

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Jean-Claude Artonne et al.
U.S. Patent No.: 6,844,990 B2 Attorney Docket No.: 50095-0114IP1
Issue Date: January 18, 2005
Appl. Serial No.: 10/706,513
Filing Date: November 12, 2003
Title: METHOD FOR CAPTURING AND DISPLAYING A VARIABLE
RESOLUTION DIGITAL PANORAMIC IMAGE

Mail Stop Patent Board

Patent Trial and Appeal Board
U.S. Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

**PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT
NO. 6,844,990 PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42**

TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	IPR REQUIREMENTS	1
	A. Standing	1
	B. Challenge and Relief Requested	1
	C. Claim Construction	2
III.	'990 PATENT	5
	A. Overview	5
	B. Relevant Prosecution History	12
	C. Panasonic IPR and Subsequent Reexamination	13
	D. LG IPRs	14
IV.	LEVEL OF ORDINARY SKILL IN THE ART	15
V.	APPLYING PRIOR ART TO CHALLENGED CLAIMS	15
	A. Ground 1: Baker in view of Shiota Renders Obvious Claims 2, 4, 27, and 29	15
	1. Baker (APPLE-1006)	15
	2. Shiota (APPLE-1012)	20
	3. Combination of Baker and Shiota	22
	4. Analysis	27
	B. Ground 2: Baker in view of Shiota and Fisher Renders Obvious Claims 29 and 30	62
	1. Fisher (APPLE-1009)	62
	2. Combination of Baker, Shiota, and Fisher	65
	3. Analysis	69
VI.	DISCRETIONARY DENIAL IS NEITHER APPROPRIATE NOR EQUITABLE	70
	A. §314(a): The <i>Fintiv</i> Factors Favor Institution	70
	1. Factor 1: Institution Will Increase Likelihood of Stay	71
	2. Factor 2: The Final Written Decision will Issue Before Any Foreseeable Trial	72
	3. Factor 3: Early Stage of Parallel Proceedings	72
	4. Factor 4: Under the Current Trial Schedule, No Overlap is Possible	72
	5. Factor 5: Apple's involvement in Parallel Proceedings	73
	6. Factor 6: Other Circumstances Support Institution	73

B.	§325(d): This Petition Applies New Arguments Not Previously Considered or Relied Upon by the Office	73
VII.	CONCLUSION AND FEES	79
VIII.	MANDATORY NOTICES UNDER 37 C.F.R § 42.8(a)(1).....	79
A.	Real Party-In-Interest Under 37 C.F.R. § 42.8(b)(1).....	79
B.	Related Matters Under 37 C.F.R. § 42.8(b)(2)	79
C.	Lead And Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3).....	80
D.	Service Information	81

PETITIONER’S EXHIBIT LIST

APPLE-1001	U.S. Patent No. 6,844,990 to Artonne et al. (“the ’990 patent”)
APPLE-1002	Prosecution History of the ’990 Patent (“Original Prosecution History”)
APPLE-1003	Declaration of Dr. David Kessler, Ph.D.
APPLE-1004	Curriculum Vitae of Dr. David Kessler, Ph.D.
APPLE-1005	Service of complaint in <i>ImmerVision, Inc. v. Apple, Inc.</i> , D.Del. 1:21-cv-01733-MN-CJB (January 18, 2022)
APPLE-1006	U.S. Patent No. 5,686,957 to Baker (“Baker”)
APPLE-1007	“Fish Eye Lens” by K. Miyamoto (Feb. 19, 1964) (“Miyamoto”)
APPLE-1008	Service of complaint in <i>ImmerVision, Inc. v. Apple, Inc.</i> , D.Del. 1:21-cv-01484-MN-CJB (January 18, 2022)
APPLE-1009	U.S. Patent No. 3,953,111 to Fisher et al. (“Fisher”)
APPLE-1010	U.S. Patent No. 6,128,145 to Nagaoka (“Nagaoka”)
APPLE-1011	Reexamination File History for the ’990 Patent (“Reexam History”)
APPLE-1012	EP 1028389 A2 to Shiota et al. (“Shiota”)
APPLE-1013	Rebiai et al., “Image Distortion from Zoom Lenses: Modeling and Digital Correction,” 1992 IBC International Broadcasting Convention (July 1992) (“Rebiai”)
APPLE-1014	JP 2000-242773 to Matsui et al. (“Matsui”) (original and translated documents also provided in APPLE-1011, 43-51, 180-198, as provided by Patent Owner during reexamination)

APPLE-1015	U.S. Patent No. 5,861,999 to Tada (“Tada”)
APPLE-1016	Zeljko Andreic, “Simple 180° field-of-view F-theta all-sky camera,” SPIE Proc. 1500 (Oct. 1, 1991) (“Andreic”)
APPLE-1017	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”)
APPLE-1018	Susan Houde-Walter, “Recent Progress In Gradient-Index Optics,” SPIE Proc. 0935 (Apr. 8, 1988) (“Houde-Walter”)
APPLE-1019	Petition for Inter Partes Review of U.S. Patent No. 6,844,990, filed by Panasonic System Networks Co., Ltd. (IPR2014-01438)
APPLE-1020	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”)
APPLE-1021	Vidal, “Interim Procedure for Discretionary Denials in AIA Post Grant Proceedings with Parallel District Court Litigation” (USPTO, June 2021)
APPLE-1022	Scheduling Order entered in <i>ImmerVision, Inc. v. Apple, Inc.</i> , D.Del. 1:21-cv-01733-MN-CJB and <i>ImmerVision, Inc. v. Apple, Inc.</i> , D.Del. 1:21-cv-01484-MN-CJB (entered on June 21, 2022)

LISTING OF CLAIMS

Claim 1	
[1pre]	A method for capturing a digital panoramic image
[1a]	by projecting a panorama onto an image sensor by means of a panoramic objective lens,
[1b]	the panoramic objective lens having an image point distribution function that is not linear relative to the field angle of object points of the panorama,
[1c]	the distribution function having a maximum divergence of at least $\pm 10\%$ compared to a linear distribution function,
[1d]	such that the panoramic image obtained has at least one substantially expanded zone and at least one substantially compressed zone.
Claim 27	
[27pre]	A method for displaying a digital panoramic image, the method comprising:
[27a]	obtaining a digital panoramic image by projecting a panorama onto an image sensor using a panoramic objective lens,
[27b]	the panoramic objective lens having an image point distribution function that is not linear relative to a field angle of object points of the panorama,
[27c]	the distribution function having a maximum divergence of at least $\pm 10\%$ compared to a linear distribution function,
[27d]	such that the panoramic image obtained has at least one substantially expanded zone and at least one substantially compressed zone, and
[27e]	displaying the obtained panoramic image by correcting the non-linearity of the initial image,

[27f]	correcting the non-linearity ... performed by retrieving image points on the obtained image in a coordinate system of center O' using at least the non-linear distribution function and a size L of the obtained image
Claim 2	
[2pre]	The method according to claim 27,
[2a]	wherein the objective lens has a non-linear distribution function that is symmetrical relative to the optical axis of the objective lens, the position of an image point relative to the center of the image varying according to the field angle of the corresponding object point
Claim 4	
[4pre]	The method according to claim 27,
[4a]	wherein the objective lens expands the edges of the image and compresses the center of the image.
Claim 29	
[29pre]	The method according to claim 27,
[29a]	wherein the objective lens comprises a set of lenses forming an apodizer.
Claim 30	
[30pre]	The method according to claim 29,
[30a]	wherein the set of lenses forming an apodizer comprises at least one aspherical lens.

I. INTRODUCTION

Apple, Inc. (“Apple” or “Petitioner”) petitions for Inter Partes Review (“IPR”) of claims 2, 4, 27, 29, and 30 (“Challenged Claims”) of U.S. Patent 6,844,990 (“’990 Patent”).

II. IPR REQUIREMENTS

A. Standing

Apple certifies that the ’990 Patent is available for IPR. Apple is not barred or estopped from requesting this review on the grounds identified below. APPLE-1005; APPLE-1008.

B. Challenge and Relief Requested

Petitioner requests an IPR of the Challenged Claims on the grounds set forth below. Additional explanation/support for each ground is set forth in Dr. Kessler’s declaration (APPLE-1003, ¶¶43-259).

Ground	’990 Patent Claims	Basis
1	2, 4, 27, 29	§103: Baker in view of Shiota
2	29, 30	§103: Baker in view of Shiota and Fisher

The application that resulted in the ’990 Patent was filed on November 12,

2003, and is identified as a continuation of PCT Application No. PCT/FR02/01588, filed on May 10, 2002. APPLE-1001, Face. The '990 Patent claims foreign priority to FR Application 01 06261, filed on May 11, 2001. APPLE-1001, Face. Thus, the earliest priority date of the '990 Patent is May 11, 2001¹ ("Critical Date")².

Each of the prior art references applied in Grounds 1-2 qualifies as prior art to the '990 Patent on at least the bases shown below:

Reference	Date	Prior Art Status
Baker (APPLE-1006)	Filed: June 30, 1995 Issued: November 11, 1997	102(b)
Shiota (APPLE-1012)	Filed: January 7, 2000 Published: August 16, 2000	102(a)
Fisher (APPLE-1009)	Filed: November 4, 1974 Issued: April 27, 1976	102(b)

C. Claim Construction

For the analysis presented herein, Petitioner is applying the constructions adopted in IPR2020-00195 for certain applicable claim terms in the Challenged

¹ In reexamination, Patent Owner contended that May 10, 2002 is the earliest priority date for the '990 Patent. APPLE-1011, 227-228.

² Petitioner does not concede that the '990 Patent is entitled to this priority date.

Claims, as reflected below:

Claim Term	Construction
“panoramic objective lens”	“a super-wide or ultra-wide objective lens”
“object points of the panorama”	“points of the object in the panorama being viewed by the lens”
“image point”	“a point of light projected by the lens onto an image plane, said light coming from the corresponding object point of a viewed object in the panorama”
“field angle of object points”	“the angles of incident light rays passing through the object points and through the center of the panorama photographed, relative to the optical axis of the objective lens”
“maximum divergence”	“Defined by the formula $DIV_{max} \% = \frac{dr(Pd) - dr(Pdl)}{dr(Pdl)} * 100$, where $dr(Pd)$ is the relative distance from the center of the image to the point

	of maximum divergence P_d , and $dr(P_d)$ is the relative distance in relation to the center of the corresponding point on the linear image distribution line”
“expanded zone”	“the portion of the image point distribution function where the gradient is higher than the gradient of the linear distribution function”
“compressed zone”	“the portion of the image point distribution function where the gradient is lower than the gradient of the linear distribution function”

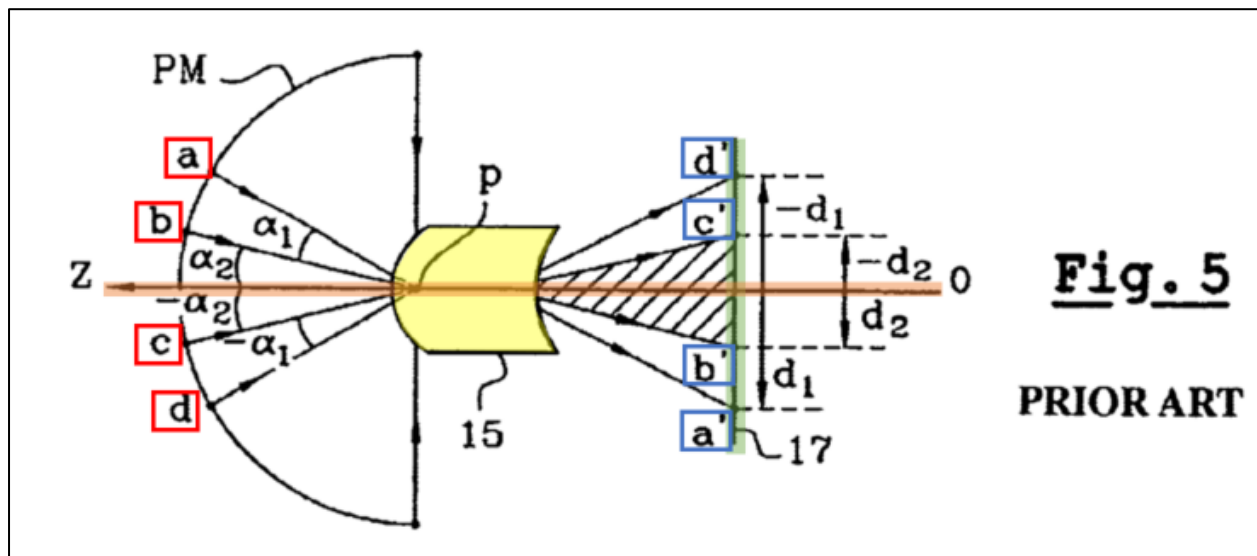
For the other claims terms of the Challenged Claims, because the evidence below and the prior art’s description of the claimed elements are similar to that of the ’990 specification, Petitioner believes that no claim constructions are necessary “to resolve [a] controversy” as to such claim terms. *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011). Petitioner is pursuing prior art-based invalidity grounds in this IPR and is not waiving arguments concerning invalidity grounds (*e.g.*, §112) that cannot be raised in this proceeding.

III. '990 PATENT

A. Overview

The '990 Patent is directed to “a method for capturing a digital panoramic image” using “a panoramic objective lens.” APPLE-1001, Abstract; APPLE-1003, ¶¶75-94.

The '990 Patent's Figure 5 (reproduced and annotated below) represents a conventional system “for taking panoramic shots,” and includes a panoramic objective lens 15 (yellow) having an optical axis OZ (orange) and a digital image sensor 17 (green) arranged in the image plane of the objective lens 15. APPLE-1001, 6:66-7:2.



As shown, object points (e.g., a, b, c, d – red above) are projected through the panoramic objective lens and captured as respective image points (e.g., a', b', c', and d' – blue above) at the image sensor 17. APPLE-1001, 7:2-14. The field angle of

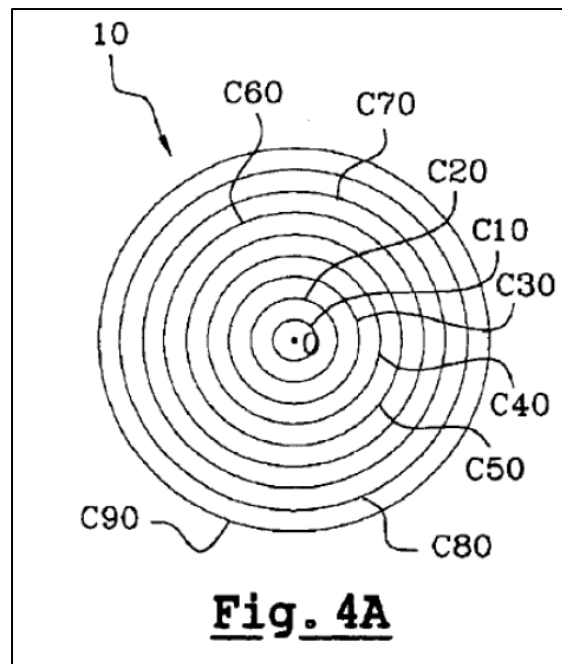
each of the object points is identified above as α_1 , α_2 , $-\alpha_2$, $-\alpha_1$ ³, and represents the “angle that an incident light ray passing through the object point considered and through the center of the panorama PM, marked by a point ‘p’ on FIG. 5, has relative to the optical axis OZ of the objective lens.” APPLE-1001, 7:2-10. On the image sensor 17, image points a’, b, c’, and d’ are located at distances from the center of the image, respectively, equal to d1, d2, -d2, -d1. APPLE-1001, 7:11-14.

Per the ’990 Patent, the distribution of image points according to the field angle of the object points is linear in prior art panoramic objective lenses. APPLE-1001, 7:14-19. “Linearity” as used in the ’990 specification refers to a ratio of proportionality between the distance of an image point measured relative to the center of the image and the field angle of the corresponding object point. APPLE-1001, 7:24-28. Thus, the distances d1 and d2 are linked by the following relation: $d1/\alpha_1 = d2/\alpha_2$. APPLE-1001, 7:20-22. Because the angle α_1 for object point a is twice angle α_2 for object point b (i.e., $\alpha_1 = 2\alpha_2$), distance d1 of the corresponding image point a’ will be twice the distance d2 of the corresponding image point b’ (i.e.,

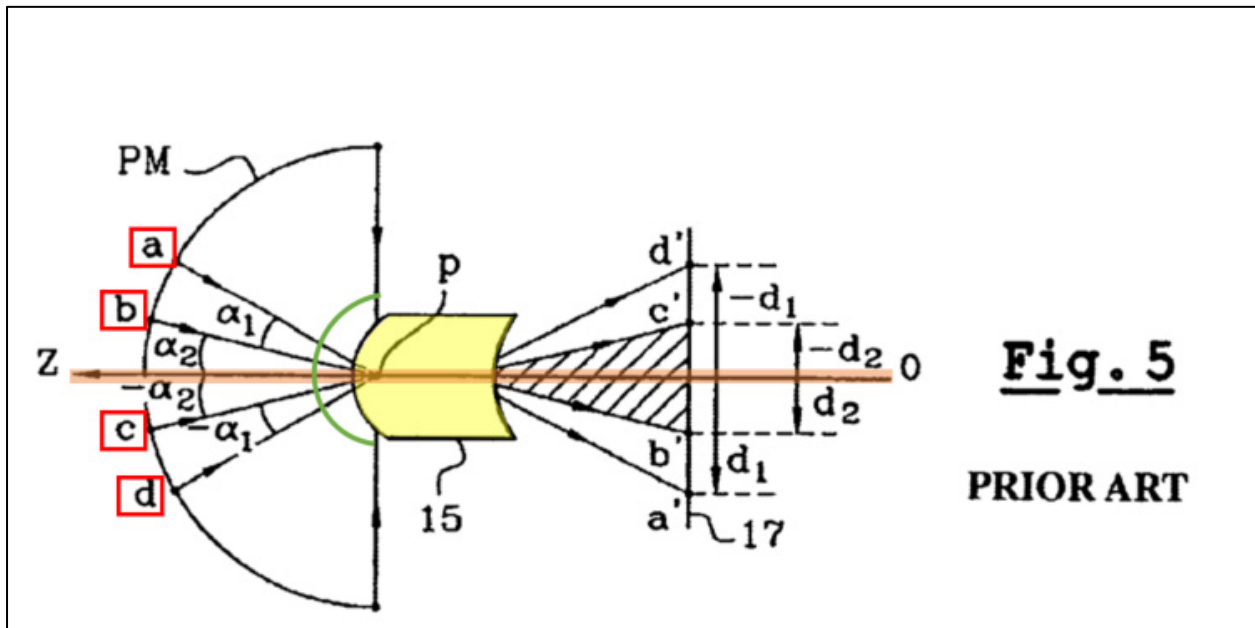
³ In Figure 5, angles α_1 and $-\alpha_1$ should have been shown as being between “a” and the axis OZ, and the angle between “d” and the axis OZ, respectively. APPLE-1003, ¶77 n. 1.

$d1=2d2$). *Id.*

Because of such linearity in prior art panoramic objective lenses and the axial symmetry of panoramic objective lenses, the '990 Patent states that image points corresponding to object points having an identical field angle form equally spaced concentric circles C10, C20 through C90 on an image disk 10, as shown in Figure 4A (below). APPLE-1001, 1:30-32, 2:14-29, 18:17-23.

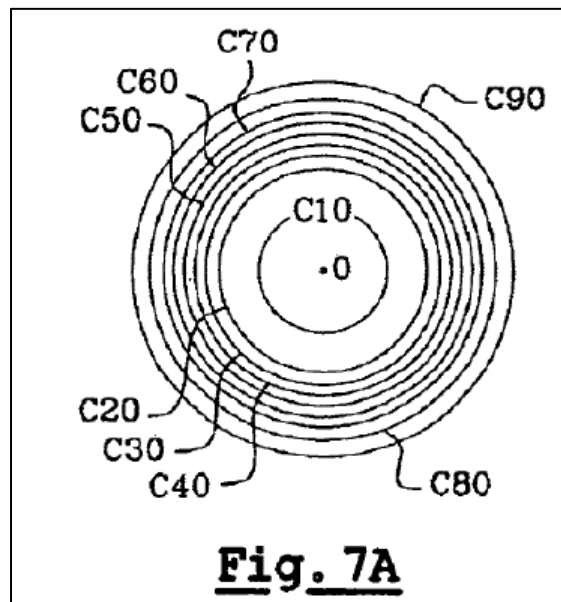


Additionally, because of axial symmetry, the field angle of an object point is between 0° and 90° for an objective lens having an aperture of 180° , e.g., as shown by the green semicircle below. APPLE-1001, 1:30-32, 2:22-23, 18:17-23, FIG. 4 (annotated).



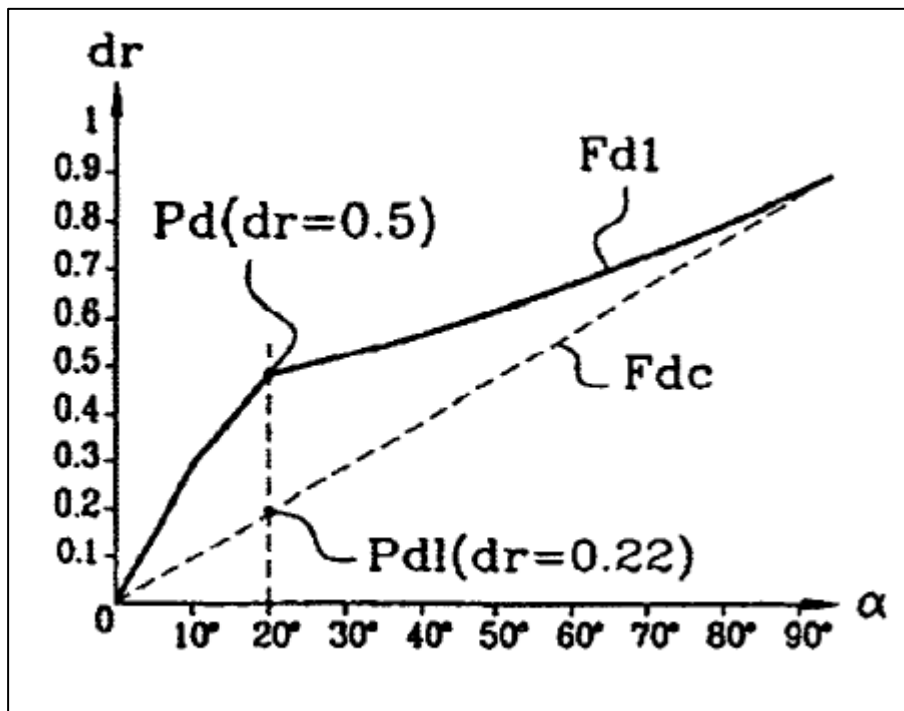
The purported invention of the '990 Patent is a panoramic objective lens having an image point distribution function that is not linear relative to the field angle of object points, which creates at least one zone of the image that is expanded and at least another zone that is compressed. APPLE-1001, Abstract. Per the '990 Patent, the expanded zones of the image cover more pixels of the image sensor than if they were not expanded. APPLE-1001, 4:3-6.

The '990 Patent states that the portions of the image to expand and compress can be chosen according to the intended application. APPLE-1001, 7:66-8:5, 4:6-10. Figure 7A (below) illustrates one such application by providing an image distribution function of a panoramic objective lens that expands the center of the image:



APPLE-1001, Fig. 7A, 8:12-14. As seen by comparing Fig. 7A and 4A (the latter is obtained using a linear panoramic objective lens), the circles C10 and C20 are further from the center of the image and further from each other in FIG. 7A, while the circles C30 to C90 are closer to each other. APPLE-1001, 8:21-26. This panoramic image (shown in FIG. 7A) thus has an expanded zone in the center and a compressed zone towards the edge of the image disk. APPLE-1001, 8:26-28.

Another way the '990 Patent illustrates the expanded and compressed zones is by using a curve of a corresponding image point distribution function as shown in FIG. 7B (below), where the X-axis represents the field angle of the object point (in degrees) and the Y-axis represents the relative distance of an image point in relation to the center of the image. APPLE-1001, 8:29-38; APPLE-1003, ¶86.



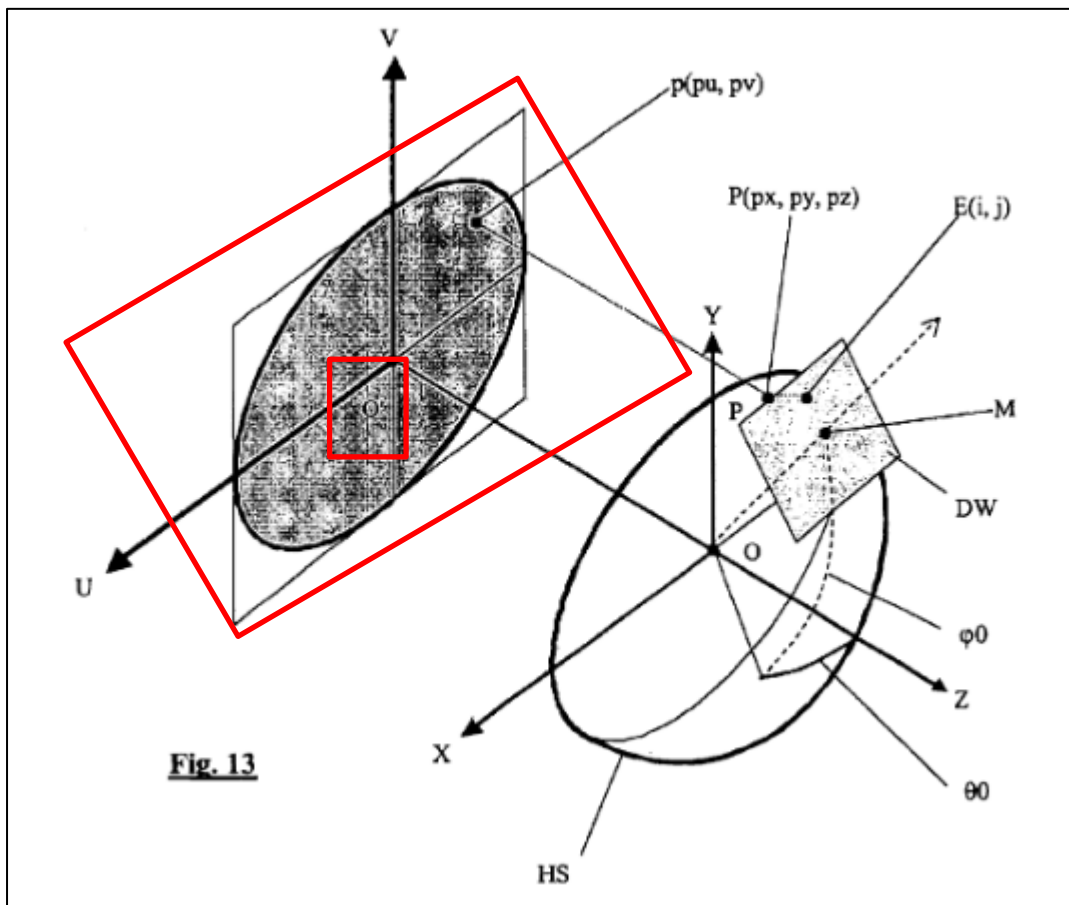
APPLE-1001, Fig. 7B (annotated). As shown, the curve of the function $Fd1$ has a higher gradient than the straight or linear line Fdc for angles α between 0° and 20° , and a lesser gradient between 20° and 90° . APPLE-1001, 8:38-41. A higher gradient relative to the linear/straight line represents an expansion of the image and a lower gradient means a compression of the image. APPLE-1001, 8:41-43; APPLE-1003, ¶¶86-87; *see also* APPLE-1001, 9:58-64, Fig. 9, APPLE-1003, ¶¶90-91 (describing and showing an image distribution for an image with compressed, expanded, and compressed zones).

The '990 Patent describes using this curve to calculate a point of maximum divergence " Pd ," which is the point with the greatest gap in relative distance dr in relation to the corresponding point on the linear distribution straight line (Fdc).

APPLE-1001, 8:44-49.

Per the '990 Patent, the maximum divergence DIV_{max} of the distribution function F_{dl} is calculated using the formula: $DIV_{max} \% = \frac{dr(P_d) - dr(P_{dl})}{dr(P_{dl})} * 100$, where $dr(P_d)$ is the relative distance from the center of the image to the point of maximum divergence P_d , and $dr(P_{dl})$ is the relative distance from the center of the image to the linear distribution straight line, at the same field angle (here 20°). APPLE-1001, 8:49-65. Applying this formula, the maximum divergence at the field angle of 20° in Figure 7B is +125% (*i.e.*, $\frac{[0.5 - 0.222]}{[0.222]} * 100$). APPLE-1001, 9:1-2.

The '990 Patent states that the non-linearity in the image can be corrected, *e.g.*, using the non-linear distribution function of the objective lens, to display an image that is “free from the optical distortion.” APPLE-1001, Abstract, 10:6-17. In one embodiment, the '990 Patent's correction method involves a two-step technique: (1) projecting the image points of an image sector corresponding to a display window (referred to as $E(i, j)$), onto a sphere portion of a hemisphere of center O and of axes OX , OY , OZ , to obtain image points $P(px, py, pz)$; and (2) projecting the determined image points P (*i.e.*, $P(px, py, pz)$) onto an image disk ($ID1$) using the lens's non-linear distribution function. APPLE-1001, 12:59-14:35, FIG. 13.



As shown above, the projection of the image points P onto the image disk ID1 allows image points $p(p_u, p_v)$ to be obtained on the image disk, in a coordinate system of center O' (corresponding to the center of the image disk) and of axes $O'U$ and $O'V$. APPLE-1001, 12:59-14:35, FIG. 13 (annotated above to show image disk and its center O'); APPLE-1003, ¶¶92-94.

B. Relevant Prosecution History

During original prosecution, Applicant cited Fisher (APPLE-1009), and foreign counterparts of Baker (APPLE-1006) and Nagaoka (APPLE-1010) (*i.e.*, EP

0 695 085 and EP 1 004 915, respectively). The Examiner issued a first-action allowance and noted in the reasons for allowance that the “prior art fails to teach ... the claimed features ... which include” the features recited in limitations [1b]-[1d] (which are similar in some respects to [27b]-[27d]). APPLE-1002, 232-233.

C. Panasonic IPR and Subsequent Reexamination

In September 2014, Panasonic System Networks Co., Ltd. (“Panasonic”) filed a petition for *inter partes* review of the ’990 Patent (“Panasonic IPR”), challenging claims 1-4, 6-7, 10, 11, 15-20, 22-23, and 25. APPLE-1019. Before an institution decision was entered, the parties in that proceeding sought—and the Board ordered—termination of that proceeding due to settlement. IPR2014-01438, Papers 9 and 11.

Patent Owner then requested *ex parte* reexamination of claims 1-4, 6-7, 10-11, 15-20, 22-23, and 25 of the ’990 Patent using the same art from the Panasonic IPR. APPLE-1011, 227-237. With the reexamination request, Patent Owner filed a preliminary amendment, in which it cancelled claims 1, 6-7, and 22, added new claims 27-48, and amended claims 2-4 and 15 (where claims 2-4 were amended to now depend from claim 27). APPLE-1011, 247.

The Office granted the request for *ex parte* reexamination of the ’990 Patent, finding that the request raised substantial new questions (SNQ) of patentability with

respect to claims for which reexamination was requested. APPLE-1011, 283-291. Baker, Fisher, and Shiota were among the references that were applied during reexamination and which formed, at least in part, the basis for the SNQ finding. *Id.* The Office subsequently issued a Notice of Intent to Issue *Ex Parte* Reexamination Certification (NIRC), finding, in part, that claims 2-4 (as amended to depend from new claim 27) and new claims 27-47 were allowable. APPLE-1011, 343-344.

In its reasons for patentability, the Office stated that the “prior art of record, including ... Baker, Fisher, Shiota ... , does not specifically disclose or fairly teach a method for capturing a digital panoramic image” including the features recited in limitations [27e]-[27f]. *Id.* The reexamination certificate then issued. APPLE-1011, 355-356; APPLE-1001, *Ex Parte Reexamination Certificate*; see APPLE-1003, ¶¶96-100.

D. LG IPRs

Petitioner LG Electronics Inc. filed two petitions (in IPR2020-00195 and IPR2020-00179) challenging the patentability of claims 5 and 21 in view of Tada (APPLE-1015) alone or in view of either Nagaoka or Baker. APPLE-1002, 342-420, 348, 387. In the FWDs, the Board found that LG’s petitioned grounds did not render claims 5 and 21 unpatentable. APPLE-1002, 380, 419. Neither of the LG IPRs addressed claim 27 or any claim depending therefrom (which are at issue here).

APPLE-1002, 374-379, 413-419.

IV. LEVEL OF ORDINARY SKILL IN THE ART

A POSITA as of the '990 Patent's Critical Date would have had at least a Bachelor's degree in Physics, Optical Engineering, and/or Electrical Engineering and at least five years' experience in developing and designing optical imaging systems and have familiarity with image processing algorithms and optical design software. APPLE-1003, ¶¶24-25. Superior education could compensate for a deficiency in work experience, and vice-versa. *Id.*

V. APPLYING PRIOR ART TO CHALLENGED CLAIMS

A. Ground 1: Baker in view of Shiota Renders Obvious Claims 2, 4, 27, and 29

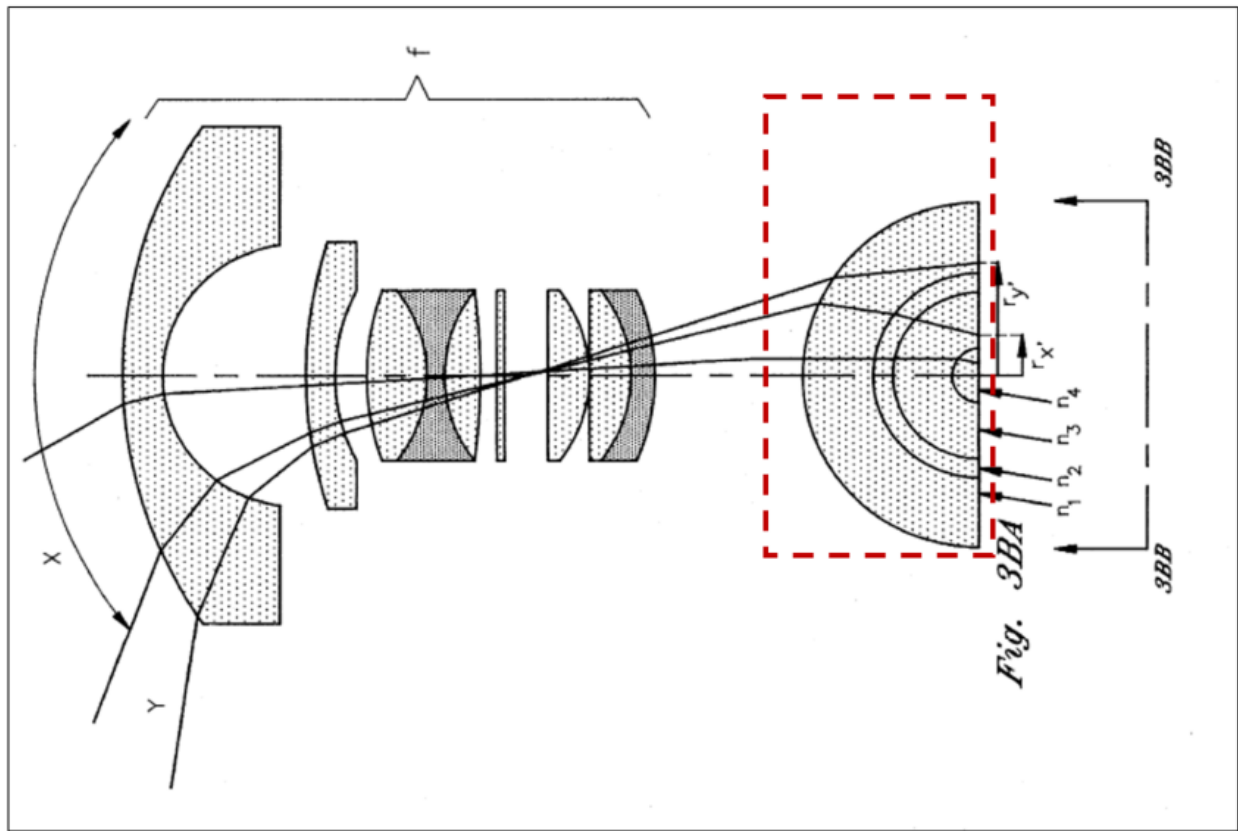
1. Baker (APPLE-1006)

Baker discloses a “video conferencing, voice-directional video imaging system for automatic electronic video image manipulation of a selected, directional signal of a hemispheric conference scene” APPLE-1006, 5:16-24; APPLE-1003, ¶¶106-115.

Baker's system includes an “imaging system” that includes a “camera having a capture lens” that captures a hemispherical or panoramic scene. *Id.*, 5:37-47. The capture lens in Baker's system “emphasizes the peripheral content of a hemispherical field of view” (*id.*, 5:48-54) by “imaging the field of view to the image

plane such that the ratio of the size of the smallest detail contained within the periphery of the scene to the size of the smallest resolving pixel of an image device is increased.” *Id.*, 5:57-62. Specifically, Baker explains that the “panoramic image” provided by its imager “is ideally suited for teleconferencing” where the “important image information” is located “along a 10 to 30 degree ... segment of the horizon,” which represents a 60° to 80° segment of the field. APPLE-1006, 5:37-47, 1:52-58; *see id.*, 3-12-16 (“To obtain sufficient detail on the critical objects in the scene, the technique should differentiate between the relevant visual information along the horizon and the remaining visual information in the scene in order to provide greater resolution in areas of higher importance”); APPLE-1003, ¶¶107-113.

An example of Baker’s capture lens as deployed in its imaging system is shown below:



APPLE-1006, FIGS. 3BA-3BB. As shown, Baker's lens includes a "multi-element refractive lens that is designed to capture a wide field of view" and a "hemispherical lens" (annotated above in red) that "is made of gradient index material" such that "points impinging the image plane incur different factors of magnification depending on what index of refraction and what portion of the hemispherical curve or lenselets they pass through." APPLE-1006, 11:52-65; *see id.*, 12:5-14 (explaining that, with the gradient index hemispherical element, index values decrease from the center such that $n_1 < n_2 < n_3 < n_4$).

Using Baker's above lens, the peripheral portion of the scene is "map[ped] to

a larger percentage of a given image detector area and, simultaneously, the mapped image of the central area of the scene ... [is] minimized by the lens so that it does not interfere with the peripheral content now covering a wider annulus in the image plane.” *Id.*, 5:55-6:1.

Baker explains that its lens increases resolution in the peripheral portion of an image compared to a typical fisheye lens: “if an ordinary fisheye lens focuses the lowest 15 degrees up from the horizon on ten percent of the imager at the imaging plane and the peripheral-enhancing lens focuses that same 15 degrees on fifty percent of the imager, there is a five-fold increase in resolution using the same imaging device” and “[d]epending on the application and exact formulation of the lens equations, there will be at least a five times increase in resolving power by this lens/imager combination.” *Id.*, 6:43-56; *see id.*, 11:48-51, 12:33-55, 8:32-40, 5:37-47, 1:52-58.

Baker’s lens projects an image on an image sensor (e.g., a CCD) of the camera and this image can be stored in memory or another storage device. APPLE-1006, 13:9-18, 14:9-17. Subsequently, “[w]hen a portion of the scene is to be displayed,” Baker’s system retrieves the image information relating to the relevant portion of the scene from memory or another storage device. *Id.*, 6:5-24. Baker explains that the image captured using its lens is in a “warped form” in which the image “warp[ing]”

is caused in part by the selective magnification along the peripheral field of view. APPLE-1006, 14:18-26. Baker's system compensates for this warping and displays a "corrected" version of the captured image with the "proper aspect of ratio for the human visual system (i.e., as a perspective corrected view)":

The transform processor subsystem compensates for the distortion or difference in magnification between the central and peripheral areas of the scene caused by the lens by applying appropriate correction criteria to bring the selected portion of the scene into standard viewing format. The transform processor subsystem can also more fully compensate for any aberrations of the enhanced peripheral image because of the image's improved resolution as it covers a larger portion of the image device (increased number of pixels used to detect and measure the smallest detail in the periphery image).

Id., 6:5-24, 14:42-15:59, 14:23-26 (recreating a "proper display of the scene in two dimensions for perspective-correct viewing). Thus, to perform this correction/transformation—i.e., "compensate[] for the distortion or difference in magnification between the central and peripheral areas of the scene caused by the lens"—Baker's transform processor applies "appropriate correction criteria to bring

the selected portion of the scene into standard viewing format.” APPLE-1006, 6:12-16; *see id.*, 6:16-24.

2. Shiota (APPLE-1012)

Like Baker, Shiota discloses an image transformation system for “transforming a fisheye image obtained by using a fisheye lens” into a “plane image for display.” APPLE-1012, Abstract

Shiota explains that an “image produced by [a] fisheye lens is ... distorted compared to ... an image obtained by using [a] standard lens and is very hard for the operator to watch it.” *Id.*, [0003]. Thus, Shiota’s system provides a two-step transformation process that transforms a “circular image obtained by using a fisheye lens into ... a plan[ar] image” (*id.*, [0004]), where the planar image is obtained by projecting points from the hemispherical objective lens surface onto a plane intersecting the lens surface at a point identifying the viewing direction from the origin of the camera. APPLE-1012, [0028]-[0032]; APPLE-1003, ¶¶116-121.

At the first step of Shiota’s transformation process, the projection of points P on the plane image (represented by u, v coordinates) are used to obtain the coordinates of the first projection points P’ (X_2 , Y_2 , Z_2) on a hemispherical face. APPLE-1012, [0028]-[0032]. This is similar to the ’990 Patent’s description of projecting image points onto a sphere portion of [a hemisphere] of center O and

along the X, Y, Z axes. *See* APPLE-1001, 12:66-13:4, 1:46-2:3; APPLE-1003, ¶118.

At the second step of Shiota's transformation process, the coordinates of the first projection points (i.e., $P' (X_2, Y_2, Z_2)$) are multiplied by a correction coefficient k_2 to generate the second projection coordinates (p_1, q_1). APPLE-1012, [0035]-[0041]; APPLE-1003, ¶119. Shiota discloses computing the correction coefficient k_2 by dividing the lens' image distribution function, h , by the radius r , which represents the distance from the origin to the projected point. APPLE-1012, [0031]-[0035]; *see id.*, [0036] (explaining that height (h) from the origin on the fisheye image face (origin of the p, q coordinate system) to an image point w is expressed as a function of the field angle and the focal distance, f), [0037] (identifying image distribution function including an equidistant projection function ($h=f*\theta$) and stereoscopic projection ($h=2f*\tan(\theta/2)$); *see* APPLE-1011, 117, 248, 250 (Patent Owner explaining that the function, $h=2f*\tan(\theta/2)$, as described in Shiota, is a non-linear distribution function that produces an image with an expanded portion); APPLE-1003, ¶120.

The correction coefficient k_2 is thus used to obtain the corrected image points (second projection coordinates (p_1, q_1)) that are to be displayed, e.g., by multiplying this coefficient with each of the first projection coordinates X_2 and Y_2 . APPLE-

1012, [0031]-[0035], [0042], [0046]; *see* APPLE-1011, 117; APPLE-1003, ¶¶120-121. Thus, Shiota describes correction or compensation of distortion in an image captured by a fisheye lens. *See id.*

3. Combination of Baker and Shiota

A POSITA would have found it obvious to combine the teachings of Baker and Shiota, and would have been motivated to do so, for at least the reasons described below. APPLE-1003, ¶¶128-139.

As described in §V.A.1 (incorporated here), Baker discloses that its objective lens is used to capture an image in a “warped form” in which the image “warp[ing]” is caused in part by the “magnification” or resolution enhancement along the peripheral field of view. APPLE-1006, 14:18-26; APPLE-1003, ¶¶129-130. Baker’s system “corrects” this warping and displays a “corrected” version of the captured image with the “proper aspect of ratio for the human visual system (i.e., as a perspective corrected view).” APPLE-1006, 14:23-26, 9:5-13.

To perform this correction/transformation and “recreate a proper display of the [captured] scene in two dimensions for perspective-correct viewing,” Baker’s system includes “processor logic in transform processor engine 22” (shown in Baker’s FIG. 1). APPLE-1006, 14:42-47, FIG. 1; *see id.*, 14:47-54. The transform processor “compensates for the distortion or difference in magnification between the

central and peripheral areas of the scene caused by the lens by applying appropriate correction criteria to bring the selected portion of the scene into standard viewing format.” APPLE-1006, 6:12-16; *see id.*, 6:16-24; APPLE-1003, ¶130.

As part of this transformation, Baker contemplates remapping of two-dimensional images from a set of Cartesian coordinates (x,y) as defined within each image sector “unit” (A1, B1, etc.) onto a newly transformed set of coordinates (u,v). APPLE-1006, 14:55-15:6, 16:5-10; APPLE-1003, ¶131. Per Baker, this remapping is matched to the image distortion—i.e., to the varying enhancement/magnification resulting from Baker’s objective lens. *See* APPLE-1006, 15:14-19 (“The remapping of the pixel location is matched to the differential magnification of the particular periphery-enhancing lens”). Therefore, a POSITA would have understood that Baker’s system corrects or compensates for the distortion introduced into the image by its objective lens (which has a non-linear image distribution). APPLE-1003, ¶¶131-132.

However, Baker does not expressly describe how such corrections are applied as part of its image transformation. APPLE-1003, ¶132. Before the Critical Date, however, it was well known to compensate for a captured image’s distortion using the non-linear image distribution function of the lens used to capture the image. APPLE-1003, ¶132 (citing as corroboration, e.g., APPLE-1013, 1-2; APPLE-

1014/Matsui (as cited in APPLE-1011, 43-51, 180-198) at [0023]-[0026], [0030]-[0031]).

Like this well-known teaching in the art, Shiota discloses compensation or correction of distortion in an image captured by a fisheye lens using a non-linear distribution function. APMT-1012, [0028]-[0042]; *see* §V.A.2, *supra*. Indeed, Patent Owner has acknowledged that Shiota's above-described teachings of compensating for the distortion in the image using a non-linear image distribution function (*see* §V.A.2, *supra*) demonstrate that Shiota discloses correcting the non-linearity of the image using a non-linear image distribution function. APPLE-1011, 117-118, 248, 250.

Given that (1) Baker and Shiota disclose compensating for or correcting the distortion in an image captured by a fisheye lens (*see* §§V.A.1-2, *supra*), and (2) Shiota provides a well-known technique to implement such a compensation, e.g., by using the non-linear image distribution function of the lens (*see* §V.A.2 *supra*), implementing Baker's image transformation functionality using Shiota's described technique of using the non-linear distribution function to perform the image transformation/compensation, would have amounted to the use of a known technique to improve similar devices in the same way, and combining prior art elements according to known methods to yield predictable results—display an image that

“compensates for distortion or difference in magnification between the central and peripheral areas of the scene caused by the lens.” APPLE-1003, ¶¶133-134; APPLE-1006, 6:5-24, 16:5-9.

Additionally, because Baker discloses “compensat[ing] for the distortion or difference in magnification between the central and peripheral areas of the scene caused by the lens” by “matching the differential magnification of” the lens (APPLE-1006, 6:12-22, 15:16-19, 16:5-9), a POSITA would have been motivated to use the same non-linear image distribution function that introduced this “differential magnification” to achieve the corresponding distortion/magnification correction. APPLE-1003, ¶¶135-136 (citing as corroboration, e.g., APPLE-1013, 1-2 (describing correction of distorted images using a function representing the deformation/distortion in the image)).

Patent Owner has similarly acknowledged that a POSITA “would recognize the need to correct” the warped image “captured by Baker” and would have “had reason to consult Shiota for a method for dewarping the image captured by the panoramic lens of Baker” given that Shiota is “in the same field of endeavor” and teaches a method of transforming an image captured using a panoramic lens “into a plane image for display using [a] non-linear image distribution function.” APPLE-1011, 234; *see also* APPLE-1006, 16:5-9 (Baker similarly noting that the “image

transformation [is] performed on the captured digitized image from modified hemispheric coordinates to planar coordinates for display”).

Therefore, a POSITA would have been motivated to implement Shiota’s specific image transformation functionality—namely, the use of the non-linear distribution function—as part of the image transformation functionality already contemplated and provided by Baker’s transform processing subsystem, to achieve Baker’s described “compensat[ion] for distortion or difference in magnification between the central and peripheral areas of the scene caused by the lens.” APPLE-1003, ¶¶137-138. In the resulting combination, Baker’s non-linear image distribution function would be used—as contemplated by Shiota—to achieve Baker’s contemplated “compensation for distortion or difference in magnification between the central and peripheral areas of the scene caused by the lens.” *Id.*

Because of the similar goals and overall functionality of Shiota and Baker (e.g., displaying an image captured using a fish eye lens that compensates for the image’s distortion), a POSITA would have had a reasonable expectation of success in so combining these references, and would have reasonably expected to reap the benefits of distortion compensation techniques described in both Shiota and Baker, that result in correction of distortion in the image to display an image with “the proper aspect ratio for the human visual system (i.e., as a perspective corrected

view).” *Id.*

The resulting combination of Baker and Shiota renders obvious claims 2, 4, 27, 29, and 30, for the reasons described below.

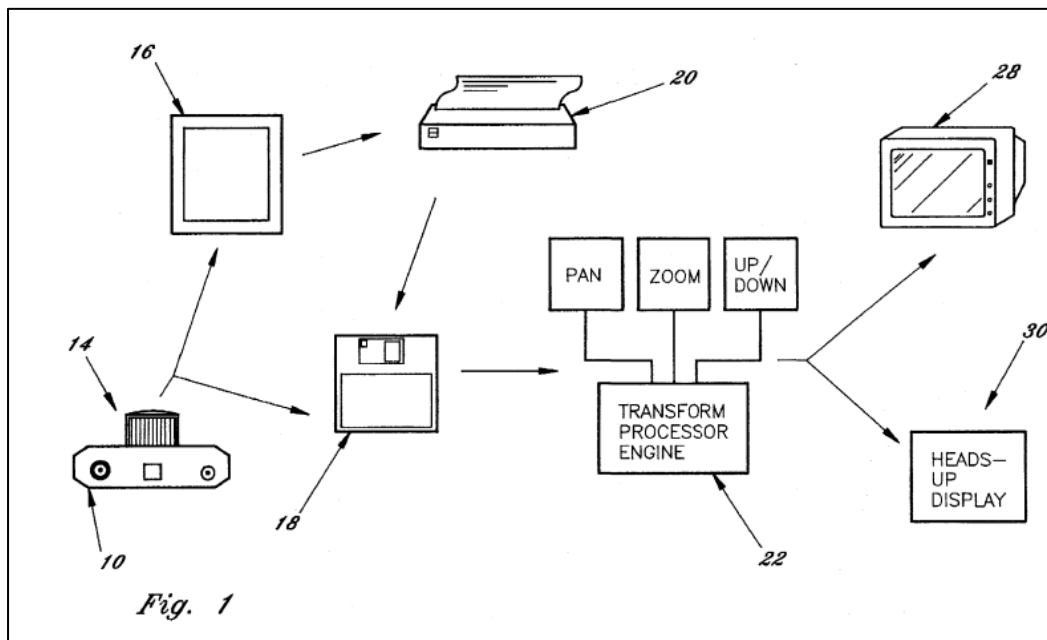
4. Analysis

(a) Claim 27

[27pre]: A method for displaying a digital panoramic image, the method comprising,

If the preamble is limiting, Baker in view of Shiota renders obvious a method of displaying a digital panoramic image, as described below. APPLE-1003, ¶142. The combination leverages Baker’s and Shiota’s teachings of a visual imaging system that uses a lens (e.g., the lens shown in Baker’s FIG. 3BA) to project a panorama onto an image sensor (e.g., CCD as contemplated by both Baker and Shiota) that is digitally stored in the system’s storage device and subsequently retrieved and transformed (e.g., to correct/compensate for the image distortion, as contemplated by both Baker and Shiota) for display on a display device. *Id.*

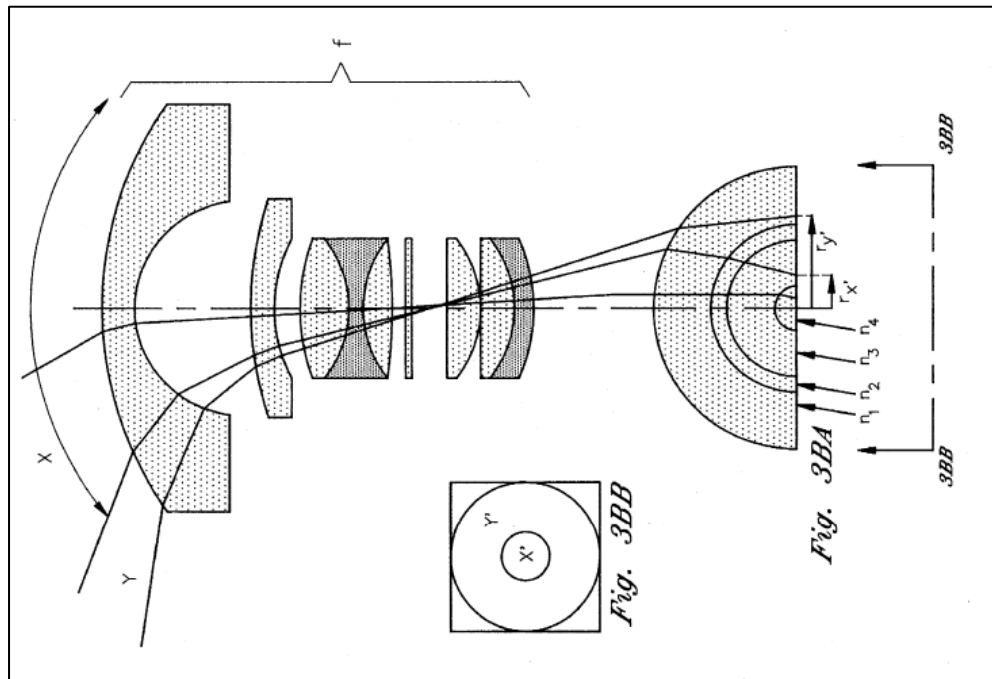
In the combination, Baker provides a “visual imaging system” that uses a “camera to capture the relevant visual information within a panoramic field of view existing along the horizon,” APPLE-1006, 6:29-32; 8:58-62; APPLE-1003, ¶143. An illustration of Baker’s visual imaging system, including the camera 10 and its lens 14 is shown below:



APPLE-1006, FIG. 1. Baker's visual imaging system can be used to "capture a panorama" in multiple applications, including in applications where an "outdoor scene" or a "room scene" is captured as well as in a teleconferencing application where the camera can be placed at a center of a conference table and can capture "a panoramic view of the participants at the conference table or in a conference room." APPLE-1006, 12:33-46, 10:28-36, 13:56-65 ("panoramic image provided by the imager is ideally suited for teleconferencing"); APPLE-1003, ¶¶143-144.

Baker explains that, using its lens as shown in FIG. 3BA (reproduced below), the panoramic image is projected into the image plane where the image sensor/detector (e.g., a CCD) is positioned. APPLE-1006, 5:55-6:4 ("The lens provides an enhanced view of the valuable information in the scene's periphery by

imaging the field of view to the image plane such that the ratio of the size of the smallest detail contained within the periphery of the scene to the size of the smallest resolving pixel of an image device is increased. For this to be accomplished, the peripheral content must map to a larger percentage of a given image detector area and, simultaneously, the mapped image of the central area of the scene must be minimized by the lens so that it does not interfere with the peripheral content now covering a wider annulus in the image plane. Information in the image plane is then detected by the video camera.”).



APPLE-1006, FIGS. 3BA-3BB. As shown, Baker's lens includes sequentially arranged lenses, including among other lenses a "hemispherical gradient index unit with a wide field multi-element lens." APPLE-1006, 12:6-11; APPLE-1003, ¶¶144-

146. The hemispherical lens “is made of gradient index material such that points impinging the image plane incur different factors of magnification depending on what index of refraction and what portion of the hemispherical curve or lenslets they pass through.” APPLE-1006, 11:54-63. By using this hemispherical gradient index unit, “a fairly significant portion of the imaging surface [is] dedicated to the peripheral field, and consequently less of the surface [is] dedicated to the central field,” as illustrated in FIG. 3BB (which shows the field coverage that the lens “provides in the image plane for detection by an imaging device or substrate”). APPLE-1006, 12:6-14, 12:23-32, 7:55-60, FIG. 3BB; APPLE-1003, ¶¶146-147. In this manner, Baker’s system/camera, which can include an imager/imaging device in the form “film emulsions or CCD,” when used in conjunction with Baker’s lens, results in the imager device “collect[ing] more information along the horizon than it will from the central area of the hemispheric scene.” APPLE-1006, 13:9-18; APPLE-1003, ¶148.

The “image received on the imager device is passed on to the system components for storage and/or transmission to a remote teleconferencing site.” APPLE-1006, 14:9-11. Baker explains that the image may be digitally stored in a storage device, such as, e.g., random access memories, a conventional diskette or hard file, or video recording tape. APPLE-1006, 14:12-18. Baker explains that the

image is stored in a “warped” form, where the warping is caused not only by the wide angle nature of Baker’s lens “but also by the enhanced peripheral field of view of the lens.” APPLE-1006, 14:18-26; APPLE-1003, ¶149.

The stored image can then be “transformed for display” (e.g., at the source location or at a remote teleconference location) to correct or dewarp the image. APPLE-1006, 14:42-47; APPLE-1003, ¶150. For example, to “recreate a proper display of the scene in two dimensions for perspective-correct viewing,” Baker’s visual imaging system uses “processor logic in transform processor engine” (as shown in Baker’s FIG. 1), which “compensates for the distortion or difference in magnification between the central and peripheral areas of the scene caused by the lens by applying appropriate correction criteria to bring the selected portion of the scene into standard viewing format.” APPLE-1006, 14:44-47, 6:7-21.

The transform processor thus “corrects the” captured panoramic image “for display on a conventional display device 28 such as a video monitor or a video projection display system.” APPLE-1006, 9:8-13, FIG. 1. Moreover, as described in §§V.A.2-3 and in [27e]-[27f] *infra*, Shiota’s teachings are leveraged in the combination to provide specific techniques for compensating for the distortion in the image, e.g., based at least on a non-linear image distribution. APPLE-1003, ¶¶128-139, 116-121; APPLE-1012, [0022]-[0026], [0037]-[0042].

Therefore, Baker in view of Shiota renders obvious a method for displaying a digital panoramic image (if the preamble is limiting). APPLE-1003, ¶¶142-152; *see* APPLE-1006, Abstract, 1:9-13, 5:16-20, 5:37-6:36, 7:45-8:9, 8:17-35, 8:58-9:14, 10:61-11:6, 11:52-12:55, 13:9-32, 13:56-65, 14:9-17, 14:42-15:59, FIGS. 1, 1A, 5, 3AA-3AC, 3BA-3BB, 6A-6B; APPLE-1012, Abstract, [0001]-[0002], [0004], [0007]-[0010], [0021]-[0026], [0048]-[0050], claims 1, 5. The additional features of claim 27's method for displaying the digital panoramic image are rendered obvious by the Baker-Shiota combination, as described with reference to limitations [27a]-[27f] below (incorporated here).

[27a]: obtaining a digital panoramic image by projecting a panorama onto an image sensor using a panoramic objective lens,

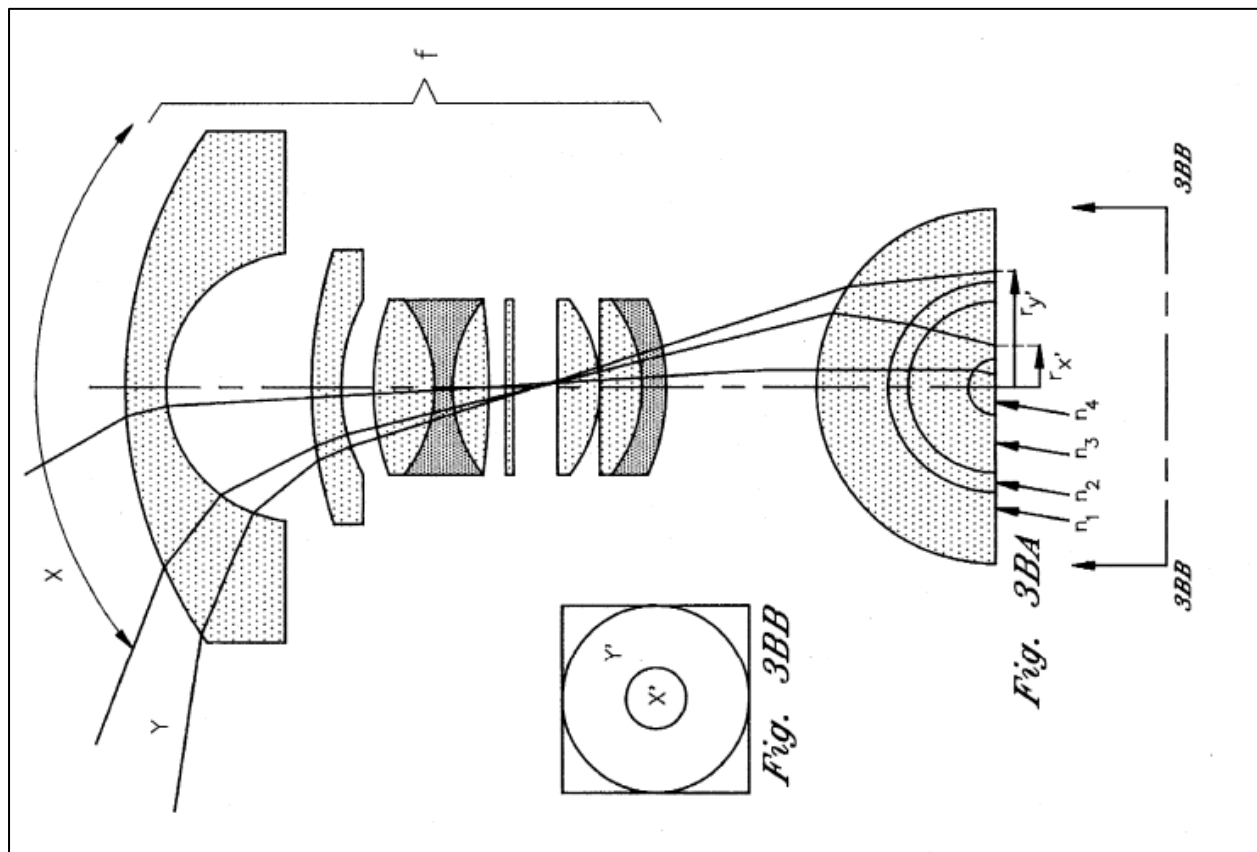
As described below, Baker in view of Shiota renders obvious obtaining a digital panoramic image by projecting a panorama onto an image sensor (e.g., Baker's imager device, such as a CCD) using its panoramic objective lens (e.g., the lens as depicted in FIG. 3BA). APPLE-1003, ¶153.

The '990 Patent's specification explains that a panoramic objective lens captures a panoramic image and can include a fisheye lens (APPLE-1001, 1:17-20), which a POSITA would have understood as a lens which covers a hemispherical field. *See id.*; APPLE-1003, ¶¶154-155 (citing as corroboration, e.g., APPLE-1007,

1 (describing a fish eye lens as a “lens which covers a hemispherical field”).

Baker similarly discloses a panoramic objective lens in the form of a lens that covers a hemispherical field and is used to capture a panoramic image. APPLE-1003, ¶156. For example, Baker’s “visual imaging system” uses “a single camera to capture the relevant visual information within a panoramic field of view existing along the horizon.” APPLE-1006, 6:29-32, 8:58-62 (“the visual imaging system ... includes a still image or moving picture camera 10, having a lens, ... designed to capture and enhance the peripheral content of a hemispheric scene”), 13:56-57 (providing a “panoramic image” that is “ideally suited for teleconferencing”), 16:19-23, Abstract (providing a system that captures a “panoramic ... scene” and includes a “camera and lens system that provides a panoramic display”). A POSITA would have understood that, because Baker’s objective lens captures a panoramic or hemispheric scene, this lens is a super-wide or ultra-wide angle lens. APPLE-1003, ¶¶156-157.

FIG. 3BA, reproduced below, shows an example lens used in Baker’s visual imaging system that is used to capture a panoramic image:



As shown, and as described with reference to [27pre] (incorporated here), Baker's objective lens includes sequentially arranged lenses, including among other lenses a "hemispherical gradient index unit with a wide field multi-element lens," the use of which results in "the portion of the camera dedicated to the periphery [being] increased, thereby increasing the relative resolution of information detectable by the imaging device sensing elements." APPLE-1006, 12:6-11, 12:23-32; APPLE-1003, ¶¶157-158.

Moreover, as described with reference to [27pre], Baker's lens projects a panorama onto an image sensor located in the image plane of the objective lens.

APPLE-1003, ¶¶142-152; APPLE-1001, 5:55-6:4, 13:8-65. For example, Baker's lens "imag[es] the field of view" representing a scene to "the image plane" APPLE-1006, 5:57-62. In particular, the objective lens is used to image a "panoramic" or "hemispheric" "field of view," with a particular emphasis on the peripheral content in the image. APPLE-1006, 6:29-35, 8:62-65; *see id.*, 2:35-39. From these disclosures, a POSITA would have understood that Baker's objective lens projects a panorama into an image plane of the objective lens. APPLE-1003, ¶¶158-159 (explaining that imaging a hemispheric scene is equivalent to imaging a panoramic image); APPLE-1001, 1:17-20 (similarly describing capturing of hemispheric field of view using the panoramic objective lens). Baker further discloses that the digital sensor (e.g., a CCD) is positioned within the image plane of Baker's lens and thus, Baker's lens projects the panorama onto a digital image sensor (e.g., a CCD) located in the image plane of its objective lens. APPLE-1006, 13:9-18, 14:8-17, 5:55-6:4, 7:55-60; APPLE-1003, ¶160.

Baker also discloses that that scene/visual information obtained by its objective lens and captured on an image sensor (e.g., a CCD device) "can be stored onto an assortment of media, e.g., ... electronic storage 18, or other conventional storage means." APPLE-1006, 13:9-18. 8:62-65; 2:35-39; 10:55-57; 14:32-36; APPLE-1003, ¶161. Baker thus discloses digital storage of the image captured on

its imager device, e.g., within a “storage device” such as “random access memories, a conventional diskette or hard file.” *See id.*; APPLE-1006, 14:9-17. Thus, a POSITA would have understood that Baker’s system obtains a digital panoramic image. APPLE-1003, ¶161.

Therefore, the Baker-Shiota combination renders obvious [27a]. APPLE-1003, ¶¶153-162; *see* APPLE-1006, Abstract, 1:10-14, 6:29-34, 7:12-25, 10:22-12:22, 12:33-55, 13:9-65, 14:9-36, FIGS. 1, 5, 6A-6B, claim 1, FIG. 1, 5, 6A-6B; APPLE-1012, [0002]-[0007], [0021]-[0026], [0048]-[0050]; *see* APPLE-1011, 135, 229.

[27b]: the panoramic objective lens having an image point distribution function that is not linear relative to a field angle of object points of the panorama,

As described below, Baker in view of Shiota renders obvious that the panoramic objective lens (e.g., lens shown in FIG. 3BA) has an image point distribution function that is not linear relative to a field angle of object points of the panoramic image. APPLE-1003, ¶163; *see* §II.C *supra*.

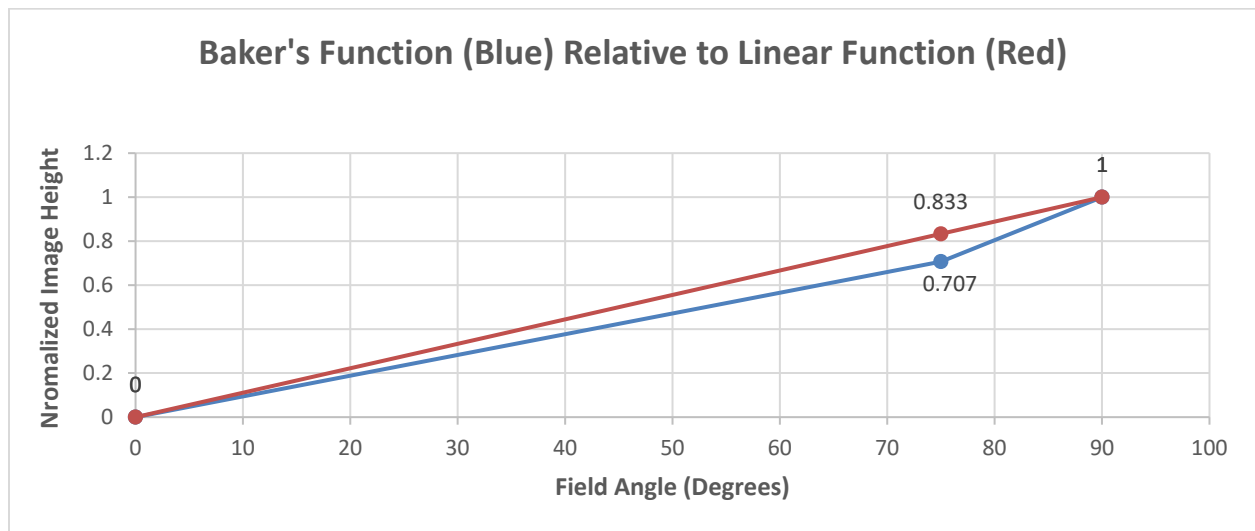
In more detail, Baker’s objective lens (including its series of multiple optical elements), as shown in FIG. 3BA, is “designed to capture and enhance the peripheral content of a hemispheric scene.” APPLE-1006, 8:60-62. “To maximize data collection and resolution for analysis and/or display of the relevant visual

information located in this portion of the hemispheric scene,” Baker contemplates “maximiz[ing] the dedication of the available image detection area to this peripheral field portion.” APPLE-1006, 8:32-36. As to the example objective lens shown in FIG. 3BA, Baker explains that, by using a “hemispherical gradient index unit with wide field multi-element lens,” the “portion of the camera dedicated to the periphery is increased, thereby increasing the relative resolution of information detected by the imaging device[’s] sensing elements.” APPLE-1006, 11:1-4, 11:48-63, 12:6-14; APPLE-1003, ¶¶164-165.

Baker explains that, compared to “an ordinary fish eye lens” that “focuses the lowest 15 degrees up from the horizon on ten percent of the imager at the imaging plane,” the objective lens, e.g., as shown in FIG. 3BA, “focuses that same 15 degrees on fifty percent of the imager” at the imaging plane. APPLE-1006, 6:43-56, 11:48-65; APPLE-1003, ¶166. Per Baker, this results in a “five-fold increase in resolution” and “at least five times increase in resolving power by this lens/imager combination.” *Id.*

The following plot shows an image distribution function that corresponds to Baker’s above-described objective lens—where the last 15° segment of the horizon fills the top 50% of the image height. APPLE-1003, ¶¶167-168 (0° of the horizon represents a field angle of 90°; thus, the last 15° segment of the horizon represents a

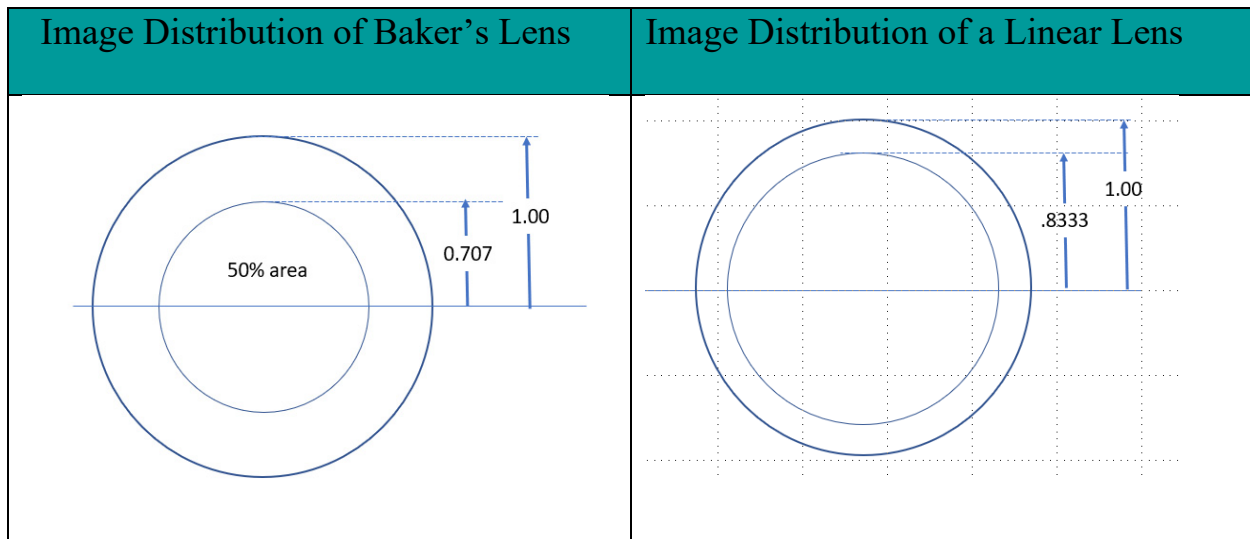
field angle range of 75° to 90°). Using a normalized image height of 1 at a field angle of 90°, a POSITA would have determined that the area of the circular image with height h at 75° occupies 50% of the area of the entire circular image. *Id.* (representing this relationship as: area of circular image at height h (at 75°) = $\pi * h^2$ = $\pi * r^2 * 0.5$, where $r=1$). Thus, when solving for h , which would be the square root of ($1^2 * .5$), h at 75° is 0.707. APPLE-1003, ¶168. Baker's image distribution function can thus be represented using the following plot showing the normalized image height at various field angles:



APPLE-1003, ¶169. In the above plot, a red line has been added to present a linear function with a constant gradient that results in a linear growth/increase in field angles and the corresponding distance of image points relative to the image center. APPLE-1003, ¶170. Comparing the blue line (Baker's function) to the red line (linear function) shows that Baker's function has varying gradient at different field

angles i.e., relative to the linear distribution function, a lower gradient for the field angle between 0° and 75° and a higher gradient for the field angles between 75° and 90° . APPLE-1003, ¶¶171-172. Thus, a POSITA would have understood that Baker's objective lens has an image distribution function that is not linear relative to the field angle (of the object points of the panorama). *Id.*

This is further illustrated using the following image sensor circle diagram, which is similar to the diagram shown in the '990 Patent (*see* APPLE-1001, Fig. 4A, 2:14-29). APPLE-1003, ¶173. Assuming a normalized image height of 1 at a field angle of 90° , a POSITA would have observed that Baker's fisheye lens in the above scenario would define two image zones (Zone A and Zone B), with Zone A appearing more compressed and Zone B appearing more compressed relative to a lens with a linear image distribution function:



APPLE-1003, ¶173; APPLE-1006, FIGS. 2B, 3B, 13:29-65.

Therefore, the Baker-Shiota combination renders obvious [27b]. APPLE-1003, ¶¶163-173; *see* APPLE-1006, Abstract, 4:24-29, 5:37-6:4, 6:29-56, 8:16-55, 9:62-10:5, 10:22-11:6, 11:42-51, 11:52-12:55, 14:18-26, 15:13-19, claims 1-4, FIGS. 1, 3AA-3AC, 3BA-3BB, 5; *see* APPLE-1011, 135, 229.

[27c]: the distribution function having a maximum divergence of at least +/-10% compared to a linear distribution function,

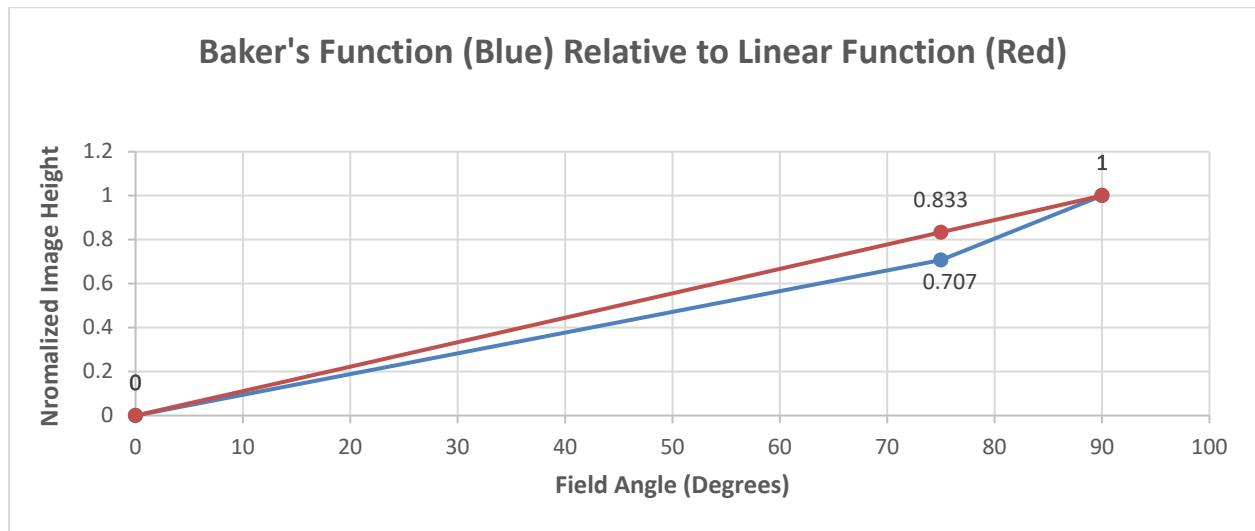
As described below, Baker in view of Shiota renders obvious that the panoramic objective lens (e.g., Baker's lens as shown in FIG. 3BA) has an image point distribution function with a maximum divergence of at least +/-10% compared to a linear distribution function. APPLE-1003, ¶175.

Maximum divergence is defined by the formula $\text{DIVmax \%} = \frac{[\text{dr(Pd)} - \text{dr(Pdl)}]}{[\text{dr(Pdl)}]} * 100$, where dr(Pd) is the relative distance from the center of the image to the point of maximum divergence Pd , and dr(Pdl) is the relative distance in relation to the center of the corresponding point on the linear image distribution line. *See supra* §II.C; APPLE-1001, 8:44-60.

Applying this maximum divergence formula to the image distribution function described with reference to [27b] (incorporated here), a POSITA would have understood that Baker's image distribution functions have a maximum divergence of at least $\pm 10\%$ compared to a linear distribution function. APPLE-

1003, ¶¶176-177.

The following plot shows one example image distribution function that corresponds to Baker's objective lens as described with reference to [27b] (incorporated here)—where the last 15° up from the horizon (where the horizon is at 90°) fills the top 50% of the image height:



APPLE-1003, ¶178. A POSITA would have observed that the gap between the linear distribution function (red) and Baker's image distribution function (blue) is greatest at the field angle of 75°. APPLE-1003, ¶179. At that angle, the relative distance of an image point on Baker's function ($dr(Pd(75))$) is 0.707 and the relative distance of a corresponding point on the linear distribution function ($dr(Pd1(75))$) is 0.833. APPLE-1003, ¶180.

When applying the above-recited maximum divergence formula r , the resulting maximum divergence for the above distribution function amounts to

approximately -15% (i.e., $[0.707-0.833]/0.833*100$). *Id.*

Therefore, the Baker-Shiota combination renders obvious [27c]. APPLE-1003, ¶¶175-181; *see* APPLE-1011, 135-136, 229.

[27d]: such that the panoramic image obtained has at least one substantially expanded zone and at least one substantially compressed zone, and

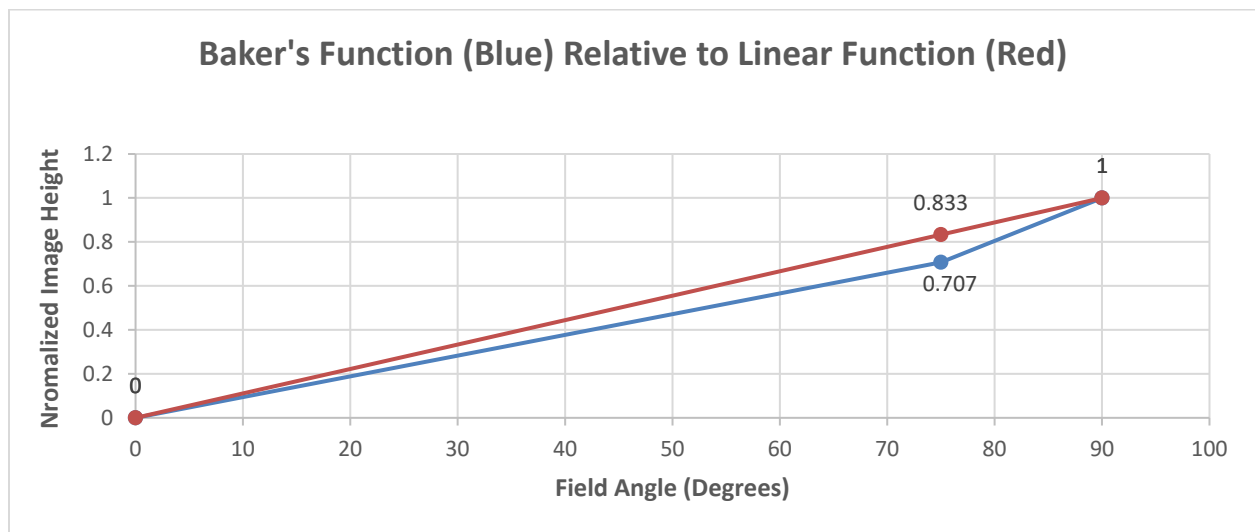
Baker in view of Shiota renders obvious that the panoramic objective lens (e.g., Baker's lens as shown in FIG. 3BA) projects a panoramic image that has at least one substantially expanded zone and at least one substantially compressed zone(s). APPLE-1003, ¶182.

As described with reference to [27a]-[27b] (incorporated here), Baker's objective lens obtains a panoramic image. APPLE-1003, ¶¶153-174.

Moreover, Baker's objective lens projects the panoramic image, which has one substantially expanded zone and one substantially compressed zone. APPLE-1003, ¶¶184-185. Specifically, Baker discloses that the panoramic image obtained by its objective lens "has a fairly significant portion of the imaging surface dedicated to the peripheral field, and consequently less of the surface dedicated to the central field," such that the lens "fill[s] the greater available area of an imager device with the peripheral areas than the central areas of the captured scene." APPLE-1006, 12:29-32, 10:46-60; *see id.*, 5:57-61 (describing the objective lens providing an

“enhanced view of the valuable information in the scene’s periphery such that the “peripheral content ... map[s] to a larger percentage of a given image detector area and, simultaneously, the mapped image of the central area ... [is] minimized”), 6:43-56.

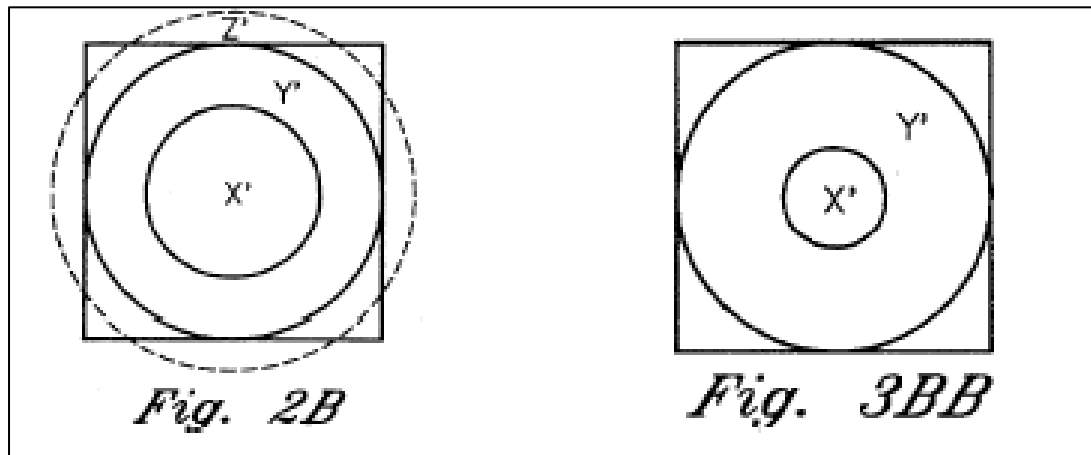
This is also illustrated using the image distribution function described and depicted with reference to [27b]-[27c] (incorporated here), where at least one zone of the image (e.g., a zone ranging from 75°-90° of the field) occupies 50% of the image height and has greater resolution relative to at least one other zone (e.g., a zone ranging from 0° to 75°) that occupies occupying less of the image height and has lesser resolution. APPLE-1003, ¶¶185-186, 163-181.



As shown, the gradient of the Baker’s above-depicted image distribution function (blue) is less than that of the linear distribution function (red) for the zone ranging from 0° to 75°, and thus, this zone represents a compressed zone. APPLE-

1003, ¶¶186-187 (for the 0-75° segment of the field, gradient of Baker's function is 0.009 (0.707/75), which is less than the linear function's gradient of 0.011); *see* §II.C *supra*. For the zone ranging from 75° to 90°, the gradient of Baker's image distribution function (blue) is higher than that of the linear distribution function (red) °, and thus, this zone represents an expanded zone. *Id.* (for this segment of the field, gradient of Baker's function is 0.0195 ((1-0.707)/(90-75)), which is higher than the linear function's gradient of 0.011); *see* §II.C *supra*.

This is further illustrated when comparing Baker's FIG. 2B, which relates to an objective lens (as shown in FIG. 2A) with a linear image distribution function, and FIG. 3BB, which provides an objective lens (as shown in FIG. 3BA) with a non-linear image distribution function (*see supra* [27b] and [27c], incorporated here):



APPLE-1003, ¶188; APPLE-1006, FIGS. 2B, 3BB, 12:29-32. Comparing the images in Fig. 2B and 3BB shows that zone X' has been substantially compressed and zone Y' has been substantially expanded when using Baker's objective lens

shown in FIG. 3BA (right). APPLE-1003, ¶¶188-189. Indeed, Patent Owner has previously acknowledged that the comparison of these two figures shows that Baker's objective lens has an image distribution function with a substantially expanded zone Y' and a substantially compressed zone X'. APPLE-1011, 135-136, 229.

Therefore, the Baker-Shiota combination renders obvious [27d]. APPLE-1003, ¶¶182-192, 50-61; *see* APPLE-1006, Abstract, 5:37-6:4, 6:29-56, 8:17-55, 10:37-12:55, 13:29-65, 14:18-26, 15:14-19, FIG. 3BA-3BB, 2A-2B, 5, claims 1-4.

[27e]: displaying the obtained panoramic image by correcting the non-linearity of the initial image,

As described below, and as confirmed by Patent Owner during its self-initiated reexamination of the '990 Patent, Baker in view of Shiota renders obvious displaying the obtained panoramic image by correcting the non-linearity of the initial image. APPLE-1003, ¶191.

The combination leverages Baker's teachings of displaying a transformed image on a display device by "compensat[ing] for the distortion" in the image "caused by" its lens (e.g., the lens shown in FIG. 3BA). APPLE-1006, 6:5-24, 9:5-13; *see* APPLE-1001, 7:24-28, 10:60-11:8; APPLE-1003, ¶192. Specifically, Baker describes that an image captured by its camera (and the associated panoramic

objective lens) can be “transformed for display” at a “source location or a remote teleconference location.” APPLE-1006, 14:42-47. Baker explains that the image captured using its lens is in a “warped form” in which the “warp[ing]” is caused in part by the selective magnification along the peripheral field of view. APPLE-1006, 14:18-26. Baker’s system compensates for this warping and displays a “corrected” version of the captured image with the “proper aspect of ratio for the human visual system (i.e., as a perspective corrected view).” APPLE-1006, 14:23-26; APPLE-1003, ¶192.

To perform this correction/transformation and “recreate a proper display of the [captured] scene in two dimensions for perspective-correct viewing,” Baker’s system includes “processor logic in transform processor engine 22” (as shown in Baker’s FIG. 1). APPLE-1006, 14:42-47; *see id.*, 14:47-54. The transform processor “compensates for the distortion or difference in magnification between the central and peripheral areas of the scene caused by the lens” by applying “appropriate correction criteria” to bring the selected portion of the scene into standard viewing format.” APPLE-1006, 6:12-16; *see id.*, 6:16-24; APPLE-1003, ¶193.

The combination would have further leveraged Shiota’s teachings, which Patent Owner acknowledges as disclosing “correct[ion] [of] the non-linearity of the

initial image” APPLE-1003, ¶195; APPLE-1011, 117. For example, as described with reference to §§V.A.2 and V.A.3 (incorporated here), Shiota describes a two-step image transformation process for an image captured by a fisheye lens, as part of which, a non-linear image distribution function is used to compute a correction coefficient, which in turn is used to obtain the image points to be displayed. APPLE-1012, [0031]-[0035], [0024], [0037]-[0042]; APPLE-1003, ¶¶195-196. Because the correction coefficient “is computed using the non-linear distribution function,” Patent Owner has stated that Shiota discloses “correcting the non-linearity of the initial image, performed ... by means of the non-linear distribution function.” *See id.*; APPLE-1011, 117, 248, 250.

As described with reference to §V.A.3 *supra* (incorporated here), a POSITA would have been motivated to implement Shiota’s specific image transformation teachings, which include using a correction coefficient computed based on a non-linear image distribution to perform the image transformation, within Baker’s system, which already contemplates transformation of a distorted image captured using Baker’s objective lens. APPLE-1003, ¶¶197, 116-121, 128-138; *see* §§ V.A.2-3, *supra*. Again, Patent Owner has confirmed that a POSITA would have been motivated to so combine these references to render obvious correction for the non-linearity of the initial image, as obtained by the combination’s objective lens.

APPLE-1011, 117, 234, 248.

Therefore, Baker in view of Shiota renders obvious [27e]. APPLE-1003, ¶¶191-198, 70-74; *see* APPLE-1006, Abstract, 5:31-37, 6:5-35, 7:6-11, 8:32-55, 9:5-13, 14:41-16:47, FIGS, 1, 6A-6B, claims 1, 12-14; APPLE-1012, Abstract, [0001], [0004]-[0005], [0014]-[0017], [0021]-[0026], [0029]-[0042], [0044], [0048]-[0050], claim 1.

[27f]: [correcting the non-linearity of the initial image] performed by retrieving image points on the obtained image in a coordinate system of center O' using at least the non-linear distribution function and a size L of the obtained image.

As described below, Baker in view of Shiota renders obvious correcting the non-linearity of the image by retrieving image points on the obtained image in a coordinate system of center O' using at least the non-linear distribution function and a size L of the obtained image. APPLE-1003, ¶199.

As described with reference to [27e] (incorporated here), Baker's transform processor "compensates for the distortion or difference in magnification between the central and peripheral areas of the scene caused by the lens" by applying "appropriate correction criteria" to bring the selected portion of the scene into standard viewing format." APPLE-1006, 6:12-16; *see id.*, 6:16-24; APPLE-1003, ¶¶191-198, 200.

As described with reference to §§V.A.2-3 *supra* and [27e] (incorporated here), a POSITA would have found it obvious to implement Shiota's image transformation techniques in combination with Baker, to transform and display a panoramic image captured with Baker's objective lens in a "proper aspect ratio" to provide a "perspective corrected view," as contemplated by Baker. APPLE-1003, ¶¶128-138, 201; APPLE-1006, 14:18-26. The Baker-Shiota combination would have leveraged Shiota's teachings that describe image correction by applying a correction coefficient (k_2)—which is determined based on a non-linear image distribution function—to the captured image to obtain transformed image points that compensate for the distortion in the captured image. APPLE-1012, [0022]-[0024], [0037]-[0042]; APPLE-1003, ¶¶116-121. Specifically, the equation for determining the correction coefficient is $k_2 = h/r$, where h represents the lens image distribution function and r is the distance from the origin of an X, Y, Z coordinate system to the projected point on the image plane. APPLE-1012, [0037]-[0042]; APPLE-1003, ¶¶116-121, 128-138, 201-202. Patent Owner has acknowledged that these Shiota disclosures teach correcting the non-linearity of the initial image using a non-linear distribution function. APPLE-1011, 234, 117, 248, 250.

In the combination, and for the reasons described with reference to §V.A.1-3 *supra*, the combination's image transformation functionality would similarly

leverage the image distribution function used by Baker's lens (which, as described with reference to [27b]-[27d], is a non-linear image distribution function) to determine a correction coefficient that is used to compensate for the magnification/distortion introduced by the lens (as disclosed in Shiota). APPLE-1003, ¶204. The resulting compensation/transformation would thereby determine/retrieve transformed image points of the obtained image (e.g., (p, q) coordinates, as recited in Shiota) using Baker's non-linear distribution function. APPLE-1003, ¶¶204-205.

The combination would have also leveraged Shiota's teaching of using the size of the image in performing the above-described image transformation/correction. APPLE-1003, ¶205. For its described image transformation operations, Shiota assumes a normalized radius of 1 of the image circle at a field angle of 90° (from the front of the lens). APPLE-1012, [0023]. However, Shiota acknowledges that the image circle diameter (i.e., the size of the image) "differs according to at least the size of the [CCD] image pickup device" (the size of the image disk/sensor) and that "at the time of actual[] use, magnification adjustment is performed." *Id.* A POSITA would have thus understood that these references to "magnification adjustment" and variation in image size based on size of the image disk/sensor refers to an adjustment that accounts for the actual size of

the image pickup device—and by extension, the actual size of the image—as part of the image transformation. APPLE-1003, ¶205; *see* APPLE-1012, [0025]-[0026] (explaining that necessary parameters for the image transformation operations include, e.g., the magnification of the image), [0024] (using “the scale factor (zoom ratio) as the size of the plane image” for image transformation).

Thus, a POSITA would have understood or found obvious that the image transformation described in Shiota, when applied to an actual application accounts for the size of the actual image for the underlying image transformation. APPLE-1003, ¶206. Because the size of the image pickup device (and by extension the size of the image) varies depending on the implementation, a POSITA would have found it obvious to use the actual size of the image—as applicable in Baker’s system—as part of the image transformation to generate a properly compensated/transformed image for display. APPLE-1003, ¶¶205-206.

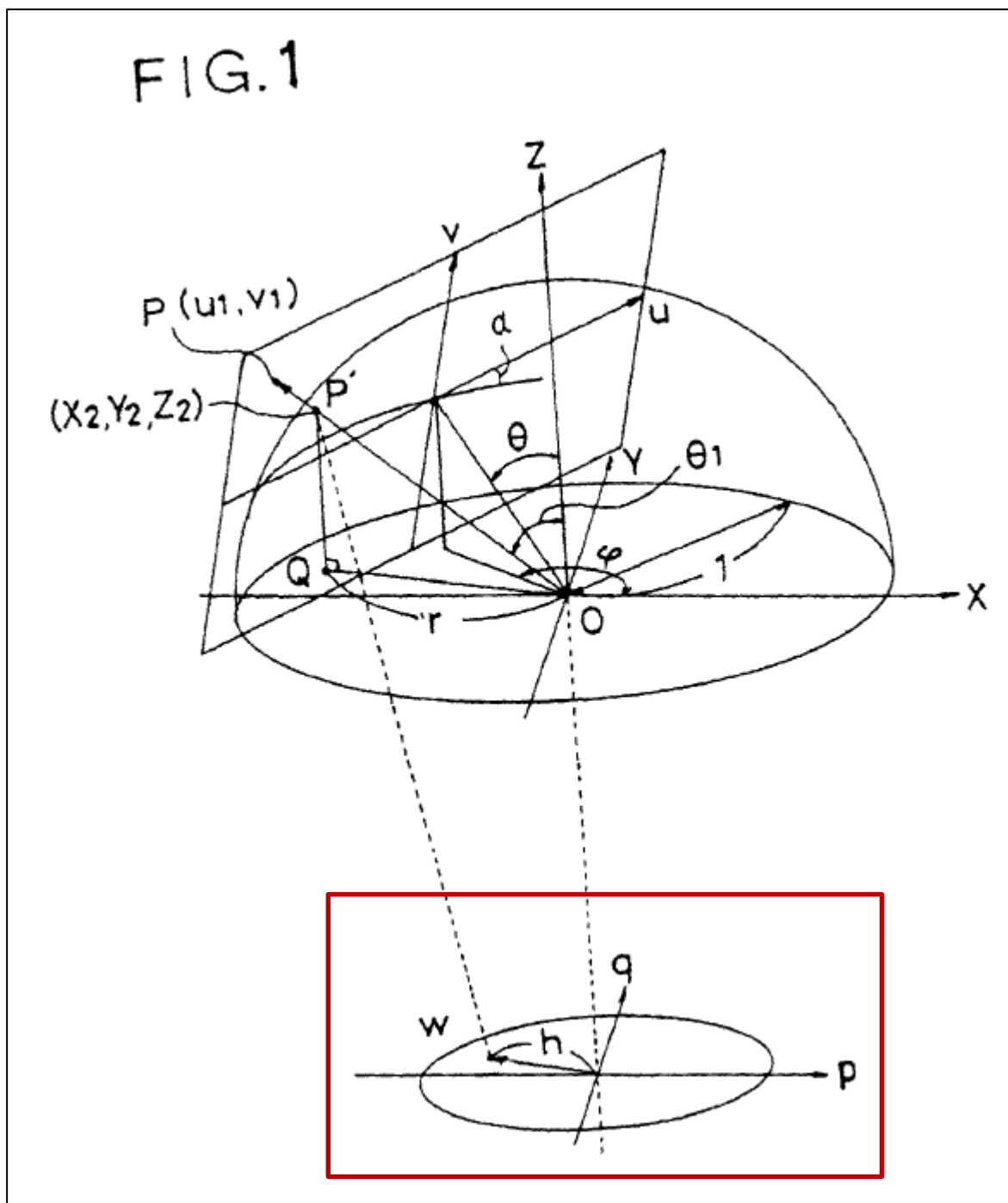
Moreover, a POSITA would have understood or found obvious that the size of the image pickup device could be represented using any appropriate units, e.g., pixels, inches, millimeters, etc. APPLE-1003, ¶207. Baker discloses that its image transformation process includes a “pixel remapping” process (APPLE-1006, 14:64-15:19), and Shiota additionally describes its image transformation process accounts for pixel-based measurements for its image transformation process (APPLE-1012,

[0022]-[0023], [0025], [0049]. Accordingly, a POSITA would have found it obvious that the size of the image pickup device (and by extension, the size of the image captured by this device) is represented in pixels. APPLE-1003, ¶207.

Additionally, a POSITA would have understood that the transformed image points/coordinates in the Baker-Shiota combination are image points in a coordinate system with center O'—consistent with the '990 Patent's description of this feature. APPLE-1003, ¶208. In the '990 Patent, the image transformation includes the following processing: (1) the image points of the display window $E(i,j)$ are projected onto a sphere portion HS of center O to obtain points $P(p_x, p_y, p_z)$ and (2) these points P are then projected onto the image disk using the non-linear distribution function to obtain points $p(p_u, p_v)$ in a coordinate system of center O' (which corresponds to the center of the image disk). APPLE-1001, 12:66-13:24; *see also id.*, 1:46-2:13; APPLE-1003, ¶208.

Similarly, in Shiota's two-step image transformation process: (1) the points on a plane image corresponding to coordinates of a display monitor are projected on a hemispherical surface to obtain point P' (APPLE-1012, [0022], [0024], [0028]) and (2) the point P' is used to obtained second projection points (p, q coordinates) on the CCD image pickup face (which corresponds to the image disk in '990 Patent) by using a non-linear image distribution function (APPLE-1012, [0023], [0033],

[0035]-[0037], [0040]-[0041]). APPLE-1003, ¶209. Thus, the image points p, q are coordinates on the image pickup face/sensor (or image disk as referenced in the '990 Patent). APPLE-1003, ¶210. And, as shown below, the p, q coordinate system has a center that corresponds to the center of the image disk/pickup surface (i.e., a center O' per the '990 Patent):



APPLE-1012, FIG. 1 (annotated); *see also id.*, [0022], [0025], [0048]. Thus, in the combination, a POSITA would have understood that the retrieved image points are

points in a coordinate system with center O'. APPLE-1003, ¶¶208-210; *see also* APPLE-1001, 12:59-13:25

Therefore, Baker in view of Shiota renders obvious [27f]. APPLE-1003, ¶¶199-213; *see* APPLE-1006, Abstract, 6:5-23, 13;15-28, 14:41-16:46, claims 12-14; APPLE-1012, Abstract, [0001], [0004]-[0005], [0014]-[0017], [0021]-[0026], [0029]-[0042], [0044], [0048]-[0050], claim 1; *see* APPLE-1011, 117-118.

(b) Claim 2

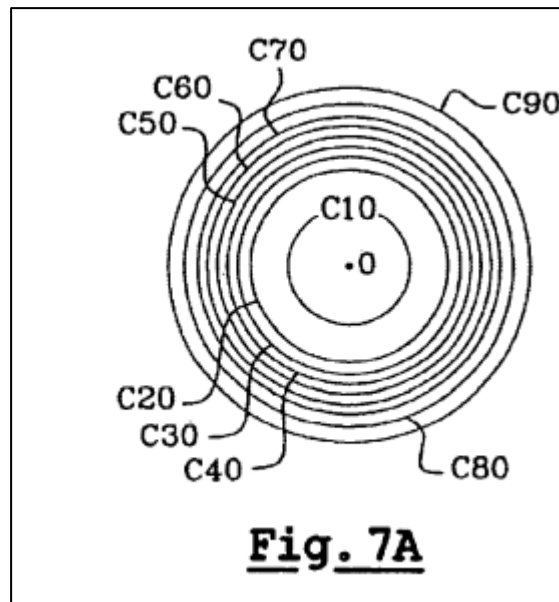
[2pre]: The method according to claim 27,

Baker in view of Shiota discloses or renders obvious the method of claim 27. *See supra* [27pre] to [27f], which are incorporated here.

[2a]: wherein the objective lens has a non-linear distribution function that is symmetrical relative to the optical axis of the objective lens, the position of an image point relative to the center of the image varying according to the field angle of the corresponding object point.

As described with reference to [27a] (incorporated here), Baker's objective lens has a non-linear image distribution function. This non-linear distribution function is symmetrical relative to the optical axis of the objective lens, such that the position of an image point relative to the center of the image varies according to the field angle of the corresponding object point. APPLE-1003, ¶¶218-225.

The '990 Patent's specification explains that a “non-linear panoramic objective lens with axial symmetry relative to optical axis” is one “in which the position of an image point only varies with the field angle relative to this axis of the corresponding object point, “which gives a distribution of points in concentric circles” as shown in FIG. 7A of the '990 Patent that are reproduced below:



APPLE-1001, FIG. 7A, 18:17-28.

Consistent with these descriptions of the '990 Patent, Baker's objective lens with its non-linear distribution function provides a distribution of points in concentric circles, as shown in FIG. 3BB, which is reproduced below (*see* APPLE-1006, FIG. 3BB, 13:29-65):

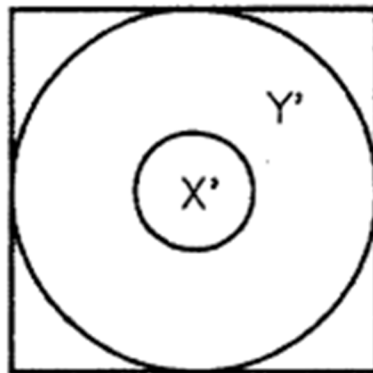
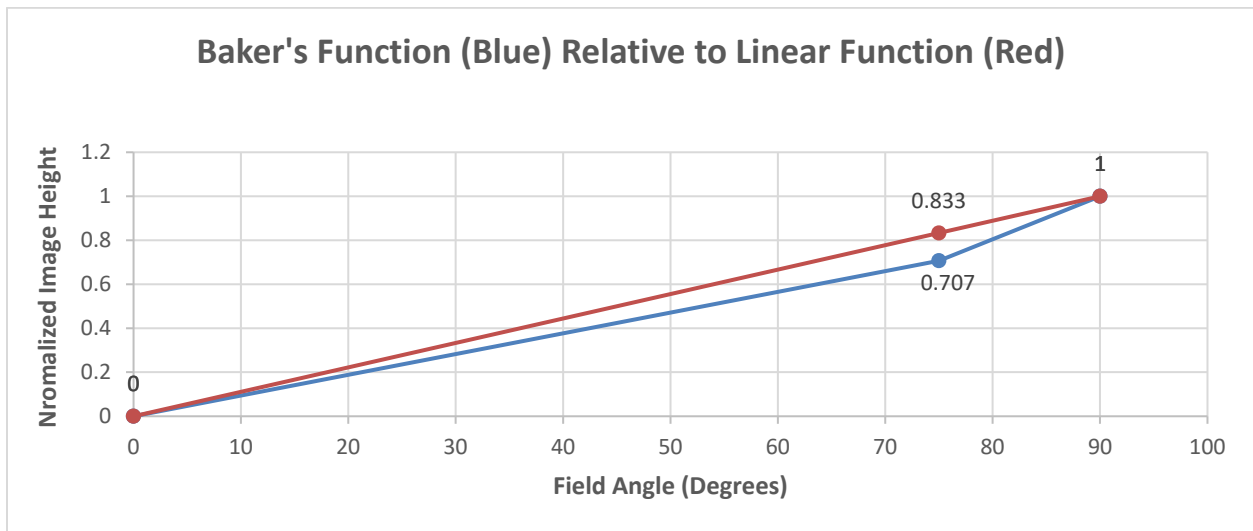


Fig. 3BB

Indeed, during reexamination, Patent Owner acknowledged that, for “symmetric distribution functions” the “image points would be distributed in concentric circles,” and that Baker’s FIG. 3BB provides such a symmetric distribution function by “show[ing] concentric circular distribution of image points.” See APPLE-1011, 137, 251-252; APPLE-1003, ¶¶220-221.

Moreover, as depicted in FIG. 3BB above as well as in the plots generated to represent the non-linear distribution function of Baker’s objective lens, the position of an image point varies according to the field angle of the corresponding object point:



APPLE-1003, ¶¶222-223 (explaining that the image points represented on the y-axis of the above plot vary according to the field angles that are represented on the x-axis).

Given these disclosures in Baker and per Patent Owner's statements regarding the same, a POSITA would have understood that Baker's objective lens has a non-linear distribution function that "is symmetrical relative to the optical axis of the objective lens" with "the position of an image point relative to the center of the image varying according to the field angle of the corresponding object point." APPLE-1003, ¶224.

Therefore, Baker in view of Shiota renders obvious claim 2. APPLE-1003, ¶¶217-225; *see* APPLE-1011, 137, 229, 251-252; APPLE-1006, 7:51-65, 12:15-55, 13:29-55, FIGS. 3BA-3BB, 2A-2B, 5.

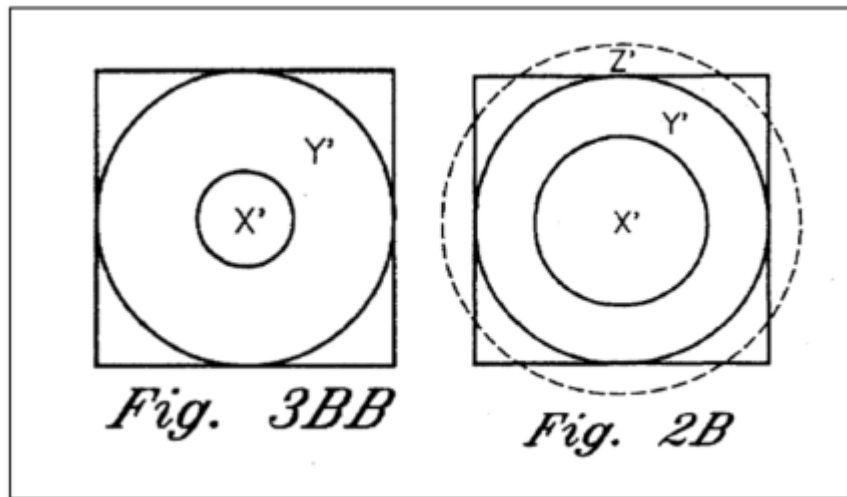
(c) Claim 4

[4pre]: The method according to claim 27,

Baker in view of Shiota renders obvious the method of claim 27. *See supra* [27pre] to [27f], which are incorporated here.

[4a]: wherein the objective lens expands the edges of the image and compresses the center of the image.

As described with reference to [27d] (incorporated here), Baker discloses an objective lens that emphasizes or expands the periphery or edges of the image and compresses the center of the image. APPLE-1003, ¶¶229-232, 182-190. For example, Baker discloses that its objective lens “fill[s] the greater available area of an imager device with the peripheral areas rather than the central areas of the captured scene” such that “a fairly significant portion of the imaging surface is dedicated to the peripheral field, and consequently less of the surface dedicated to the central field.” APPLE-1006, 10:57-60, 12:29-32. This is illustrated with reference to Baker’s FIG. 3BB, which is reproduced below and which similarly shows the expansion of the periphery or edges of the image and compression of the center of the image (especially when compared to zones X’ and Y’ in a linear objective lens shown in FIG. 2).



Therefore, Baker in view of Shiota renders obvious an objective lens that expands the edges of the image and compresses the center of the image. APPLE-1003, ¶¶229-232; *see* APPLE-1011, 137, 229; [27d] *supra* (incorporated here); APPLE-1006, Abstract, 5:37-6:4, 6:29-56, 8:17-55, 10:37-12:55, 13:29-65, 14:18-26, 15:14-19, FIG. 3BA-3BB, 2A-2B, 5, claims 1-4.

(d) Claim 29

[29pre]: The method according to claim 27,

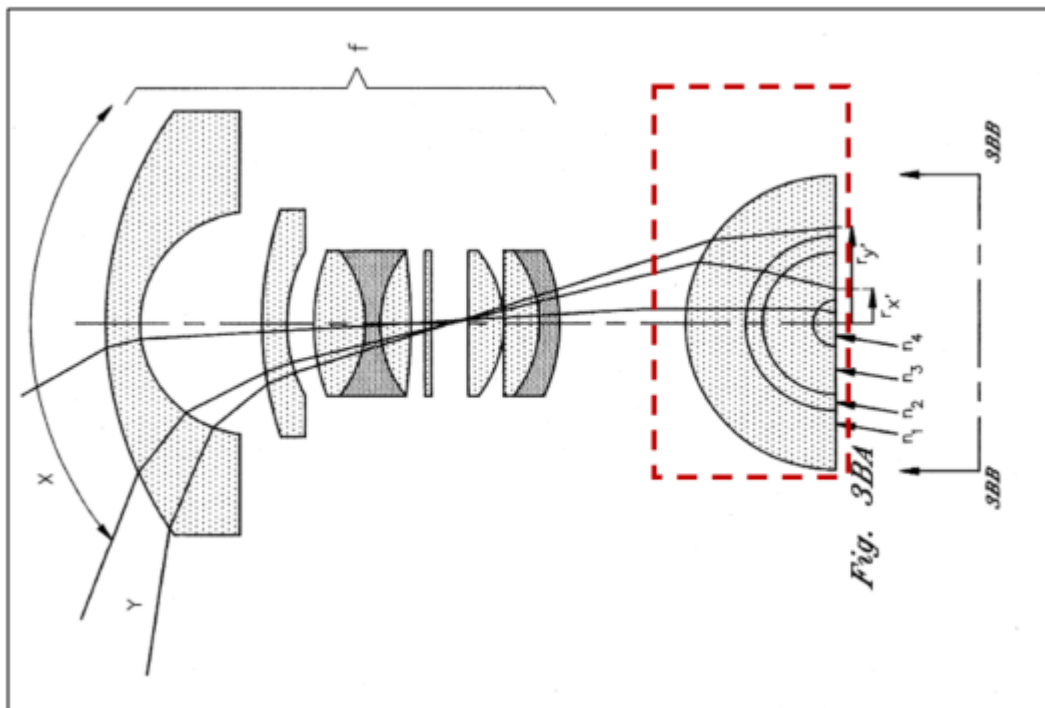
Baker in view of Shiota renders obvious the method of claim 27. *See supra* [27pre] to [27f], which are incorporated here.

[29a]: wherein the objective lens comprises a set of lenses forming an apodizer.

Baker discloses that its objective lens comprises a set of lenses forming an

apodizer (e.g., a hemispherical lens element or combination of lenslets made of gradient index material). APPLE-1003, ¶236.

The '990 Patent's specification states that "the idea of the present invention is to use an apodizer" and that "the principles of the apodizer is used to control the angular distribution of a panoramic objective lens and to obtain the non-linearity sought." APPLE-1001, 16:1-4; APPLE-1003, ¶237. Consistent with this description of "apodizer" in the '990 Patent's specification, Baker's objective lens (reproduced below) includes an apodizer in the form of its "hemispherical lens" or "combination of lenslets" that are "of gradient index material":



APPLE-1006, FIG. 3BA, 11:1-6; APPLE-1003, ¶¶238-239.

This hemispherical lens element or combination of lenslets, when used “with a wide angle multi-element lens,” controls the angular distribution of Baker’s objective lens and obtains non-linearity by increasing “the portion of the camera dedicated to the periphery” and “thereby increasing the relative resolution of information detectable by the imaging device sensing elements.” APPLE-1006, 11:1-4, 12:6-14; *see id.*, 11:52-63 (“the hemispherical lens is made of gradient index material such that points impinging the image plane incur different factors of magnification depending on what index of refraction and what portion of the hemispherical curve or lenslets they pass through”); APPLE-1003, ¶¶238-239.

Therefore, Baker in view of Shiota renders obvious an objective lens that includes a set of lenses forming an apodizer (e.g., a hemispherical lens element or combination of lenslets made of gradient index material). APPLE-1003, ¶240; *see* APPLE-1011, 137, 229; APPLE-1006, 10:61-11:6, 11:41-45, 11:48-12:55, claim 3.

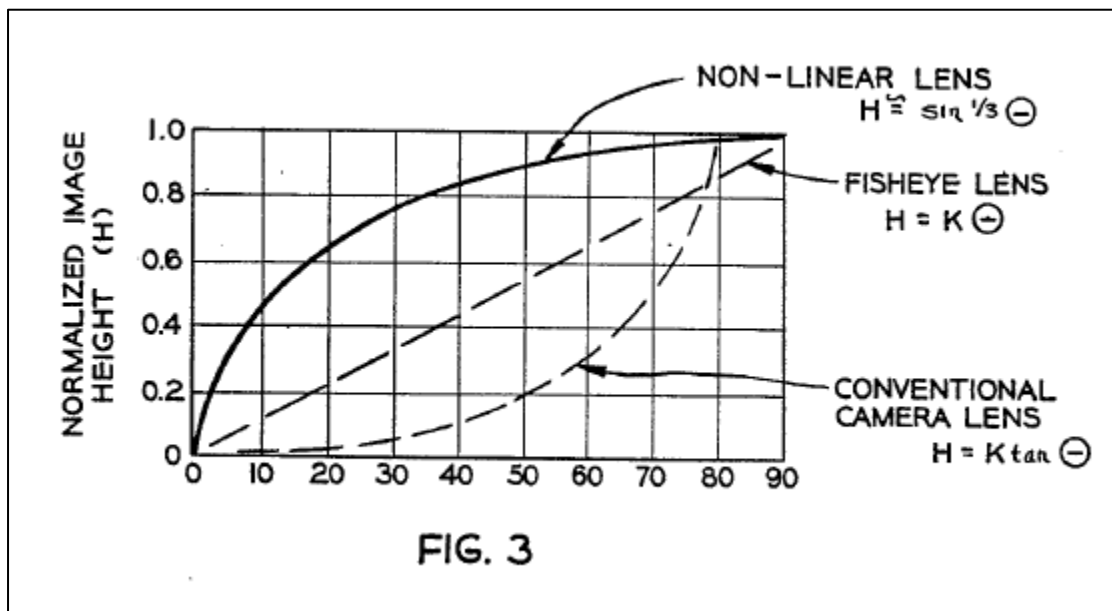
B. Ground 2: Baker in view of Shiota and Fisher Renders Obvious Claims 29 and 30

1. Fisher (APPLE-1009)

Like Baker, Fisher discloses a fish-eye lens with non-linear image distribution—i.e., with distortion characteristics that result in certain portions of the image captured with such a lens being expanded while other portions of the image being compressed. APPLE-1009, Abstract, 2:5-10 (“non-linear lens possesses

distortion characteristics which are such that objects along the optical axis of the lens occupy disproportionately large areas of the image cast by the lens, whereas objects near the periphery of the field of view occupy a disproportionately small area of the image.”); APPLE-1003, ¶¶122-127.

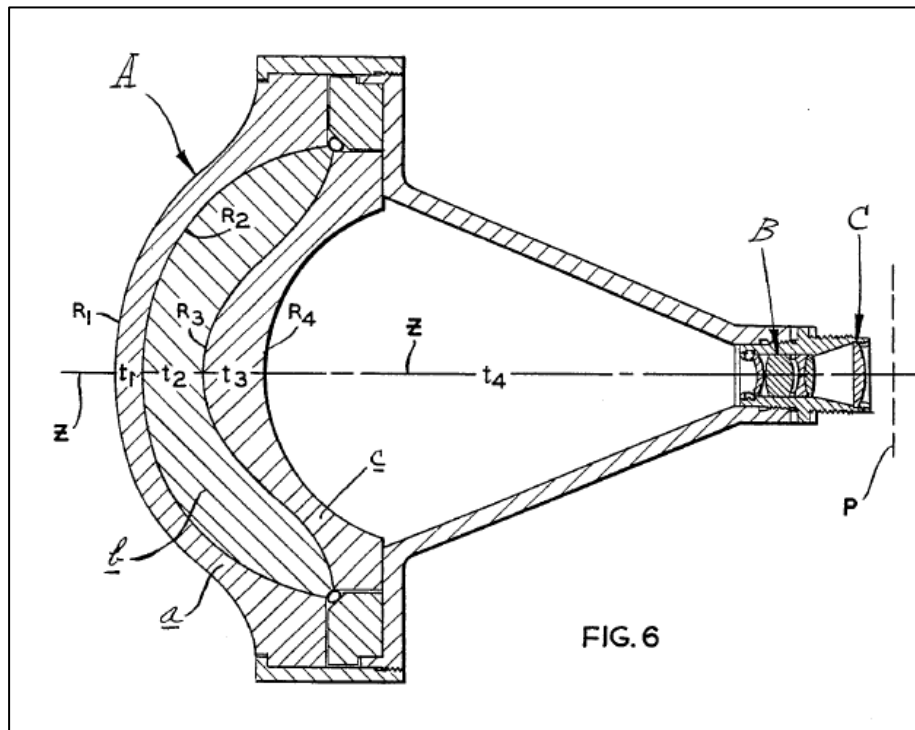
FIG. 3, reproduced below, shows “the distortion characteristics” of Fisher’s non-linear lens “in terms of normalized image height and field of view” and compares these “distortion characteristics with the distortion characteristics of a linear fisheye lens and a conventional camera lens”:



APPLE-1009, 2:38-43, FIG. 3. As shown, with a linear or fisheye lens, the image height is directly proportional to the field angle; whereas, Fisher’s “non-linear lens” use a “variable function of the field angle” such that objects located in certain portions of the image (e.g., the center of the image in Fisher’s lens) occupy “a

disproportionately large share of the image” compared with objects located in other portions of the image. APPLE-1009, 3:1-15.

An example of Fisher’s non-linear lens is provided below:



APPLE-1009, 2:56-57, FIG. 6, 5:44-45. As shown, Fisher’s non-linear lens has three lens groupings A, B, and C. APPLE-1009, 5:44-50. The “first lens grouping A” is “a triplet and provides the mapping function, that is the unique distortion” defined by the non-linear distribution function shown in FIG. 3 (above). APPLE-1009, 5:44-60. The first lens grouping has lenses with non-spherical (aspheric) lens surfaces. See APPLE-1009, 5:61-6:1. Specifically, grouping A (shown above) includes three adjacent lens elements: an outside lens element *a*, an intermediate lens

element *b*, and an inside lens element *c*, with no air gaps between these elements.

Id. The “outside lens element *a* has a non-spherical surface R_1 exposed outwardly and a spherical surface R_2 ,” (2) the intermediate lens element *b* has a spherical surface R_2 and an opposite surface R_3 that is non-spherical, and (3) the inside lens element *c* has a non-spherical surface R_3 and an opposite surface R_4 that is spherical.

Id. Thus, a POSITA would have understood that the first lens grouping A, with the non-spherical (aspherical) lens surfaces on the included lenses, achieves the non-linear image distribution described and shown above with reference to FIG. 3. *See id.*, 5:44-6:1; APPLE-1003, ¶127; *see* APPLE-1011, 230.

2. Combination of Baker, Shiota, and Fisher

A POSITA would have found it obvious to combine Fisher’s teachings with those of Baker and Shiota, and would have been motivated to do so, for at least the reasons described below. APPLE-1003, ¶¶242-253.

Baker discloses that its objective lens achieves the selective magnification/distortion by using a “hemispherical lens or a combination of lenslets” that is/are “made of gradient index material” such that “points impinging the image plane incur different factors of magnification depending on” the index of refraction used and the portion of the hemispherical curve or lenslets they pass through.” APPLE-1006, 11:53-63, 12:7-14. Thus, Baker’s objective lens magnifies or

increases resolution dedicated to the peripheral field of view of Baker's lens, while minimizing the central area of the scene. *See, e.g.*, APPLE-1006, 10:37-41, 5:55-6:1. A POSITA would have thus understood that Baker's objective lens achieves the non-linearity in the captured image (e.g., its selective magnification/expansion and minimization/compression of portions of the captured image) using its hemispherical lens or a combination of lenslets that are made of gradient index material. APPLE-1003, ¶¶244-245.

Before the Critical Date, it was well known to use aspheric optical elements as part of panoramic objective lenses to control angular distribution of the lens, thereby achieving a non-linear image distribution. APPLE-1003, ¶246 (citing as corroboration, e.g., APPLE-1015, Abstract, 4:8-19; APPLE-1016, 2, 4. Consistent with this common and well-established knowledge of using aspheric lenses to implement panoramic objective lenses having non-linear image distributions, Fisher discloses an objective lens that has three sets of lenses, with a first set of lenses including two aspheric lenses and achieving Fisher's contemplated non-linear image distribution. APPLE-1009, 2:56-57, 5:44-61 (explaining that lens grouping A has aspheric lenses and provides a "mapping function" with the unique non-linear distortion/magnification achieved by its lens), FIGS. 3, 6; *see supra* §V.B.1.

Additionally, before the Critical Date, there were two commonly used

techniques for designing panoramic or fish eye lenses that control the lenses' angular distribution to achieve a non-linear image distribution: (1) implementing a gradient index optical element as part of the objective lens, as described in Baker, or (2) implementing one or more aspheric optical elements as part of the objective lens. APPLE-1003, ¶¶246, 66-69. Indeed, gradient index (GRIN) optical elements—such as those disclosed in Baker—were considered equivalent to aspheric elements given that they offer similar distortion control or non-linear image distribution in the objective lens. APPLE-1003, ¶¶246-247 (citing as corroboration, e.g., APPLE-1017, 2; APPLE-1018, 2). Thus, a POSITA would have recognized and would have been motivated to implement one or more aspherical optical elements instead of Baker's hemispherical gradient index element, which would have amounted to a simple substitution of one well known element/technique for another, to obtain the same predictable result of controlling angular distribution in an objective lens to achieve a non-linear image distribution, as already contemplated by Baker and Fisher. APPLE-1003, ¶¶248-250, 66-69.

At least the above reasons would have motivated a POSITA to implement Baker's panoramic objective lens with one or more aspherical elements (e.g., aspherical lenses as disclosed in Fisher) instead/in place of Baker's disclosed gradient index-based hemispherical lens element, to achieve the same or similar non-

linear image distribution achieved by Baker's objective lens when using the hemispherical gradient-index lens element. APPLE-1003, ¶¶250-253. Indeed, a POSITA would have recognized that placing aspheric elements in the same or similar location of Baker's objective lens as the gradient index element would achieve a similar effect of controlling magnification/distortion. *See* APPLE-1020, 10, 13 (contemplating positioning of equivalent elements—gradient index element and aspheric lens—away from the aperture, to “control distortion or other field aberrations”); APPLE-1003, ¶¶251-252 (explaining that Baker's gradient index element is positioned farthest away from the aperture stop; similarly positioning one or more aspheric elements would achieve the same or similar distortion profile as offered by Baker's gradient index element).

Additionally, although Fisher describes the use of its aspheric lenses in an objective lens that achieves a non-linear image distribution where the center of the image is expanded and the periphery is compressed, a POSITA would have recognized that aspheric elements would be implemented to achieve the same or similar effect as Baker's gradient index element—where the image's center is compressed and the image's periphery is expanded. APPLE-1003, ¶254. Indeed, the above-cited evidence (including corroborating evidence) demonstrates that one or more aspherical lenses can have the same effect as Baker's gradient index

element, and thus, a POSITA would have readily sought out and implemented aspherical surfaces that achieve the same effect or image distribution as in Baker's system when using the gradient index element. APPLE-1017, 2; APPLE-1018, 2, APPLE-1018, 2; APPLE-1003, ¶¶254, 66-69. Thus, a POSITA would have had a reasonable expectation of success in implementing aspheric lenses (as contemplated by Fisher and numerous other references in the relevant field) as part of Baker's objective lens, to achieve the same or similar non-linear image distribution contemplated by (or at least rendered obvious by) Baker, where the image's center is compressed and the edges/periphery is/are expanded. *Id.*

3. Analysis

(a) Claims 29 and 30

[29pre]/[30pre]: The method according to claim 27,

Baker in view of Shiota and Fisher renders obvious the method of claim 27 for the same reasons described with reference to [27pre] to [27e], *supra*, which are incorporated here.

[29a]: wherein the objective lens comprises a set of lenses forming an apodizer.

[30a] wherein the set of lenses forming an apodizer comprises at least one aspherical lens.

Baker in view of Shiota and Fisher provides an objective lens with a set of lenses forming an apodizer. APPLE-1003, ¶258. The '990 Patent's specification states that "the idea of the present invention is to use an apodizer" and that "the principles of the apodizer is used to control the angular distribution of a panoramic objective lens and to obtain the non-linearity sought." APPLE-1001, 16:1-4.

Consistent with this description of "apodizer" in the '990 Patent's specification, and as described with reference to §V.B.1-2 (incorporated here), a POSITA would have found it obvious to implement the Baker-Shiota-Fisher combination such that it leverages Fisher's teachings of implementing one or more aspheric lenses as part of the combination's panoramic objective lens to control the objective lens' angular distribution and thereby achieve the same non-linear image distribution, as already contemplated by Baker. APPLE-1003, ¶¶257-260; *see* APPLE-1006, 10:61-11:6, 11:41-45, 11:48-12:55, claim 3; APPLE-1009, Abstract, FIGS. 3, 4-6, 2:56-3:42, 5:44-7:11, claim 6; *see* APPLE-1011, 131, 230.

VI. DISCRETIONARY DENIAL IS NEITHER APPROPRIATE NOR EQUITABLE

A. §314(a): The *Fintiv* Factors Favor Institution

Patent Owner filed infringement actions against Apple involving the '990 Patent. The actions, assigned Case Nos. 1:21-cv-01733-MN-CJB and 1:21-cv-01484-MN-CJB are concurrently pending in the District of Delaware.

Pursuant to the Interim Procedure For Discretionary Denials In AIA Post-Grant Proceedings, 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.” APPLE-1021, 5. As explained above (*see* §§V.A-B *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 these factors were considered, they weigh against discretionary denial.

1. 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. APPLE-1022, 19. 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 ’990 Patent. Accordingly, Petitioner will move to stay the district court cases, upon institution.

The proceedings’ relatively early stage and the potential for issue simplification increases the likelihood that the 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.

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

Trial is currently scheduled for October 28, 2024. APPLE-1022, 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.

3. 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 claim construction and invalidity (e.g., preparing expert reports, preparing final invalidity contentions, discovery relating to third party prior art references and systems) still 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.

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

As noted above, 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 the

currently-scheduled trial date (October 28, 2024). Because a FWD will issue before the district court's 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.

5. 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.”).

6. Factor 6: Other Circumstances Support Institution

As evidenced from the above analysis (*see* §§V.A-B, *supra*), Apple's patentability challenge is unusually strong, which favors institution regardless of the other factors.

B. §325(d): This Petition Applies New Arguments Not Previously Considered or Relied Upon by the Office

This Petition raises unpatentability grounds that are based on the teachings of three references—Baker, Fisher, and Shioti. Although these references were relied upon during the '990 Patent's reexamination⁴, this Petition relies upon

⁴ Claim 27 has not previously been challenged in IPR.

grounds/arguments that are different than those previously presented to and considered by the Office. *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 (Feb. 13, 2020) (precedential).

With respect to claim 27, this Petition presents unpatentability grounds based on the Baker-Shiota combination. *See* §V.A, *supra*. As explained below, claim 27 includes some features that are similar to those recited in claim 1 (*compare* [1a]-[1d] *with* [27a]-[27d]) and additional features recited in limitations [27e] and [27f]. As explained below, for [27a]-[27d] and for some of the features recited in [27e]-[27f], Patent Owner's own statements during reexamination confirmed the obviousness of those features in view of the Baker-Shiota combination (as presented herein). And, as also explained below, for other claim features recited in [27e]-[27f], Patent Owner only identified certain portions of Shiota during reexamination as relevant to these claim features, and in doing so, guided the Office away from the pertinent teachings in Shiota, which when explained from the vantage of a POSITA and when applied in combination with Baker—as Dr. Kessler explains in his declaration—would render obvious these claim features.

In more detail, Patent Owner added claim 27 during the '990 Patent's reexamination as an independent claim that includes, in part, features similar to those also recited in claim 1 (*compare* [1a]-[1d], *with* [27a]-[27e]), which Patent Owner

cancelled in view of the art and arguments identified in the reexamination request. APPLE-1011, 247, 229 (“Baker provides subject matter of claim 1”). Claim 27 additionally recites “displaying the obtained panoramic image by correcting the non-linearity of the initial image, performed by retrieving image points on the obtained image in a coordinate system of center O’ using at least the non-linear distribution function and a size L of the obtained image,” which are identified herein as limitations [27e] and [27f]. These limitations include (1) the feature previously included in claim 10, which recites “correcting the non-linearity of the initial image, performed by means of ... the non-linear distribution function” and which Patent Owner removed via amendment in view of the art and grounds cited during reexamination (APPLE-1011, 239, 231), and (2) two additional features reciting “correcting the non-linearity ... using at least ... the size of the image L,” and that “the retrieved image points are points in a coordinate system of center O’.” APPLE-1011, 242.

In the corresponding remarks, Patent Owner argued that Shiota does not teach claim 27’s correction method because, according to Patent Owner, Shiota’s image points (“second projection points p_1 and q_1 ”) are obtained without using the size of the image disk and instead, are obtained by “multipl[ying] ... coordinated X_2 , Y_2 on a hemisphere” with a “coefficient k_2 , which is equal to the distribution function

divided by a distance r from the origin of the image disk to a point Q on the image disk.” APPLE-1011, 250 (citing APPLE-1012, [0033]-[0041]). Subsequently, the Office found that the prior art of record (which included Baker and Shiota) did not “disclose” or “teach” limitations [27e] and [27f]. APPLE-1011, 343-344.

As an initial matter, when arguing during reexamination that Shiota does not disclose these limitations, Patent Owner did not contest—and instead offered statements and analysis to ratify what the instant Petition and the accompanying declaration of Dr. Kessler explain in great detail—that Shiota alone or in view of Baker teaches obtaining corrected/transformed image points of an image by correcting the non-linearity of the initial image using the non-linear image distribution function (as recited in [27e] and [27f]). APPLE-1011, 234, 248 (“Shiota utilizes the non-linear distribution function ... to correct the non-linearity of the initial image”), 250, 117-118; APPLE-1003, ¶¶191-198; *see supra* §V.A.4 [27e]; APPLE-1012, [0033]-[0042].

Nor did Patent Owner contest during reexamination that Shiota’s teaching of obtaining the corrected/transformed p_1 , q_1 image points are retrieved image points of an obtained image in the coordinate system of center O' , as recited in [27f]. *See* APPLE-1011, 250. Again, as this Petition and the accompanying declaration of Dr. Kessler explains, Shiota’s disclosures, in combination with Baker, teach obtaining

the retrieved image points in much the same manner as described in the '990 specification—with the retrieved/transformed image points p_1 , q_1 being points on the image disk in a coordinate system with a center (center O') that corresponds to the center of the image disk. *See* APPLE-1001, 12:66-13:24, FIG. 13; APPLE-1012, FIG. 1, [0022], [0025], [0033], [0035]-[0037], [0040]-[0041], [0048]; APPLE-1003, ¶¶208-210.

Most notably, in advancing its reexamination arguments that Shiota does not use “the size of the image disk ... to correct the image,” Patent Owner omitted reference to relevant teachings from within Shiota that demonstrate that the size of the image disk would in fact be used to correct the image in the Baker-Shiota combination. *See* APPLE-1011, 250 (citing APPLE-1012, [0033]-[0041]). In this Petition and within Dr. Kessler’s accompanying declaration, disclosures from within Shiota that Patent Owner failed to confront or even cite are identified, to reveal that Shiota describes (1) correction techniques illustrated using a normalized radius of 1 for the size of the image circle at a field angle of 90° (APPLE-1012, [0023]) and (2) that the image circle diameter (i.e., the size of the image) “differs according to at least the size of the image pickup device” and that “at the time of actual[] use, magnification adjustment is performed” for the correction. *Id.*, [0023]; *see also* [0024]-[0026]. As Dr. Kessler explains, a POSITA would have understood from

these disclosures that “magnification adjustment” refers to an adjustment that accounts for the actual size of the image pickup device (i.e., image disk)—and by extension, the actual size of the image—as part of the image transformation. APPLE-1003, ¶¶205-207; *see also* APPLE-1012, [0023]-[0026]. Dr. Kessler thus explains that, in view of Shiota, a POSITA would have understood or found obvious that Shiota’s image transformation, when applied to an actual application (e.g., as contemplated by Baker), would account for the size of the actual image disk/sensor (and by extension, the size of the image) for the underlying image transformation/correction. *Id.*

On this record, there is no evidence suggesting that the Office considered or otherwise relied upon these teachings, as applied in combination, in assessing claim 27’s patentability—particularly with reference to limitations [27e] and [27f]. Therefore, this Petition and Dr. Kessler’s testimony advances new and different arguments with respect to claim 27, which were not cited or considered by the Office. *See id.*; *Oticon Medical AB v. Cochlear Ltd.*, IPR2019-00975, Pap. 15, 10-19 (PTAB Oct. 16, 2019) (precedential). Had this evidence been properly put forth and considered by the Office, the Office would not have reached its erroneous finding of patentability of claim 27.

With respect to challenged claims 2 and 4, Patent Owner acknowledged during the reexamination that Baker discloses these claims and subsequently, Patent Owner amended these claims to depend from new claim 27. APPLE-1011, 229, 137. Similarly, Patent Owner acknowledged that the teachings of Baker and/or Fisher disclosed or rendered obvious now-cancelled claims 6 and 7 (both depending from claim 1), which included substantively the same limitations as in new claims 29 and 30. APPLE-1011, 131, 137, 229, 233. Each of these claims (2, 4, 29, and 30) depend from new claim 27, for which this Petition presents unpatentability grounds that advance new arguments and associated teachings in the art than those previously presented to and considered by the Office (as explained above).

Therefore, this Petition should not be discretionarily denied under §325(d).

VII. CONCLUSION AND FEES

Petitioner requests institution of an IPR for the Challenged Claims. Please charge any fees to Deposit Account No. 06-1050.

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

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

Apple is a real party-in-interest.

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

Petitioner is not aware of any disclaimers, reexamination certificates or petitions for *inter partes* review for the '990 Patent, other than those listed below:

- IPR2014-01438 (APPLE-1019)
- Reexamination Request 90/013,410 (APPLE-1011)
- IPR2020-00195
- IPR2020-00179
- *ImmerVision, Inc. v. Apple, Inc.*, D. Del. 1:21-cv-01733-MN-CJB (case pending)
- *ImmerVision, Inc. v. Apple, Inc.*, D. Del. 1:21-cv-01484-MN-CJB
- *ImmerVision, Inc. v. LG Electronics U.S.A., Inc.*, D. Del., 1:18-cv-01631
- *ImmerVision, Inc. v. LG Electronics U.S.A., Inc.*, D. Del., 1:18-cv-01630

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

Petitioner provides the following designation of counsel.

Lead Counsel	Backup counsel
W. Karl Renner, Reg. No. 41,265 Fish & Richardson P.C. 60 South Sixth Street, Suite 3200 Minneapolis, MN 55402 Tel: 202-783-5070 Fax: 877-769-7945 Email: IPR50095-0114IP1@fr.com	Karan Jhurani, Reg. No. 71,777 David Holt, Reg. No. 65,161 Fish & Richardson P.C. 60 South Sixth Street. Suite 3200 Minneapolis, MN 55402 Tel: 202-783-5070 Fax: 877-769-7945 IPR50095-0114IP1@fr.com

D. Service Information

Please address all correspondence and service to the address listed above.

Petitioner consents to electronic service by email at IPR50095-0114IP1@fr.com.

Respectfully submitted,

Dated: January 18, 2023

/W. Karl Renner/

W. Karl Renner, Reg. No. 41,265

Karan Jhurani, Reg. No. 71,777

David Holt, Reg. No. 65,161

Fish & Richardson P.C.

60 South Sixth Street, Suite 3200

Minneapolis, MN 55402

T: 202-783-5070

F: 877-769-7945

(Control No. IPR2023-00471)

Attorneys for Petitioner

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 13,886 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated: January 18, 2023

/W. Karl Renner/

W. Karl Renner, Reg. No. 41,265

Karan Jhurani, Reg. No. 71,777

David Holt, Reg. No. 65,161

Fish & Richardson P.C.

60 South Sixth Street, Suite 3200

Minneapolis, MN 55402

T: 202-783-5070

F: 877-769-7945

Attorneys for Petitioner

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, Power of Attorney, and all supporting exhibits were provided via Federal Express, to the Patent Owner by serving the PAIR correspondence address of record as follows:

PANITCH SCHWARZE BELISARIO & NADEL LLP
TWO COMMERCE SQUARE
2001 MARKET STREET, SUITE 2800
PHILADELPHIA PA 19103

/Crena Pacheco/
Crena Pacheco
Fish & Richardson P.C.
60 South Sixth Street, Suite 3200
Minneapolis, MN 55402
(617) 956-5938