paper 2 (Petition), 30-31

'120 Patent

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.

Ex. 1001 ('120 Patent), 6:28-41;
Paper 2 (Petition), 30-31

'120 Patent Teaches Relevant Feature of FIG. 7 Is Downward Slope After Absolute Maximum

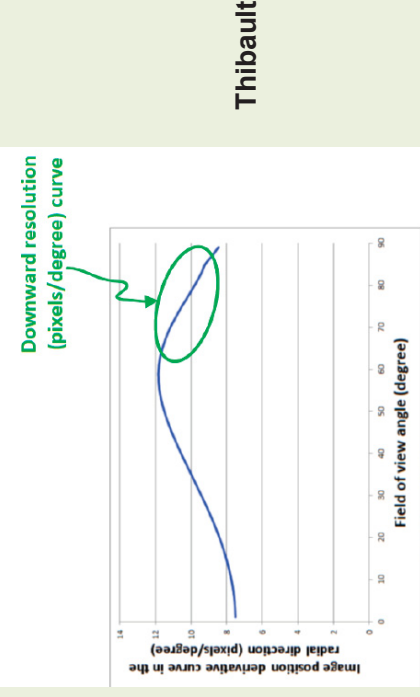
Dr. Kessler Supplemental Decl.

18. Dr. Lebby argues that I based my analysis “on a theory that ImmerVision conflated a low magnification with a downward sloped curve,” but this characterization is a vast oversimplification of my analysis. See EX2001, ¶83. I did not focus on just any given downward slope within the curve presented in FIG. 7 or in the corresponding curves in the prior art, but instead I focused on the downward slope that succeeded the absolute maximum resolution across the entire field of view (FOV) in the targeted resolution curve. See EX1003, ¶¶123, 167, 198. As Dr. Lebby

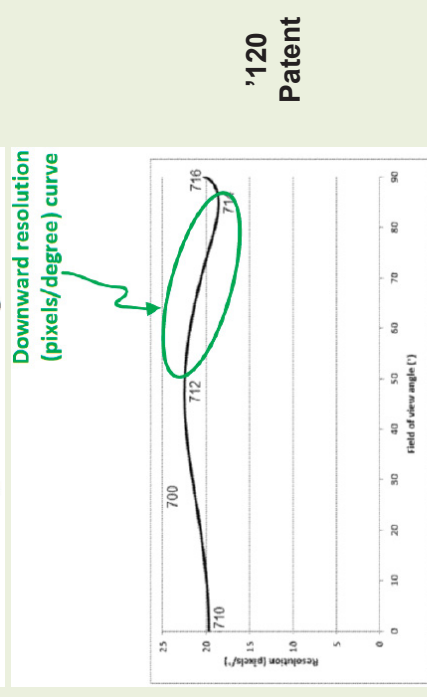
equal. See EX2001, ¶57. As a result, an area around the absolute maximum resolution in a non-linear targeted resolution curve will always be a zone of increased magnification, because that area must be above the comparable linear targeted resolution curve in order to provide the balance described by Dr. Lebby. According to the '120 Patent's description of FIG. 7, this downward slope after an absolute maximum corresponds to the benefits the '120 Patent purports to claim. See EX1001, 6:28-41; EX1002, 27.

Ex. 1023 (Kessler Supp. Decl.), ¶ 18;
Paper 13 (Pet. Reply), 11-12

Dr. Kessler Original Decl.



EX1004, Annotated Figure 6



EX1001, Annotated FIG. 7

Ex. 1003 (Kessler Orig. Decl.), ¶ 123;
Paper 2 (Petition), 30-32

'120 Patent Teaches Relevant Feature of FIG. 7 Is Downward Slope After Absolute Maximum

Dr. Kessler Supplemental Decl.

18. Dr. Lebby argues that I based my analysis “on a theory that ImmerVision conflated a low magnification with a downward sloped curve,” but this characterization is a vast oversimplification of my analysis. See EX2001, ¶83. I did not focus on just any given downward slope within the curve presented in FIG. 7 or in the corresponding curves in the prior art, but instead I focused on the downward slope that succeeded the absolute maximum resolution across the entire field of view (FOV) in the targeted resolution curve. See EX1003, ¶¶123, 167, 198. As Dr. Lebby

Ex. 1023 (Kessler Supp. Decl.), ¶ 18;
Paper 13 (Pet. Reply), 11-12

'120 Patent

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.

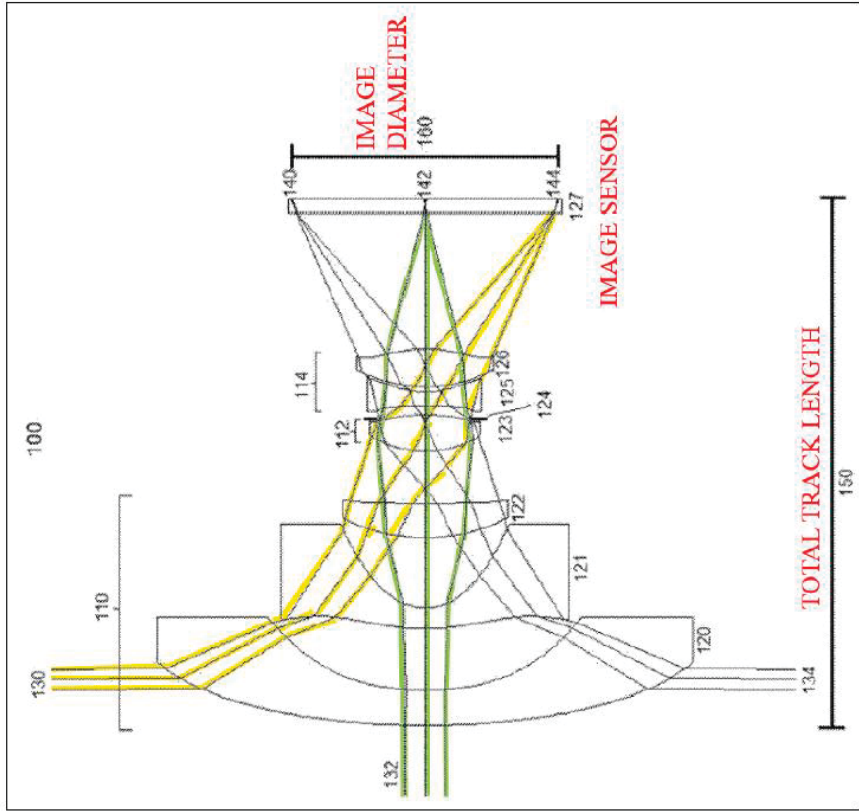
Ex. 1001 ('120 Patent), 6:28-41;
Paper 2 (Petition), 30-31;
Paper 13 (Pet. Reply), 9, 11-2

Ground 2

Matsusaka Renders Claim 1 Obvious Under
Either Construction of “Compensate” Limitation

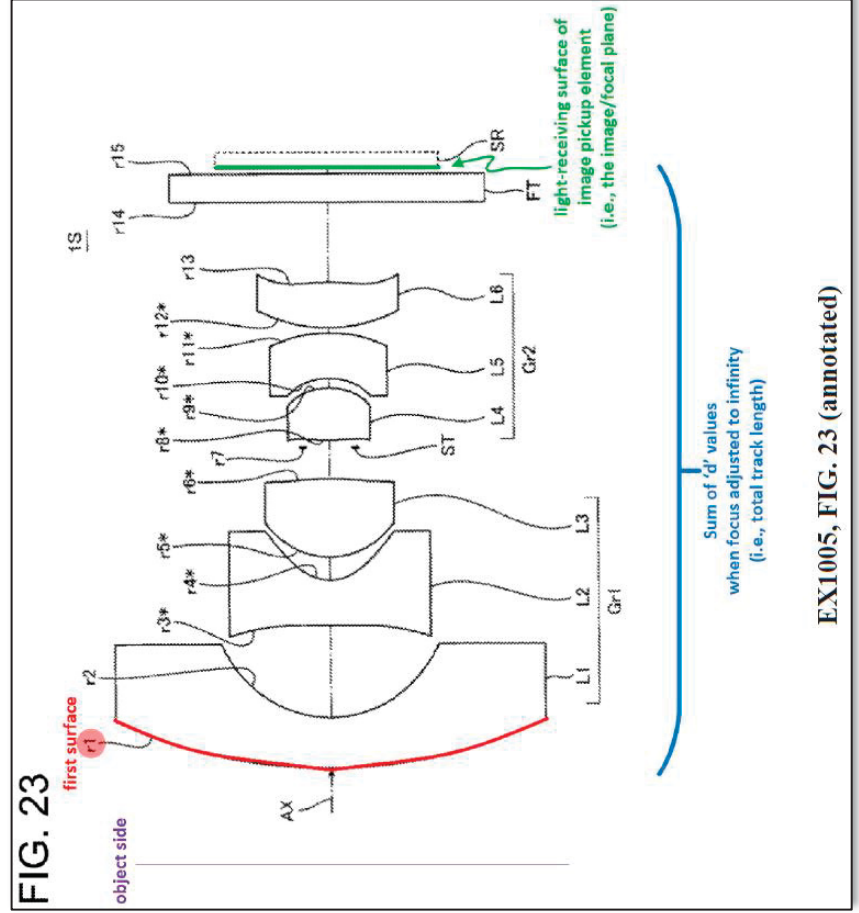
Matsusaka's Lens

'120 Patent's Lens



EX1001, FIG. 1 (highlighted; annotated)

Matsusaka's Lens

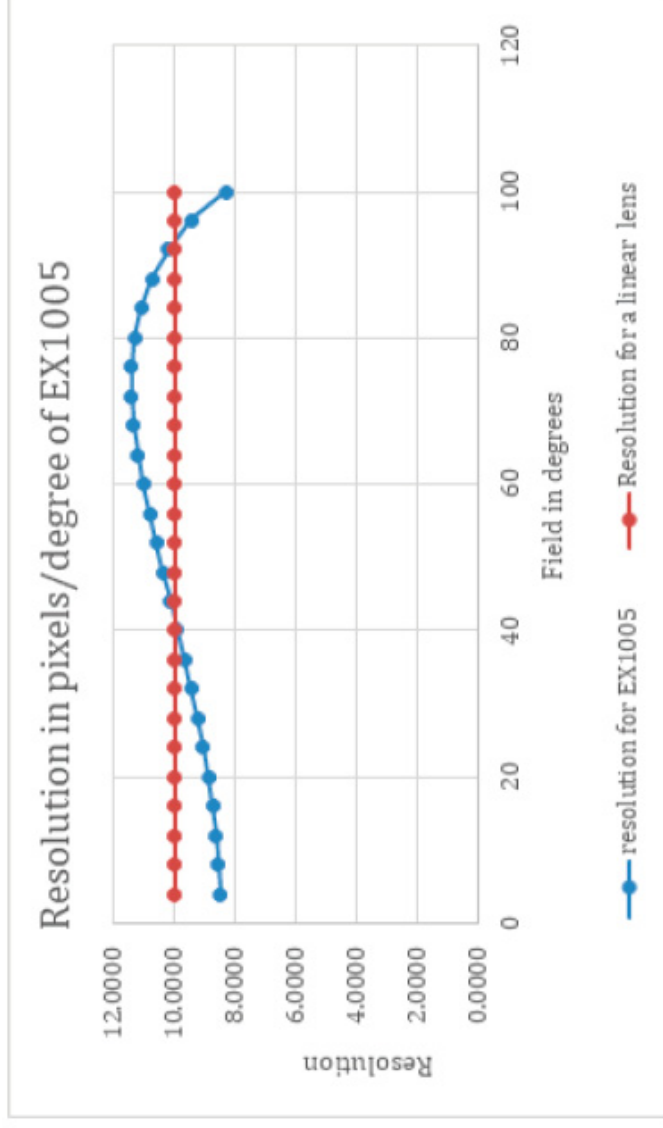


EX1005, FIG. 23 (annotated)

Issue 2A

Matsusaka Renders Obvious Patent Owner's
Narrow Construction Based On Responsive
Evidence Timely Submitted in Reply to The
New Construction

Petition's Identification of Claimed "zone...with a lower or higher object to image magnification" in Matsusaka

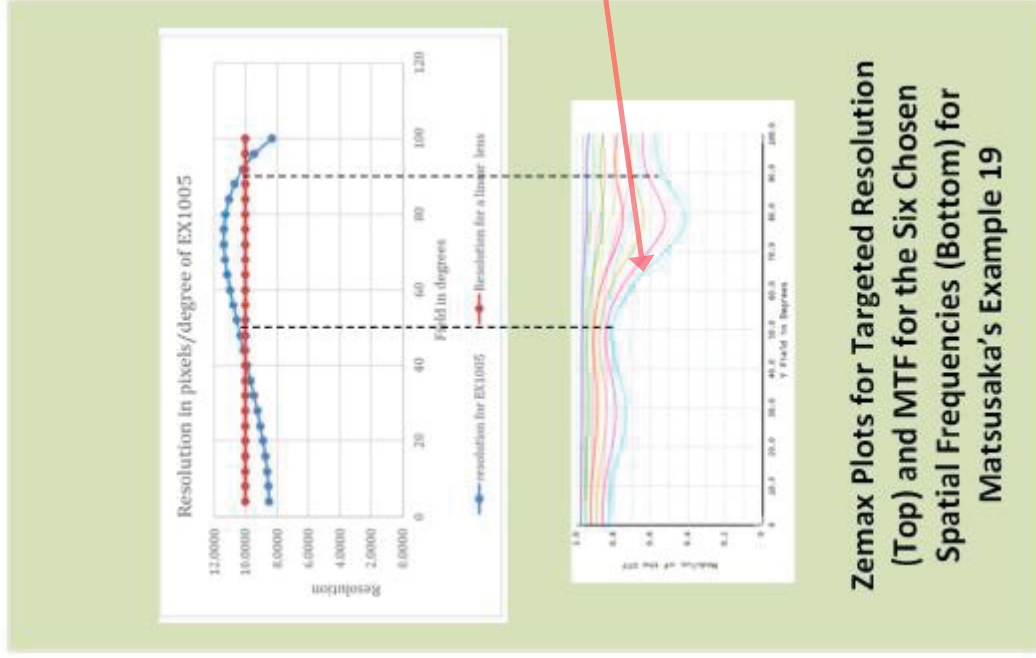


Areas where the blue curve are above the red curve are areas of increased magnification with respect to the linear targeted resolution, and areas where the blue curve are below the red curve are areas of decreased magnification with respect to the linear targeted resolution. EX1003, ¶165.

Paper 2 (Petition), 58-59

Claimed “zone...with a lower or higher object to image magnification” Identified in Matsusaka Corresponds With a Drop In MTF

Matsusaka

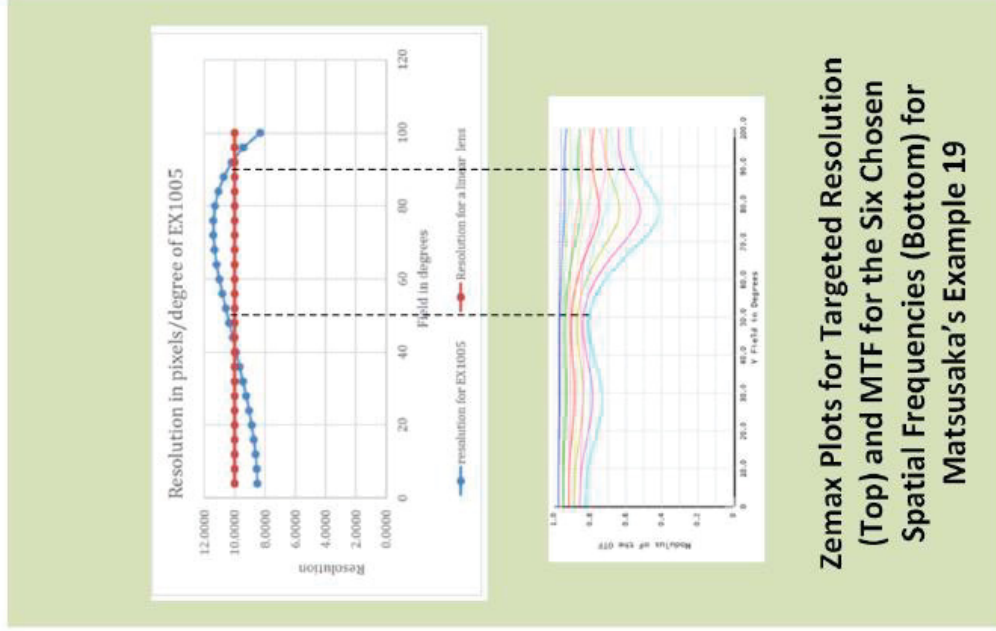


Dr. Kessler's Supplemental Declaration

33. Notably, limitation [1e] 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.” As the Zemax plots show at left, there is a marked drop in MTF in the region corresponding to the zone of increased magnification. Thus, even under Dr. Lebby's new construction, in which the “the zones need to align with appropriate regions exhibited in a relative illumination or MTF curve,” Matsusaka's Example 19 lens anticipates or at least renders obvious the claim language.

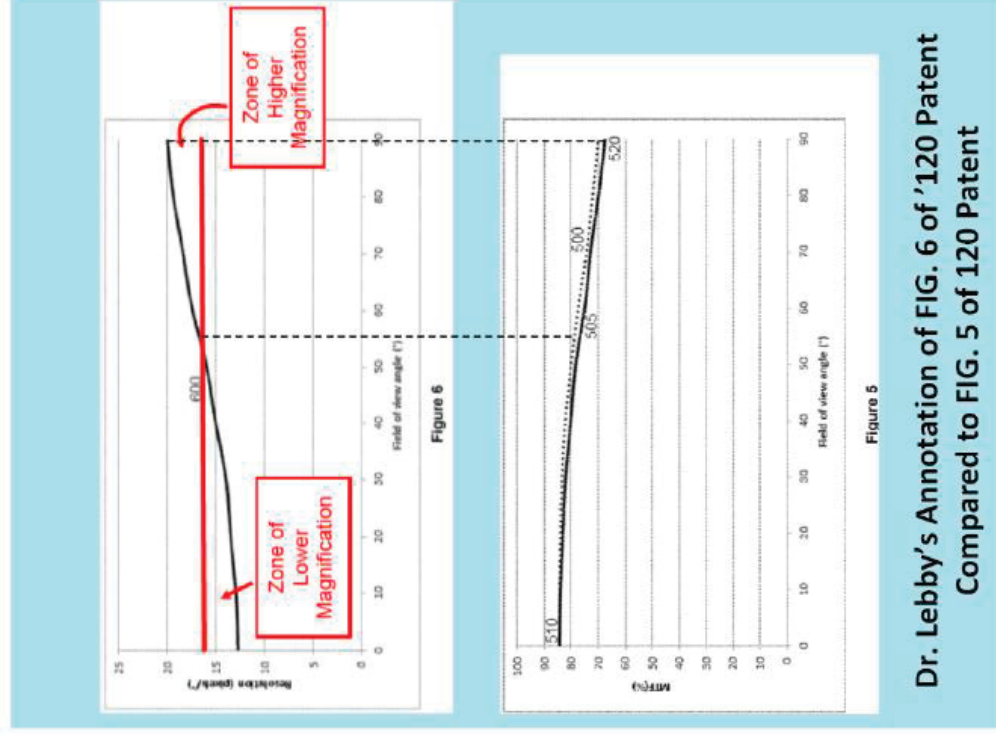
Claimed “zone...with a lower or higher object to image magnification”
Identified in Matsusaka Corresponds With a Drop In MTF

Matsusaka



**Zemax Plots for Targeted Resolution
(Top) and MTF for the Six Chosen
Spatial Frequencies (Bottom) for
Matsusaka's Example 19**

'120 Patent



**Dr. Lebby's Annotation of FIG. 6 of '120 Patent
Compared to FIG. 5 of 120 Patent**

Patent Owner Argues Reply's Responsive MTF Data Is Late

From Sur-Reply

II. ARGUMENT

A. Petitioner Was Well Aware of the Evidence Required to Show Claim 1's Alleged Unpatentability

Section III of Petitioner's Reply discusses evidence (paragraphs 21-33 of Dr.

Kessler's second declaration (Ex. 1023)) that should have been presented in the

Petition. Section I constitutes Petitioner's attempt to justify the belated submission

— framing the issue as a new claim construction dispute and professing to have

been caught entirely unaware. Petitioner is wrong on both counts. Patent Owner

Paper 14 (PO Sur-Reply), 2

Federal Circuit Precedent Explicitly Supports Provision of New Evidence and Arguments in Reply to Patent Owner, Particularly for New Claim Constructions



“[W]e have regularly held, the petitioner in an *inter partes* review proceeding may introduce new evidence after the petition stage if the evidence is a legitimate reply to evidence introduced by the patent owner.”

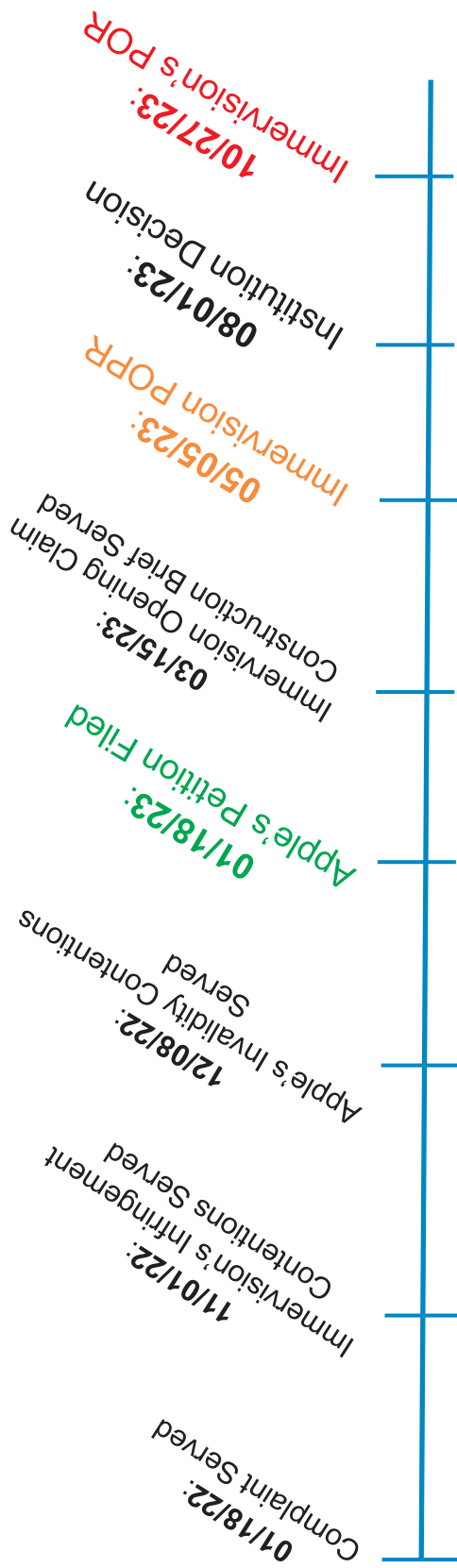
Apple Inc. v. Andrea Elec. Corp., 949 F.3d 697, 705-07 (Fed. Cir. 2020) (quotations omitted)



“There is no rule, for example, requiring a petition to describe all possible or reasonable claim constructions and to present invalidity theories under those constructions. . . . [W]e have continued to recognize that a petitioner is entitled under the APA to respond to new claim construction arguments made by a patent owner”

Axonics Inc. v. Medtronic, 75 F.4th 1374, 1380-82 (Fed. Cir. Aug. 7, 2023)

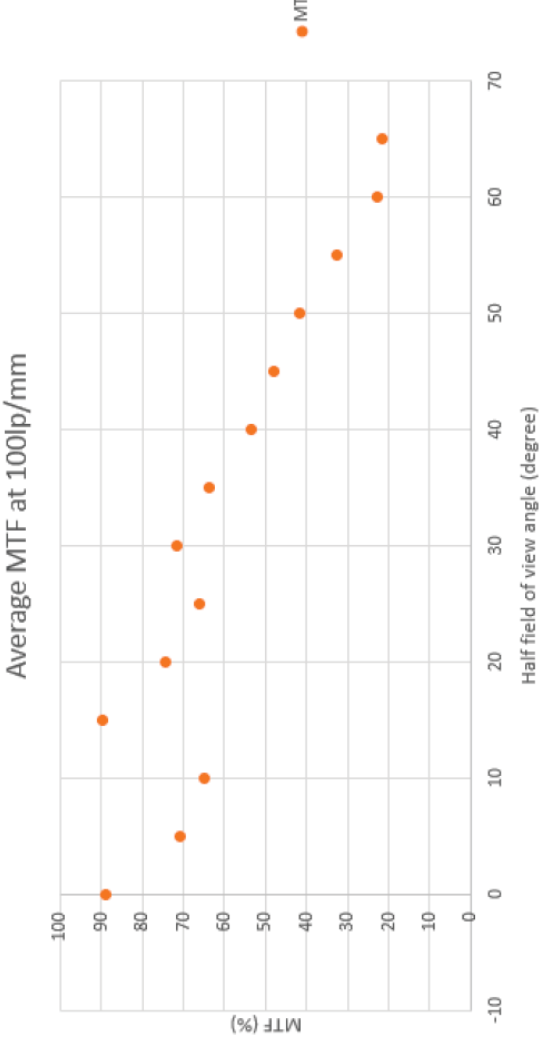
Patent Owner First Asserted that Fig. 7's "Higher Relative Illumination" Is Not Sufficient to Meet "Compensating" Limitation **After** Petition Filing



Paper 13 (Pet. Reply), 2-4;
Paper 15 (Pet. Rebuttal), 1-2

Infringement Contentions Do Not Explain that Fig. 7's "Higher Relative Illumination" Is Insufficient to Meet "Compensate" Limitation of Claim 1

Immervision's Infringement Contentions (Ex. 2012)
Served Nov. 1, 2022

Claim 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,	<u>Apple iPhone 11 Pro Smartphone</u>  The image quality, as demonstrated by the MTF measurements shown above, in the zone having a higher object-to-image magnification (greater than about 33 degrees from center) is lower than in the center zone of the image, where there is a lower object to image magnification. This graph shows data captured by the Optikos Lenscheck measurement machine. Specifically, the graph shows the average of the Sagittal and Tangential MTFs measured at 100 lp/mm. The MTF is seen to drop sharply after about 30 degrees from center to a minimum at the edge of the field of view, which mainly coincides with the highest resolution areas of the lens. The non-linear targeted resolution therefore compensates, at least in part, for the lower image quality in this zone of the image.
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Invalidity Contentions Prove Apple's Belief That Fig. 7's "Higher Relative Illumination" Is Sufficient to Meet "Compensate" Limitation of Claim 1

Apple's Invalidity Contentions (Ex. 2003) Served Dec. 8, 2022

[1(f)] 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,	In addition to embodiment 1, Apple reserves the right to rely on the lenses disclosed in Kim's embodiments 2 and 3 for a disclosure of the creation of non-linear targeted resolution to intentionally create regions of higher or lower magnification within the projected image in a manner similar to the lens of embodiment 1, as shown above. Apple contends that this limitation has no patentable weight because it merely states an intended result. However, to the extent ImmerVision contends that this claim limitation does carry patentable weight, Kim discloses this limitation. For instance, the lens disclosed in Kim's embodiment 1 exhibits a drop in relative illumination as the object angle increases, such that the image at these angles would also exhibit decreased resolution that would compensate, at least in part, for the drop in image quality due to the lower relative illumination at these angles. <table border="1"> <caption>Approximate data points from the Relative Illumination graph</caption> <thead> <tr> <th>Y Field in Degrees</th> <th>Relative Illumination</th> </tr> </thead> <tbody> <tr><td>0</td><td>1.00</td></tr> <tr><td>14.4</td><td>0.98</td></tr> <tr><td>28.8</td><td>0.95</td></tr> <tr><td>43.2</td><td>0.90</td></tr> <tr><td>57.6</td><td>0.85</td></tr> <tr><td>72.0</td><td>0.80</td></tr> </tbody> </table> In addition to Kim's embodiment 1, Apple reserves the right to rely on the lenses disclosed in Kim's embodiments 2 and 3 for a disclosure of a lens in which a zone of lower or higher magnification compensates, at least in part, for a decrease in relative illumination within that zone. To the extent that Kim does not explicitly teach that the higher magnification its lenses produce for certain image zones would 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 that zone of the image, a person of skill in the art would have understood that this would be the case. It was well-known in the optics field in 2015 that relative illumination and MTF tend to drop in an image captured in the peripheral angles of a camera lens, particularly a wide-angle lens. It was also well-known in the optics field in 2015 that decreasing the resolution in a region of an image will impact (e.g., compensate for) the	Y Field in Degrees	Relative Illumination	0	1.00	14.4	0.98	28.8	0.95	43.2	0.90	57.6	0.85	72.0	0.80
Y Field in Degrees	Relative Illumination														
0	1.00														
14.4	0.98														
28.8	0.95														
43.2	0.90														
57.6	0.85														
72.0	0.80														

Invalidity Contentions Prove Apple's Belief That Fig. 7's "Higher Relative Illumination" Is Sufficient to Meet "Compensate" Limitation of Claim 1

Apple's Invalidity Contentions (Ex. 2003) Served Dec. 8, 2022

effect of the drop in relative illumination in that region, and that increasing the resolution in a region of an image will impact (e.g., compensate for) the effect of the drop in MTF in that region.

Further still, to the extent that Kim does not explicitly teach that the higher magnification its lenses produce for certain image zones would 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 that zone of the image, using it in that matter would have been obvious to a person of skill in the art in view of Shabtay or Charles:

The following relates generally to imaging optics, and more specifically to a lens architecture in conjunction with a distorted image for relative illumination such that the light distribution over the lens is substantially uniform.
Shabtay at 1:7–10.

Herein, an overview of some of the embodiments for enhancing a depth of field based on a uniform (or near uniform) relative illumination utilizing a lens with large distortion has been presented above. Shabtay at 5:23–26.

The principle of uniform relative illumination is obtained using a lens design that leads to a distorted image on the sensor such that the light distribution over the lens is substantially uniform. The disclosed aspects provide a lens that produces a distorted image, which can then be corrected during image processing by using a distortion correction function. An advantage of the various aspects disclosed herein is that the disclosed aspects enable an increase of the DoF with a higher F-number while maintaining sensor illumination commensurate to that obtained with a regular lens with a low F-number and narrow DoF. Shabtay at 6:45–55.

Ex. 2003 (Apple's Invalidity Contentions), 31-33
Paper 14 (PO Sur-Reply), 6; see also Paper 15 (Pet. Rebuttal), 1-2.

Reply Evidence Submitted in Response to Narrowing of Claimed “a zone...with a lower or higher object to image magnification”

From Sur-Reply

Patent’s intrinsic record. For example, Patent Owner argued that the downward slope in the ‘120 Patent’s Fig. 7 had no significance to claim 1, not that Fig. 7 was wholly inapplicable, as Petitioner implies. None of Petitioner’s cherry-picked

Paper 14 (PO Sur-Reply), 1

From Dr. Lebby Declaration with POR

90. This is the same concept the ‘120 Patent describes in relation to Fig. 7. The downward curve “allows the lens system to have a higher relative illumination value toward the edge of the field of view” (EX1001 6:35-41); *i.e.*, the downward curve allows for an increase in the relative illumination values.
91. This is different from the other technique described in the ‘120 Patent with respect to Figs. 4-6 and recited in claim 1, where the magnification zones are arranged to “compensate for” drops in relative illumination (or MTF), not to actually increase the relative illumination. Pursuant to this difference, the term

Ex. 2001 (Lebby Decl.), ¶¶ 90-91;
Paper 10 (POR), 22-23; see also Paper 13 (Pet. Reply), 7

POR Recognizes That Shabtay's Teachings Are Consistent with FIG. 7's "Higher Relative Illumination"

Fig. 7 is described as illustrating a different, but related, principle, which is that a decrease in resolution can be utilized to *actually raise relative illumination*. Ex. 1001 at 6:35-41; Ex. 2001 at ¶¶ 89-90. That is, *instead of compensating* for poor image quality from low relative illumination by magnifying that area to capture more detail, as is done in Fig. 6, the illumination itself can be increased by dropping resolution. Ex. 2001 at ¶¶ 89-90. This particular concept is not new. For example, Shabtay (cited during prosecution of the '120 Patent) utilizes an exaggerated negative distortion at the edge to keep relative illumination high throughout the FOV. Ex. 2004 at ¶¶ [0001], [0042], [0044], [0076]-[0077], Figs. 10-11; Ex. 2001 at ¶ 89. This changes the relative illumination curve from

Paper 10 (POR), 22.

POPR Argued FIG. 7 Taught Relevant Position of Zones, Not That It Had “No Significance”

From Sur-Reply

Patent’s intrinsic record. For example, Patent Owner argued that the downward slope in the ‘120 Patent’s Fig. 7 had no significance to claim 1, not that Fig. 7 was wholly inapplicable, as Petitioner implies. None of Petitioner’s cherry-picked

Paper 14 (PO Sur-Reply), 1

From POPR

satisfy claim 1’s “being used to compensate” clause. The ‘120 Patent makes clear that any magnification zones present in the Fig. 7 resolution curve are carefully located according to at least one of the relative illumination or the MTF of the subject lens. Ex. 1001 at 6:28-61. Petitioner and its expert offer no similar

Institution Decision Agreed that Fig. 7's "Higher Relative Illumination" Was Consistent with the "Compensate" Limitation of Claim 1

From Institution Decision

a zone" as in limitation [1e]. *Id.* at 30 (citing Ex. 1003 ¶ 122). With respect to the "being used to compensate" language, we are persuaded on this record that Petitioner's comparison of Thibault's Figure 6 and the '120 patent's Figure 7 (above), particularly with respect to the downward resolution curve circled in green, supports Petitioner's assertion that Thibault's apparatus meets the "being used to compensate" language. *Id.* at 30–31. We are also persuaded that Petitioner's comparison of Thibault's Figure 6 and the '120 patent's Figure 7, in view of the language of the '120 patent (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," Ex. 1001, 6:36–41), supports Petitioner's assertion that Thibault's apparatus "would therefore have the same impact on relative illumination as described in the '120 Patent." *Id.* at 31 (citing Ex. 1003 ¶ 123). Although

Patent Owner Acknowledges that Claim Lacks Clarity

this case, and ImmerVision likewise cannot find any. This is because the claim simply means the lower or higher object to image magnification (i.e., the non-linear resolution) compensates for the lower image quality. It is also apparent that “being used to” imparts structure to the claim by designating the location of the magnification zone within the field of view of the lens – *i.e.*, positionally correlating the magnified zone with the drop in relative illumination or MTF. Like with the prior term, while this may not be the most articulate way to phrase the claim, it is still limited with reasonable clarity and thus not indefinite.

Prosecution History Demonstrates FIG. 7 Relevant to Scope of Claim 1

REMARKS

Claims 1-3 and 5-8 are currently pending in this application, as amended. Claim 4 has been cancelled and the subject matter thereof has been moved into claim 1. Claim 1 has been further amended to clarify the invention. Support for the further amendments to claim 1 can be found, for example, at least in original Figs. 6 and 7; and in the original specification at paragraphs [0040]-[0041]. Accordingly, no new matter has been added by the amendments to the claims and entry thereof is respectfully requested.

[0041] 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.

1. (Currently Amended) A miniature wide-angle optical apparatus comprising:
 - a light-receiving first surface;
 - a focal plane;
 - a total track length measured from a center of the first surface to the focal plane;
 - 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
 - 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,
- an opening angle of light entering the optical apparatus being over 100°.

Ex. 1002 (Pros. Hist.), 27; see also *id.*, 9, 25; Paper 13 (Pet. Reply), 7

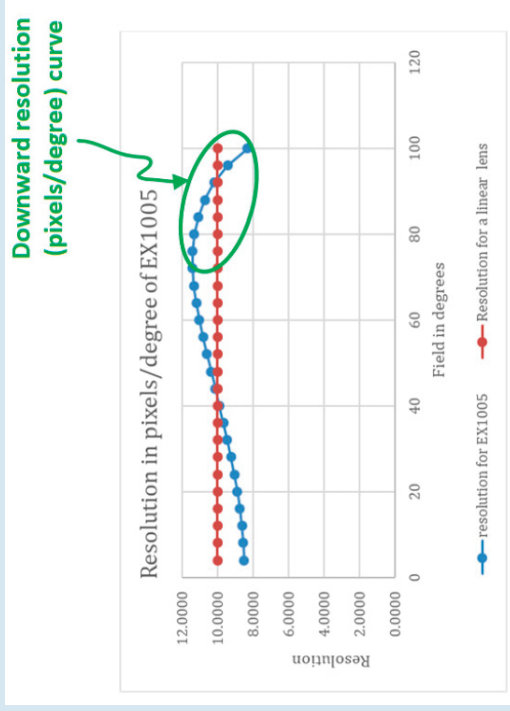
FISH

Issue 2B

Matsusaka Renders Claim 1 Obvious Under
the Petitioner's Construction

Undisputed that Matsusaka Discloses FIG. 7's "Downward Curve" and "Higher Relative Illumination"

From Kessler Original Decl.



for the claimed optical apparatus. However, to the extent that the final clause of this limitation is considered further limiting, the curvature of the above resolution curve of Matsusaka's wide-angle optical system 1S of Example 19 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. The '120 Patent describes that the "downward curve

Ex. 1003 (Kessler Orig. Decl.), ¶ 167;
Paper 2 (Petition), 59-60

Undisputed that Matsusaka Discloses FIG. 7's "Downward Curve" and "Higher Relative Illumination"

From Kessler Original Decl.

for the claimed optical apparatus. However, to the extent that the final clause of this limitation is considered further limiting, the curvature of the above resolution curve of Matsusaka's wide-angle optical system 1S of Example 19 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. The '120 Patent describes that the "downward curve

'120 Patent

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.

Ex. 1003 (Kessler Orig. Decl.), ¶ 167;
Paper 2 (Petition), 59-60

Ex. 1001 ('120 Patent), 6:28-41;
Paper 2 (Petition), 59-60

'120 Patent Teaches Relevant Feature of FIG. 7 Is Downward Slope After Absolute Maximum

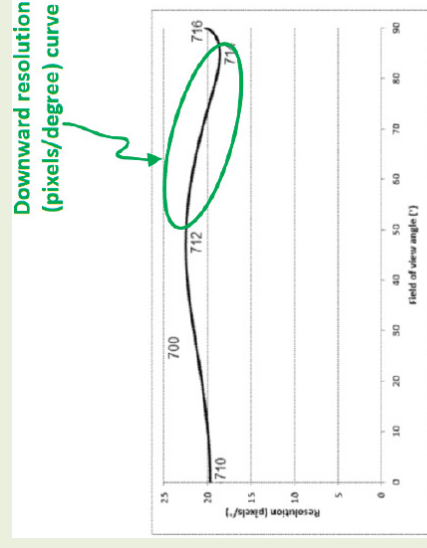
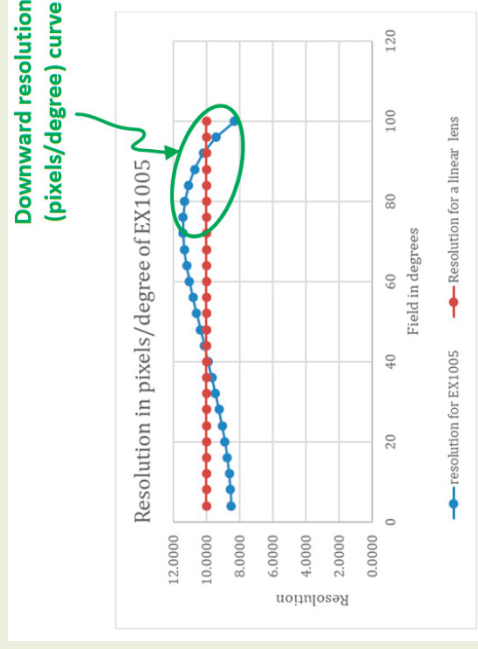
Dr. Kessler Supplemental Decl.

18. Dr. Lebbey argues that I based my analysis “on a theory that ImmerVision conflated a low magnification with a downward sloped curve,” but this characterization is a vast oversimplification of my analysis. See EX2001, ¶83. I did not focus on just any given downward slope within the curve presented in FIG. 7 or in the corresponding curves in the prior art, but instead I focused on the downward slope that succeeded the absolute maximum resolution across the entire field of view (FOV) in the targeted resolution curve. See EX1003, ¶¶123, 167, 198. As Dr. Lebbey

equal. See EX2001, ¶57. As a result, an area around the absolute maximum resolution in a non-linear targeted resolution curve will always be a zone of increased magnification, because that area must be above the comparable linear targeted resolution curve in order to provide the balance described by Dr. Lebbey. According to the '120 Patent's description of FIG. 7, this downward slope after an absolute maximum corresponds to the benefits the '120 Patent purports to claim. See EX1001, 6:28-41; EX1002, 27.

Ex. 1023 (Kessler Supp. Decl.), ¶ 18;
Paper 13 (Pet. Reply), 11-12

Dr. Kessler Original Decl.



EX1001, Annotated FIG. 7

Ex. 1003 (Kessler Orig. Decl.), ¶ 167;
Paper 2 (Petition), 59-60

'120 Patent Teaches Relevant Feature of FIG. 7 Is Downward Slope After Absolute Maximum

Dr. Kessler Supplemental Decl.

18. Dr. Lebby argues that I based my analysis “on a theory that ImmerVision conflated a low magnification with a downward sloped curve,” but this characterization is a vast oversimplification of my analysis. See EX2001, ¶83. I did not focus on just any given downward slope within the curve presented in FIG. 7 or in the corresponding curves in the prior art, but instead I focused on the downward slope that succeeded the absolute maximum resolution across the entire field of view (FOV) in the targeted resolution curve. See EX1003, ¶¶123, 167, 198. As Dr. Lebby

Ex. 1023 (Kessler Supp. Decl.), ¶ 18;
Paper 13 (Pet. Reply), 11-12

'120 Patent

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.

Ex. 1001 ('120 Patent), 6:28-41;
Paper 2 (Petition), 59-60;
Paper 13 (Pet. Reply), 9, 11-2

Claim Construction

Patent Owner Is Wrong That FLG. 7's
Downward Slope Is Not Sufficient to Meet
“Compensate” Limitation

'120 Patent: Challenged Indep. Claim 1

1. A miniature wide-angle optical apparatus comprising:
a light-receiving first surface;
a focal plane;
a total track length measured from a center of the first surface to the focal plane;
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
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,
an opening angle of light entering the optical apparatus being over 100°.

'120 Patent: Claim Constructions

Claim Term	Petitioner Construction	Patent Owner Construction
“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”	If given patentable weight, satisfied if either of the relevant feature of FIG. 6 (“zone . . . with a higher object to image magnification” aligned with a drop in relative illumination or MTF) or FIG. 7 (“a downward curve between the maximum 712 and a region near the edge of the field of view around position 714”) is present in resolution curve	Satisfied only if the relevant feature of FIG. 6 (“zone . . . with a higher object to image magnification” aligned with a drop in relative illumination or MTF) is present in resolution curve

The Purported Invention of the '120 Patent

'120 Patent's Specification

One of the challenges to achieve good imaging performance over the whole field of view of a miniature wide-angle lens is the change of relative illumination from the center to the edge of the field of view. In wide-angle lenses, the relative illumination is usually maximum in the center and drops continuously toward the edge of the field of view. The consequence of lower illumination toward the edge is a lower image quality at the edge due to increased diffraction effects and additional sensor noise at the edges.

Another challenge to achieve good imaging performance over the whole field of view of a miniature wide-angle lens is a drop of the modulation transfer function (MTF) from the center to the edge of the field of view. In wide-angle lenses, the image MTF is usually maximum in the center and drops continuously toward the edge of the field of view. The consequence of lower MTF toward the edge is a lower image quality at the edge.

Ex. 1001 ('120 Pat), 1:53-2:3;
Paper 2 (Petition), 11

The Purported Invention of the '120 Patent

'120 Patent's Specification

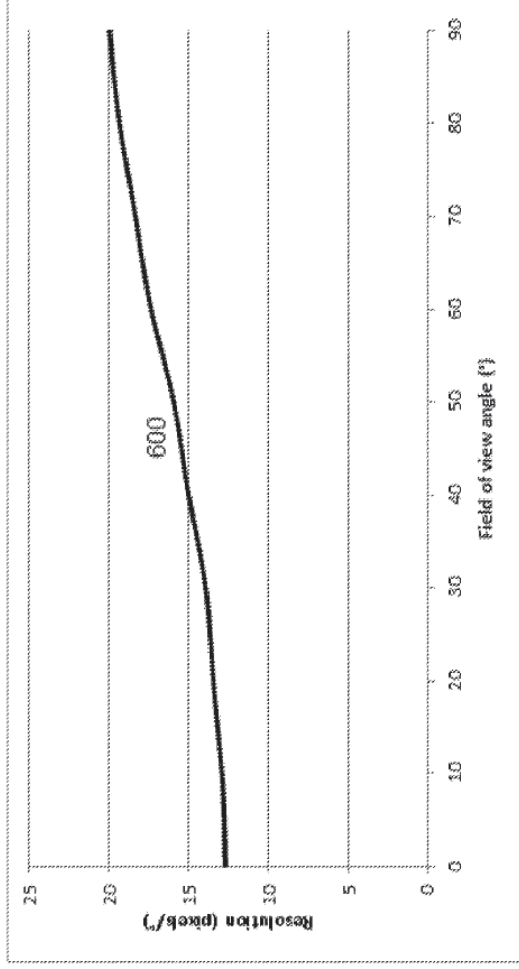


Figure 6

FIG. 6 shows an example 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. In some embodiments of the miniature wide-angle, the shape of the targeted resolution curve is intentionally designed to compensate for the drop of relative illumination seen in FIG. 4. In some other embodiments of the miniature wide-angle lens, the shape of the targeted resolution is intentionally designed to compensate for the drop of MTF seen in FIG. 5. In the zone where the resolution is higher, there are more pixels of the sensors used to image a given angle of the object space. By having more imaging pixels in this zone, this compensates for the lower image quality in this zone either due to the lower relative illumination or the lower MTF. The final resulting image can then be processed to create a resulting image with constant image quality across the whole field of view.

Ex. 1001 ('120 Pat), FIG. 6, 6:9-27;
Paper 2 (Petition), 4-5

Dr. Kessler Explains How Zones in FIG. 6 “Compensate” for Drop in Relative Illumination or MTF

Dr. Kessler’s Explains How FIG. 7’s “Downward Slope” Meets the “Compensate” Limitation of Claim 1

zone of the image.” Dr. Lebbby claims that “a POSA can tolerate the low relative illumination at the edges of this lens because the lens is projecting that area of the image onto more pixels,” and he cites to column 6, lines 19-27 of the ’120 Patent for support. EX2001, ¶60. However, this portion of the ’120 Patent simply explains that, “[i]n the zone where the resolution is higher, there are more pixels of the sensors used to image a given angle of the object space,” and that “having more pixels in this zone . . . compensates for the lower image quality in this zone.” EX1001, 6:19-

24. The ’120 Patent appears to suggest that this compensation occurs because the “final resulting image can then be processed to create a resulting image with constant image quality across the whole field of view.” EX1001, 6:24-27. Assuming for the sake of argument this is true, it is not the lens that compensates for the lower image quality—as apparently shown in FIGS. 4 and 5, the image quality remains low in the image—it is the processing of the image data after it is captured by the sensor that compensates for the lower image quality. In other words, it would be some

Ex. 1023 (Kessler Supp. Decl.), ¶ 14;
Paper 13 (Pet. Reply), 10-11

’120 Patent

compensate for the drop of MTF seen in FIG. 5. In the zone where the resolution is higher, there are more pixels of the sensors used to image a given angle of the object space. By having more imaging pixels in this zone, this compensates for the lower image quality in this zone either due to the lower relative illumination or the lower MTF. The final resulting image can then be processed to create a resulting image with constant image quality across the whole field of view.

Ex. 1001 (’120 Patent), 6:19-27;
Paper 13 (Pet. Reply), 10-11

The Purported Invention of the '120 Patent

'120 Patent's Specification

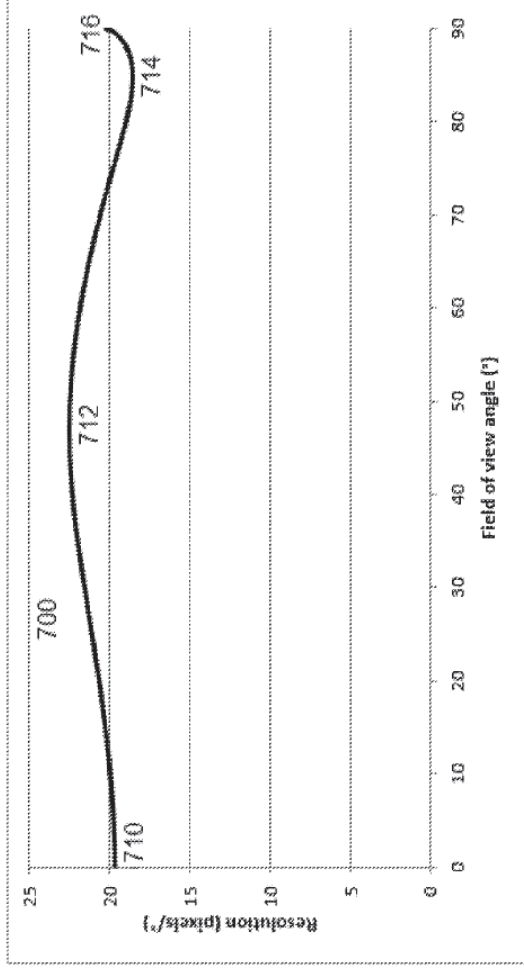


Figure 7

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.

Ex. 1001 ('120 Pat), FIG. 7, 6:28-41;
Paper 2 (Petition), 5-6

The Relevant “Downward Slope” in FIG. 7 Compensates For Drop In Relative Illumination Observed In “Usual” Wide-Angle Lens

Dr. Kessler’s Explains How FIG. 7’s “Downward Slope” Meets the “Compensate” Limitation of Claim 1

With respect to FIG. 7, the '120 Patent describes how the shape and position of the targeted resolution curve of the lens system itself can directly alter the relative illumination and MTF of the image and therefore provides “the best image quality on the lens and camera system” by creating “more balanced relative illumination” and “more balanced MTF.” See EX1001, 6:28-61. As the '120 Patent explains in its background, “[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,” and “the image MTF is usually maximum in the center and drops continuously toward the edge of the field of view.” See EX1001, 1:53-2:3. Thus, FIG. 7 purports to show a structure by which the lens system itself “compensates” for the drop in relative illumination or MTF experienced in these “usual” wide-angle lenses based on the shape and position of the targeted resolution curve.

Ex. 1023 (Kessler Supp. Decl.), ¶ 15;
Paper 13 (Pet. Reply), 9, 11

Dr. Leiby Agrees Relative Illumination Is Increased

90. This is the same concept the '120 Patent describes in relation to Fig. 7. The downward curve “allows the lens system to have a higher relative illumination value toward the edge of the field of view” (EX1001 6:35-41); *i.e.*, the downward curve allows for an increase in the relative illumination values.

Ex. 2001 (Leiby Decl.), ¶ 90;
Paper 10 (POR), 22

Prosecution History Demonstrates FIG. 7 Has Significance to Claim 1

REMARKS

Claims 1-3 and 5-8 are currently pending in this application, as amended. Claim 4 has been cancelled and the subject matter thereof has been moved into claim 1. Claim 1 has been further amended to clarify the invention. Support for the further amendments to claim 1 can be found, for example, at least in original Figs. 6 and 7; and in the original specification at paragraphs [0040]-[0041]. Accordingly, no new matter has been added by the amendments to the claims and entry thereof is respectfully requested.

[0041] 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.

1. (Currently Amended) A miniature wide-angle optical apparatus comprising:
 - a light-receiving first surface;
 - a focal plane;
 - a total track length measured from a center of the first surface to the focal plane;
 - 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
 - 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,an opening angle of light entering the optical apparatus being over 100°.

Ex. 1002 (Pros. Hist.), 27; see also *id.*, 9, 25; Paper 13 (Pet. Reply), 7

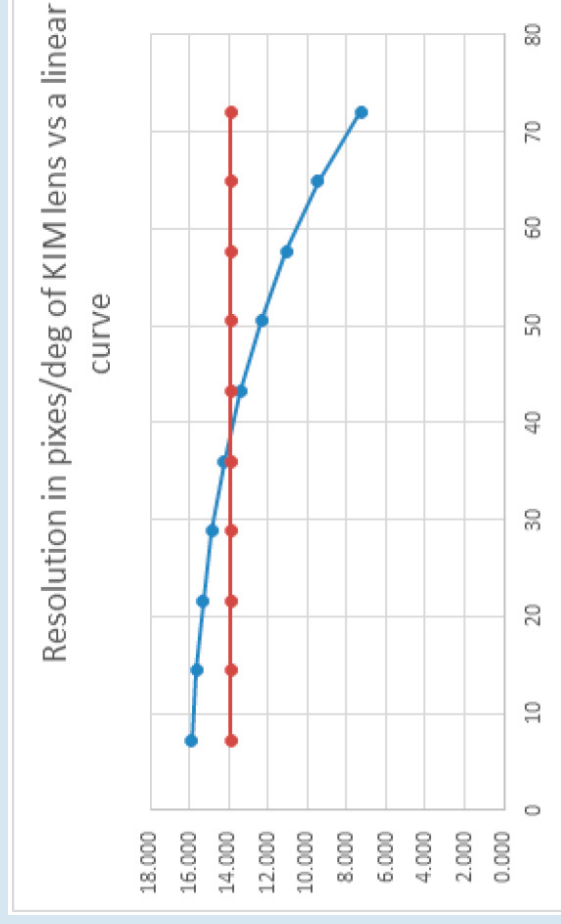
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Ground 3

Kim Renders Claim 1 Obvious Under the
Proper Construction of Claim 1

Undisputed that Kim Discloses FIG. 7's "Downward Curve" and "Higher Relative Illumination"

From Kessler Original Decl.



for the claimed optical apparatus. However, to the extent that the final clause of this limitation is considered further limiting, the curvature of the above resolution curve of Kim's First Embodiment 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. The '120

Ex. 1003 (Kessler Orig. Decl.), ¶ 198;
Paper 2 (Petition), 80

Undisputed that Kim Discloses FIG. 7's "Downward Curve" and "Higher Relative Illumination"

From Kessler Original Decl.

for the claimed optical apparatus. However, to the extent that the final clause of this limitation is considered further limiting, the curvature of the above resolution curve of Kim's First Embodiment 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. The '120

Ex. 1003 (Kessler Orig. Decl.), ¶ 198;
Paper 2 (Petition), 80

'120 Patent

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.

Ex. 1001 ('120 Patent), 6:28-41;
Paper 2 (Petition), 80

Appendix



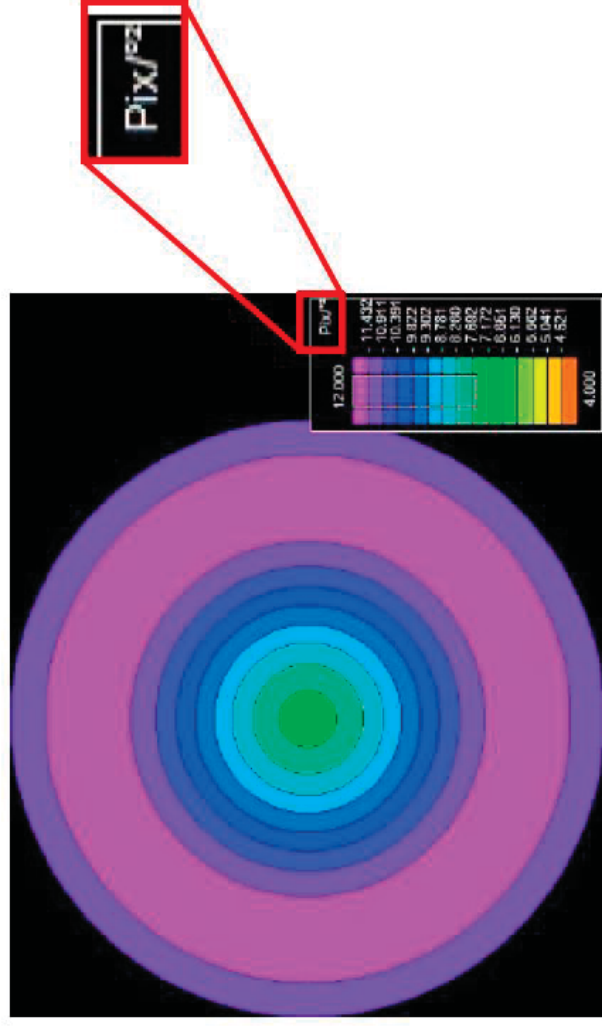
Patent Owner's New Sur-Reply Arguments Are Inconsistent with Thibault's Own FIG. 6

Rebuttal to:

"Had Dr. Kessler reviewed Thibault's Fig. 6 more closely, he would have realized that the 'surfacic resolution' in the bottom image is not equivalent to the image position derivative curve at the top." Sur-reply, 16.

From Sur-Reply

The first clue is the surfacic resolution image legend (reproduced and annotated below) shows the units as pixels per degree *squared*, not pixels per degree, as in the upper plot. Ex. 1004 at 7.



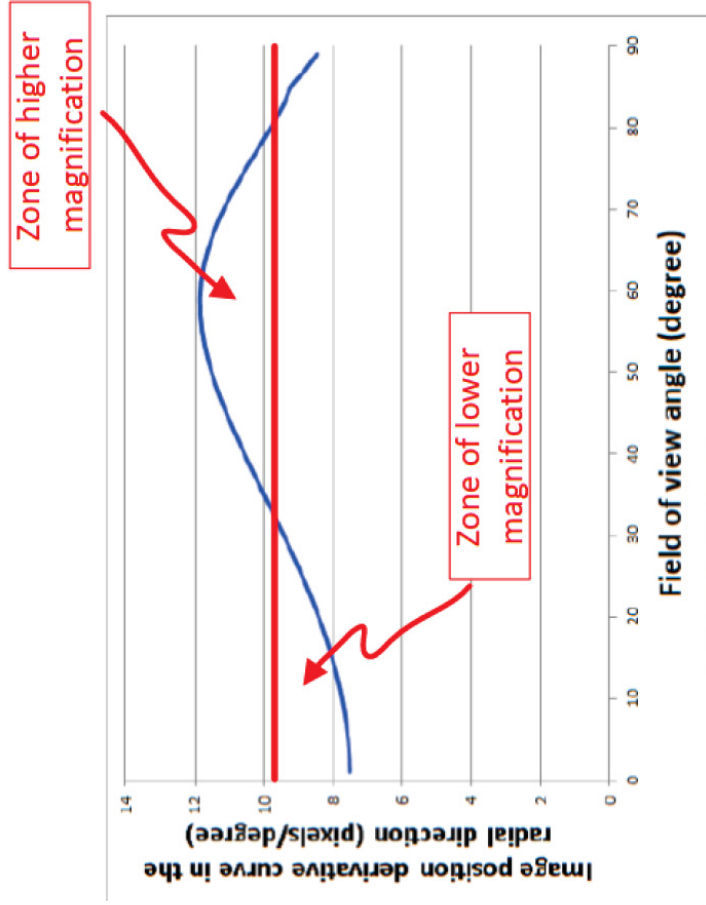
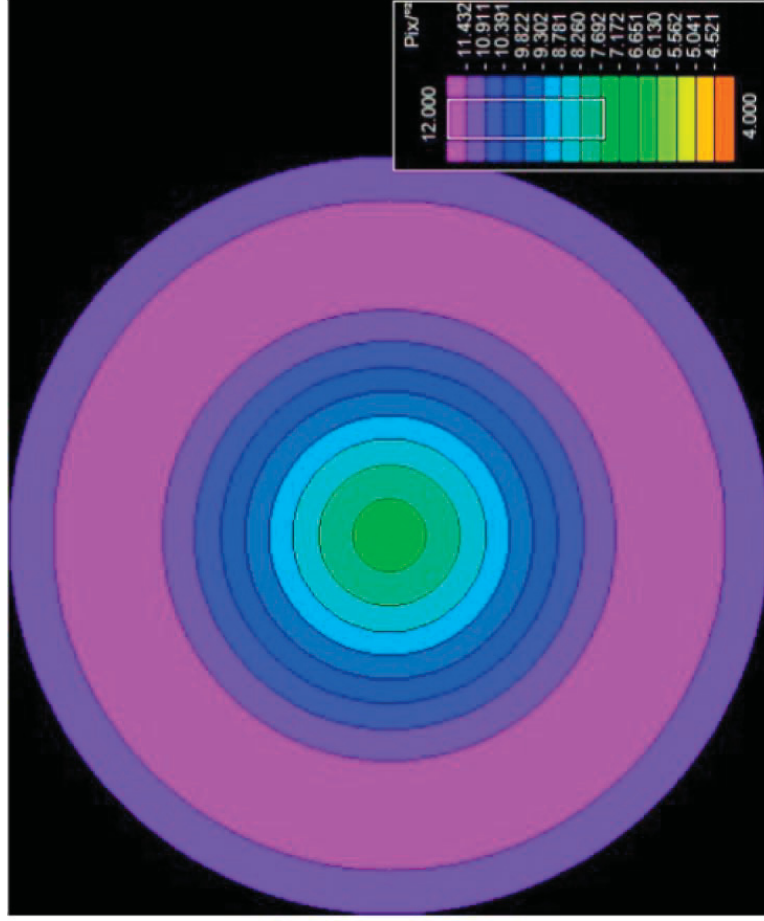
Patent Owner’s New Sur-Reply Arguments Are Inconsistent with Thibault’s Own FIG. 6

Rebuttal

to:

“Had Dr. Kessler reviewed Thibault’s Fig. 6 more closely, he would have realized that the ‘surfacic resolution’ in the bottom image is not equivalent to the image position derivative curve at the top.” Sur-reply, 16.

Figure 6. The number of pixels of 1.12 μm is increased in the zone for mobile video chat applications. Top) Image position derivative curve in the radial direction (pixels/degree). Bottom) Surfacic resolution over the full circular panomorph image.

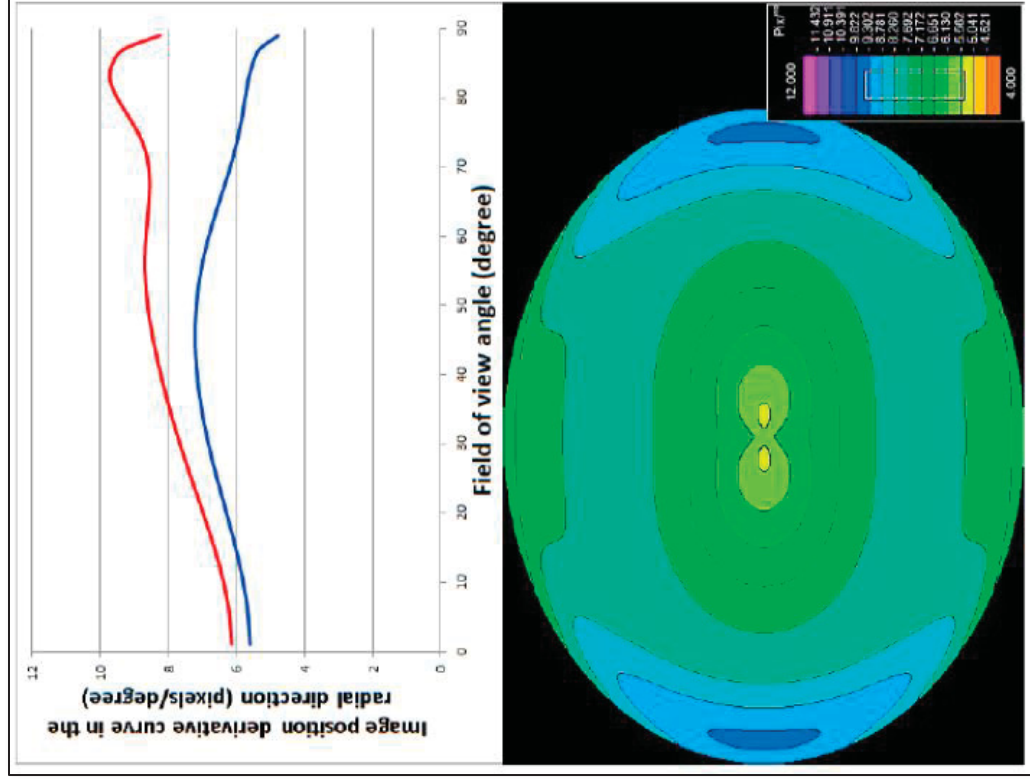


Patent Owner's New Sur-Reply Arguments Are Inconsistent with Thibault's Own FIG. 6

Rebuttal

to:

"Had Dr. Kessler reviewed Thibault's Fig. 6 more closely, he would have realized that the 'surfacic resolution' in the bottom image is not equivalent to the image position derivative curve at the top." Sur-reply, 16.



Ex. 1004 (Thibault), 5
Paper 6 (Institution Decision), 15

Patent Owner's New Sur-Reply Arguments Are Inconsistent with Thibault's Own FIG. 6

Rebuttal

to:

"Had Dr. Kessler reviewed Thibault's Fig. 6 more closely, he would have realized that the 'surfacic resolution' in the bottom image is not equivalent to the image position derivative curve at the top." Sur-reply, 16.

From Sur-Reply

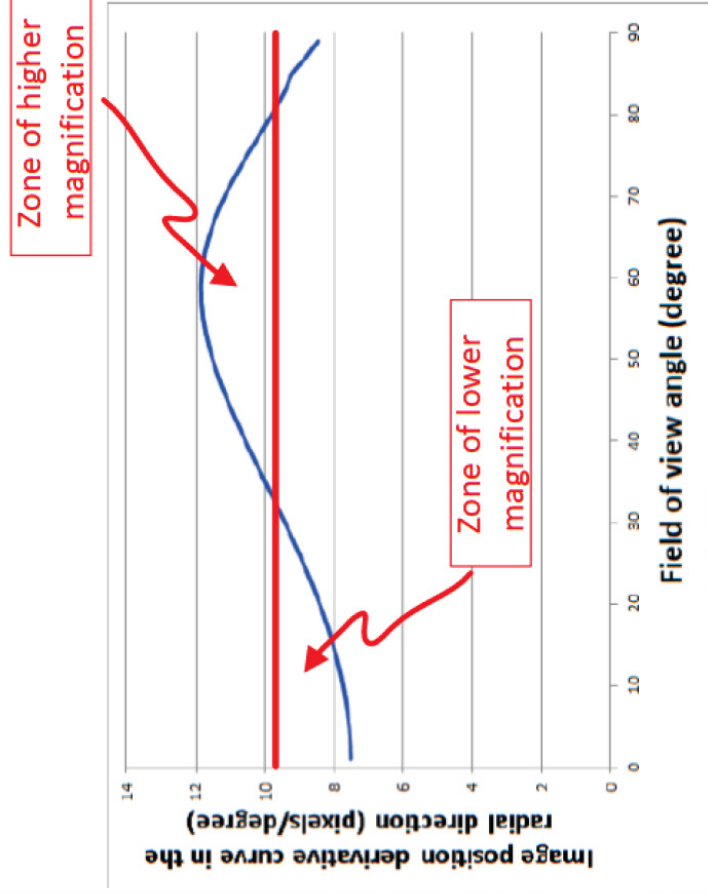
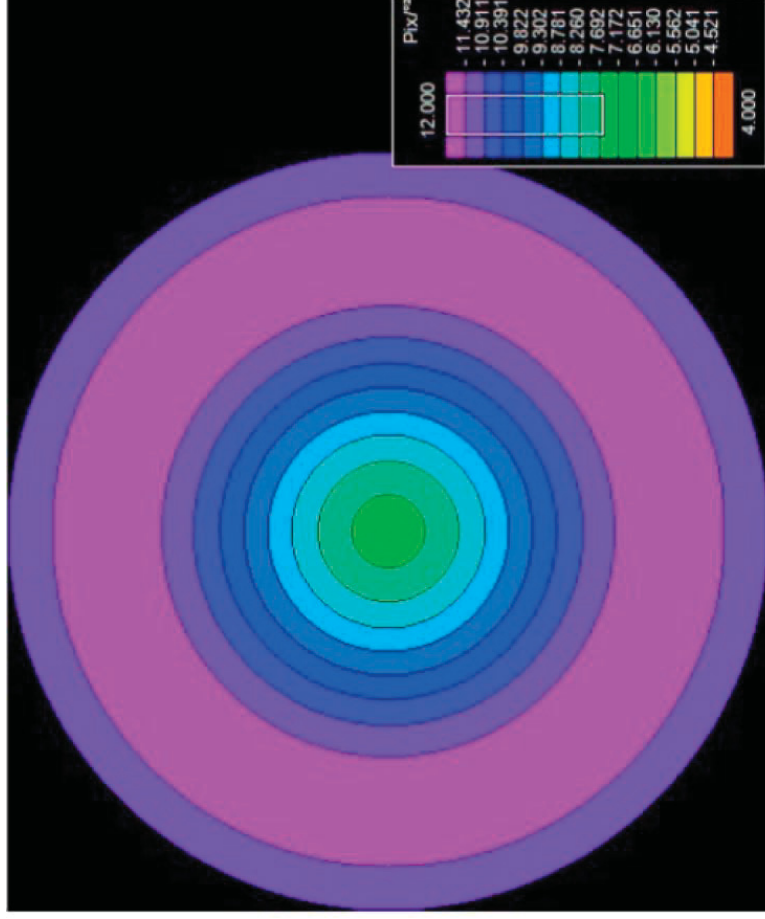
The second clue is the outer colored band in the surfacic resolution image does not match the resolution indicated at the edge by the image position derivative plot. In the upper plot, the resolution is below 10 (pixels/degree) for the final ~10-12 degrees in the field of view. *Id.* But the color of the outermost band in the surfacic resolution image indicates a value between 10.911 and 11.432 (pixels/degree squared) for this segment, clearly demonstrating a disconnect. *Id.*

Patent Owner's New Sur-Reply Arguments Are Inconsistent with Thibault's Own FIG. 6

Rebuttal

to:

"Had Dr. Kessler reviewed Thibault's Fig. 6 more closely, he would have realized that the 'surfacic resolution' in the bottom image is not equivalent to the image position derivative curve at the top." Sur-reply, 16.



No Evidence Stands Against Dr. Kessler's Matsusaka Model

Rebuttal to:

"Based on the information Dr. Kessler shared, he generated the resolution plot using a weighted spectra spanning the visible range but plotted MTF under a single wavelength."
Sur-reply, 20.

Dr. Kessler's Explicit Basis for Choosing MTF Parameters

30. The MTF curve referred to by Dr. Leebby and similarly in the '120' is quite poorly defined. The MTF is actually a multi-parameter function for almost all lenses. The '120 Patent only refers to the tangential and sagittal MTFs. See EX1001, 5:66-6:8. When using the MTF curves as a function of the field one has to specify at which spatial frequency the MTF is shown. Commonly one would show a collection of MTF curves as a function of the field for a chosen collection of spatial frequencies, each of which often can be significantly different. Thus the term "MTF curve" requires a mention of a **particular spatial frequency** and if it is a tangential or sagittal curve. Alternately, a designer could seek to utilize an average MTF over a specified range of spatial frequencies or a weighted MTF curve over the spatial

frequencies over a given range (e.g., 10 cycles per mm to 90 cycles/mm). However, the '120 Patent does not provide sufficient description of the MTF curves shown in FIG. 5 to know with certainty exactly which type of MTF curve is illustrated. Regardless, independent claim 1 does not appear to be limited to the MTF curves in FIG. 5 or an MTF curve under any specific parameters when evaluating "a drop of MTF in a zone of the image," as recited in limitation [1e].

31. Because the '120 Patent does not specify the spatial frequency at which the MTF is to be considered, I have plotted the MTF curve for Matsusaka's Example 19 lens at six different spatial frequencies. Each frequency shows the tangential MTF and the sagittal MTF (the dashed line).

No Evidence Stands Against Dr. Kessler's Matsusaka Model

Rebuttal to:

"Dr. Lebby explained that Dr. Kessler's resolution data relied on a 100° half field of view instead of Matsusaka's given value of 104.183°." Sur-reply, 20.

Dr. Lebby's Footnote About Half Field

did this for his analysis. EX1003 ¶¶ 164, 195. With respect to Matsusaka, for example, he arbitrarily assigned the image radius as 1000 pixels and divided by the 100° half field of view³ to place a horizontal line at 10 pixels per degree on his plot. EX1003 ¶ 164. This is fine, provided he used the same 1000 pixel image size to derive the resolution curve for Matsusaka's actual lens (which Dr. Kessler does not confirm in his declaration) so that the comparison with the horizontal line is accurate.

³ I note that Dr. Kessler inexplicably rounded the half field of view in his analysis to 100°. To be accurate, Dr. Kessler should have used Matsusaka's given half field of view of 104.183°. EX1005 ¶ [0411].

No Evidence Stands Against Dr. Kessler's Matsusaka Model

Rebuttal to:

“Dr. Lebbby explained that Dr. Kessler’s resolution data relied on a 100° half field of view instead of Matsusaka’s given value of 104.183°.” Sur-reply, 20.

Dr. Kessler’s Testimony About Half Field

22 Q Why would you use 100 and not the full
1 104?
2 A Why? Because it's a prettier image,
3 more -- sometimes Zemax when they do drawings,
4 they scale it, okay. You have a beam coming from
5 infinity, and it comes at more than 90 degrees,
6 there is an automatic scaling factor on the
7 drawings which blows it up -- sorry. Diminishes
8 the image. So by putting 100, I get a pretty
9 image which then can be easily compared size-wise
10 to the patent.

21 And for that, you only care about,
22 especially for these kind of items, the position
1 of the central beam, okay, which is not
2 affected -- or the behavior of the distribution
3 function is not affected by the F number at all
4 and affected on the field only in the sense that
5 if you do 100, you don't get all the way to 104,
6 you run it at 104 and you get the image
7 distribution all the way to 104.

However, to confirm this, I went back into my models and corrected these minor issues. I found that the outcome did not substantively change, and my original analysis and conclusions remain the same.

Ex. 2002 (Kessler Depo Trans.), 41:22-43:7;
Ex. 1023 (Kessler Supp. Decl.), ¶ 27, n. 3;
Paper 13, (Pet. Reply), 17

Patent Owner's Discussion of "Image Quality"

POR

Lens design is complicated by the numerous tradeoffs that must be balanced to achieve various design objectives. Ex. 2001 at ¶ 49; Ex. 2006 at 9-10. Key drivers of the design can include costs, tolerances, and optical performance. Ex. 2001 at ¶ 48; Ex. 2006 at 13-17. Optical performance factors to be balanced include sharpness, relative illumination, MTF, and distortion, among others. Ex. 2001 at ¶ 49; Ex. 2006 at 9-10, 18-26. These considerations have taken greater

Dr. Lebby's Declaration

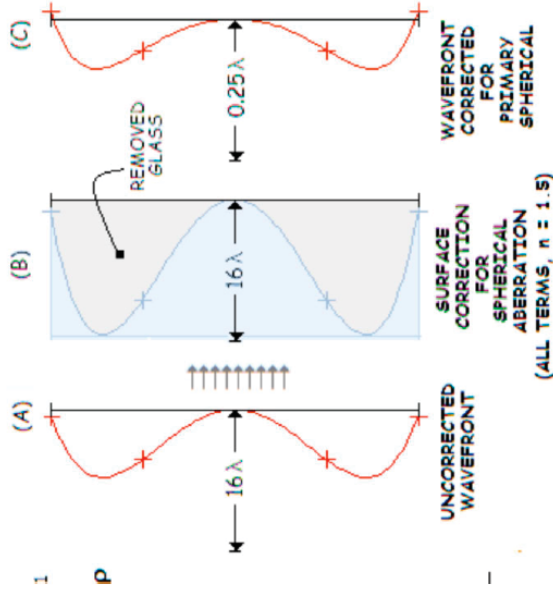
49. The basic performance of an optical lens system will be based also on for example, image quality, image sharpness, relative illumination, and modulation transfer function (MTF). Galstian pp. 18-26. While these characteristics are a sub-

Ex. 2001 (Lebby Decl.), ¶ 49;

Patent Owner's Explanation of "Compensate"

Immervision's Claim Construction Briefing

Next, Dr. Reiley explains that "compensate" is equivalent in lens design to "correction." *Id.*, ¶ 44. Correction of aberrations is "one of the essential elements of lens design, in which an excess of one form of image degradation is corrected by the addition of a *similar amount, but opposite sign*, of the same form of image degradation." *Id.* (emphasis added). Dr. Reiley gives examples of several types of aberration correction, including a detailed explanation of a long-known technique for the correction of "spherical aberration." *Id.*, ¶¶ 44-46.



Ex. 1024 (Joint Claim Construction Brief), ¶ 49;
Paper 13 (Pet. Reply), 5

Patent Owner Misrepresents Teachings of FIGS. 4 and 5

1001 at 6:30-41; Ex. 2001 at ¶ 88. Unlike Fig. 6, which is tied to Figs. 4-5, the ‘120 Patent does not align Fig. 7 with any illustrated relative illumination or MTF plot. Ex. 1001 at 6:9-61; Ex. 2001 at ¶ 91. Dr. Kessler further admits that the ‘120 POR, 21

3:18-25, 6:9-61. There is also no relative illumination curve provided in the ‘120 Patent to compare with the Fig. 7 resolution plot.

Ex. 2001 (Leby Decl.), ¶ 91

FIG. 4 shows a typical relative illumination curve **400** for a miniature wide-angle lens according to embodiments of the present invention. The exact values of the relative illumination with respect to the field of view vary between each embodiment of the present invention, but the overall shape having a value around 100% at 0° shown at center **410** and under 80% at the maximum field angle shown at position **420** is present in all families of miniature wide-angle lenses according to the present invention.

FIG. 5 shows a typical sagittal MTF curve **500** and tangential MTF curve **505** for a miniature wide-angle lens according to embodiments of the present invention. The exact values of the MTF with respect to the field of view vary between each embodiment of the present invention and also vary according to the spatial frequency at which the MTF is calculated, but the overall shape having a higher value at 0° shown at center **510** than at the edge shown at position **520** is present in all families of miniature wide-angle lenses according to the present invention.

Ex. 1001 (‘120 Patent), 5:57-6:8;
Paper 13 (Pet. Reply), 8