

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

IMMERVISION, INC.,
Patent Owner.

IPR2023-00471
Patent 6,844,990 B2

Before JOHN D. HAMANN, STEVEN M. AMUNDSON, and
STEPHEN E. BELISLE, *Administrative Patent Judges*.

HAMANN, Administrative Patent Judge.

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

I. INTRODUCTION

In this *inter partes* review, instituted pursuant to 35 U.S.C. § 314 (2018), Apple Inc. (“Petitioner”) challenges the patentability of claims 2, 4, 27, 29, and 30 (“the challenged claims”) of U.S. Patent No. 6,844,990 B2 (Ex. 1001, “the ’990 patent”), owned by ImmerVision, Inc. (“Patent Owner”). We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is entered pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73 (2023). For the reasons discussed herein, we determine that Petitioner shows by a preponderance of the evidence that the challenged claims are unpatentable.

A. Procedural History

Petitioner filed a Petition requesting *inter partes* review of the challenged claims of the ’990 patent. Paper 2 (“Pet.”). Patent Owner filed a Preliminary Response. Paper 7. With authorization, Petitioner filed a Preliminary Reply (Paper 8) addressing issues relating to discretionary denial under § 325(d), and Patent Owner filed a Preliminary Sur-reply (Paper 9) in response. The majority instituted *inter partes* review of the challenged claims on the grounds raised in the Petition. Paper 10 (“Dec. on Inst.”), 31.¹

Following institution, Patent Owner filed a Request for Rehearing relating to discretionary denial under § 325(d). Paper 12. The majority

¹ Administrative Patent Judge Kristina M. Kalan filed a dissenting opinion finding that “the Board should exercise its discretion to deny institution under 35 U.S.C. § 325(d).” Dec. on Inst. 32. During trial, a Panel Change Order was entered and stated that “[d]ue to unavailability, Administrative Patent Judge Steven M. Amundson replaces Administrative Patent Judge Kristina M. Kalan on the panel.” Paper 17, 2.

denied Patent Owner's request. Paper 14. Patent Owner thereafter filed a Response to the Petition. Paper 15 ("PO Resp."). Petitioner filed a Reply to Patent Owner's Response. Paper 20 ("Pet. Reply"). Patent Owner filed a Sur-reply to Petitioner's Reply. Paper 22 ("PO Sur-reply").

An oral hearing was held on April 11, 2024. A transcript of the oral hearing is included in the record. Paper 27.

B. Real Parties-In-Interest

The parties identify themselves as the real parties-in-interest. Pet. 79; Paper 3, 2.

C. Related Matters

The parties collectively identify (i) *ImmerVision, Inc. v. Apple Inc.*, 1:21-cv-01733 (D. Del.); (ii) *ImmerVision, Inc. v. Apple Inc.*, 1:21-cv-01484 (D. Del.); (iii) *ImmerVision, Inc. v. LG Electronics U.S.A., Inc.*, 1:18-cv-01630 (D. Del.); and (iv) *ImmerVision, Inc. v. LG Electronics U.S.A., Inc.*, 1:18-cv-01631 (D. Del.), as matters that may affect, or be affected by, a decision in this proceeding. Pet. 80; Paper 3, 2–3.

D. The Challenged Patent

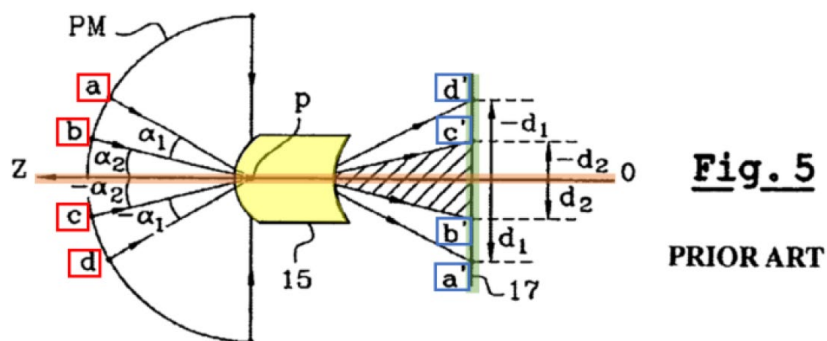
The '990 patent "relates to obtaining digital panoramic images and displaying panoramic images on computer screens." Ex. 1001, 1:12–14. The '990 patent explains that in order to avoid a displayed image sector having geometrical distortions, "the classical panoramic objective lenses must have a distribution function of the image points according to the field angle of the object points of a panorama that is as linear as possible." *Id.* at 2:4–8. However, when digital enlargement increases using techniques of displaying a digital panoramic image sector on a computer screen, "the granularity of the image appears as the limits of the resolution of the image

sensor are being reached.” *Id.* at 3:1–9. The ’990 patent observes that for this problem of the low quality in enlargements “only certain zones of a panoramic image are of a practical interest and are likely to be expanded by the observer by means of a digital zoom.” *Id.* at 3:43–46. According to the ’990 patent, using a panoramic objective lens that is not linear, which expands certain zones of the image and compresses other zones of the image, “the expanded zones of the image cover a number of pixels of the image sensor that is higher than if they were not expanded, and thus benefit from a better definition.” *Id.* at 3:66–4:6. The ’990 patent thus discloses:

a method for capturing a digital panoramic image, by projecting a panorama onto an image sensor by means of a panoramic objective lens, in which the panoramic objective lens has an image point distribution function that is not linear relative to the field angle of object points of the panorama, the distribution function having a maximum divergence of at least $\pm 10\%$ compared to a linear distribution function, such that the panoramic image obtained has at least one substantially expanded zone and at least one substantially compressed zone.

Id. at 4:11–21.

Petitioner’s annotated version of Figure 5 is reproduced below:



Pet. 5 (annotating Ex. 1001, Fig. 5). Figure 5 illustrates a prior art, classical system for taking panoramic shots using panoramic objective lens 15 (yellow) having optical axis OZ (horizontal orange line) and digital image

sensor 17 (vertical green line) arranged in the image plane of lens 15.

Ex. 1001, 6:65–7:2. Object points a, b, c, d (in red boxes) are projected through lens 15 and captured as respective image points a', b', c', d' (in blue boxes) at image sensor 17. *Id.* at 7:2–14. Each of field angles α_1 , α_2 , $-\alpha_2$, $-\alpha_1$ of corresponding object points a, b, c, d is an angle that an incident light ray passes through the corresponding object point and center p of panorama PM. *Id.* at 7:2–10. On image sensor 17, image points a', b', c', and d' are located at distances d1, d2, -d2, -d1, respectively, from the center of the image. *Id.* at 7:11–14.

Figure 7A of the '990 patent is reproduced below:

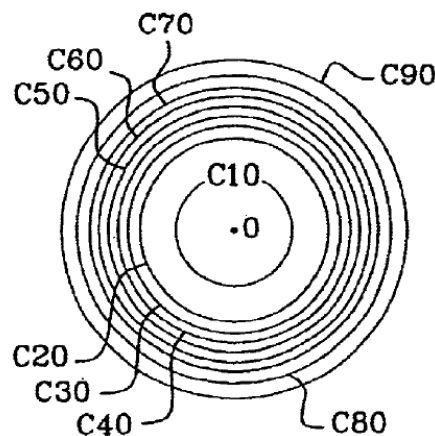


Fig. 7A

Fig. 7A shows the non-linearity of a panoramic objective lens. Ex. 1001, 6:29–30. The circles represent distributions of image points corresponding to object points having an identical field angle on a disk. *Id.* at 2:15–17. Because of the non-linear panoramic objective lens, circles C10 and C20 are further from the center of the image and further from each other whereas circles C30 to C90 are closer to each other, thereby representing a panoramic

image having an expanded zone in the center and a compressed zone towards the edge of the image disk. *Id.* at 8:21–28.

The '990 patent further discloses that the point of “maximum divergence” refers to the point on an image point distribution function plot that is farthest away from a corresponding point on a linear distribution function plot. *Id.* at 8:44–67. The maximum divergence from the non-linearity of a panoramic objective lens is demonstrated in Figure 8, which is reproduced below:

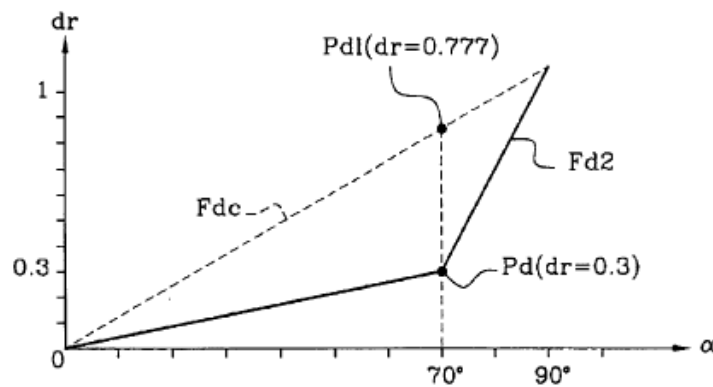
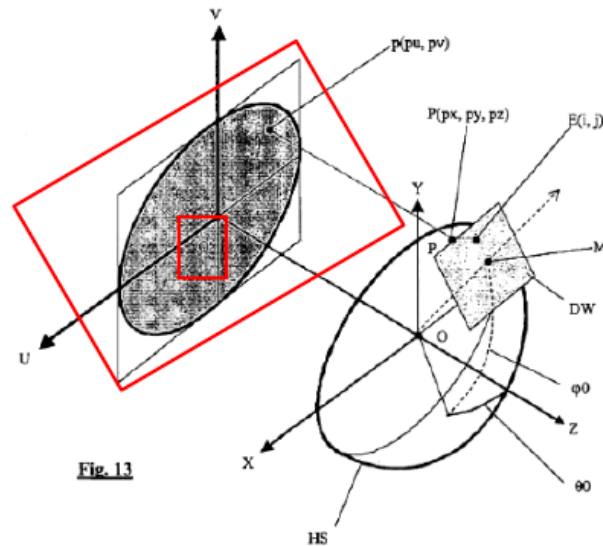


Fig. 8

Figure 8 shows an image point distribution function $Fd2$ plotted on an x-axis that represents the field angle α of the object point and on a y-axis that represents the relative distance dr of an image point in relation to the center of the image. *Id.* at 8:34–38, 9:36–52. Distribution function $Fd2$ here has a point of maximum divergence Pd at the angle $\alpha = 70^\circ$ and at a relative distance $dr = 0.3$ in relation to the center of the image, and the greatest relative distance between image point distribution function $Fd2$ and linear distribution function Fdc is found between points Pd and Pdl . *Id.* at 9:36–52.

Petitioner's annotated version of Figure 13 is reproduced below:



Pet. 12 (annotating Ex. 1001, Fig. 13). Figure 13 illustrates schematically an image point mapping method for correcting optical distortion of an initial image that was obtained from using the non-linear distribution function of the objective lens. Ex. 1001, 6:46–47, 10:12–17. Display window DW having image point $P(p_x, p_y, p_z)$ is projected on an image disk that has size L (within large red box) and projected to image point $p(p_u, p_v)$ that has a coordinate system with center O' (within small red box) which is the center of the image disk and axes $O'U$ and $O'V$. *Id.* at 12:59–14:35. Using an algorithm, image point $p(p_u, p_v)$ is obtained using equations, such as $p_u = L * U * F_d(\alpha)$ and $p_v = L * U * F_d(\alpha)$, in which the size of the image disk L is multiplied with the non-linear distribution function F_d at an angle α . *Id.* at 12:66–14:35.

E. Illustrative Claim

Of the challenged claims, claim 27 is independent. Claim 27 is illustrative of the challenged claims, and reads as follows:

27. A method for displaying a digital panoramic image, the method comprising:

obtaining a digital panoramic image by projecting a panorama onto an image sensor using a panoramic objective lens, 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, the distribution function having a maximum divergence of at least $\pm 10\%$ compared to a linear distribution function, such that the panoramic image obtained has at least one substantially expanded zone and at least one substantially compressed zone; and

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.

Ex. 1001, *Ex Parte* Reexam. Cert., US 6,844,990 C1, issued May 8, 2015.

F. Instituted Grounds of Unpatentability

We instituted trial based on the following grounds of unpatentability, which are all the grounds of unpatentability raised in the Petition:

Claim(s) Challenged	35 U.S.C. §²	Reference(s)/Basis
2, 4, 27, 29	103(a)	Baker, ³ Shiota ⁴
29, 30	103(a)	Baker, Shiota, Fisher ⁵

Pet. 4, 41–65. Petitioner submits in support of its arguments the Declaration of Dr. David Kessler, Ph.D. (Ex. 1003) and the Second Declaration of

² The Leahy-Smith America Invents Act (“AIA”) included revisions to 35 U.S.C. § 103 that became effective on March 16, 2013. Because the earliest effective filing date for the ’990 patent is before March 16, 2013, we apply the pre-AIA version of the statutory basis for unpatentability.

³ US 5,686,957, issued Nov. 11, 1997 (Ex. 1006, “Baker”).

⁴ EP 1 028 389 A2, published Aug. 16, 2000 (Ex. 1012, “Shiota”).

⁵ US 3,953,111, issued Apr. 27, 1976 (Ex. 1009, “Fisher”).

Dr. David Kessler, Ph.D. (Ex. 1023). Patent Owner submits in support of its arguments the Declaration of James F. Munro (Ex. 2001).

II. LEVEL OF ORDINARY SKILL IN THE ART

To determine whether an invention would have been obvious at the time it was made, we consider the level of ordinary skill in the pertinent art at the time of the invention. *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966). In assessing the level of ordinary skill in the art, various factors may be considered, including the “type of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made; sophistication of the technology; and educational level of active workers in the field.” *In re GPAC, Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995) (citing *Custom Accessories, Inc. v. Jeffrey-Allan Indus., Inc.*, 807 F.2d 955, 962–63 (Fed. Cir. 1986)). “[O]ne or more factors may predominate.” *Id.*

In our Decision on Institution, we adopted the definition Petitioner proposes for one having ordinary skill in the art at the time of the invention of the ’990 patent, with the exception of the open-ended phrase “at least.” Dec. on Inst. 10. Namely, we found that one of ordinary skill in the art “would have had . . . a Bachelor’s degree in Physics, Optical Engineering, and/or Electrical Engineering and . . . five years’ experience in developing and designing optical imaging systems and have familiarity with image processing algorithms and optical design software” and that “[s]uperior education could compensate for a deficiency in work experience, and vice-versa.” *Id.* (quoting Pet. 15 (citing Ex. 1003 ¶ 24)).

Patent Owner does not identify a level of skill in the art that one would have had at the time of the invention of the ’990 patent or identify any shortcoming in Petitioner’s formulation. See PO Resp. 12–13.

Because Petitioner’s definition of the level of skill in the art is consistent with the ’990 patent and the asserted prior art, we maintain it for purposes of this Final Written Decision. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001); *In re GPAC*, 57 F.3d at 1579; *In re Oelrich*, 579 F.2d 86, 91 (CCPA 1978).

III. CLAIM CONSTRUCTION

Because the Petition was filed after November 13, 2018, we apply the same claim construction standard that would be used in a civil action under 35 U.S.C. § 282(b), following the standard articulated in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). 37 C.F.R. § 42.100(b); 83 Fed. Reg. 51,340, 51,340–41, 51,343 (Oct. 11, 2018). In applying such standard, claim terms are generally given their ordinary and customary meaning, as would be understood by a person of ordinary skill in the art, at the time of the invention and in the context of the entire patent disclosure. *Phillips*, 415 F.3d at 1312–13. “In determining the meaning of the disputed claim limitation, we look principally to the intrinsic evidence of record, examining the claim language itself, the written description, and the prosecution history, if in evidence.” *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 469 F.3d 1005, 1014 (Fed. Cir. 2006) (citing *Phillips*, 415 F.3d at 1312–17).

Petitioner states that it “is applying the constructions adopted in IPR2020-00195 for certain applicable claim terms in the [c]hallenged [c]laims” and provides proposed constructions for “panoramic objective lens,” “object points of the panorama,” “image point,” “field angle of object points,” “maximum divergence,” “expanded zone,” and “compressed zone.” Pet. 2–4. Petitioner, however, does not do more. *Id.* Patent Owner states

that it “does not object to the constructions proposed by Petitioner.” PO Resp. 13.

We determine that no claim terms require specific construction to resolve the disputes between the parties. Thus, we afford the language of the challenged claims its plain and ordinary meaning. *See, e.g., Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)) (“[W]e need only construe terms ‘that are in controversy, and only to the extent necessary to resolve the controversy.’”).

IV. GENERAL PRINCIPLES OF LAW

“In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)). This burden of persuasion never shifts to Patent Owner. *See Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (discussing the burden of proof in *inter partes* review).

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

prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of non-obviousness, if present.⁶ *See Graham*, 383 U.S. at 17–18. When evaluating a claim for obviousness, we also must “determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue.” *KSR*, 550 U.S. at 418 (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)).

V. OBVIOUSNESS OVER BAKER AND SHIOTA

Petitioner argues that the combination of Baker and Shiota renders claims 2, 4, 27, and 29 obvious. Pet. 1, 22–62. For the reasons that follow, we determine that Petitioner shows by a preponderance of the evidence that the combination of Baker and Shiota renders these claims obvious.

A. Summary of Baker

Baker is titled “Teleconferencing Imaging System with Automatic Camera Steering” and is directed to a system that includes “a video camera and a lens system” that “provides a panoramic display that can electronically select portions of that image and, through warping techniques, remove any distortion from the most significant portions of the image which lie from the horizon up to approximately 30 degrees in a hemispheric viewing area.” Ex. 1006, codes (54), (57). Baker explains that although conventional lenses “achieve a view of a large field, the valuable content from the peripheral areas lacks in potential image quality (resolution) mapping because the imaging device and system does not differentiate between these areas and the central areas of less valuable detail.” *Id.* at 3:60–64. Baker purports to resolve this problem by providing a hemispheric electronic image

⁶ Patent Owner does not present arguments or evidence of such objective evidence of non-obviousness. *See generally* PO Resp.

manipulator subsystem having a capture lens “that allows for useful electronic manipulation of a segmented portion of a hemispheric scene” by creating an electronic image that is warped to have “a desired subview in proper aspect ratio.” *Id.* at 5:37–47. “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,” in which “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.” *Id.* at 5:57–6:1.

When a portion of the scene is to be displayed, a transform processor subsystem “electronically manipulates the scene for display as a perspective-correct image on a display device.” Ex. 1006, 6:5–9. Baker discloses:

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). More pixels equates to more measurement data, hence more accurate data collection.

Id. at 6:12–24.

B. Summary of Shiota

Shiota is titled “Arithmetic Unit for Image Transformation” and relates to transforming a fisheye image obtained by using a fisheye lens into

a plane image for display. Ex. 1012, codes (54), (57). Shiota explains that an image produced by the fisheye lens is “distorted as compared with an image obtained by using the standard lens and is very hard for the operator to watch.” *Id.* ¶ 3. Shiota purports to resolve this problem by providing a unit for image transformation that comprises:

a first coordinate calculating unit for obtaining first projection coordinates on a fisheye image face as an imaginary object face derived by projecting coordinates on the plane image; and a second coordinate calculating unit for obtaining second projection coordinates derived by projecting the first projection coordinates obtained by the first coordinate calculating unit onto the fisheye image face.

Id. ¶ 8.

Figure 1, shown below, helps illustrate Shiota’s teachings.

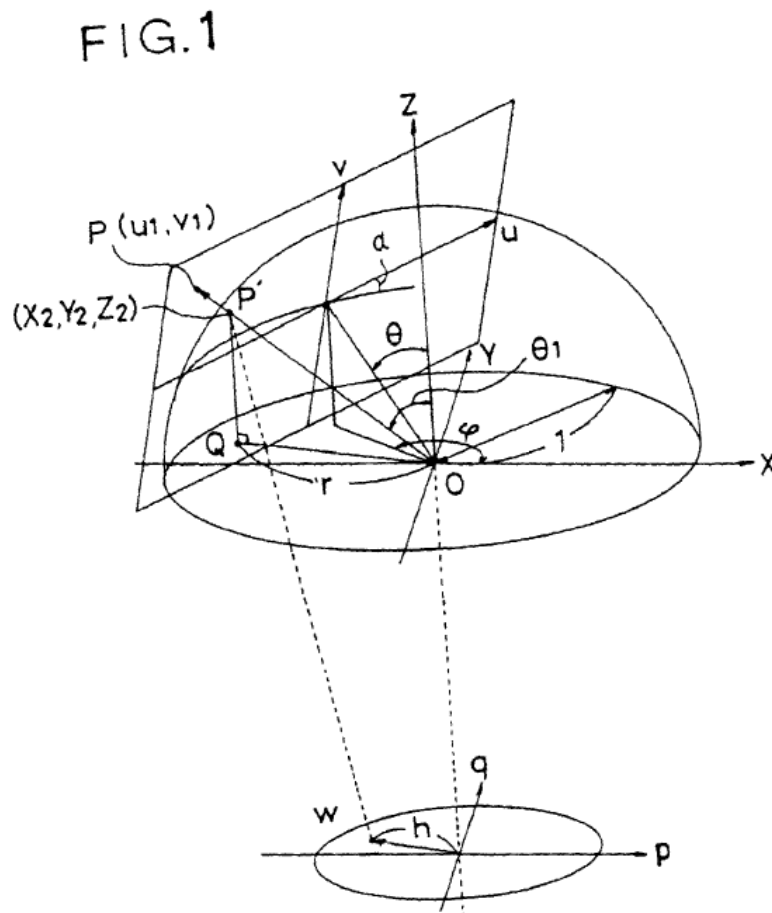


Figure 1 “is a diagram showing setting of a coordinate system.” *Id.* ¶ 18. Shiota teaches that in a first step, coordinates on a surface of a hemisphere (X, Y, Z) are obtained from a projection from a plane display image (u, v) and then corresponding coordinates in the fisheye image (p, q) are obtained from a projection from the hemisphere. *Id.* ¶¶ 22–23. A coefficient k_1 , taken from a lookup table for various distances L from the origin in the (u, v) coordinates, is used to map coordinates from the hemispherical surface to the plane image in the (X, Y, Z) coordinate system. *Id.* ¶¶ 28–32.

In a second step, a distribution function of the lens is used to compute a coefficient k_2 , which equals h (the height from the origin of the fisheye image face and defined by the distribution function) divided by distance r from the origin. Ex. 1012 ¶¶ 36–40. These steps, among others, provide a calculating procedure for image transformation to correct for or compensate distortions in an image that is captured by a fisheye lens. *Id.* ¶¶ 8, 26–27.

C. Challenged Claim 27

1. Method for Displaying (Preamble)

Petitioner argues that Baker teaches “[a] method for displaying a digital panoramic image,” as recited in the preamble of claim 27. Pet. 27–32. More specifically, Petitioner argues that Baker teaches a “‘visual imaging system’ that uses a ‘camera to capture the relevant visual information within a panoramic field of view existing along the horizon.’” Pet. 27 (quoting Ex. 1006, 6:29–32, 8:58–62). According to Petitioner, “Baker explains that, using its lens . . . , the panoramic image is projected into the image plane where the image sensor/detector (e.g., a CCD) is positioned.” *Id.* at 28 (citing Ex. 1006, 5:55–6:4).

In addition, Petitioner argues that Baker teaches that the “image received on the imager device is passed on to the system components for storage.” *Id.* at 30 (quoting Ex. 1006, 14:9–11). According to Petitioner, Baker teaches that “[t]he 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.” *Id.* at 31 (citing Ex. 1006, 14:42–47; Ex. 1003 ¶ 150). More specifically, Petitioner argues that Baker teaches a transform processor that “‘corrects the’ captured panoramic image ‘for display on a conventional display device 28 such as a video monitor or a video projection display system.’” *Id.* (quoting Ex. 1006, 9:8–13; citing *id.* at Fig. 1).

After reviewing Petitioner’s arguments and evidence, which are not addressed by Patent Owner (*see generally* PO Resp.), we determine that Petitioner demonstrates by a preponderance of the evidence that Baker teaches “[a] method for displaying a digital panoramic image.” In light of our finding, we need not, and thus do not, reach whether claim 27’s preamble is limiting.

2. Obtaining a Digital Panoramic Image

Petitioner argues that Baker teaches “obtaining a digital panoramic image by projecting a panorama onto an image sensor using a panoramic objective lens,” as recited in claim 27. Pet. 32–36. More specifically, Petitioner argues that Baker teaches “a panoramic objective lens in the form of a lens that covers a hemispherical field and is used to capture a panoramic image.” *Id.* at 33 (citing Ex. 1003 ¶ 156). In particular, Petitioner argues that “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.’” *Id.* (quoting Ex. 1006, 6:29–32; citing *id.* at 8:58–62, 13:56–

57, 16:19–23, code (57)). According to Petitioner, one of ordinary skill in the art “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.” Pet. 33 (citing Ex. 1003 ¶¶ 156–157); *see also id.* at 33–34 (citing Ex. 1006, 12:6–11, 12:23–32; Ex. 1003 ¶¶ 157–158) (arguing that Baker’s objective lenses include sequentially arranged lenses, including a “hemispherical gradient index unit with a wide field multi-element lens”).

In addition, Petitioner argues that “Baker’s lens projects a panorama onto an image sensor located in the image plane of the objective lens.” *Id.* at 34–35 (citing Ex. 1006, 5:55–6:4, 13:8–65; Ex. 1003 ¶¶ 142–152). In particular, Petitioner argues that “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.” *Id.* at 35 (citing Ex. 1006, 5:55–6:4, 7:55–60, 13:9–18, 14:8–17; Ex. 1003 ¶ 160).

In addition, Petitioner argues that Baker teaches 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.’” *Id.* (quoting Ex. 1006, 8:62–65; citing *id.* at 2:35–39, 10:55–57, 13:9–18, 14:32–36; Ex. 1003 ¶ 161) (alteration in original). Thus, one of ordinary skill “would have understood that Baker’s system obtains a digital panoramic image,” according to Petitioner. Pet. 36 (citing Ex. 1003 ¶ 161).

After reviewing Petitioner’s arguments and evidence, which are not addressed by Patent Owner (*see generally* PO Resp.), we determine that

Petitioner demonstrates by a preponderance of the evidence that Baker teaches this limitation.

3. *Having an Image Point Distribution Function*

Petitioner argues that Baker teaches “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 recited in claim 27. Pet. 36–40. More specifically, Petitioner argues that “Baker’s objective lens (including its series of multiple optical elements) . . . is ‘designed to capture and enhance the peripheral content of a hemispheric scene.’” *Id.* at 36 (citing Ex. 1006, 8:60–62). In particular, Petitioner argues that “[t]o 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.’” *Id.* at 36–37 (quoting Ex. 1006, 8:32–36) (second alteration in original).

In fact, Baker teaches 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 detect[able] by the imaging device[’s] sensing elements,” according to Petitioner. *Id.* at 37 (quoting Ex. 1006, 12:6–12; citing *id.* at 11:1–4, 11:48–63; Ex. 1003 ¶¶ 164–165) (internal quotation marks omitted; second alteration in original). In particular, Petitioner argues that Baker teaches 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 . . . ‘focuses that same 15 degrees on fifty percent of the imager’ at the imaging plane,” resulting in a “five-fold increase in

resolution” and “at least five times increase in resolving power by this lens/imager combination.” *Id.* (quoting Ex. 1006, 6:48–56; citing Ex. 1003 ¶ 166). Thus, one of ordinary skill in the art “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),” according to Petitioner. *Id.* at 39 (citing Ex. 1003 ¶¶ 171–172); *see also* Ex. 1003 ¶¶ 168–170 (plotting this lens’s non-linear image distribution function).

After reviewing Petitioner’s arguments and evidence, which are not addressed by Patent Owner (*see generally* PO Resp.), we determine that Petitioner demonstrates by a preponderance of the evidence that Baker teaches this limitation.

4. Distribution Function Having a Maximum Divergence

Petitioner argues that Baker teaches “the distribution function having a maximum divergence of at least $\pm 10\%$ compared to a linear distribution function,” as recited in claim 27. Pet. 40–42. More specifically, Petitioner argues that “[m]aximum divergence is defined by the formula $\text{DIVmax \%} = \frac{[\text{dr}(\text{Pd}) - \text{dr}(\text{Pdl})]}{[\text{dr}(\text{Pdl})]} * 100$, where $\text{dr}(\text{Pd})$ is the relative distance from the center of the image to the point of maximum divergence Pd, and $\text{dr}(\text{Pdl})$ is the relative distance in relation to the center of the corresponding point on the linear image distribution line.” *Id.* at 40 (citing Ex. 1001, 8:44–60).

According to Petitioner, “[a]pplying this maximum divergence formula to the image distribution function described [in Baker, one of ordinary skill in the art] . . . would have understood that Baker’s image distribution functions have a maximum divergence of at least $\pm 10\%$ compared to a linear distribution function.” *Id.* at 40–41 (citing Ex. 1003

¶¶ 176–177). Petitioner argues that one of ordinary skill in the art, looking at an “example image distribution function that corresponds to Baker’s objective lens” “would have observed that the gap between the linear distribution function . . . and Baker’s image distribution function . . . is greatest at the field angle of 75°,” and “[a]t 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.” *Id.* at 41 (citing Ex. 1003 ¶¶ 178–180). Petitioner argues that “[w]hen applying the above-recited maximum divergence formula, the resulting maximum divergence for the above distribution function amounts to approximately -15% (i.e., $[0.707-0.833]/0.833 \times 100$).” *Id.* at 41–42 (citing Ex. 1003 ¶ 180).

After reviewing Petitioner’s arguments and evidence, which are not addressed by Patent Owner (*see generally* PO Resp.), we determine that Petitioner demonstrates by a preponderance of the evidence that Baker teaches this limitation.

5. Expanded Zone and Compressed Zone

Petitioner argues that Baker teaches “such that the panoramic image obtained has at least one substantially expanded zone and at least one substantially compressed zone,” as recited in claim 27. Pet. 42–45. More specifically, Petitioner argues that “Baker’s objective lens projects the panoramic image, which has one substantially expanded zone and one substantially compressed zone.” *Id.* at 42 (citing Ex. 1003 ¶¶ 184–185). In particular, Petitioner argues that Baker teaches “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 [rather] than the central areas of the captured scene.’” *Id.* (quoting Ex. 1006, 10:57–60, 12:29–32; citing *id.* at 5:57–61, 6:43–56) (first alteration in original).

After reviewing Petitioner’s arguments and evidence, which are not addressed by Patent Owner (*see generally* PO Resp.), we determine that Petitioner demonstrates by a preponderance of the evidence that Baker teaches this limitation.

6. Displaying the Obtained Panoramic Image

Petitioner argues that the combination of Baker and Shiota teaches “displaying the obtained panoramic image by correcting the non-linearity of the initial image,” as recited in claim 27. Pet. 45–48. More specifically, Petitioner argues that Baker teaches “displaying a transformed image on a display device by ‘compensat[ing] for the distortion’ in the image ‘caused by’ its lens.” *Id.* at 45 (citing Ex. 1006, 6:5–24, 9:5–13, Fig. 3BA; Ex. 1003 ¶ 192) (alteration in original). In particular, Petitioner argues that “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.’” *Id.* at 45–46 (quoting Ex. 1006, 14:42–47). According to Petitioner, “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.” *Id.* at 46 (citing Ex. 1006, 14:18–26) (alteration in original). Petitioner argues that “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).”
Id. (citing Ex. 1006, 14:23–26; Ex. 1003 ¶ 192).

According to Petitioner, “[t]o 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.’” *Id.* (second alteration in original) (citing Ex. 1006, 14:42–54). Petitioner argues that Baker teaches that “[t]he 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.” *Id.* (quoting Ex. 1006, 6:12–16; citing *id.* at 6:16–24; Ex. 1003 ¶ 193).

In addition, Petitioner argues that “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.” *Id.* at 47 (citing Ex. 1012 ¶¶ 24, 31–35, 37–42; Ex. 1003 ¶¶ 195–196). Petitioner argues that the applicant during prosecution of an ex parte reexamination “stated that Shiota discloses ‘correcting the non-linearity of the initial image, performed . . . by means of the non-linear distribution function.’” *Id.* (citing Ex. 1011,⁷ 117, 248, 250) (alteration in original); *see also* Ex. 1011, 248 (citing Ex. 1012 ¶¶ 1, 22, 28–41) (“Shiota discloses image correction through mapping of coordinates onto the image. The projection process includes the use of the non-linear distribution function of the lens to obtain certain coordinates.”).

⁷ Reexamination File History for the ’990 patent.

In addition, Petitioner argues that one of ordinary skill in the art “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.” Pet. 47 (citing Ex. 1003 ¶¶ 116–121, 128–138, 197). Petitioner adds that “[g]iven that (1) Baker and Shiota disclose compensating for or correcting the distortion in an image captured by a fisheye lens . . . , 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 . . . , 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.’” *Id.* at 24–25 (citing Ex. 1003 ¶¶ 133–134; Ex. 1006, 6:5–24, 16:5–9).

After reviewing Petitioner’s arguments and evidence, which are not addressed by Patent Owner (*see generally* PO Resp.), we determine that Petitioner demonstrates by a preponderance of the evidence that the combination of Baker and Shiota teaches this limitation. Moreover, we find that Petitioner has provided sufficient articulated reasoning that one of

ordinary skill in the art would have been motivated to combine Baker and Shiota's teaching in the manner Petitioner does.

7. Correcting the Non-Linearity Performed By

Claim 27 further recites that the correction of the non-linearity of the initial image is “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.” Ex. 1001, Reexam. Cert. 1:66–2:3. We agree with Petitioner and find that the combination of Baker and Shiota teaches this limitation. Pet. 48–55; Pet. Reply 3–6.

More specifically, we agree with Petitioner and find that Shiota teaches “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.” Pet. 49 (citing Ex. 1012 ¶¶ 22–24, 37–42; Ex. 1003 ¶¶ 116–121). In particular, Shiota teaches that 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. Ex. 1012 ¶¶ 37–42.

In addition, we find that Shiota teaches also using the size of the obtained image in performing its image correction. More specifically, Shiota teaches the following:

A plane image (fisheye image) obtained through the fisheye lens is expressed by a (p, q) coordinate system as shown in Fig. 1. It is assumed that the (p, q) coordinate system is parallel to the (X, Y) plane and has the origin on the Z axis. In a position on an image pickup face (for example, position of a pixel on a CCD image pickup device), the image circle diameter

differs according to the size of the image pickup device and the focal distance of the fisheye lens. Consequently, it is assumed that a fisheye image is projected in a circle of radius 1 of an image of an object positioning at 90 degrees ($Z = 0$) from the front of the lens. At the time of actually use, magnification adjustment is performed.

Ex. 1012 ¶ 23. In other words, Shiota uses a normalized radius of 1 for the image circle, while acknowledging that the image circle diameter (i.e., the size of the image) “differs according to at least the size of the” image sensor, and thus, that “at the time of actual[] use, magnification adjustment is performed.” *Id.*

We agree with Petitioner and find that one of ordinary skill in the art “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 . . . as part of the image transformation.” Pet. 50–51 (citing Ex. 1003 ¶ 205). And we find persuasive Dr. Kessler’s testimony on this issue as the testimony is consistent with Shiota’s teachings. *Compare* Ex. 1003 ¶ 205, *with* Ex. 1012 ¶ 23. Simply put, one of ordinary skill in the art would have understood having to adjust for the actual size of the image to obtain the corrected image points for display because the image circle radius/diameter had been normalized. Ex. 1023 ¶¶ 61–63.

In addition, we are persuaded by Petitioner’s arguments that Shiota’s teaching about the actual size of the image pickup device extends to the actual size of the image. Pet. 51. In particular, we agree with Petitioner and find that Shiota “expressly teaches that the image circle diameter differs according to the size of the image pickup device/sensor,” and thus, “image size and sensor size are . . . directly related.” Pet. Reply 20 n.2 (citing

Ex. 1012 ¶ 23; Ex. 1003 ¶ 68; Ex. 1023 ¶¶ 68–69). Also, we are persuaded by Dr. Kessler’s testimony that one of ordinary skill in the art “would have recognized the direct relationship between image size and sensor size,” and “consistent with Shiota’s teaching, . . . [one of ordinary skill in the art] would have readily understood that the image circle diameter differs according to (and therefore is directly related to) the size of [a] rectangular image pickup/sensor.” Ex. 1023 ¶¶ 70, 73; *see also id.* ¶¶ 70–73 (providing support for this testimony). Thus, we find persuasive Dr. Kessler’s testimony that one of ordinary skill in the art “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.” Ex. 1003 ¶ 206.

In addition, we agree with Petitioner and find that one of ordinary skill in the art “would have understood that the transformed image points/coordinates in the Baker-Shiota combination are image points in a coordinate system with center O’.” Pet. 52. In particular, in Shiota (i) the points on a plane image corresponding to coordinates of a display monitor are projected on a hemispherical surface to obtain point P’; and (ii) the point P’ is used to obtain second projection points (p, q coordinates) on the CCD image pickup face by using a non-linear image distribution function. *See* Ex. 1012 ¶¶ 22–24, 28, 33, 35–37, 40–41; Ex. 1003 ¶ 209. And Shiota teaches that the p, q coordinate system has a center that corresponds to the center of the image disk/pickup surface (i.e., a center O’). Ex. 1012 ¶ 23, Fig. 1. Accordingly, we agree with Petitioner and find that one of ordinary skill in the art “would have understood that the retrieved image points are

points in a coordinate system with center O’.” Pet. 54; Ex. 1003 ¶¶ 208–210.

We find unavailing Patent Owner’s argument that the size of an image pickup device and the size of the image are not as inextricably linked as Petitioner argues. PO Resp. 15 n.3 (citing Pet. 50–51). In particular, Patent Owner argues that “it is a conventional practice to intentionally underfill (entire image disk captured by sensor, leaving unused space) or overfill (sensor captures only portion of overall image disk) the image sensor, meaning various size images may be used with the same image sensor size.” *Id.* (citations omitted). But, as we discuss above, *Shiota* expressly teaches that the image circle diameter differs according to the size of the image pickup device/sensor, and thus, in *Shiota* the sizes are directly related. Ex. 1012 ¶ 23. Moreover, we are persuaded that one of ordinary skill in the art “would have recognized that there are multiple applications in which the image size and the sensor size are directly related.” Pet. Reply 20 n.2 (citing Ex. 1023 ¶¶ 73–75).

We also find unavailing Patent Owner’s argument that “Dr. Kessler confirm[ed] that the discussion within *Shiota*’s paragraphs [23–26] is related, and the clear context that ‘magnification’ and ‘scale factor (zoom ratio)’ discussed in these passages refer to operator-selectable properties of the final image to be displayed.” PO Resp. 19 (citing Ex. 2001 ¶ 56; Ex. 1003 ¶ 205). We disagree that there was any such confirmation. Rather, Dr. Kessler, after describing paragraph 23 “as part of the image transformation,” provides a “see also” cite to paragraphs 24–26, which describe additional aspects of image transformation operations. Ex. 1003 ¶ 205.

Regardless, as the parties agree, Shiota's paragraphs 24–26 relate to operator inputted information relating to the plane image (i.e., the displayed image in the (u, v) coordinates). *See* PO Resp. 17–19; Pet. Reply 13–14; Ex. 1012 ¶¶ 24–26. In contrast, paragraph 23 relates to the fisheye image obtained on the image pickup device (which corresponds to the “obtained image” on the “image sensor,” as recited in claim 27). *See* Ex. 1012 ¶ 23; Ex. 1023 ¶ 67. Accordingly, we disagree with Patent Owner's argument that one of ordinary skill in the art “would have understood from Shiota's full disclosure that ‘magnification’ in this context refers to being able to properly perform image transformation based on the operator's selected parameters for the final plane image display.” PO Resp. 19 (citing Ex. 2001 ¶ 56). Moreover, this incorrect argument is based on an incorrect premise (i.e., that paragraphs 23–26 should be tied together). *See id.*; *see also* PO Sur-reply 3–5 (incorrectly tying together paragraphs 23–26).

We also find unavailing Patent Owner's argument that Dr. Kessler “ignores that ‘magnification’ is well understood in the optics field as being a dimensionless quantity.” PO Resp. 15–16 (citing Ex. 2001 ¶ 52; Ex. 2004,⁸ 347–50). Patent Owner adds that “Dr. Kessler offers no explanation as to how or why . . . [one of ordinary skill in the art] would have initially understood from Shiota's reference to a dimensionless number that Shiota suggests using the claimed linear quantity for retrieving image points and correcting image distortion.” *Id.* at 16 (citing Ex. 2001 ¶ 52); *see also* PO Sur-reply 6 (making substantively the same argument). Rather, as we discuss above, Shiota teaches both normalizing the image circle to a radius

⁸ Excerpt from Michael P. Keating, *Geometric, Physical, and Visual Optics* (2d ed. 2002).

of 1, and that “magnification adjustment is performed” “[a]t the time of actual[] use.” Ex. 1012 ¶ 23. And Dr. Kessler repeatedly testifies that one of ordinary skill in the art “would have thus understood that this reference to ‘magnification adjustment’ refers to an adjustment that accounts for the actual size of the image pickup device—and by extension, the actual size of the image.” Ex. 1003 ¶ 205; Ex. 1023 ¶¶ 61–63.

Moreover, we find unavailing Patent Owner’s argument that “‘magnification’ would be an odd term to use in paragraph [23] if Shiota intended Petitioner’s interpretation.” PO Sur-reply 6 (citing Ex. 2001 ¶¶ 51–52). Rather, “magnification” in its context—“[a]t the time of actual[] use, magnification adjustment is performed”—and in the context of paragraph 23, which normalizes the circle radius and recognizes differing sizes of image pickup devices, supports our findings that Shiota teaches adjusting for the actual size of the image, as we discuss above. Ex. 1012 ¶ 23. Moreover, we look to the substance of paragraph 23, rather than a particular word choice. *Cf. In re Gleave*, 560 F.3d 1331, 1334 (Fed. Cir. 2009) (a reference does not have to satisfy an *ipsis verbis* test to disclose a claimed element).

In sum, we find by a preponderance of the evidence that the combination of Baker and Shiota teaches this limitation.

D. Challenged Claims 2, 4, and 29

Petitioner argues that the combination of Baker and Shiota teaches the limitations recited in claims 2, 4, and 29. Pet. 55–62. These claims each depend directly from independent claim 27. Patent Owner does not separately address Petitioner’s arguments directed to these claims, and instead Patent Owner relies on its arguments for independent claim 27.

PO Resp. 20. As we discuss above, we find these arguments unavailing.
See supra Section V.C.

Based on the evidence and arguments of record, we find that Petitioner demonstrates by a preponderance of the evidence that claims 2, 4, and 29 would have been obvious over the combination of Baker and Shiota.

VI. ALLEGED OBVIOUSNESS OVER BAKER, SHIOTA, AND FISHER

Petitioner argues that the combination of Baker, Shiota, and Fisher renders claims 29 and 30 obvious. Pet. 62–70. Claim 29 depends from independent claim 27, and claim 30 depends from claim 29. Patent Owner does not separately address Petitioner’s arguments directed to claims 29 and 30 for this ground. Instead, Patent Owner relies on its arguments for claim 27. PO Resp. 20–21.

As we discuss above, we find unavailing Patent Owner’s arguments directed to claim 27. *See supra* Section V.C. And we are persuaded by Petitioner’s showings for claims 29 and 30, and Petitioner’s provided reasoning for combining the references. Pet. 65–70.

Based on the evidence and arguments of record, we find that Petitioner demonstrates by a preponderance of the evidence that claims 29 and 30 would have been obvious to one of ordinary skill in the art over the combination of Baker, Shiota, and Fisher.

VII. CONCLUSION⁹

Based on the full record, we determine that Petitioner shows by a preponderance of the evidence that claims (i) 2, 4, 27, and 29 are obvious in view of the combination of Baker and Shiota and (ii) 29 and 30 are obvious in view of the combination of Baker, Shiota, and Fisher.

Claim(s)	35 U.S.C. §	Reference(s) /Basis	Claim(s) Shown Unpatentable	Claims Not Shown Unpatentable
2, 4, 27, 29	103(a)	Baker, Shiota	2, 4, 27, 29	
29, 30	103(a)	Baker, Shiota, Fisher	29, 30	
Overall Outcome			2, 4, 27, 29, 30	

VIII. ORDER

In consideration of the foregoing, it is hereby

ORDERED that, pursuant to 35 U.S.C. § 314(a), Petitioner has shown by a preponderance of the evidence that claims 2, 4, 27, 29, and 30 of the '990 patent are unpatentable; and

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

⁹ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. § 42.8(a)(3), (b)(2).

IPR2023-00471
Patent 6,844,990 B2

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