

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MOTOROLA MOBILITY LLC,
Petitioner,

v.

LARGAN PRECISION CO., LTD.,
Patent Owner.

Case IPR2024-00688
U.S. Patent No. 9,997,660
Issued: June 12, 2018
Application No. 15/434,163
Filed: February 16, 2017

Title: LIGHT BLOCKING SHEET, IMAGING LENS MODULE AND
ELECTRONIC APPARATUS

PETITION FOR
INTER PARTES REVIEW OF U.S. PATENT NO. 9,997,660

TABLE OF CONTENTS

	Page(s)
LIST OF EXHIBITS	vii
MANDATORY NOTICES UNDER 37 C.F.R. § 42.8	x
1. Real Party-In-Interest.....	x
2. Related Matters	x
3. Lead And Back-Up Counsel, And Service Information.....	x
I. INTRODUCTION	1
II. GROUNDS FOR STANDING PER 37 C.F.R. § 42.104(a)	2
III. IDENTIFICATION OF CHALLENGE	2
A. Statement Of The Precise Relief Requested / Statutory Grounds.....	2
B. No Examiner Addressed These Unpatentability Grounds	3
C. <i>Fintiv</i> Denial Is Improper	4
IV. STATE OF THE ART	4
A. Lens Designers Have Long Used Light-Blocking Elements To Reduce Stray Light And Glare.....	4
B. It Was Also Known That, Ironically, Glare Arose From Stray Light Reflecting Off The Inner Edges Of Light-Blocking Elements	10
C. Lens Designers Used Three Known Techniques, Often Together, To Reduce Reflections Off Of Light-Blocking Elements	14
1. Baffles Or “Light Traps” Reduce Stray Light By Trapping It.....	15
2. Altering The Shape Of The Edge Surface Traps Or Reflects Stray Light Away From The Image Sensor.....	19

3.	Changing The Reflectivity Of The Edge Surface Absorbs Or Redirects Stray Light Away From The Sensor	22
D.	Light Traps At The Edge Of Light-Blocking Elements Were A Known Solution For Suppressing Stray Light, Both Historically And In More Recent Miniature Lens Designs	23
E.	POSITAs Knew How To Calculate An Appropriate Depth For A Given Light Trap	24
V.	THE '660 PATENT	28
A.	Without Using The Term “Light Trap,” The '660 Patent Describes The Alleged Invention As A Light Trap That Reduces Stray Light, Without Explaining How To Make Such A Light Trap	28
B.	In Prosecution, Applicant Distinguished The Prior Art By Arguing That It Failed To Disclose Or Teach “Reduction Of Stray Light By Forming A Light Trap”	32
C.	Claims Listing	35
VI.	LEVEL OF SKILL IN THE ART	35
VII.	CLAIM CONSTRUCTION	36
VIII.	GROUND 1: CLAIMS 1-9, 15-19 ARE OBVIOUS OVER CN182	37
A.	CN182 (EX1004)	38
B.	Claim 1	41
1.	Element 1.1	41
2.	Elements 1.2-1.4	41
3.	Element 1.5	42
4.	Element 1.6	43

a)	POSITAs Would Have Been Motivated To Adapt The CN182 PET Substrate Etching Process To Create A Light Trap Between The Two Outer Carbon Layers.....	45
b)	POSITAs Would Have Been Motivated To Create The Light Trap With Dimensions In The Claimed Range	49
c)	POSITAs Would Have Expected Success In Implementing Such A Light Trap Using The Known Etching Processes Described In CN182	56
d)	These Obvious Light Traps Satisfy Element 1.6.....	58
e)	Contemporaneous Independent Development Further Confirms The Obviousness Of Using The CN182 Process To Form A Light Trap	60
C.	Claim 2	62
D.	Claim 3	62
E.	Claim 4	63
F.	Claim 5	64
G.	Claim 6	64
H.	Claim 7	65
I.	Claim 8	65
J.	Claim 9	66
K.	Claim 15	67
L.	Claim 16	67
M.	Claim 17	67
N.	Claim 18	70
O.	Claim 19	70

IX.	GROUND 2: CLAIMS 5, 7, 10, 14, 19, 20, AND 22 ARE OBVIOUS OVER CN182 IN VIEW OF CHO.....	70
A.	Cho (EX1006)	70
B.	CN182 and Cho	73
C.	Claim 5	74
D.	Claim 7	75
E.	Claim 10	76
	1. Element 10.1	76
	2. Element 10.2	76
	3. Element 10.3	77
	4. Element 10.4	78
F.	Claim 14	79
	1. Element 14.1	79
	2. Element 14.2	80
	3. Element 14.3	80
G.	Claim 19	80
H.	Claims 20 and 22.....	81
X.	GROUND 3: CLAIMS 11-13 AND 21 ARE OBVIOUS OVER CN182 IN VIEW OF CHO AND TAKAHASHI	81
A.	Takahashi (EX1025).....	81
B.	Claim 11	82
C.	Claim 12	85
D.	Claim 13	86
E.	Claim 21	87
XI.	NO OBJECTIVE INDICIA OF NON-OBVIOUSNESS.....	87

XII. CONCLUSION.....	87
CERTIFICATE OF COMPLIANCE.....	88

TABLE OF AUTHORITIES

Page(s)

Cases

Geo. M. Martin Co. v. All. Mach. Sys. Int’l LLC,
618 F.3d 1294 (Fed. Cir. 2010) 60

In re Fox,
471 F.2d 1405 (C.C.P.A. 1973).....58

Regents of Univ. of Cal. v. Broad Inst., Inc., 903 F.3d 1286 (Fed. Cir. 2018).....60

Statutes

35 U.S.C. § 103 3

Rules

37 C.F.R. § 42.104 2

37 C.F.R. § 42.15 3

37 C.F.R. § 42.24 88

37 C.F.R. § 42.6 89

LIST OF EXHIBITS

No.	Description
1001	U.S. Patent No. 9,997,660 (“ 660 patent ”)
1002	File History of U.S. Patent No. 9,997,660
1003	Declaration of Professor Tom D. Milster, dated March 29, 2024, with CV (“ Milster ”)
1004	Certified Translation and Original Copy of Chinese Patent Application Publication No. CN 104460182 A (“ CN182 ”)
1005	Certified Translation and Original Copy of Chinese Patent Application Publication No. CN 101634738 A (“ CN738 ”)
1006	U.S. Patent Application No. 2015/0022896 to Cho et al. (“ Cho ”)
1007	Michael P. Schaub, <i>The Design of Plastic Optical Systems</i> (SPIE Press 2009) (excerpts) (“ Schaub ”)
1008	Robert E. Fischer et al., <i>Optical System Design</i> (SPIE Press, 2nd ed. 2008) (excerpts) (“ Fischer ”)
1009	Julie Bentley & Craig Olson, <i>Field Guide to Lens Design</i> (SPIE Press 2012) (excerpts) (“ Bentley ”)
1010	Michael Bass, <i>Handbook Of Optics, Volume II</i> (McGraw Hill, 3d ed. 2010) (excerpts) (“ HandbookVol2 ”)
1011	Michael Bass, <i>Handbook Of Optics, Volume IV</i> (McGraw Hill, 3d ed. 2010) (excerpts) (“ HandbookVol4 ”)
1012	U.S. Patent Application No. 2015/0015713 to Wang et al. (“ Wang ”)
1013	U.S. Patent No. 2,738,700 to Taylor (“ Taylor ”)
1014	Jean-Jacques Arnoux, <i>Star Sensor Baffle Optimization: Some Helpful Practical Design Rules</i> , Proc. SPIE 2864 (Nov. 11, 1996) (“ Arnoux ”)
1015	Certified Translation and Original Copy of Chinese Patent Grant No. CN 107045249 B (“ CN249 ”)

No.	Description
1016	James D. Plummer et al., <i>Silicon VLSI Technology</i> (Prentice Hall 2000) (excerpts) (“ Plummer ”)
1017	Jane Bareau & Peter P. Clark, <i>The Optics of Miniature Digital Camera Modules</i> (2006) (“ Bareau ”)
1018	U.S. Patent No. 7,457,052 to Hirata (“ Hirata ”)
1019	U.S. Patent No. 7,663,812 to Chang (“ Chang ”)
1020	U.S. Patent No. 8,570,673 to Lai et al. (“ Lai ”)
1021	U.S. Patent No. 9,128,267 to Ogino et al. (“ Ogino ”)
1022	U.S. Patent Application No. 2016/0161702 to Yang (“ Yang ”)
1023	Full Claims Listing (Claims 1-22)
1024	U.S. Patent Application No. 2006/0033010 to Jiang et al. (“ Jiang ”)
1025	U.S. Patent Application No. 2015/0103226 to Takahashi et al. (“ Takahashi ”)
1026	U.S. Patent Application No. 2013/0155495 to Wang (“ Wang-495 ”)
1027	Bernhard Braunecker et al., <i>Advanced Optics Using Aspherical Elements</i> (SPIE Press 2008) (excerpts) (“ Braunecker ”)
1028	Expert Report of Dr. Julie L. Bentley dated 1 June 2023 (“ Bentley Report ”)
1029	Rudolf Kingslake, <i>A History of the Photographic Lens</i> (Academic Press 1989) (excerpts) (“ Kingslake ”)
1030	John E. Greivenkamp, <i>Field Guide to Geometrical Optics</i> (SPIE Press 2004) (excerpts) (“ Greivenkamp ”)
1031	U.S. Patent No. 9,405,042 to Toshima (“ Toshima ”)
1032	PCT Publication No. WO 2005/045500 to Cahall et al. (“ Cahall ”)

No.	Description
1033	U.S. Patent Application No. 2009/0268299 to Furui et al. (“ Furui ”)
1034	U.S. Patent No. 6,818,287 to Ogawa et al. (“ Ogawa ”)

MANDATORY NOTICES UNDER 37 C.F.R. § 42.8

1. Real Party-In-Interest

Motorola Mobility LLC (“Motorola”) is the sole real party-in-interest. Additionally, for the purposes of disclosing potential conflicts only, Petitioner notes that Motorola Mobility Holdings, LLC, owns 100% of Motorola Mobility LLC’s stock and is, indirectly, a wholly owned subsidiary of Lenovo Group Limited.

2. Related Matters

The ’660 patent (EX1001) has not been asserted in any litigations or proceedings.

An international family member of the ’660 patent, Indian Patent No. 363203, has been asserted in *Largan Precision Co., Ltd. v. Motorola Mobility India Pvt. Ltd. & Ors.*, Code 36017.02 (India), filed Nov. 10, 2022.

3. Lead And Back-Up Counsel, And Service Information

Lead Counsel	Back-up Counsel
Andrew M. Mason, Reg. No. 64,034 andrew.mason@klarquist.com	Frank Morton-Park, Reg. No. 80,750 frank.morton-park@klarquist.com
KLARQUIST SPARKMAN, LLP 121 SW Salmon Street, Suite 1600 Portland, Oregon, 97204 503-595-5300 (phone) 503-595-5301 (fax)	

Petitioner consents to electronic service by email, with each service email addressed to each above email address and Moto-Largan@klarquist.com.

Pursuant to 37 C.F.R. § 42.10(b), concurrently filed with this Petition is a Power of Attorney executed by Petitioner and appointing the above counsel.

I. INTRODUCTION

Motorola Mobility LLC (“Petitioner”) respectfully requests *inter partes* review (“IPR”) of claims 1-22 of U.S. Patent No. 9,997,660 (EX1001, “’660 patent”), allegedly owned by Largan Precision Co., Ltd. (“Patent Owner”). For the reasons set forth below, these claims should be found unpatentable and cancelled.

The challenged claims of the ’660 patent relate to a light-blocking sheet with a three-layer structure and an opening. The ’660 patent admits that “conventional” light-blocking sheets used the same three-layer “sandwich” construction, with a plastic middle layer or “substrate” surrounded on either side by “carbon-containing” outer layers. EX1001, 1:33-49. Such sheets have been used—since well before the ’660 patent—in the lens modules of cell phones and other portable electronic devices, to block unnecessary stray light and thus minimize the appearance of glare in captured images, e.g., photos. The purported invention relates to an air gap between the two outer carbon layers, along the inner edge of the sheet’s opening.

Yet this allegedly inventive air gap is nothing more than a conventional “light trap.” While the ’660 patent never uses that term, light traps are a staple of optical design that have been used for decades to minimize stray light reflections and reduce glare. Prior art CN182 (EX1004) discloses a light-blocking sheet with the same conventional three-layer structure and is directed at the same problem as the ’660 patent: reducing glare caused by stray light reflecting off the inner edge of a light-

blocking sheet's hole. And CN182 teaches to etch the material between the carbon layers in furthering this goal. Given the regular use of light traps to efficiently reduce stray light, POSITAs would have immediately recognized the benefits, and ease, of using the CN182 etching process to create a light trap on the inner surface of the CN182 light-blocking sheet, thus furthering CN182's goal of reducing stray light. Moreover, POSITAs knew how to calculate appropriate light trap dimensions for a given design and would have naturally implemented light-blocking sheets with light traps meeting the conditions recited in the challenged claims. CN182 and the knowledge of a POSITA render most challenged claims obvious, and all challenged claims are obvious over CN182 and the additional art discussed below.

II. GROUND FOR STANDING PER 37 C.F.R. § 42.104(a)

Petitioner certifies that the '660 patent is available for IPR and that Petitioner is not barred or estopped from requesting an IPR challenging the patent claims on the grounds identified in this petition.

III. IDENTIFICATION OF CHALLENGE

A. Statement Of The Precise Relief Requested / Statutory Grounds

Petitioner requests *inter partes* review of claims 1-22 (the "challenged claims") of the '660 Patent, on the following statutory grounds:

	Reference(s)	Basis	Claims
Ground 1	Chinese Pat. Appl. Pub. No. CN 104460182 A (EX1004, “ CN182 ”) ¹	§ 103	1-9, 15-19
Ground 2	CN182 and U.S. Pat. App. No. 2015/0022896 (EX1006, “ Cho ”)	§ 103	5, 7, 10, 14, 19-20, 22
Ground 3	CN182, Cho, and U.S. Pat. App. No. 2015/0103226 (EX1025, “ Takahashi ”)	§ 103	11-13, 21

For each ground, in Sections VIII, IX, and X below, the petition presents evidence of unpatentability and establishes a reasonable likelihood that the Petitioner will prevail in establishing that each Challenged Claim is unpatentable.

With the filing of this petition an electronic payment of \$43,750 for the requisite fees is being charged to deposit account no. 02-4550. 37 C.F.R. § 42.15(a). Any fee adjustments may be debited/credited to the deposit account.

B. No Examiner Addressed These Unpatentability Grounds

Prior art references CN182 and Takahashi were neither cited nor discussed during prosecution, and are not referenced in the '660 patent. Nothing suggests that their teachings relied on herein—much less the combination of those teachings as informed by expert testimony—were considered by the Examiner. Prior art reference

¹ Citations below are to the certified English translation of CN182, provided within EX1004.

Cho was cited and discussed as a primary reference during prosecution, but the arguments herein are substantially different from those presented during prosecution at least because the Examiner never considered CN182 and its teachings on etching a middle PET layer to reduce stray light reflections off of the inner surface of a light-blocking sheet. Accordingly, this petition should not be denied under Section 325(d).

C. Fintiv Denial Is Improper

There is no basis for discretionary denial under Section 314(a) because there is no parallel district court proceeding in the U.S.

IV. STATE OF THE ART

A. Lens Designers Have Long Used Light-Blocking Elements To Reduce Stray Light And Glare

Stray light and the associated glare have long been well-known problems for optical system designers. EX1008, 703 (“Stray light can be the curse of an optical system.”); EX1007, 118 (“Stray light is unwanted light that degrades the performance of a system.”). Accordingly, designers have long identified and addressed sources of stray light during the lens design process. EX1007, 118-119; EX1009, 3 (“a complete design process and performance evaluation includes ... stray light analysis”); *id.*, 89 (encouraging designers to “identify any design changes needed to reduce the stray light”); EX1003, ¶42.

Both historically and in miniature camera modules, designers have reduced stray light using light-blocking elements, often referred to as light-blocking sheets, light shield sheets, shading rings, glare stops, flare stops, spacers, baffles, or vanes. *E.g.*, EX1018, 1:14-40; EX1019, 3:24-28; EX1020, 1:10-12; EX1004, [0002]; EX1007, 117-118; EX1009, 90, 111; EX1006, [0004]; EX1003, ¶¶43-44.

The 2009 Schaub book illustrates an example stray light path that might exist in the absence of light-blocking elements:

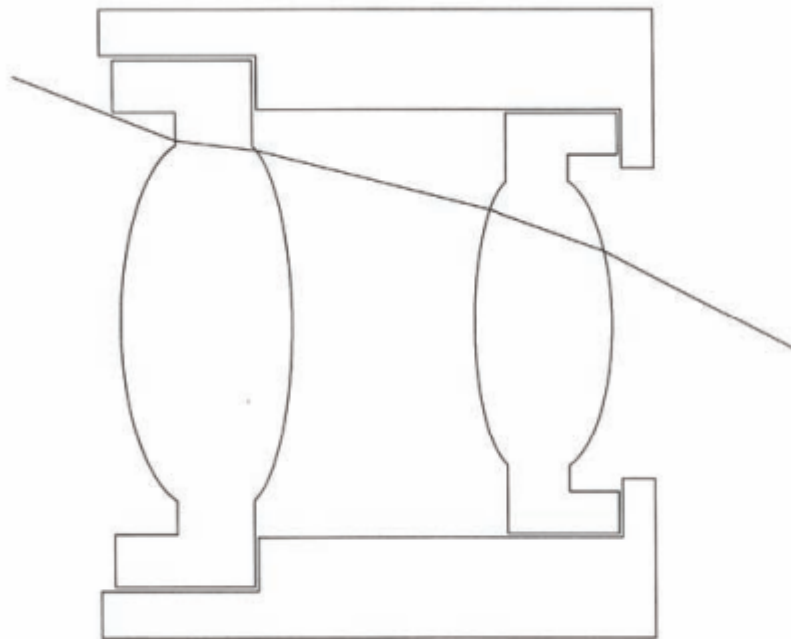
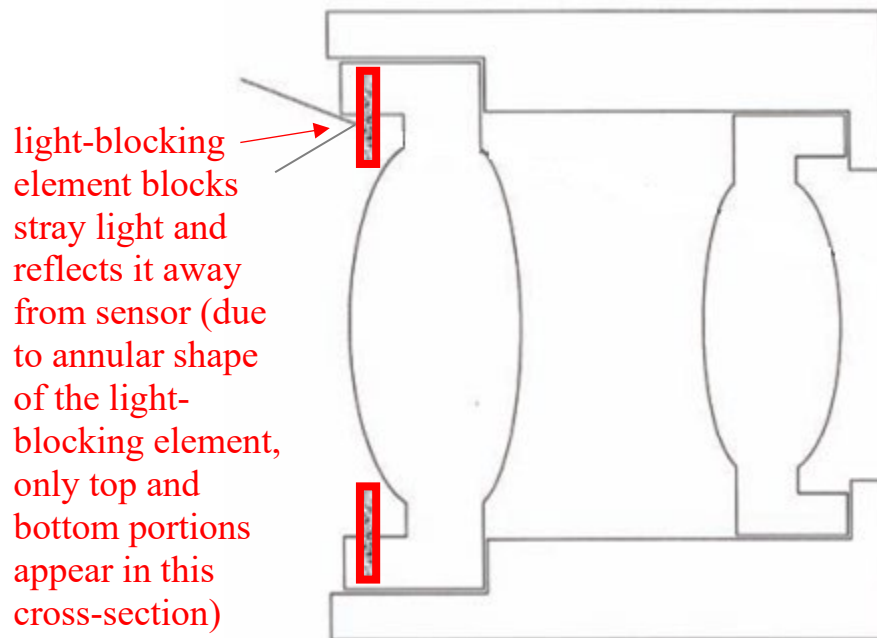


Figure 4.25 Stray-light path through lens transition zone on first element.

EX1007, 124. Schaub then explains to “place a baffle or blocking structure in front of the first element” or “[i]f a blocking structure cannot be placed in front of the element, the direct path could also be blocked behind the lens.” *Id.*, 125. The

following annotated version of Schaub Figure 4.25 illustrates the described addition of a light blocking structure in front of the first element:



EX1007, 124 (Figure 4.25 with red annotations added, original stray light path modified to illustrate blocking described on EX1007, 125). EX1003, ¶45.

A light-blocking element “may serve a dual purpose” such as a spacer that both “sets the distance between the two lenses as well as blocks the direct path.” *Id.*, 125; *id.*, 117:9-22 (describing lens assembly with lenses “along with any apertures, spacers, or stray light baffles”); EX1003, ¶45.

The ’660 patent describes these known light-blocking elements, noting they “block unnecessary lights” and were used in “suppressing stray lights.” EX1001,

1:27-37; 1:55-61. Fig. 1A shows the “annular” or ring shape of conventional light-blocking sheets:

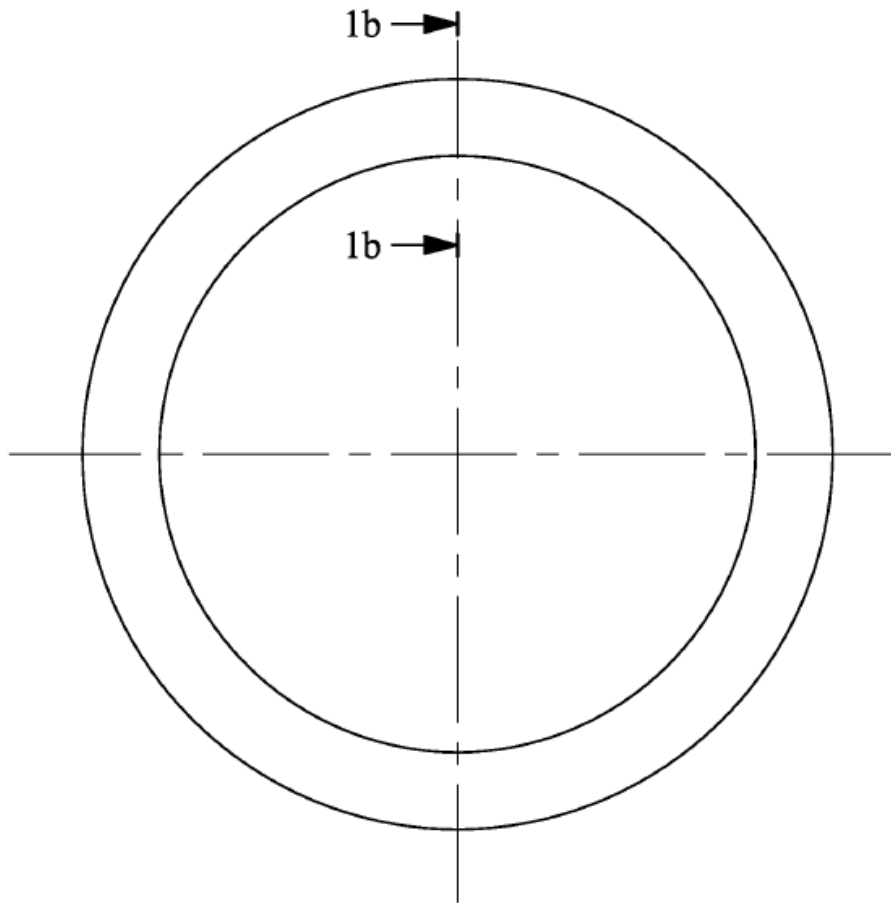


Fig. 1A (prior art)

EX1001, Fig. 1A. And Fig. 1B provides a cross-sectional view, illustrating the prior art “three-layer structure,” as shown in the following annotated copy:

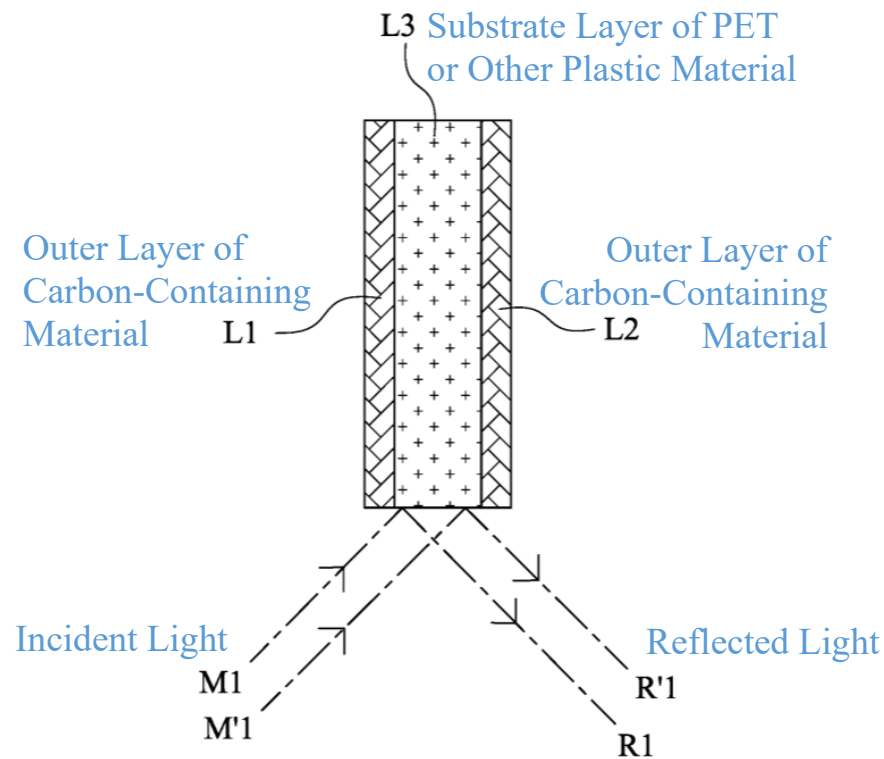
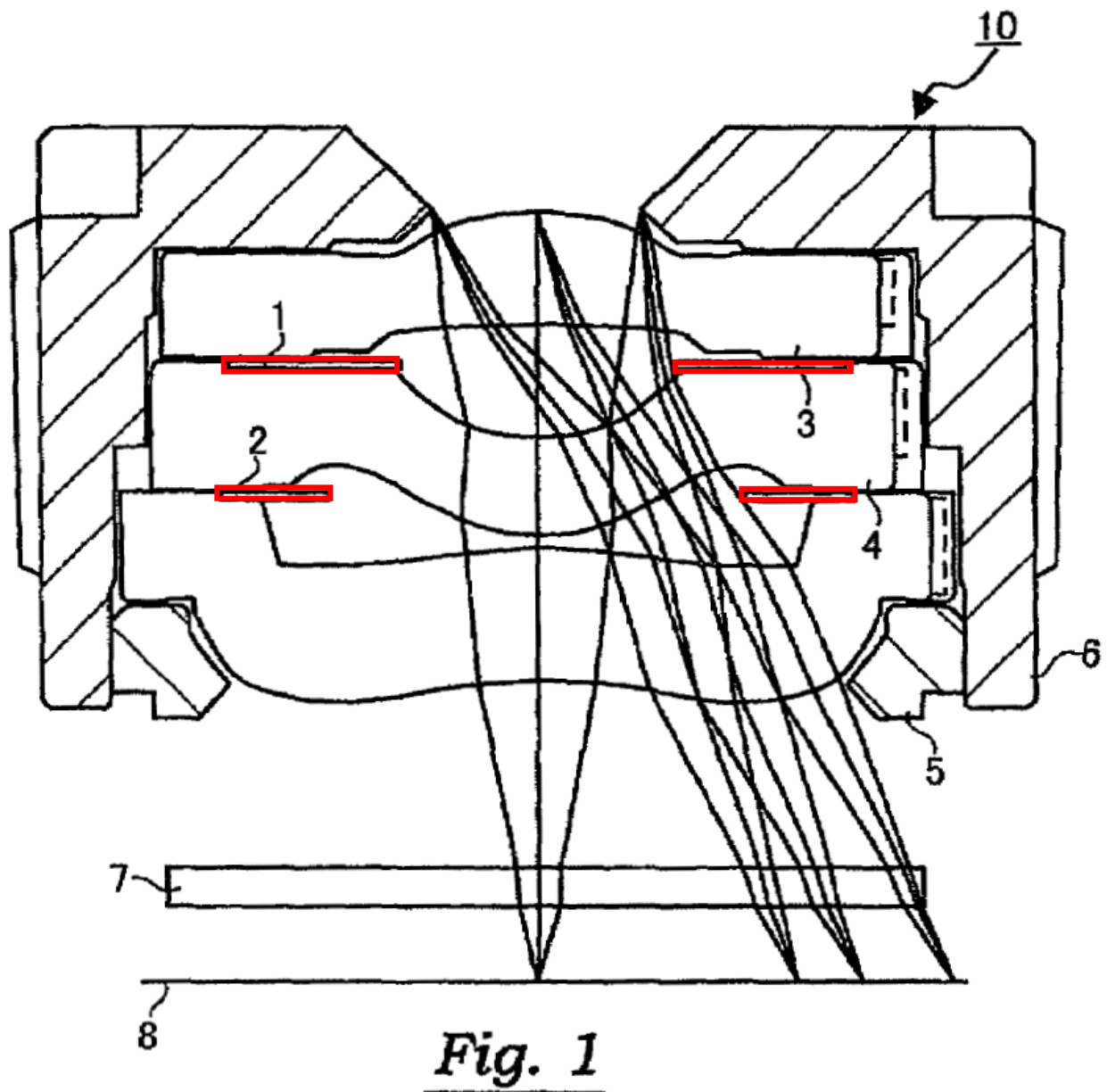


Fig. 1B (prior art)

Id., Fig. 1B (blue annotations added); *id.*, 1:55-2:14. These prior art light-blocking sheets included “a substrate layer made of a plastic material, such as a polyethylene terephthalate (PET), sandwiched by two outer layers made of a carbon-containing material.” *Id.*, 1:33-41. EX1003, ¶46.

A 2008 patent to Hirata (EX1008) also describes the annular shape, and carbon-PET-carbon structure, of known light-blocking sheets (called a “light shield sheet” in Hirata). *E.g.*, EX1018, 3:63-4:4:12 (“light shielding effect ... prevents light

transmission that causes flare and ghost”); *id.*, Fig. 2. Hirata also illustrates how light-blocking sheets (labeled 1 and 2, and annotated in red below) were placed between lenses in the optical system, “shaped and arranged so as not to obstruct a light transmission area that is determined by the aperture stop” (i.e., light through the center of the system that properly forms the image) but “to shield unwanted light.” *Id.*, 4:35-38.



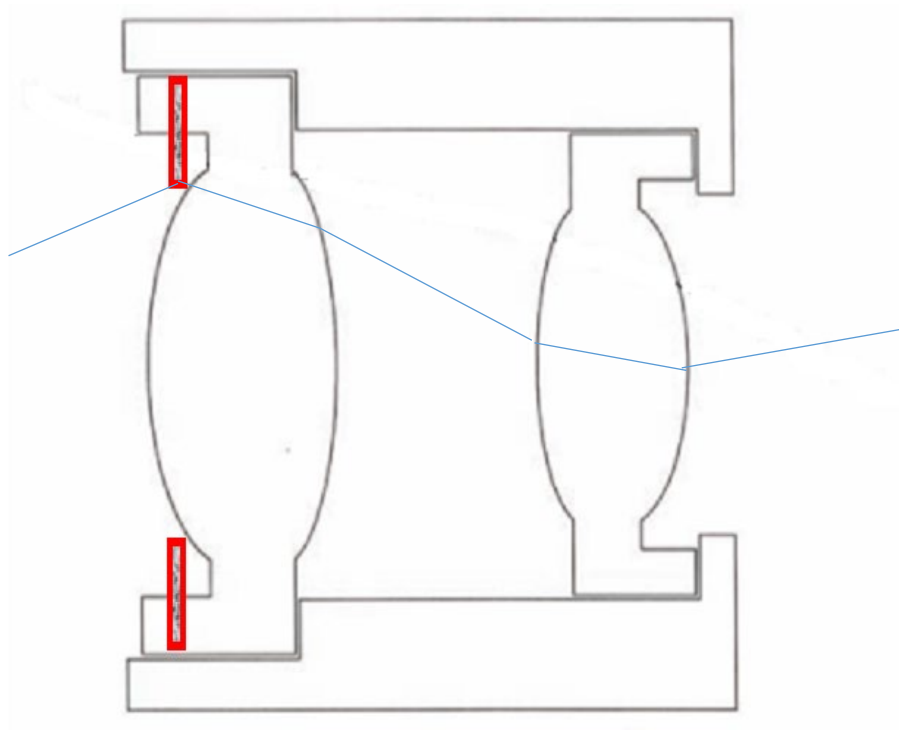
EX1018, Fig. 1 (red annotations added to highlight light-blocking elements).

EX1003, ¶47.

**B. It Was Also Known That, Ironically, Glare Arose From Stray
Light Reflecting Off The Inner Edges Of Light-Blocking Elements**

Just as lens designers have long used light-blocking elements, they have also long been familiar with the ironic problem where the edge of the light-blocking

element itself contributes to glare when light bounces off that edge and through to the image plane. For example, Schaub notes the problem of stray light reflections off of light-blocking elements such as “baffles” and “spacers.” EX1007, 120. The following modified and annotated version of Schaub Figure 4.25 illustrates stray light bouncing off the inner edge of a light-blocking element and towards the sensor end of the system:



EX1007, 124 (Figure 4.25 with red annotations added, original gray stray light path removed and blue stray light path added). EX1003, ¶48.

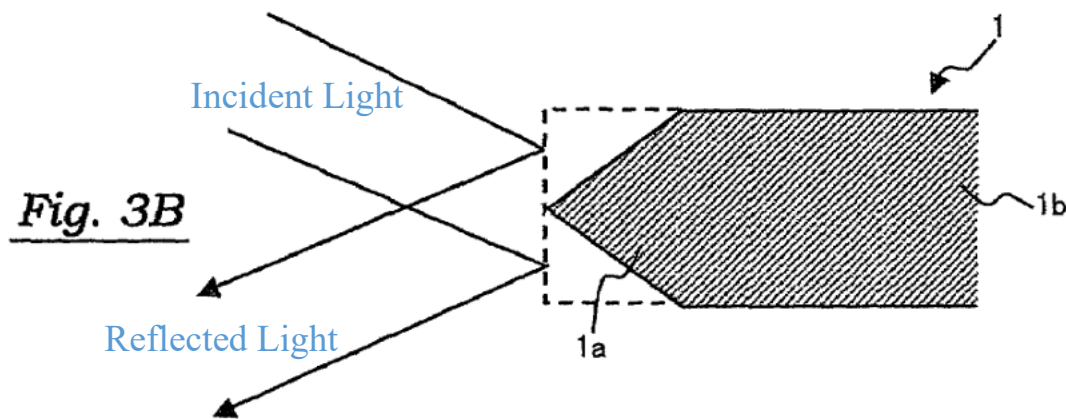
A 1956 patent to Taylor (EX1013) describes the use of a ring-shaped light-blocking “glare stop.” EX1013, 1:32-40. It notes concerns with light reflecting off the edge or inner surface and causing glare:

In optical systems ... *the usual means* for providing the systems with glare-stops is the placing of *apertured blackened discs in the system with the apertures thereof concentric with the optic axis* of the system and so spaced along the axis ... Some of the *light diffused from the edges of the stop apertures*, however, always reaches the field, and *provides glare, or noise*, or reduced contrast in visual, electronic or photographic systems respectively.

EX1013, 1:13-24 (emphasis added). To reduce this problem, Taylor teaches making the “edge” of the glare stop incredibly thin. *Id.*, 1:32-40; *see also id.*, 2:8-13 (same). EX1003, ¶49.

More modern, miniaturized lens systems also suffer from glare caused by stray light reflecting off the inner edges of light-blocking elements. For example, Bareau’s 2006 article on miniature camera lens design notes “stray light considerations” and that scaled down “aperture[s] or baffle feature[s]” might “cause a larger fraction of the light to scatter from their edges, resulting in flare or veiling glare.” EX1017, 3; EX1003, ¶50.

Hirata's 2008 mobile phone lens system patent also noted this problem, explaining that, "since the light shield sheet used for a lens stop has a certain thickness, incident light is reflected on its side face to cause ghost or flare." EX1018, 1:14-20, 1:35-37. Much like the '660 patent would later do, Hirata illustrated this known phenomenon, e.g., its Fig. 3B shows how the inner edges of a light shield might reflect stray light if left flat and wide, as "indicated by the dotted line":



EX1018, FIG. 3b (blue annotations added); *see also id.*, 5:2-9 (describing one approach to reducing this light reflection), 3:16-17. EX1003, ¶51.

The '660 patent Fig. 1B (prior art) also shows the known phenomenon of "stray lights" reflecting off the inner edge of the sheet's hole and reducing image quality. *Id.*, 1:48-54; *see also id.*, 2:7-14.

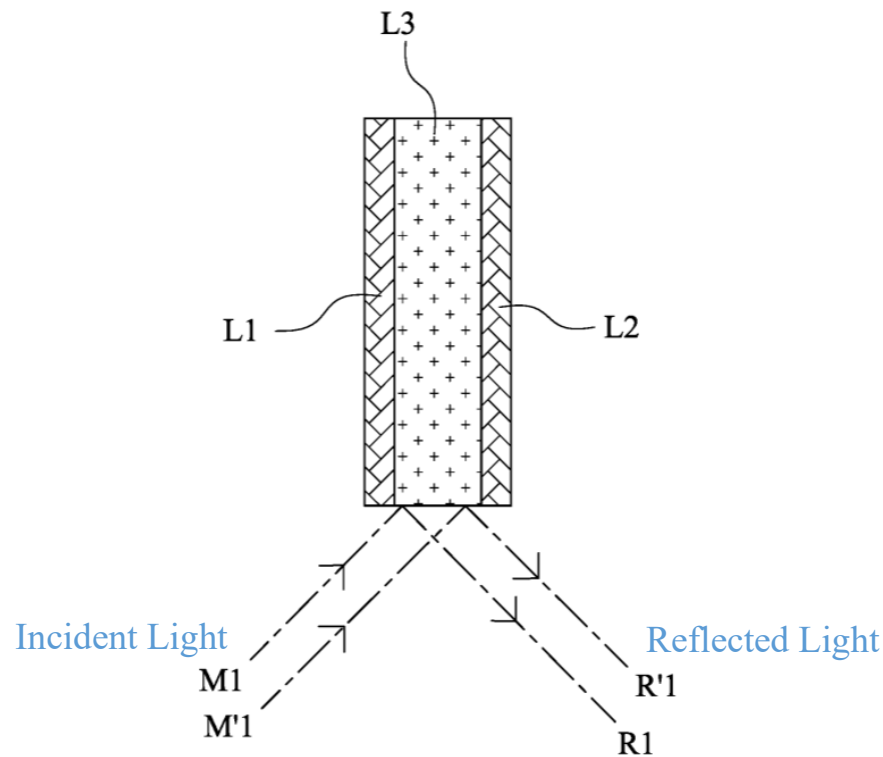


Fig. 1B (prior art)

Id., Fig. 1B (blue annotations added). EX1003, ¶52.

C. Lens Designers Used Three Known Techniques, Often Together, To Reduce Reflections Off Of Light-Blocking Elements

Schaub, a 2009 book published by the Society of Photo-Optical Instrumentation Engineers (“SPIE”), lays out three known approaches that were “usually” employed when dealing with stray light reflecting off inner surfaces of light-blocking sheets and other non-optical surfaces in a design. EX1007, 120

(“Stray light due to reflection from a nonoptical surface is usually handled using *one or more of three methods.*”) (emphasis added); *see also* EX1009, 89; EX1003, ¶53. **First**, “prevent the reflection from reaching the image plane through the use of baffling,” i.e., light traps. *Id.* **Second**, “alter the shape, location, or orientation of the surface that is causing the stray-light reflection.” *Id.* **Third**, “alter the reflective nature of the offending surface,” e.g., through applying “black ink” or “texturing the surface.” *Id.*, 121. EX1003, ¶54.

POSITAs used these methods in combination. *Id.*, 120:37-38 (“one or more of three methods”), 121 (“it may require multiple techniques to prevent unwanted reflections”), 122:29-40 (example design that used two of the methods together); EX1009, 90 (Dr. Bentley book, describing use of both baffles/vanes and “blackening or roughening” of surfaces for “Stray Light Reduction”); EX1003, ¶55.

1. Baffles Or “Light Traps”
Reduce Stray Light By Trapping It

POSITAs regularly used baffle features to trap and suppress stray light in optical systems. *E.g.*, EX1008, 587 (“It is important that the designer be reasonably fluent in ... baffling and stray light control.”). Wang’s February 2013 patent application explains the well-known “light trap” concept in the context of an automotive camera system:

The light trap or baffles, formed of light absorbing materials/surfaces, may trap the extraneous light and limit

or preclude or reduce the extraneous light from reflecting towards the camera. The light baffle or light trap [is designed] to limit or reduce the amount of light that reflects off of the baffles.

EX1012, [0106]. Wang FIG. 46 shows how adjacent baffles trap light, causing it to reflect several times within the “trap” rather than undesirably reflecting forward into the system:

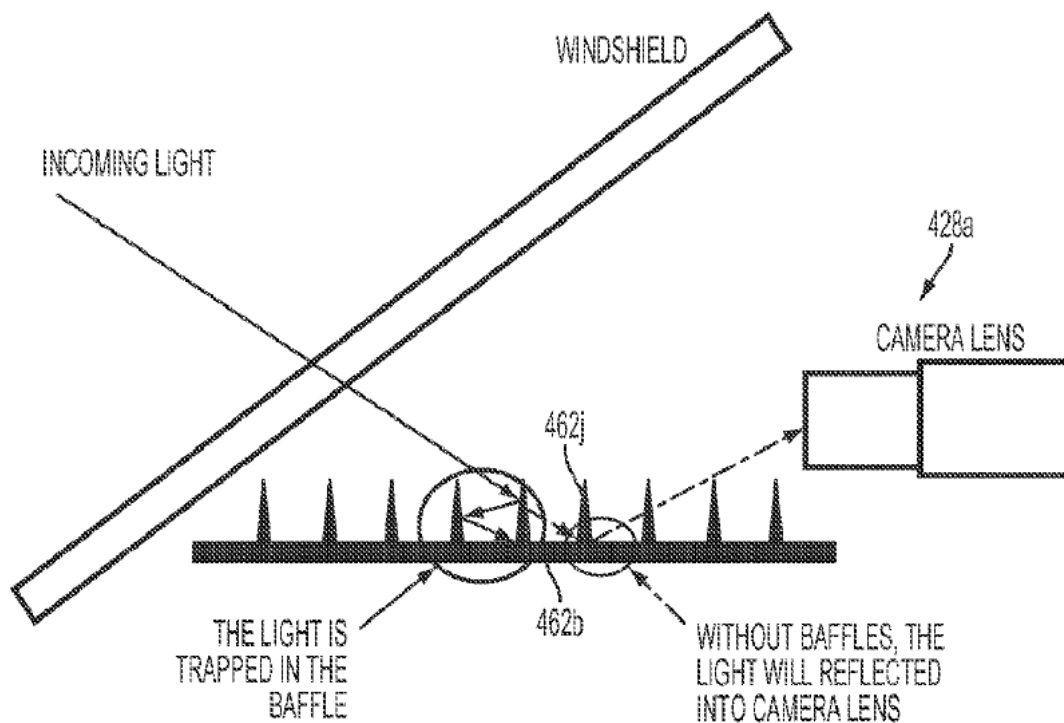
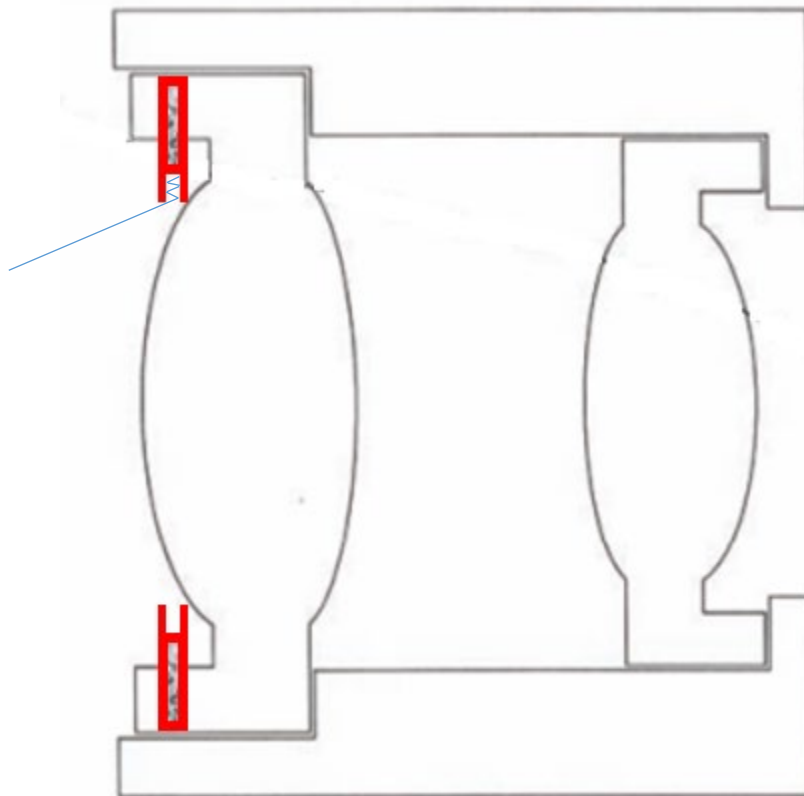


FIG. 46

EX1012, FIG. 46. POSITAs use terms such as “vanes,” “baffles,” and “glare stops” in similar fashion to refer to structures that implement the well-known baffle concept

of blocking and trapping stray light in a recess or cavity. EX1010, 7.10-7.11 (defining terms for clarity because “[o]ther authors have used their own different definitions”); *see also* EX1009, 90 (describing “blocking light with baffles, vanes, and knife edges” and figure showing “Knife-Edge Baffles”). EX1003, ¶¶56-57.

Thus, the “use of baffling” to handle “[s]tray light due to reflection from a nonoptical surface,” as noted by Schaub (EX1007, 120) included use of well-known baffled light traps on light-blocking elements. The following annotated version of Schaub Figure 4.25 illustrates how such baffles trap stray light (in blue) and prevent it from bouncing off the edge of the light-blocking element:



EX1007, 124 (Figure 4.25 with red annotations added, original gray stray light path removed, blue stray light path added). EX1003, ¶58.

In 1996, Arnoux described use of baffles (sometimes called “vanes”) to form a light trap on the inner surface of a light-blocking element, thus reducing stray light edge reflections. EX1014, 2, (providing “helpful practical design rules” for optimizing baffles, including “an additional vane” at “the sharp edge of the vane” “to prevent scattering at large source angle[s]”); *id.*, 5. As depicted in Arnoux’s Figure 9, such a light trap at the edge of the vane includes an air layer formed by the two vanes (the vane and the additional vane). *Id.*

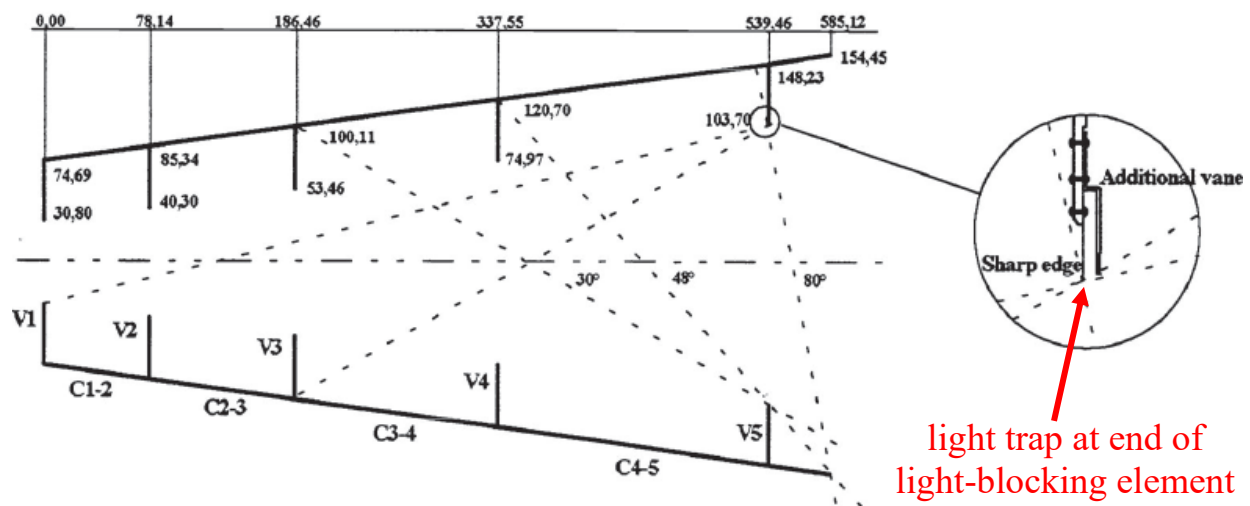


Figure 9 : Baffle Final design

EX1014, 5 (red annotations added). EX1003, ¶59.

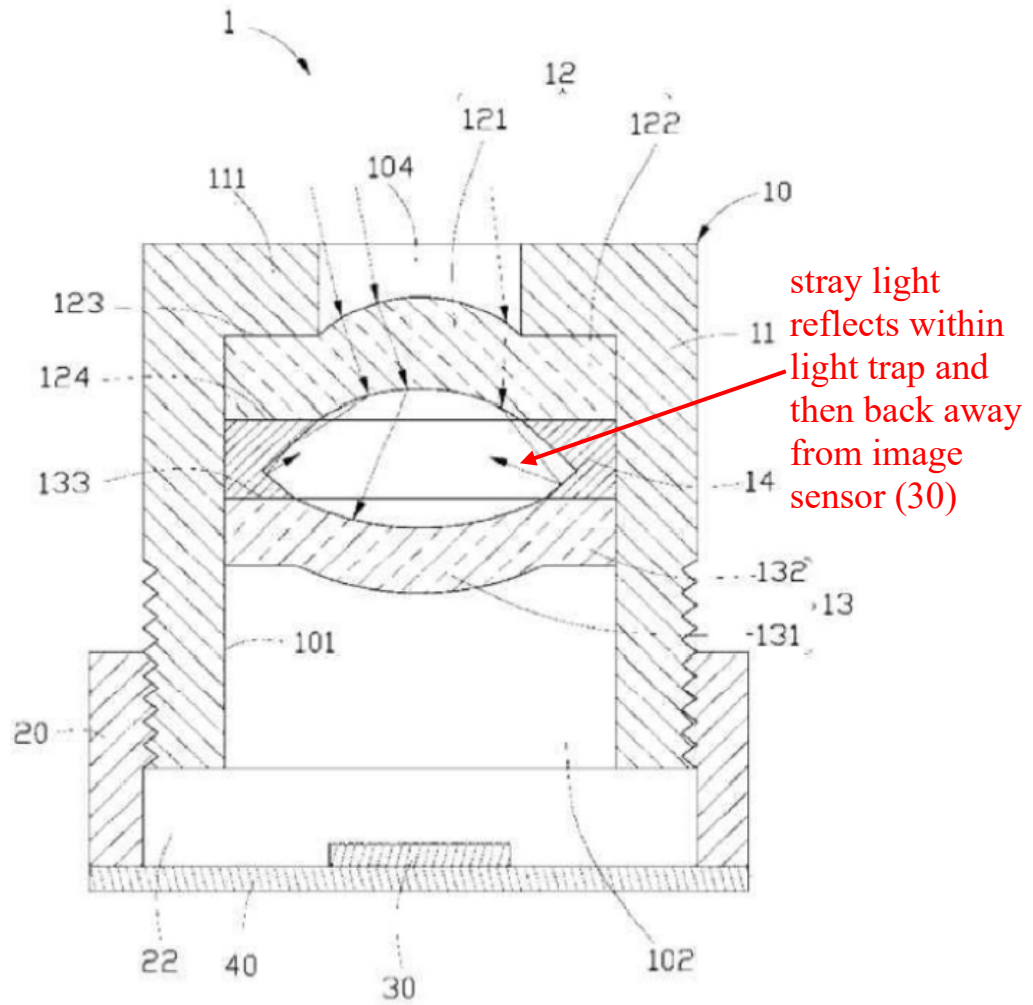
Arnoux’s technique of adapting a baffle design to block a potential source of stray light was a standard procedure in stray light analysis. EX1003, ¶60.

2. Altering The Shape Of The Edge Surface Traps Or Reflects Stray Light Away From The Image Sensor

Schaub's "second method of handling reflections" includes "altering the shape ... of the surface that is causing the stray-light reflection." EX1007, 120. Schaub gives an example of "altering the spacer geometry" such that "a given reflection can be shifted from going to the detector to going into the rear flanging of the barrel." *Id.*, 121. EX1003, ¶61.

One known approach to altering the shape of an edge was to bevel it to redirect the light away from the image sensor, instead of towards it. *E.g.*, EX1010, 7:11-7:14 ("bevel of vanes" for redirecting light); EX1020, 1:10-15; EX1003, ¶62.

In 2008, a Chinese patent application described a form of light trap on the inner surface of a light-blocking "spacer ring," "to avoid the formation of glare" in lens systems for "mobile phones." EX1005 ("CN738"), 6:32-37, 7:24-36. CN738 uses "inclined planes" to trap and reflect light away from the image sensor. *Id.*; *see also id.*, 1:28-36.



EX1005, 8 (Figure 1) (red annotations added).

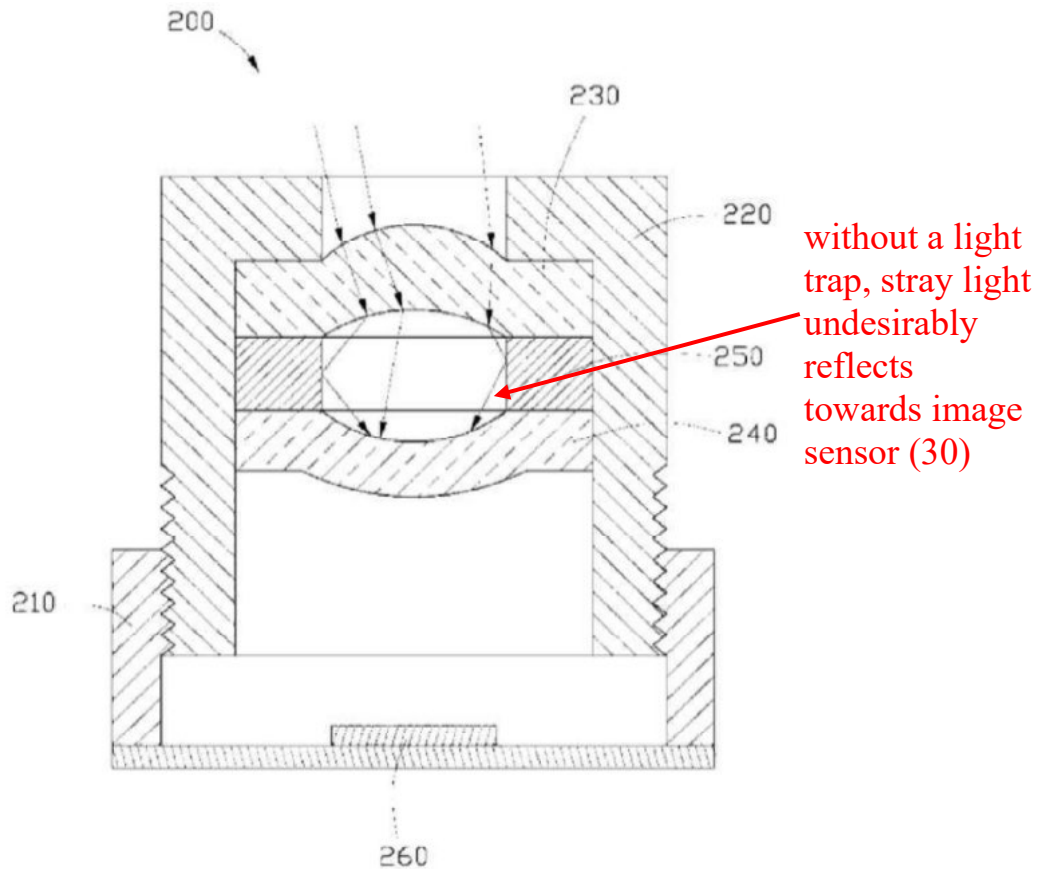
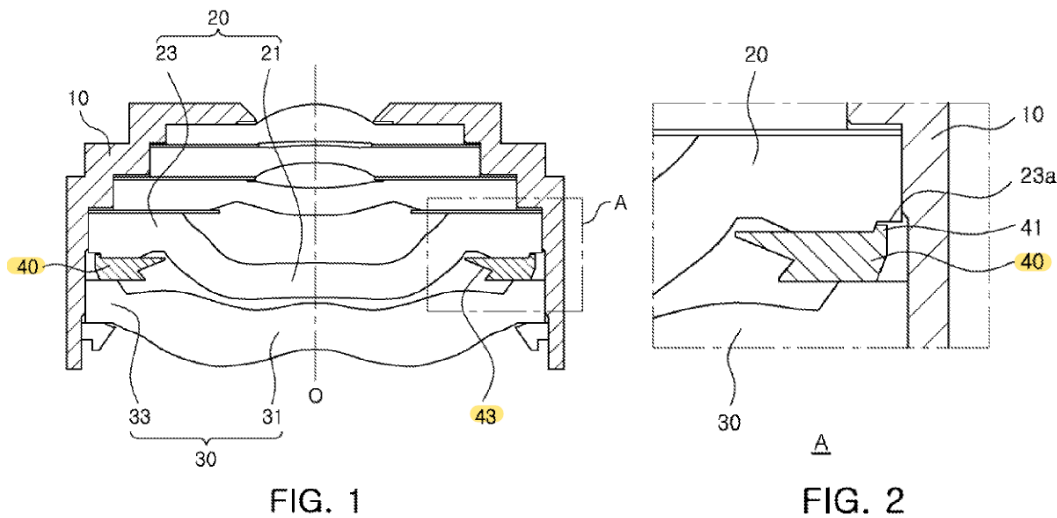


Figure 5

EX1005, 12 (Figure 5) (red annotations added). EX1003, ¶63.

Yang similarly discloses modifying the inner edge of a spacer to create a “light shielding hole.” Its “light shielding hole 43 includes a plurality of inclined surfaces that are discontinuously formed in an inner diameter of the spacer 40 in order to prevent a flare phenomenon due to reflection of incident light on ... an inner circumferential surface of the light shielding hole 43.” EX1022, [0033], FIGS. 1-2.



EX1022, FIGS. 1-2 (highlighting added). This stray-light reduction technique is similar to that used in the threaded-baffle light traps described in Fischer, which also rely on reflections off inclined planes. *E.g.*, EX1008, 597 (discussing baffle features “for optimum stray light attenuation”), 598 (Fig. 21.7b)). Like Arnoux, Yang and CN738 use a form a type of light trap on the edge of a light-blocking element “to prevent scattering at large source angle.” EX1014, 5; *supra* Section IV.C.1. Rather than adding additional structures, Yang and CN738 form this light trap by shaping the edge of the light-blocking element. These known solutions all incorporate a baffle feature into the inner edge of a light-blocking element, thereby reducing stray light and associated glare. EX1008, 717-18; *infra* Section IV.E; EX1003, ¶64.

3. Changing The Reflectivity Of The Edge Surface Absorbs Or Redirects Stray Light Away From The Sensor

“The third method of dealing with reflections from nonoptical surfaces is to alter the reflective nature of the offending surface,” including by “apply[ing] an

absorptive coating to the surface,” or “chang[ing] the part reflectance by texturing the surface.” EX1007, 121; *see also* EX1009, 90 (“[E]dges of optical elements can be treated to absorb or scatter light by blackening or roughening.”); EX1003, ¶65.

In addition to making the surface absorptive, an antireflective coating, sometimes referred to as an antireflection (AR) coating or film, was often applied to reduce surface reflections. *E.g.*, EX1007, 110 (coatings “typically used” for “reducing the surface reflectance”); EX1009, 91 (“Optical surfaces require antireflection (AR) coatings to reduce stray light and improve transmission.”). By at least 2009, “an antireflection (AR) coating” was a “commonly used coating for plastic optics.” EX1007, 111; *id.*, 120; EX1008, 571; EX1029, 17; EX1003, ¶66.

Thus, in addition to other above-noted techniques, making the structures themselves more absorptive and antireflective was known to further reduce stray light. *E.g.*, EX1008, 717 (“The key to scatter suppression is to create an opto-mechanical housing structure which maximizes the number of light absorbing surfaces.”); EX1003, ¶67.

**D. Light Traps At The Edge Of Light-Blocking Elements
Were A Known Solution For Suppressing Stray Light,
Both Historically And In More Recent Miniature Lens Designs**

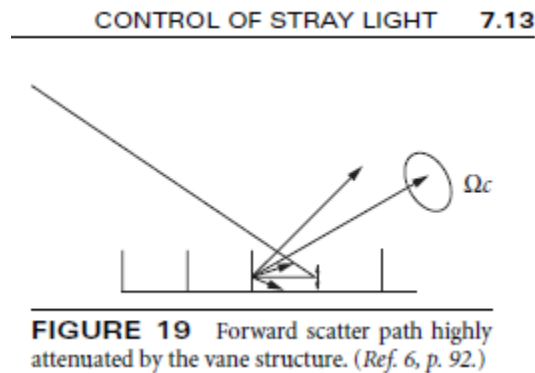
The use of a light trap at the edge of a light-blocking element was a well-known technique for eliminating edge reflections. As noted above, Arnoux taught using “an additional vane” at “the sharp edge of the vane” of a baffle in order “to

prevent scattering at large source angle[s].” EX1014, 5; *supra* Section IV.C.1. Another approach, taught by Yang and CN738, includes altering the edge itself of a light-blocking element to form a light trap in the edge. *Supra* Section IV.C.2. These latter two references show that, in the cell phone context, it was known to combine the first two known methods for reducing stray light reflections: use of baffles / light traps and alteration of the shape of the inner surface. EX1003, ¶68.

**E. **POSITAs Knew How To Calculate
An Appropriate Depth For A Given Light Trap****

POSITAs knew how to calculate the requisite depth of a given light trap because vane / baffle design was an established and well-understood practice. *See, e.g.*, EX1008, 718-721 (“baffle design”), 722-725 (“optimal baffle geometry”), 725-726 (“baffle profile design”), 726-728; EX1010, 7.10-7.17 (explaining designs for baffles and vanes); EX1003, ¶69.

POSITAs refer to the structures that form the sides of a light trap as “vanes” or “baffles.” The Handbook of Optics uses the term “vanes” to describe these light trap-forming structures but notes that “[o]ther authors have used the term ‘baffles’ or ‘glare stops’ to describe these vanes.” EX1010, 7.11:16-17.

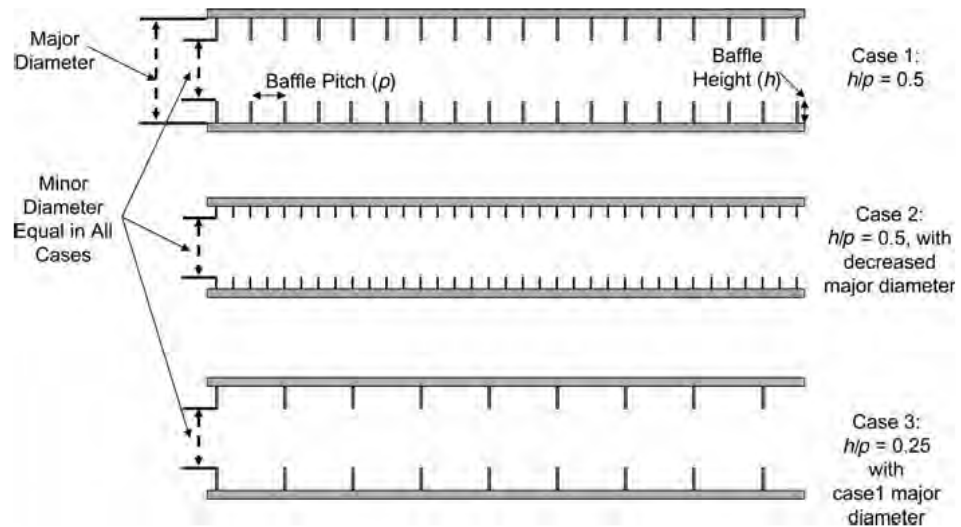


EX1010, 7.13 (Figure 19)

Stray Light and Optical Scattering

719

Figure 24.10
Example of Baffle
Structures in a Bore

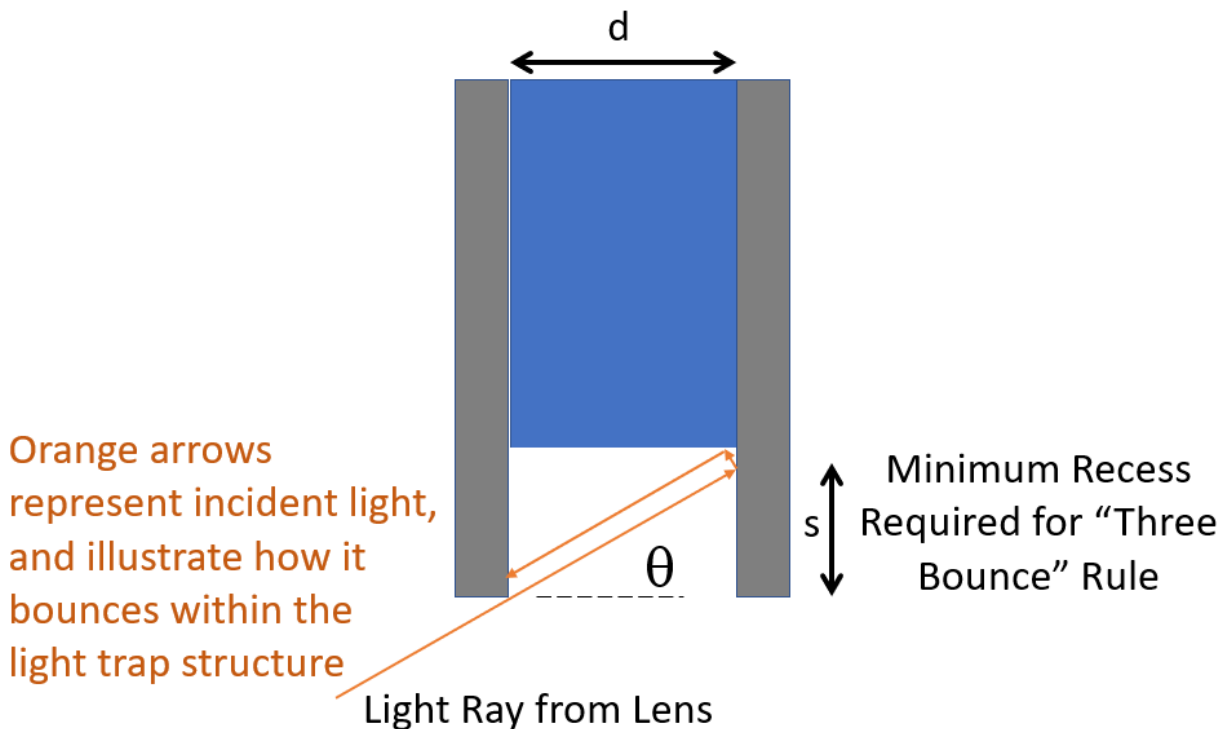


EX1008, 719 (Figure 24.10). EX1003, ¶70.

POSITAs knew that the “three-bounce rule” helped inform light trap dimensions. Fischer’s *Optical System Design* book states, “[i]f there’s one rule to remember, it’s the ‘three-bounce rule’” for suppressing stray light. EX1008, 717-18. “Three bounces of a 1% reflection will reduce the amount of light to one *millionth*

of the original energy. This is a great rule of thumb for most scatter suppression applications!” *Id.* (emphasis original). EX1003, ¶71.

POSITAs knew that basic trigonometry relates the angle of the incoming light to the width of a given light trap, as depicted below, allowing for simple determination of the minimum depth or recess required to achieve three “bounces” or reflections, and thus sufficiently reduce stray light in the system. The minimum recess depth s for a given width d and stray light angle θ can be readily determined from the equation $s = d \cdot \tan(\theta)$:



As shown, a depth calculated from this equation will cause the stray light to bounce twice in the upper right corner and then a third time on the lower left edge. A shallower depth would allow the light to exit the trap after just two bounces, whereas

a greater depth would better trap the light. *E.g.*, EX1010, 7.13 (“Designing the Vane Spacing and Depth”); *id.*, 7.16:9-38; EX1008, 718 (relationship between vane pitch and vane depth). The law of reflection dictates that the angle of reflection is equal to the angle of incidence. EX1030, 4. POSITAS would thus easily calculate the bounces taken by incident light and determine the light trap depth needed to achieve at least three bounces for a given light trap width and stray light input angle. EX1003, ¶71.

Fischer further explains the relationship between the spacing and the depth of light trap baffles and notes a “trade-off study” that examined “the optimal spacing” or “pitch” p for a given baffle height. EX1008, 718:27-720:34. Based on this study, Fischer determined that a reasonable balance between stray light suppression and design complexity would result from a ratio of $h/p = 0.5$, or a baffle height that was $1/2$ the baffle separation. *Id.*, 718-722. POSITAs would have understood this as a good rule of thumb when implementing light traps to reduce stray light in an optical system. *Id.*; *see also* EX1010, 7.16:9-14. Under this rule, if a light trap’s two sides were separated by $15\mu\text{m}$, POSITAs knew that a reasonably acceptable depth would be at least $7.5\mu\text{m}$. Certain designs might have more exacting specifications and benefit from analysis using the three-bounce rule, to better guarantee stray light suppression. *Id.* EX1003, ¶72.

V. THE '660 PATENT

The '660 patent issued June 12, 2018, from an application filed February 16, 2017, and alleges priority to a Taiwanese application filed November 14, 2016. EX1001, Cover.

A. Without Using The Term “Light Trap,” The '660 Patent Describes The Alleged Invention As A Light Trap That Reduces Stray Light, Without Explaining How To Make Such A Light Trap

The '660 patent admits the “conventional light blocking sheet” is a ring-shaped disc with a PET substrate layer “sandwiched by two outer layers made of a carbon-containing material.” EX1001, 1:33-41; FIG. 1. It then describes the alleged invention as a light blocking sheet of the same three-layer structure with a minimum diameter of the substrate opening greater than the openings of the first and second carbon-containing layers. *Id.*, 2:22-39. The alleged invention is thus the addition of an “inner space” or an “air layer 140 ... located between the first outer layer 110 and the second outer layer 120” of a conventional light blocking sheet, as shown in Fig. 2C, reproduced below. *Id.*, 5:9-17, Fig. 2C.

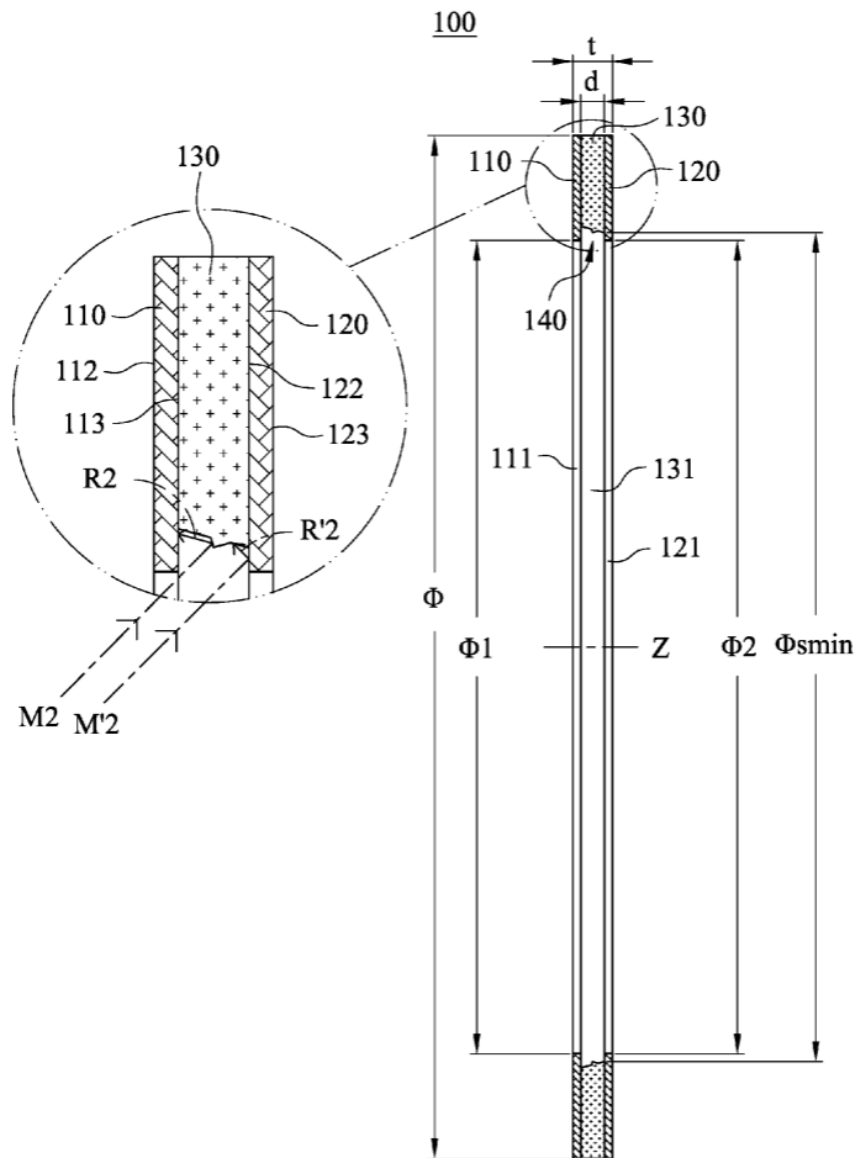


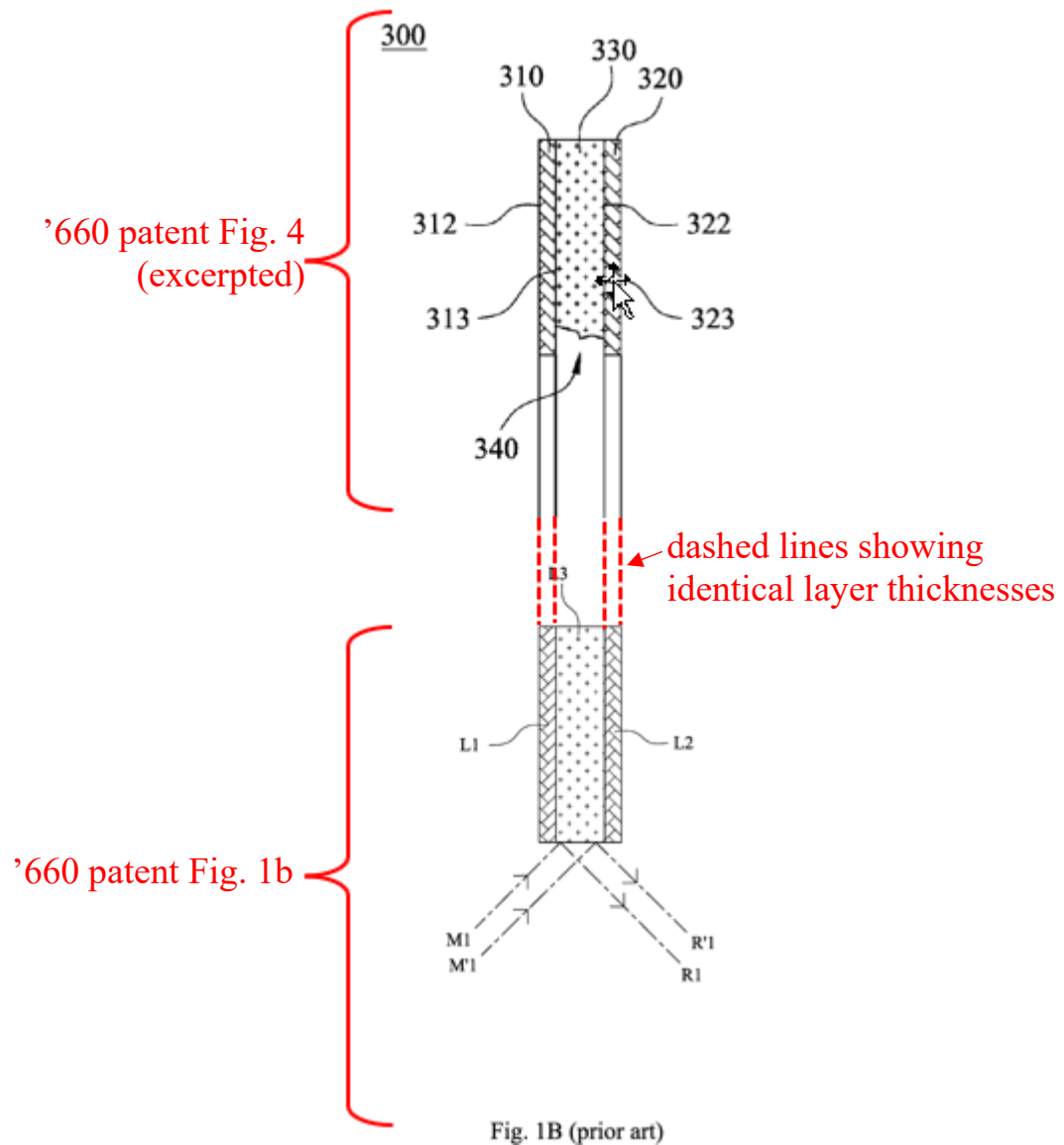
Fig. 2C

Id., Fig. 2C.

The '660 patent does not use the terminology “light trap” or acknowledge the wide use of light traps. Instead, it describes the alleged invention in a way that suggests the inventors somehow came up with the light trap concept, stating that “when an incident light M2 and an incident light M’2 strike a surface of the inner

space (air layer 140), ... a reflected light R2 and a reflected light R'2 generated thereby tend to reflect again in the inner space (air layer 140).” *Id.*, 5:24-31. This reflection of light within the inner space “can effectively attenuate an intensity of the light reflected therefrom” such that “stray lights can be effectively reduced, and the image quality can be enhanced.” *Id.*, 5:31-36; *see also id.*, 2:15-18.

Confirming that the alleged invention merely adds a light trap to the same three-layer structure as the prior art, the exemplary “prior art” light-blocking sheet shown in Fig. 1B has the same layer thicknesses as the ’660 embodiment shown in Fig. 4.



Thus, without expressly using the terms for the well-known “light trap,” the '660 patent effectively describes the alleged invention as use of a light trap to reduce stray light. EX1003, ¶¶73-80.

The '660 patent does not describe how to create this light trap.

B. In Prosecution, Applicant Distinguished The Prior Art By Arguing That It Failed To Disclose Or Teach “Reduction Of Stray Light By Forming A Light Trap”

An Office action rejected the original claims as obvious over U.S. 2015/0022896 (to Cho et al.) in view of U.S. 2016/0349504 (Kim et al.). EX1002, 176-191/237². In response, Applicant amended the independent claims to incorporate a limitation regarding the range of minimum diameter of the inner substrate to the diameter of the openings in the outer layers. *Id.*, 197-212/237. That amendment is reproduced here:

wherein a minimum diameter of the substrate opening is Φ_{min} , a diameter of the first opening is Φ_1 , a diameter of the second opening is Φ_2 , and the following conditions are satisfied:

$$\Phi_{\text{min}} > \Phi_1 \underline{2.0 \mu\text{m} < (\Phi_{\text{min}} - \Phi_1)/2 < 200 \mu\text{m}}; \text{ and}$$

$$\Phi_{\text{min}} > \Phi_2 \underline{2.0 \mu\text{m} < (\Phi_{\text{min}} - \Phi_2)/2 < 200 \mu\text{m}}.$$

Id., 199/237 (emphasis original).

In argument, Applicant focused on these conditions (which became Element 1.6 in the issued claims) and for the first time characterized the alleged invention as a light trap:

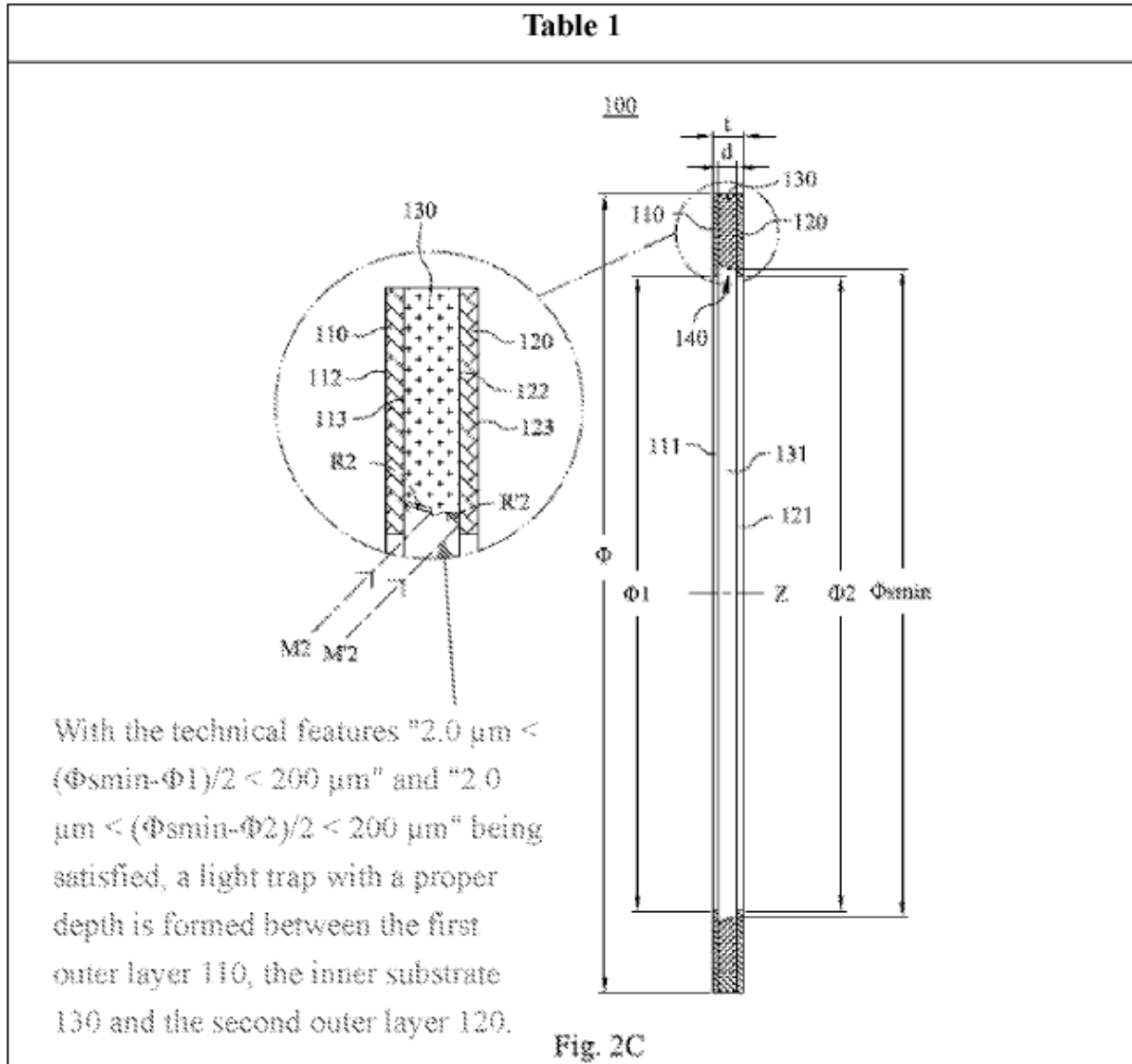
[T]he mechanism for reducing the stray light according to the present application is to form a light

² Citations are to page numbering added by Petitioner.

trap (i.e., the inner space formed between the first outer layer 110, the inner substrate layer 130 and the second outer layer 120), once the incident light strike therein, the intensity thereof is attenuated by repeated reflections.

Id., 208/237 (emphasis original).

With no cited support, the response further alleged that the claimed conditions led to a proper light trap: “the depth of the light trap is proper, and the effect for trapping the incident light is more significant.” *Id.* In explaining these dimensions, applicant submitted an annotated copy of its Fig. 2C, which is reproduced below. This figure shows that the recited dimensions are satisfied by a light trap that is greater than 2μm deep, and less than 200μm deep, with respect to either outer layer.



EX1002, 207/237. EX1003, ¶81.

Applicant then asserted that Cho and Kim “fail[ed] to disclose, teach and suggest the reduction of stray light by forming a light trap.” *Id.*, 208-211/237.

Based on these arguments, the Examiner allowed the amended claims. *Id.*, 216-222/237.

C. Claims Listing

The challenged claims are reproduced in their entirety in EX1023. Challenged claim 1 is representative and listed here, with element numbering added in the lefthand column:

[1.1]	A light blocking sheet, comprising:
[1.2]	a first outer layer comprising a first opening;
[1.3]	a second outer layer comprising a second opening;
[1.4]	an inner substrate layer disposed between the first outer layer and the second outer layer, wherein the inner substrate layer connects the first outer layer to the second outer layer, and the inner substrate layer comprises a substrate opening; and
[1.5]	a central axis coaxial with the first opening, the second opening and the substrate opening;
[1.6]	wherein a minimum diameter of the substrate opening is Φ_{min} , a diameter of the first opening is Φ_1 , a diameter of the second opening is Φ_2 , and the following conditions are satisfied: $2.0\mu\text{m} < (\Phi_{\text{min}} - \Phi_1)/2 < 200\mu\text{m}$; and $2.0\mu\text{m} < (\Phi_{\text{min}} - \Phi_2)/2 < 200\mu\text{m}$.

VI. LEVEL OF SKILL IN THE ART

The person of ordinary skill in the art in November 2016 (“POSITA”) would have held a bachelor’s degree in physics, optical sciences, or a closely related field, and approximately three years’ experience in optical system design, including stray light suppression. More education would compensate for less work experience and vice versa. POSITAs understood the fundamentals of stray light suppression. EX1008, 587:18-20 (“It is important that the designer be reasonably fluent in ... baffling and stray light control.”); *id.*, 167 (“[The designer] needs to be fully

confident that [stray light is] understood and under control.”); *id.*, 595:32-33; xiii:24-26. EX1003, ¶¶31-37.

Lens design books, including Schaub (EX1007), Fischer (EX1008), Bentley (EX1009), and the Handbook of Optics (EX1010) reflect the knowledge of a POSITA, and Section IV herein describes specific knowledge and skill possessed by POSITAs. A POSITA could be part of a team that includes a lens designer and a stray light specialist. EX1007, 120 (“[I]t is useful for the stray light analyst and the optomechanical designer (if they are not the same person) to be in close collaboration.”) (parentheticals original). EX1003, ¶¶33, 36, 38-41.

VII. CLAIM CONSTRUCTION

Petitioner applies the plain and ordinary meaning of all claim terms, without waiving any rights to raise additional issues of claim construction, indefiniteness, or invalidity in any litigation.

Claim element [1.6] recites:

wherein a minimum diameter of the substrate opening is Φ_{min} , a diameter of the first opening is Φ_1 , a diameter of the second opening is Φ_2 , and the following conditions are satisfied:

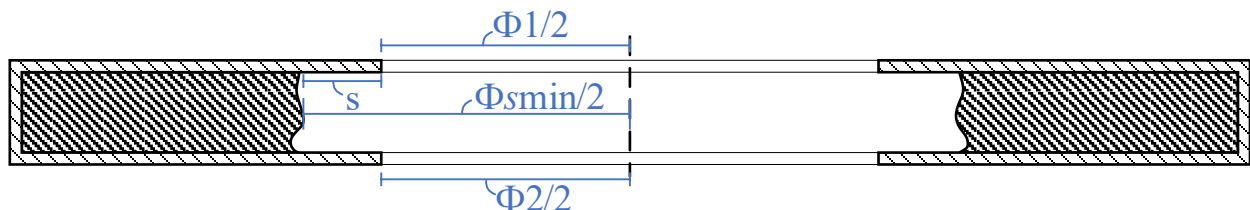
$2.0\ \mu\text{m} < (\Phi_{\text{min}} - \Phi_1)/2 < 200\ \mu\text{m}$; and

$2.0\ \mu\text{m} < (\Phi_{\text{min}} - \Phi_2)/2 < 200\ \mu\text{m}$.

The plain meaning of this term encompasses a light trap on the inner surface of a three-layer light-blocking sheet, formed by recessing the middle substrate layer at least $2\mu\text{m}$ and no more than $200\mu\text{m}$, with respect to each outer layer, along the inner circumference of the sheet. EX1003, ¶¶82-86.

A light-blocking sheet with such a light trap has a minimum substrate opening diameter Φ_{min} that is between $4\mu\text{m}$ and $400\mu\text{m}$ greater than the diameters of each of the first and second openings Φ_1 and Φ_2 . The prosecution history confirms that such a light trap satisfies Element 1.6, as the applicant argued that this element corresponds to “a light trap with a proper depth.” EX1002, 207/237; *supra* Section V.B. EX1003, ¶86-87.

To further illustrate, the middle portion of the conditions can be rewritten as $(\Phi_{\text{min}}/2) - (\Phi_1/2)$ and $(\Phi_{\text{min}}/2) - (\Phi_2/2)$. As shown in the following figure, each of these values reflects the minimum depth that the middle layer is recessed relative to each outer layer:



EX1003, ¶85.

VIII. GROUND 1: CLAIMS 1-9, 15-19 ARE OBVIOUS OVER CN182

As explained below, claims 1-9 and 15-19 are obvious over CN182 and the knowledge of a POSITA.

A. CN182 (EX1004)

Chinese Patent Publication No. CN 104460182 A (EX1004, “CN182”) published March 25, 2015, and qualifies as prior art under at least Section 102(a)(1). EX1004, Cover. CN182 is analogous art to the ’660 patent because they are in the same field of endeavor of blocking stray light to reduce glare in compact imaging lens modules. EX1001, 1:14-17, 1:21-32; EX1004, [0001]-[0002]; EX1003, ¶¶88-89.

CN182 discloses a “shading ring” used to block stray light in “cell phones and digital cameras,” and a method for manufacturing the shading ring. EX1004, [0002]. The CN182 shading ring “aims to solve the existing technical problems of glare, halo and flare ... caused by the existing shading rings due to the reflection from the inner-wall of the through-hole.” *Id.*, [0003]. Like the ’660 patent, and as known in the art, CN182 discloses a basic three-layer structure for its shading ring, with a PET plastic inner layer body sandwiched between two carbon-containing outer layers. EX1004, [0026]; *id.*, [0002] (inner layer made of “polyethylene terephthalate (PET)”), [0005], [0027]-[0028], [0036], [0038]. At least because it is used for light blocking and has the same 3-layer construction as the ’660 patent invention, a

POSITA would have understood the CN182 “shading ring” to be a “light blocking sheet” as that term is used in the ’660 patent. EX1003, ¶¶90-91.

CN182 notes the same problem later noted by the ’660 patent: the stamping process used to create the shading ring’s hole leaves a shiny inner surface that reflects stray light, “result[ing] in obvious glare, halo and flare and other undesirable effects.” EX1004, [0002-0003]; *compare with* EX1001, 1:49-51. EX1003, ¶92.

To mitigate these undesirable effects, CN182 describes etching the PET material of the middle layer to create a rough matte surface instead of a shiny surface. EX1004, [0006] (“[F]orming a matte structure on the hole-wall of the through-hole by etching with an alkaline solution.”). This process etches the PET (plastic) inner layer but not the outer carbon layers. *Id.*, [0028], [0038]. The resulting non-uniform “matte structure” helps “avoid the occurrence of glare, halo and flare.” *Id.*, [0038], [0040], FIG. 3 (reproduced below).

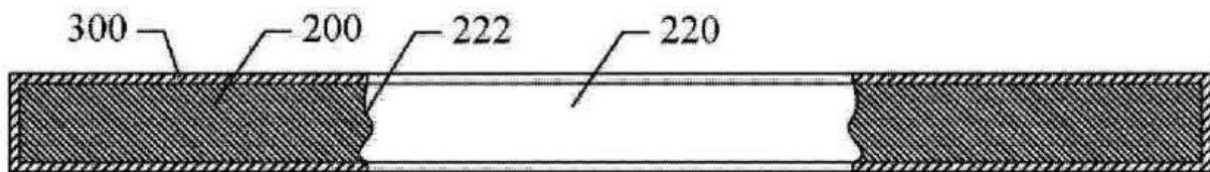
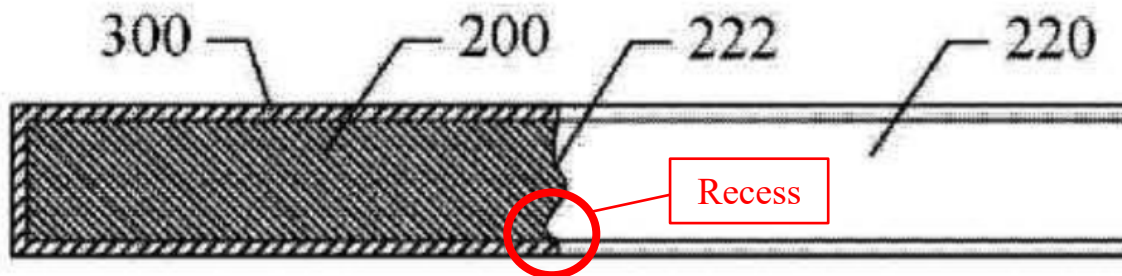


Figure 3

Id., FIG. 3. EX1003, ¶93.

CN182 Figure 3 reflects the removal of the PET layer by etching, with an inner surface of the PET middle layer (200) partially recessed relative to the through-hole's outer carbon layers (300):



EX1004, FIG. 3 (cropped and annotated). EX1003, ¶94.

The only difference from the light blocking sheet of the challenged claims is that CN182 does not expressly disclose a light trap that satisfies the conditions recited in Element 1.6, e.g., a substrate layer recessed 2-200 μ m with respect to the outer layers. *Supra* Section VII (construction of Element 1.6); EX1003, ¶95.

Given a POSITA's knowledge on light traps, however, it would have been obvious to adapt the CN182 etching process to create a more recessed PET middle layer, thus forming a stray light trap to reduce glare more effectively. EX1003, ¶95.

As discussed further below, CN182 either discloses or renders obvious all elements of claims 1-9, 15-19. EX1003, ¶96.

B. Claim 1

1. Element 1.1

[1.1]³ A light blocking sheet, comprising:

To the extent the preamble is limiting, CN182 discloses a “shading ring” that is “placed inside the camera of high-pixel cell phones and digital cameras to adjust the aperture of the light and to *block other stray light*.” EX1004, [0002] (emphasis added). EX1004, [0002]. At least because of its name, structure, and functional purpose, the CN182 shading ring would have been understood to be a “light-blocking sheet,” as claimed. EX1003, ¶97; EX1007, 125; *supra* Section VIII.A.

2. Elements 1.2-1.4

[1.2] a first outer layer comprising a first opening;

[1.3] a second outer layer comprising a second opening;

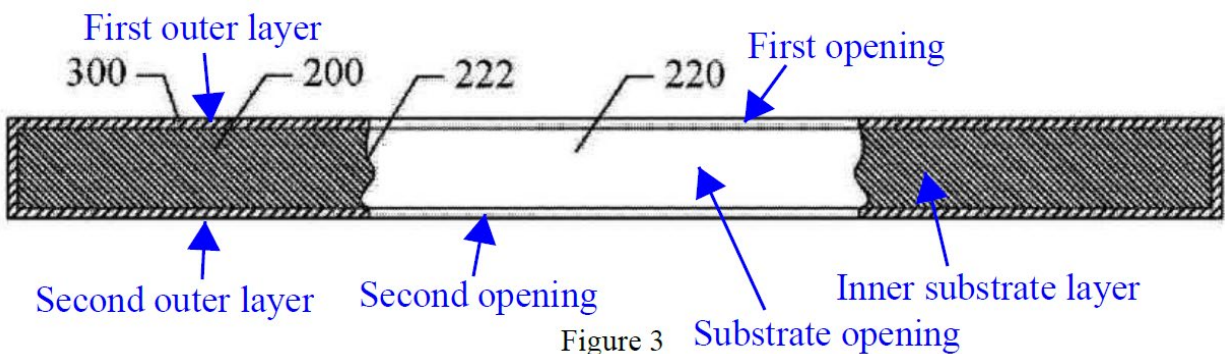
[1.4] an inner substrate layer disposed between the first outer layer and the second outer layer, wherein the inner substrate layer connects the first outer layer to the second outer layer, and the inner substrate layer comprises a substrate opening; and

CN182 discloses first and second outer layers, with an “inner substrate layer disposed between,” as recited in Elements 1.2-1.4. For example, CN182 discloses a “body ... made of plastic material” (inner substrate layer) disposed between and

³ Reference numbers in the format of [claim#.element#] are added throughout for ease of reference.

connecting two outer “carbon powder layer[s]” (first and second outer layers). EX1004, [0026]; *id.*, [0005], [0014], [0027]-[0028], [0036]-[0038], Claims 1 & 6-11, Figure 3. Each of these three layers has an “opening” as claimed. *E.g., id.*, [0005], [0018], [0026]; Fig. 3. EX1003, ¶98.

CN182 Figure 3, annotated below, shows these layers and respective holes/openings, with the inner PET substrate body 200 disposed between and connecting the first and second outer carbon layers:



EX1004, FIG. 3 (blue annotations added); *see also id.*, [0036], [0002]. EX1003, ¶99.

CN182 thus discloses this element and uses the same three-layer carbon-PET-carbon sandwich structure that the ‘660 patent admits was “conventional.” *E.g.*, EX1001, 1:32-49; *id.*, FIG. 1B. EX1003, ¶¶100-101.

3. Element 1.5

[1.5] a central axis coaxial with the first opening, the second opening and the substrate opening;

CN182 discloses this element as the shading ring's through-hole 220 forms the first, second, and substrate openings, and thus the central axis of the through-hole is coaxial with the first, second opening, and substrate openings. *E.g.*, EX1004, [0036].

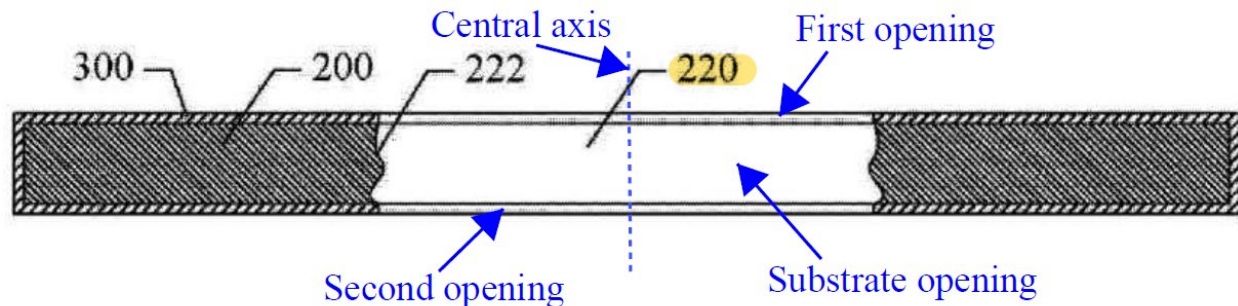


Figure 3

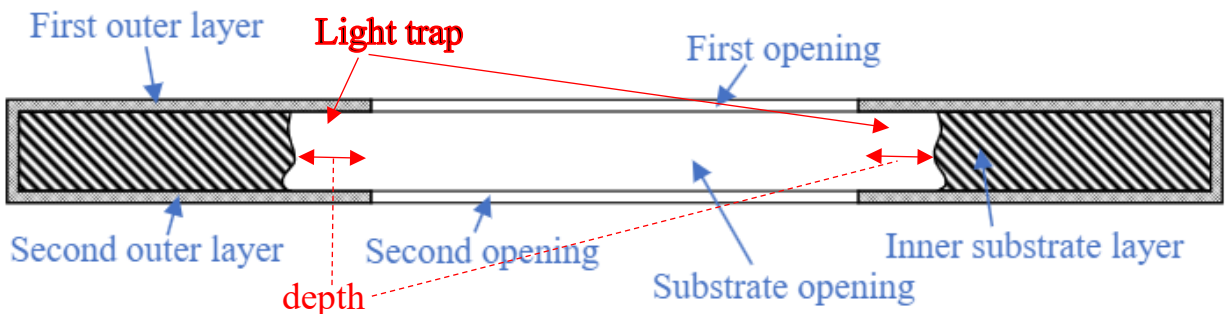
Id., FIG. 3 (highlighting and annotations added). EX1003, ¶102.

4. Element 1.6

[1.6] wherein a minimum diameter of the substrate opening is Φ_{smin} , a diameter of the first opening is Φ_1 , a diameter of the second opening is Φ_2 , and the following conditions are satisfied:
 $2.0\ \mu\text{m} < (\Phi_{smin} - \Phi_1)/2 < 200\ \mu\text{m}$; and
 $2.0\ \mu\text{m} < (\Phi_{smin} - \Phi_2)/2 < 200\ \mu\text{m}$.

As noted above, these conditions are satisfied by a light trap in which the substrate material is recessed by at least $2\ \mu\text{m}$ (and no more than $200\ \mu\text{m}$) with respect to each of the first and second outer layers. *Supra* Section VII. While CN182 does not expressly disclose such a light trap, it would have been obvious to implement the CN182 shading ring with a light trap having dimensions that satisfied Element 1.6. EX1003, ¶103.

Given CN182's express goal of avoiding stray light reflections off the inner surface of the through-hole, and knowledge regarding conventional light traps and other stray light suppression techniques, POSITAs would have promptly recognized the benefits of using the CN182 etching process to create a conventional "light trap" on the inner surface of CN182's shading ring. POSITAs would have naturally and predictably used CN182's etching process to further erode the inner PET layer relative to the outer carbon layers, to a depth that effectively trapped stray light. While many obvious variants would have dimensions within the claimed range and thus satisfy Element 1.6, exemplary obvious implementations of CN182 include **a light trap from 5.2-9.7 μ m deep** along the circumference of the inner surface, shown here in the following cross-section:



EX1003, ¶104. Such a light trap satisfies the claimed conditions. *Supra* Section VII; *infra* Section VIII.B.4.d).

Given that light traps had long been used to improve optical designs by reducing stray light, this obvious design used known light trap techniques to improve similar optical systems in a predictable way. CN182 already applies 1 of the 3

common techniques for reducing stray light reflections, namely roughening the PET surface by etching it. *Supra* Section IV.C.3. Using that same process to further etch the middle PET layer, thus creating a light trap by altering the surface's shape, applies the other two common stray-light mitigation techniques, without adding any additional processing steps. The three techniques (roughening, light traps, and altering the shape) were complementary and regularly used together in reducing stray light reflections off the inner surface of light-blocking elements. *Supra* Section IV.C. Because of this, POSITAs naturally would have extended CN182's etching process to create a light trap of proper dimensions, thus furthering CN182's goal of reducing stray light reflections. EX1003, ¶105.

The below sub-sections further explain why, upon reviewing CN182, POSITAs would have been motivated with a reasonable expectation of success to implement such light traps, and how near-contemporaneous development by others confirms the obviousness of the challenged claims.

a) POSITAs Would Have Been Motivated To Adapt The CN182 PET Substrate Etching Process To Create A Light Trap Between The Two Outer Carbon Layers

CN182 states a goal of minimizing reflections off the inner surface of the shading ring, thus reducing undesirable glare, i.e., “avoid the occurrence of glare, halo and flare caused by the reflection from the hole-wall of the through-hole,

thereby ensuring the capturing effect and improving the quality of the imaging products.” EX1004, Abstract; *see also id.*, [0003], [0019]. EX1003, ¶106.

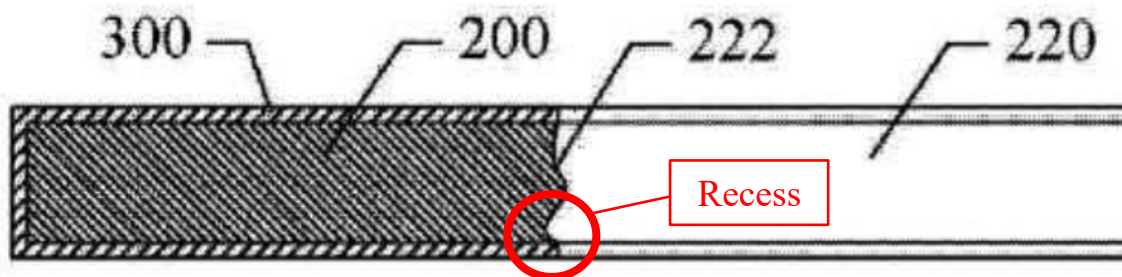
To further this goal, CN182 uses one of the three well-known techniques for reducing inner surface reflections within an optical system, namely *roughening* the inner PET material to create a “matte” surface. *E.g.*, EX1004, [0002], [0019], [0035], [0040]; *see also supra* Section IV.C; EX1007, 120; EX1003, ¶107.

Given the expressly stated (and commonly known) goal of reducing reflections off the CN182 shading ring’s inner surface, POSITAs would have been motivated to use the two other established techniques that were “usually” employed to reduce those reflections: (i) baffles/light traps and (ii) altering the shape of the reflecting inner surface. *Supra* Section IV.C. POSITAs would have been motivated to employ these known-compatible solutions to the same problem of reducing stray light reflections, as stray light reduction often “require[d] multiple techniques.” *E.g.*, EX1007, 121. EX1003, ¶108.

Indeed, Schaub explains that POSITAs regularly used “one or more” of these methods to solve the stray light problem (EX1007, 120:37-38) and gives a specific example of using two in combination, altering the shape of the surface by adding a chamfer *and* roughening it (*id.*, 122:29-40). *Id.* (noting “benefits of making the effort, and taking the time, to perform stray-light analysis”). POSITAs would have

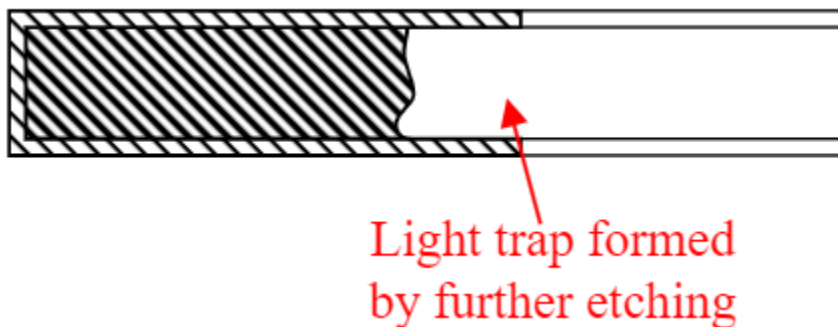
recognized that these additional techniques furthered CN182's goal by better reducing stray light and improving image quality. EX1003, ¶108.

POSITAs would have recognized that simply extending the CN182 etching process would elegantly create a stray light trap and reduce the inner surface area of the shading ring, thus eliminating stray-light reflections and glare, without additional processing steps. CN182 teaches etching the PET layer, explaining that the surrounding carbon layers are “less sensitive” to the etching solution and “basically will not be etched.” *E.g.*, EX1004, [0038]. While CN182 describes use of this etching to “form a matte structure” (*e.g.*, *id.*), POSITAs knew that this process removed PET material while leaving the carbon layers largely intact. EX1003, ¶109. CN182 Figure 3 reflects this, with portions of the middle PET layer recessed relative to the two outer carbon layers:



EX1004, FIG. 3 (cropped and annotated). POSITAs knew that prolonging, or otherwise modifying, this etching process would further etch and recess the middle PET layer, beneficially creating a light trap. *Supra* Sections IV.C, IV.D; EX1027,

277-283 (etching techniques enable submicron accuracy); EX1008, 736-37 (specifying to “[e]mploy threads [and] baffles ... where possible”); *id.*, 768 (“Always consider the possible effects of stray light, and provide suitable baffles *and* low-reflectivity interior system finish to attenuate it.”) (emphasis added).



EX1003, ¶109.

By *altering the surface* of the inner PET surface to *form a reflection-reducing light trap*, this natural extension of the CN182 etching process employs the other two known anti-reflection methods: baffled light traps and modifying the inner surface of the light-reflecting element. As explained above, adding a light trap at the edge of a baffle vane, such as a light-blocking sheet or shading ring, was known for decades to address edge reflections. *E.g.*, EX1014, 5; *supra* Sections IV.C.1, IV.D. And the CN182 etching process provided an elegant way to create the desirable light trap on the inner surface of the shading ring. *Supra* Section IV.C.2. Given this knowledge and the teachings and stated goal of CN182, POSITAs would have been

motivated to create a recess in the PET body of the shading ring in CN182, thus forming a light trap and further reducing glare. EX1003, ¶¶110-111.

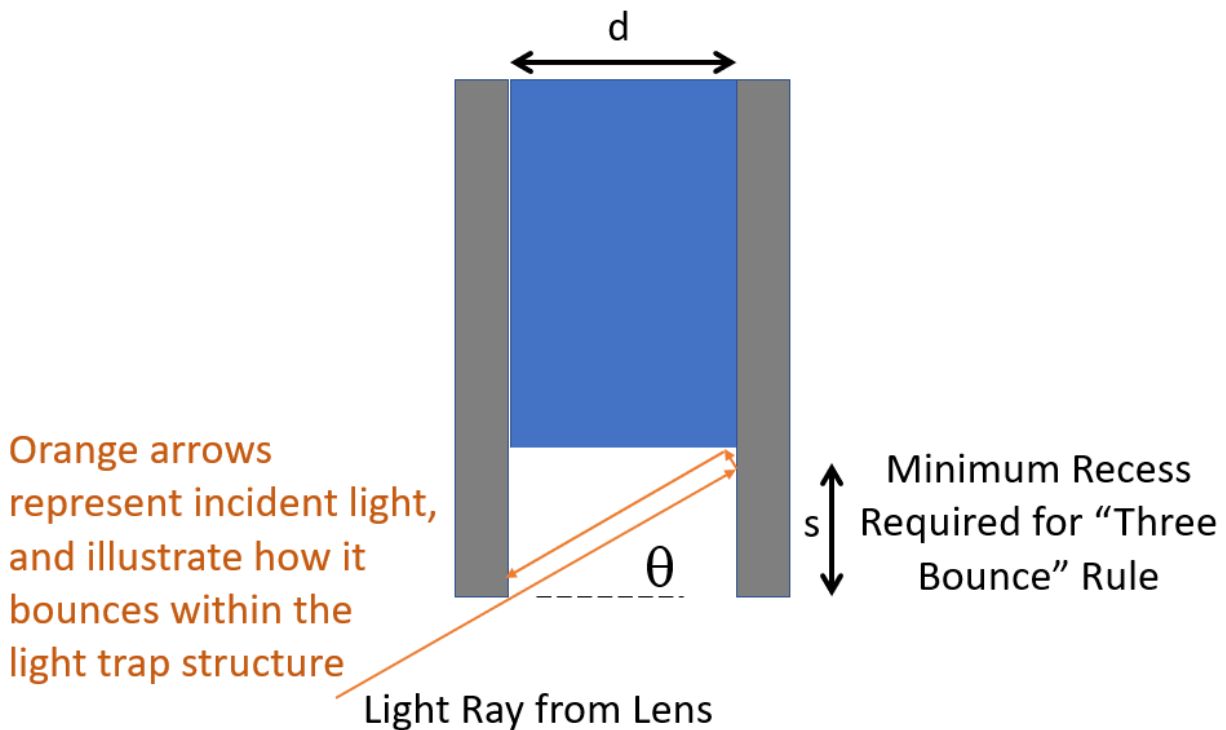
**b) POSITAs Would Have Been Motivated To Create The
Light Trap With Dimensions In The Claimed Range**

A POSITA knew that the established “three-bounce rule” provided guidance on how deep to etch the PET layer to sufficiently “trap” incident stray light. *Supra* Section IV.E; EX1008, 722-725 (“Optimal Baffle Geometry” that satisfies “Three Bounce Rule”). With this guidance in mind, POSITAs knew to use basic optical principles and math to calculate proper light trap depth based on the incoming stray light angle θ and the distance between the vanes d (i.e., the distance between outer carbon layers). *Supra* Section IV.C.1; EX1005, 6, Figure 1 (depicting bounced light within baffle feature); EX1010, 7.13 (“Designing the Vane Spacing and Depth”); EX1008, 718 (relationship between vane pitch and vane depth).

As shown below, the minimum recess required to satisfy the “three bounce” rule was readily determined by simple modeling of a light ray entering the leading edge of the light blocking sheet and calculating the minimum recess depth d as:

$$s=d*\tan(\theta)$$

where d is the thickness of the PET substrate layer and θ is the incoming angle of stray light. *Supra* Section IV.C; EX1008, 723-725.



POSITAs knew that this $d \cdot \tan(\theta)$ equation led to a light trap depth that caused light incident at θ degrees (or less) to bounce at least three times. EX1003, ¶¶112-113.

Following conventional light-blocking sheet design, POSITAs would have been motivated to implement CN182 with known carbon layer thicknesses of 4-6 μm and thus a middle PET layer of 13-17 μm for CN182's total thickness of 25 μm . A POSITA would have known that these thicknesses balanced structural stability of the carbon layers with minimal edge reflections off the inner surfaces of those layers. EX1007, 125:20-21; EX1018, 1:37-40; EX1003, ¶114 (explaining how thicker outer layers would reflect more light, while thinner layers would provide less mechanical strength and shape stability). CN182 discloses a total shading ring thickness of

25 μ m, including all three layers. EX1004, [0013] (“a thickness of the shading ring is 0.025 mm”), [0037].

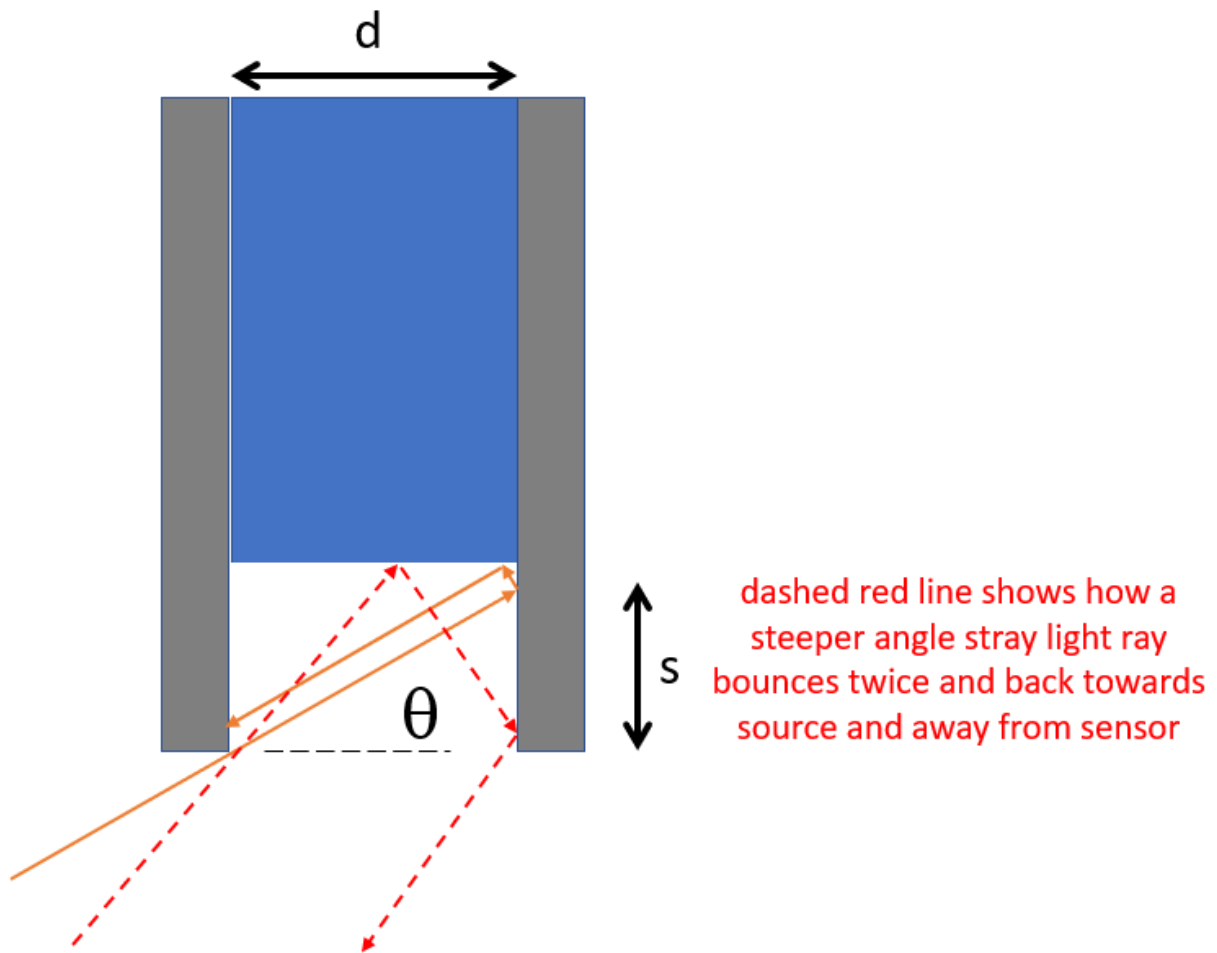
A POSITA knew that for shading rings with 25 μ m thickness, the conventional thickness of each outer layer would typically range from 4-6 μ m. EX1006, [0020] (suggesting each outer layer for a 25 μ m shading ring is *at least* 4 μ m thick); EX1031, 3:22-25 (noting “increasing demands for a thinner [carbon outer] layer” that is “thinner than 6 μ m or so”); *id.*, 3:18-22 (thickness can be selected according to “use purpose” of the carbon layer); *see also* EX1034, 3:55-4:31 (disclosing thickness of 2-8 μ m for each carbon black outer layer coating plastic substrate having thickness of 12-125 μ m to “assure the light shielding property”); EX1033, [0014], [0075] (disclosing preferable lower limit of 5 μ m thickness for an “anti-dazzling” layer to reduce glare). EX1003, ¶115. POSITAs understood that carbon layers of 4-6 μ m thickness reduced the light-reflecting surface area and yet would provide structural support for most applications. A POSITA would have been motivated with a reasonable expectation of success to select a larger thickness in this range, such as 6 μ m, for deeper light traps, to minimize edge reflections and maintain structural stability. EX1003, ¶116.

This is consistent with the “conventional” light-blocking sheet described and shown in the ’660 patent as having carbon layers 6 μ m thick in sheet of 29.5 μ m total thickness. *E.g., compare* EX1001, FIG. 1B (labeled “prior art”) *with* FIG. 4

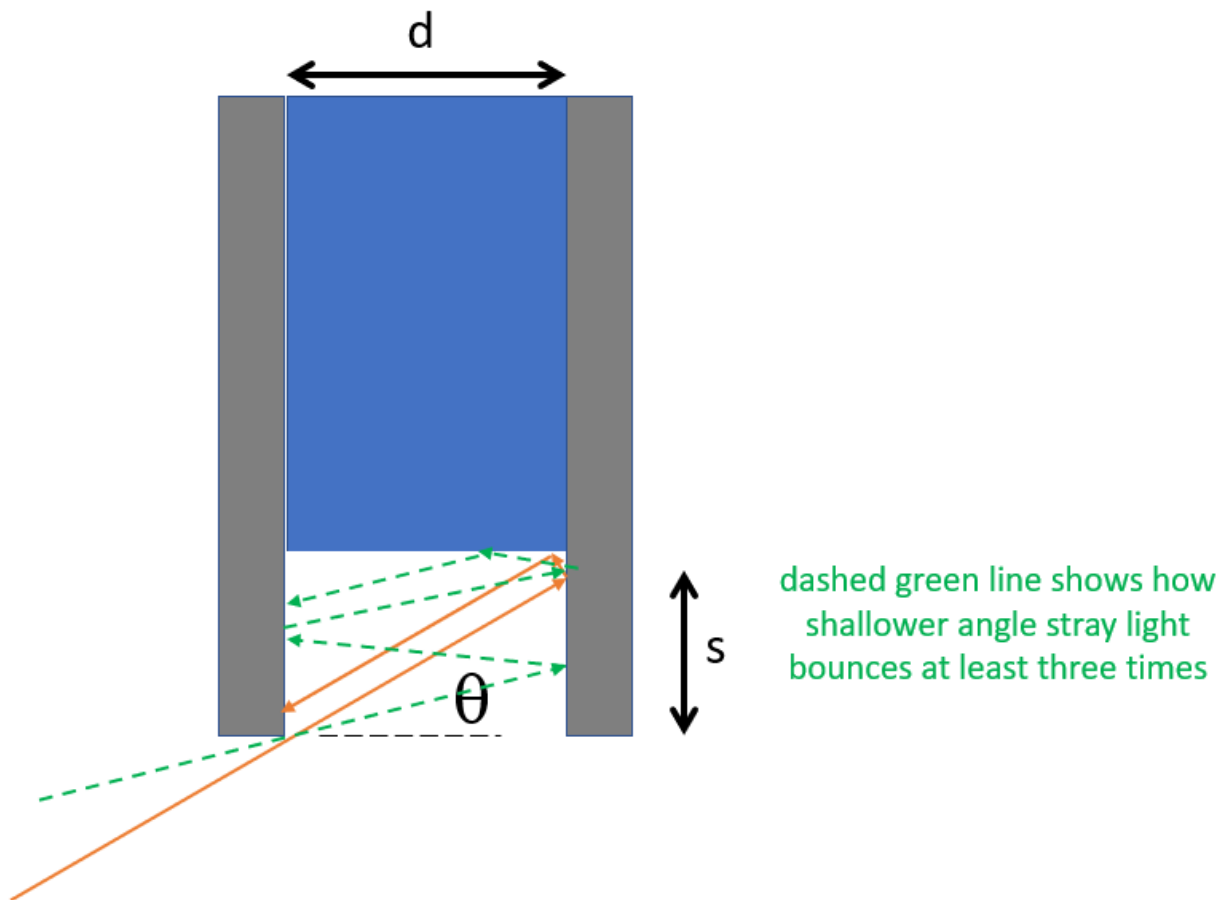
(embodiment of alleged invention with same layer thicknesses as FIG. 1B); *see also id.*, 9:36-55 (describing FIG. 4 total thickness t of $29.5\mu\text{m}$ and substrate layer d of $17.5\mu\text{m}$); EX1003, ¶115.

A POSITA therefore would have been motivated with a reasonable expectation of success to use a shading ring with outer layers that are $4\text{-}6\mu\text{m}$ thick each. For a total thickness of $25\mu\text{m}$, as CN182 discloses, outer layer thicknesses of $4\text{-}6\mu\text{m}$ would provide a **PET layer thickness of $13\text{-}17\mu\text{m}$** . EX1003, ¶116.

While a given light trap implementation would depend on the associated optical design, POSITAs understood that designing a trap for stray light at a 30-degree angle of incidence would provide satisfactory stray light attenuation for most designs. EX1003, ¶¶117-118 (explaining how stray light at greater incidence angles was less common and more likely to be sufficiently weakened by bouncing off additional structures). POSITAs also knew that to a degree light at higher incidence angles would bounce at least twice within the trap and, ultimately, exit in a desirable direction away from the image sensor. *Id.*, ¶118.



EX1003, ¶118. Moreover, light incident at less than 30 degrees would be adequately “trapped” because it would reflect at least three times within the trap and likely even more, as the following diagram shows:



EX1003, ¶118.

While certain designs might allow for a shallower angle, and others might benefit from a steeper angle, a trap that provided three bounces for 30 degrees of incident light would markedly reduce stray light reflections and associated downsides such as glare. EX1003, ¶119. Thus, given a conventional substrate thickness of $13\mu\text{m}$, POSITAs would have been motivated to use the CN182 etching process to etch back the substrate layer by $13\mu\text{m} * (\tan 30^\circ) = 7.5\mu\text{m}$. Were the substrate thickness $17\mu\text{m}$, then the equation would yield $17\mu\text{m} * (\tan 30^\circ) = 9.8\mu\text{m}$.

For slightly thicker carbon layers of 8μm, and a resulting substrate thickness of 9μm, the etch depth would be $9\mu\text{m} * (\tan 30^\circ) = \mathbf{5.2\mu\text{m}}$. EX1003, ¶120.

Confirming that these were appropriate depths, the Fischer optical design book rule of thumb (make the trap depth ½ the trap width) yields comparable depths of 6.5μm, 8.5μm, and 4.5μm. *Supra* Section IV.E; EX1008, 718. Moreover, as the ray angle increases, so does the minimum recess. EX1003, ¶121. Thus, if a design needed to handle steeper angles of incident light, it would result in deeper recesses. *Id.* POSITAs would have appreciated that, as a matter of design choice, obvious light trap variations would have included at least the following depths (in the righthand column), given a corresponding incident angled θ and PET thickness:

PET = 13μm thick					
	θ	θ (radians)	tan θ	d*tan θ	
	15	0.26	0.27	3.48	
	30	0.52	0.58	7.51	
	45	0.79	1	13	
	60	1.05	1.73	22.52	
PET = 17μm thick					
	θ	θ (radians)	tan θ	d*tan θ	
	15	0.26	0.27	4.56	
	30	0.52	0.58	9.81	
	45	0.79	1	17	
	60	1.05	1.73	29.44	

EX1003, ¶121.

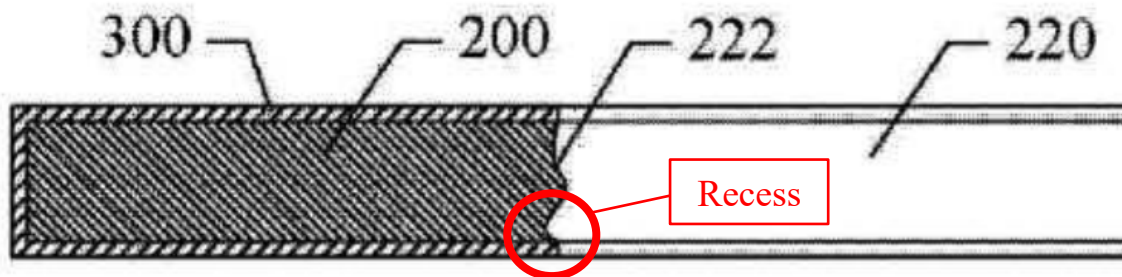
Thus, using basic optical principles and simple trigonometric math, POSITAs would have been motivated to use the CN182 process to etch back the PET material

to form an inner surface light trap with a depth that satisfied the claimed range. *E.g.*, EX1004, [0028]-[0034] (describing how to corrode the PET layer). While the specific depths of **5.2-9.8 μ m** are discussed in detail above, other designs with depths in the claimed range were also obvious. EX1003, ¶122.

**c) A POSITA Would Have Expected Success In
Implementing Such A Light Trap Using The
Known Etching Processes Described In CN182**

POSITAs would have been not only motivated, but would have reasonably expected success in implementing the CN182 shading ring with a light trap that satisfied Element 1.6. CN182 already teaches creating a small recess in the PET layer and POSITAs would have immediately recognized that—without additional steps—adaptation of the etching step would further recess that layer and create a light trap. EX1003, ¶123. This is because the PET layer has a much higher etch rate than the outer carbon powder layers, thereby allowing selective etching of the PET layer. EX1004, [0006], [0028], [0038] (explaining that the carbon powder layer “basically will not be etched with the alkali solution”); EX1016, 609 (explaining “[e]tch selectivity”); *id.*, 613; EX1027, 277-78 (the micro-optics industry commonly uses semiconductor industry techniques to achieve submicron accuracy in manufacturing), 278-79 (“standard wet-chemical developing process” applicable to micro-optics and provides precise shaping by changing the etch rate); EX1003, ¶123.

A POSITA would have recognized that the wet-etching process taught by CN182 already creates a partial recess within the hole-wall, as shown in CN182's Figure 3, cropped and annotated below to indicate where the PET layer partially recedes from the outer carbon layers:



EX1004, FIG. 3 (cropped and annotated); EX1016, 609. A POSITA would have immediately recognized that further etching of the shading ring would lead to deeper PET layer etching across the opening. And CN182 explains what POSITAs knew: that temperature and movement increase etch rate and thus predictably facilitate further etching. EX1004, [0034]; *id.*, [0039]; EX1003, ¶124.

As further confirmation, in counterpart proceedings in India, Largan submitted testimony from Dr. Bentley that “the process of chemical etching (also for spacers) was already known.” EX1028, ¶42 (parentheses original). For a desired depth, “the process parameters can be varied to yield the desired outcome” and, “if product details are known or understood, an average skilled or skilled person can work backwards to formulate process parameters to achieve that product.” *Id.* This

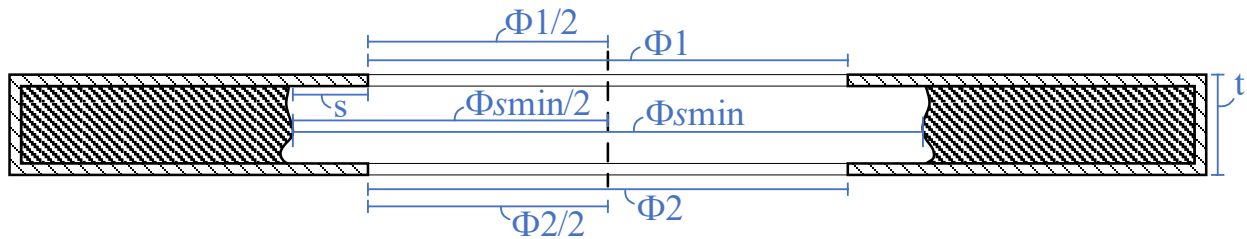
is because the chemical etching process is predictable and “can be controlled with a great degree of precision and accuracy.” *Id.*, ¶8; *see also id.*, ¶7. EX1003, ¶125.

Thus, POSITAs would have been motivated with a reasonable expectation of success to implement the shading ring of CN182 with a light trap depth within the claimed range. Finally, the '660 patent's own lack of description on the process used to create its preferred embodiments confirms that POSITAs knew how to predictably etch the PET layer in conventional Carbon-PET-Carbon light-blocking elements to create a light trap of the desired depth. *In re Fox*, 471 F.2d 1405, 1407 (C.C.P.A. 1973); EX1003, ¶¶125-126.

d) These Obvious Light Traps Satisfy Element 1.6

The preceding sections explain why CN182 renders obvious light-blocking sheets with light traps, including light traps at least 5.2-9.8µm deep along the inner circumference of the shading ring. Such light-blocking sheets satisfy Element 1.6. *Supra* Section VII (claim construction).

Here, the Petition further explains how these light traps satisfy the mathematical conditions of Element 1.6. The following labeled figure helps illustrate these conditions in the context of obvious CN182 implementations:



EX1003, ¶127.

For a light trap depth of $5.2\mu\text{m}$, at any given point the PET layer is etched back at least $5.2\mu\text{m}$ with respect to each of the first and second carbon outer layers. Thus, because the recited Φ values represent diameters of a cross-section and the PET layer is etched back on either side of that cross-section and because each of the carbon outer layers has the same diameter, each of $\Phi_{\text{smin}} - \Phi_1$ and $\Phi_{\text{smin}} - \Phi_2$ is $10.4\mu\text{m}$. Plugging these values into the recited conditions yields:

$$2.0\mu\text{m} < (10.4\mu\text{m})/2 < 200\mu\text{m}$$

$$2.0\mu\text{m} < (10.4\mu\text{m})/2 < 200\mu\text{m}$$

Applying the divisor of 2 in the middle portion yields:

$$2.0\mu\text{m} < (5.2\mu\text{m}) < 200\mu\text{m}$$

$$2.0\mu\text{m} < (5.2\mu\text{m}) < 200\mu\text{m}$$

A similar process shows that light traps of $7.5\mu\text{m}$ and $9.8\mu\text{m}$ also satisfy the claimed conditions. Thus, obvious light-blocking sheets with light traps of depths of at least $5.2\text{-}9.8\mu\text{m}$ satisfy the claimed ranges. EX1003, ¶128.

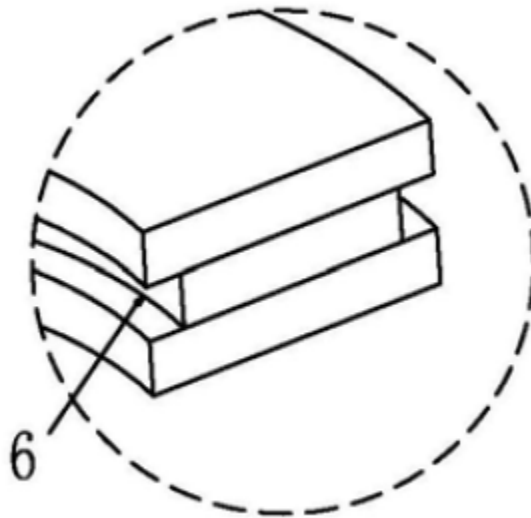
e) **Contemporaneous Independent Development
Further Confirms The Obviousness Of Using
The CN182 Process To Form A Light Trap**

Moreover, contemporaneous independent development—as reflected in CN249 (EX1015)—shows that POSITAs would have immediately recognized the benefits and feasibility of the above modifications to CN182. That independent development is “persuasive evidence that the claimed apparatus ‘was the product only of ordinary mechanical or engineering skill.’” *Geo. M. Martin Co. v. All. Mach. Sys. Int’l LLC*, 618 F.3d 1294, 1305 (Fed. Cir. 2010) (citation omitted); *see also Regents of Univ. of Cal. v. Broad Inst., Inc.*, 903 F.3d 1286, 1295 (Fed. Cir. 2018) (citations omitted) (“simultaneous invention” evidences “the level of skill in the art” and “constitutes objective evidence that persons of ordinary skill in the art understood the problem and a solution to that problem”).

The motivation to combine and reasonable expectation of success are both further confirmed by Chinese Patent Application Publication No. CN 107045249B (EX1015, “CN249”). CN249 was filed March 6, 2017, less than one month after the U.S. filing date of the ’660 patent and less than 4 months after the November 14, 2016, filing date of the ’660 patent’s alleged Taiwanese priority application.

CN249 refers expressly to the processing method and shading ring of CN182 and discusses how CN182’s shading ring “can reduce the reflection or diffusion of stray light to a certain extent,” but observes that “there is still an obvious

phenomenon of stray light.” EX1015, [0004]-[0005]. EX1003, ¶¶129-130. To further reduce this stray light, CN249 teaches using the same approach of CN182, namely wet etching a light-shielding sheet comprising a base material made of PET and coated with carbon layers with a light hole “made by a [punching] process.” EX1015, [0030]-[0037]. CN249 further discloses etching the base material to form a depression 6, thereby “suppress[ing] the stray light in an optical lens from diffusing or reflecting to an imaging surface.” *Id.*, [0032]. CN249 further discloses the “depth of the depression 6 of the [base material] 4 is equal to a thickness of the [base material] 4.” *Id.*, [0038].



EX1015, FIG. 3. By describing a light trap depth equal to the width, CN249 discloses a light trap designed to create three bounces for stray light incident at 45 degrees, as $\tan(45^\circ)=1$. As reflected in the table of obvious variants above (*supra* Section

VIII.B.4.b)), such light traps would satisfy the '660 patent's claimed conditions, as they would yield depths of 13-17 μ m.

This disclosure in CN249 corresponds precisely to how POSITAs would have applied CN182's teachings on stray light reduction to create a light trap and achieve additional reductions in glare. *See supra* Sections VIII.B.4.a)-VIII.B.4.d). This further confirms that POSITAs would have been motivated, with a reasonable expectation of success, to implement CN182 with an inner layer etched back to a desired depth as discussed above. EX1003, ¶131.

C. Claim 2

2. The light blocking sheet of claim 1, wherein the inner substrate layer is made of a plastic material, and each of the first outer layer and the second outer layer is made of a black carbon-containing material.

CN182 renders this claim obvious. CN182 discloses “a body” (inner substrate layer) and two outer “carbon powder” layers. *E.g.*, EX1004, [0026]. A POSITA knew that the carbon powder layers were a “black carbon-containing material,” because carbon powder, also referred to as “carbon black,” was a well-known material for creating light-absorbent black surfaces. *E.g.*, EX1011, 6.15 (discussing “absorbing compounds” including “carbon black particles”); *id.*, 6.35 (“black coatings” made of “approximately 20 percent carbon black”); EX1003, ¶132.

D. Claim 3

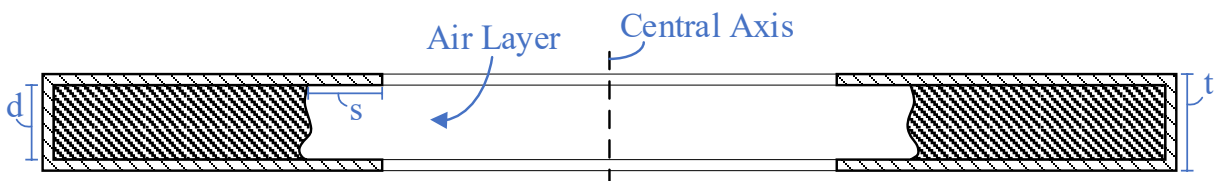
3. The light blocking sheet of claim 1, wherein the minimum diameter of the substrate opening is Φ_{min} , the diameter of the first opening is Φ_1 , the diameter of the second opening is Φ_2 , and the following conditions are satisfied:
 $3.0 \mu\text{m} < (\Phi_{\text{min}} - \Phi_1)/2 < 85 \mu\text{m}$; and
 $3.0 \mu\text{m} < (\Phi_{\text{min}} - \Phi_2)/2 < 85 \mu\text{m}$.

CN182 renders this claim obvious, as the obvious light traps discussed above satisfy the recited conditions, which merely narrow the Element 1.6 conditions. Obvious implementations of CN182 had light traps with minimum depths between $3\mu\text{m}$ and $85\mu\text{m}$, relative to each outer carbon layer, thus rendering claim 3 obvious. *Supra* Sections VIII.B.4 (element 1.6); EX1003, ¶133.

E. Claim 4

4. The light blocking sheet of claim 1, further comprising:
an air layer located between the first outer layer and the second outer layer, wherein the air layer is close to the first opening and the second opening.

CN182 renders this claim obvious, as the obvious light trap discussed above includes an air layer between the first outer layer and the second outer layer, wherein the air layer is close to the first opening and the second opening. *Supra* Section VIII.B.4 (element 1.6). This light trap is an “air layer” because there is no material within the light trap’s recess.



EX1003, ¶134.

F. Claim 5

5. The light blocking sheet of claim 4, wherein a length parallel to the central axis of the air layer is d , and the following condition is satisfied:
 $5\text{ }\mu\text{m} < d < 49\text{ }\mu\text{m}$.

CN182 renders this claim obvious. The claimed condition relates to the thickness of the air layer, which is equal to the thickness or width of the inner substrate layer. As explained above, obvious implementations of the CN182 shading ring had air/substrate layer thicknesses of 13-17 μm , which fall within the claimed range. *Supra* Section VIII.B.4. EX1003, ¶135.

G. Claim 6

6. The light blocking sheet of claim 4, wherein a thickness of the light blocking sheet is t , and the following condition is satisfied:
 $5\text{ }\mu\text{m} < t < 49\text{ }\mu\text{m}$.

CN182 renders this claim obvious because it discloses a shading ring (light blocking sheet) thickness of 25 μm , which is within the claimed range of $5\text{ }\mu\text{m} < t < 49\text{ }\mu\text{m}$. EX1004, [0013] (disclosing a preferable thickness of 0.025 mm, which is 25 μm), [0018] (same), [0027] (same), [0037] (same). EX1003, ¶136.

H. Claim 7

7. The light blocking sheet of claim 4, wherein a length parallel to the central axis of the air layer is d , a thickness of the light blocking sheet is t , and the following condition is satisfied:
 $0.12 < d/t < 0.67$.

CN182 renders this claim obvious. The claimed condition relates to the ratio of the thickness of the air layer (which is the same as the thickness of the substrate) to the thickness of the entire light-blocking sheet. CN182 discloses a total thickness of $25\mu\text{m}$ (*supra* Section VIII.G) and renders obvious PET substrate thicknesses of $13\text{-}17\mu\text{m}$ (*supra* Section VIII.F). Designs with thicknesses from $13\text{-}16.74\mu\text{m}$ fall within the claimed range, thus rendering this claim obvious. *Supra* Section VIII.B.4; EX1003, ¶137.

I. Claim 8

8. The light blocking sheet of claim 1, wherein the diameter of the first opening is $\Phi 1$, the diameter of the second opening is $\Phi 2$, and the following condition is satisfied:
 $0.93 < \Phi 1/\Phi 2 < 1.07$.

CN182 renders this claim obvious because the diameter of the through-hole is the same, such that the diameter of the first opening $\Phi 1$ is the same as the diameter of the second opening $\Phi 2$. EX1004, [0026] (“the through-hole is formed by stamping”), [0027] (“the diameter of the through-hole is 2.14 mm”). As a result, $\Phi 1/\Phi 2=1$, which is within the claimed range. EX1003, ¶138.

J. Claim 9

9. The light blocking sheet of claim 1, wherein a maximum outer diameter of the light blocking sheet is Φ , a thickness of the light blocking sheet is t , and the following condition is satisfied:
 $1 < 1000t/\Phi < 50$.

CN182 renders this claim obvious. CN182 does not explicitly disclose a maximum outer diameter of the shading ring (light blocking sheet), but the thickness t of the CN182 shading ring (light blocking sheet) is **0.025mm**. EX1004, [0027]. The outer diameter of the CN182 shading ring (light blocking sheet) is *at least* the diameter of the through-hole, or **2.14mm**. EX1004, [0027] (“the diameter of the through-hole is 2.14 mm”). This is because the through hole is stamped in the middle of the annular shading ring, which extends further out from the hole. This lower bound for the shading ring diameter satisfies the claimed range because $1000 \cdot (0.025 \text{ mm}) / 2.14 \text{ mm}$ is 11.68. EX1003, ¶139.

As for the upper bound on the shading ring diameter, POSITAs knew that elements in cell phone camera systems, including light-blocking elements such as shading rings and spacers, typically had “diameters in the 3-5mm range.” EX1017, 1. Thus, within a cell phone camera (*e.g.*, EX1004, [0002]), the CN182 shading ring diameter would be no more than 5mm. This satisfies the condition because $1000 \cdot (0.025 \text{ mm}) / 5 \text{ mm}$ is 5. EX1003, ¶140.

Moreover, considering the boundaries of the condition $1 < 1000t/\Phi < 50$ and a thickness $t=0.025\text{mm}$, the lower bound equates to a maximum outer diameter of 25mm, while the upper bound equates to a maximum outer diameter of 0.5mm. A shading ring with a through-hole diameter of 2.14 mm cannot have a maximum outer diameter of 0.5 mm, and POSITAs would not expect a cell phone camera system to have an unreasonably large 25 mm diameter. EX1003, ¶141.

K. Claim 15

Each claim 15 element is materially the same as those found in claims 1, 4, and 5 (EX1001, 19:2-19, 19:32-40; EX1023, 1-2), and claim 15 is thus obvious for the same reasons provided above. *Supra* Sections VIII.B (claim 1), VIII.E-F (claims 4-5); EX1003, ¶¶142-148.

L. Claim 16

16. The light blocking sheet of claim 15, wherein the inner substrate layer is made of a plastic material, and each of the first outer layer and the second outer layer is made of a black carbon-containing material.

Other than its dependence on Claim 15 instead of Claim 1, Claim 16 recites language identical to that of Claim 2. CN182 renders Claim 16 obvious for the same reasons provided above. *Supra* Sections VIII.B-C (claims 1-2), VIII.E-F (claims 4-5), VIII.K (claim 15); EX1003, ¶149.

M. Claim 17

17. The light blocking sheet of claim 16, wherein a thickness of each of the inner substrate layer, the first outer layer and the second outer layer is uniform.

CN182 renders this claim obvious for the same reasons discussed with regard to claim 16 and element 1.6. *Supra* Sections VIII.L (claim 16), VIII.B.4 (element 1.6). Further, CN182 depicts each layer, namely the body 200 and the antistatic coating 300 coated on both sides of the body 200, with a uniform thickness:

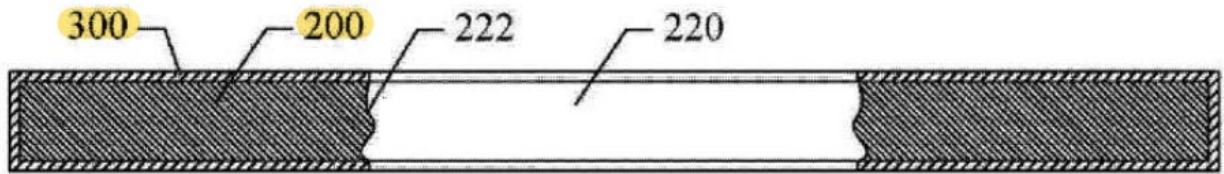
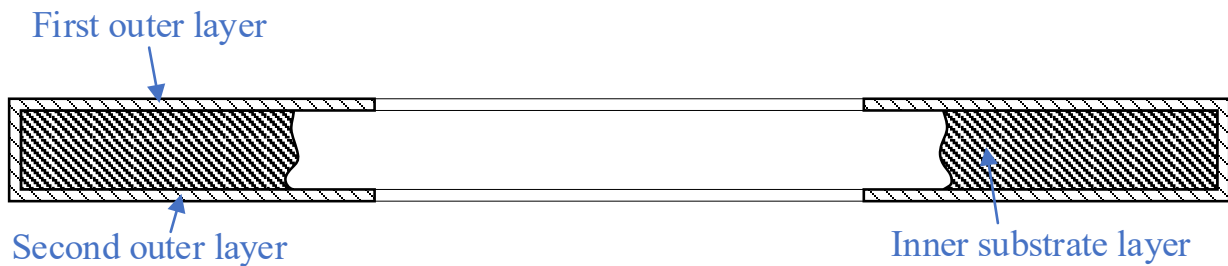


Figure 3

EX1004, FIG. 3 (highlighting added), [0036]. CN182 further discloses “the thickness of the shading ring is 0.025 mm,” indicating that the thickness is uniform across the shading ring. EX1004, [0037]. To achieve a uniform total thickness of the shading ring, POSITAs would understand that each layer of the shading ring would be uniform. EX1003, ¶¶150-151.

Further, each layer of the CN182 shading ring has a uniform thickness across the shading ring:



EX1003, ¶152. A POSITA would expect each layer to maintain uniform thickness after etching the light trap. EX1004, [0028], [0038]; *supra* Section VIII.B.4.c); EX1003, ¶152.

Therefore, CN182 renders obvious the “light blocking sheet of claim 16, wherein a thickness of each of the inner substrate layer, the first outer layer and the second outer layer is uniform.” EX1003, ¶153.

N. Claim 18

Claim 18 depends from claim 16 and includes the same elements as claim 3. EX1023, 2. CN182 renders this claim obvious for the same reasons provided above. *Supra* Sections VIII.L (Claim 16), VIII.D (claim 3); EX1003, ¶154.

O. Claim 19

Claim 19 depends from claim 16 and includes the same elements as claim 7. EX1023, 2-3. CN182 therefore renders this claim obvious for the same reasons provided above. *Supra* Sections VIII.L (claim 16), VIII.H (claim 7); EX1003, ¶155.

IX. GROUND 2: CLAIMS 5, 7, 10, 14, 19, 20, AND 22 ARE OBVIOUS OVER CN182 IN VIEW OF CHO

As explained below, claims 5, 7, 10, 14, 19, 20, and 22 are obvious over CN182 in view of Cho. CN182 does not expressly disclose an “imaging lens module,” as recited, e.g., in independent claim 10. As explained below, however, it would have been obvious to implement the improved CN182 shading rings—which were designed for use in cell phone and other cameras—in cell phone imaging lens modules, such as those expressly described by Cho.

A. Cho (EX1006)

U.S. Patent Publication No. 2015/0022896 (EX1006, “Cho”) was filed October 31, 2013, published January 22, 2015, and qualifies as prior art under Sections 102(a)(1-2). EX1006, Cover. Cho is analogous art to the ’660 patent

because they are both in the same field of endeavor of blocking stray light to reduce glare in compact imaging lens modules. EX1001, 1:14-17, 1:21-32; EX1006, [0002], [0004]-[0005]; EX1003, ¶¶156-157.

Cho discloses a “spacer” used to block stray light in a “camera module of a portable electronic device” such as a “mobile phone.” EX1006, [0004], [0018], [0027]. Cho notes the same problem later identified by CN182 and then the ’660 patent and: “since the spacer has a specific thickness, stray light may be reflected by an inner periphery of the spacer and then received by the imaging plane, such that flare or ghost phenomenon may occur.” *Id.*, [0004].

A POSITA would have understood the Cho light-blocking “spacer,” with its carbon-PET-carbon structure, to be a “light blocking sheet” as that term is used in the ’660 patent, as well as a “shading ring” as used in CN182. EX1003, ¶¶158-160.

Like the ’660 patent and CN182, and as known in the art, Cho discloses a basic three-layer structure for its spacer, with a PET plastic substrate (“inside layer”) sandwiched between two carbon-containing outside layers. EX1006, [0019]-[0020], FIG. 2. Cho also describes the conventional “stamping process” used to form a hole in the three-layer light-blocking spacer. *Id.*, [0019], [0024], [0025]. Cho discloses a total spacer thickness from 25µm-80µm, and outside layers each 4µm-15µm thick. *Id.*, [0020].

Cho discloses using its spacers 14a, 14b, 14c in an “imaging lens 1 compris[ing] a lens barrel 10,” along with “lens elements 12a, 12b, 12c.” EX1006, [0017], FIG. 1. Light “enters the lens barrel 10 along the optical axis L” and eventually “forms an image on the imaging plane 3.” *Id.*, [0018].

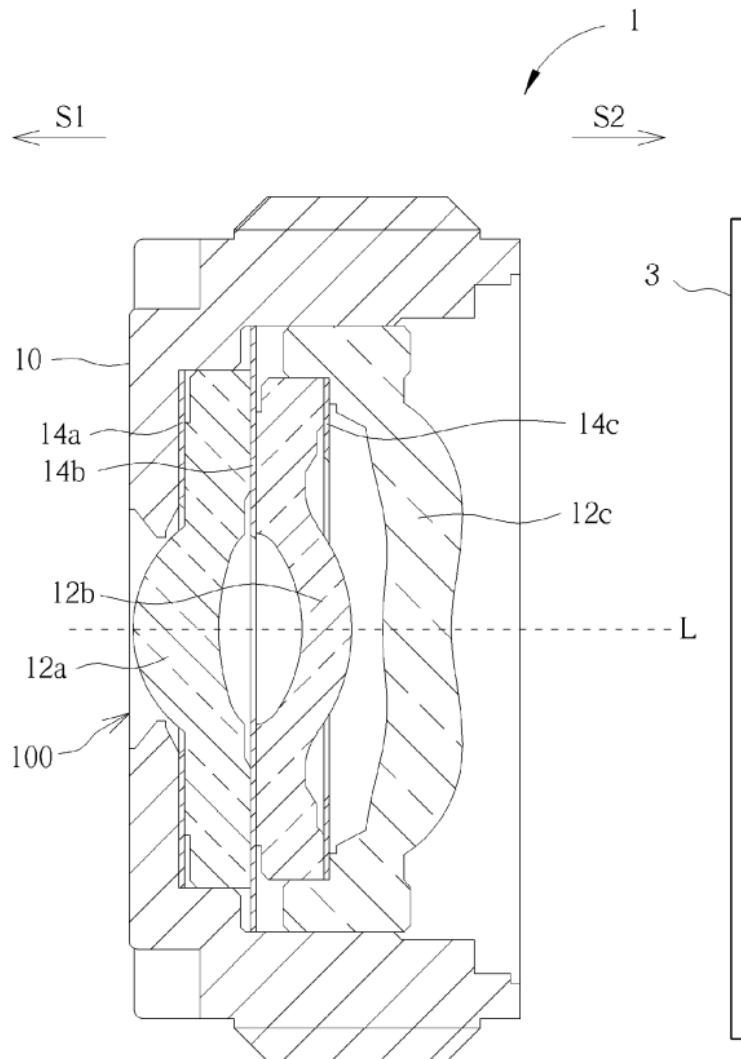


FIG. 1

Id., FIG. 1.

B. CN182 and Cho

CN182 notes that “3 to 5 pieces of shading rings need to be placed inside the camera of high-pixel cell phones and digital cameras to adjust the aperture of the light and to block other stray light.” EX1004, [0002]. Cho, in turn, discloses an example camera and imaging lens system that includes a plurality of light-blocking spacers with a same three-layer structure and dimensions as the CN182 shading ring. EX1006, [0017]-[0020], FIG. 1. Thus, POSITAs would have readily recognized that the CN182 shading rings were intended for use in, and would similarly improve, lens systems like those disclosed by Cho. Indeed, CN182 discloses a total sheet thickness of 25 μ m (EX1004, [00013]) and Cho describes light-blocking spacers from 25-80 μ m thick (EX1006, [0020]). Moreover, CN182 and Cho both address the same problem: reducing stray light reflections off inner surfaces of light-blocking elements. *E.g.*, EX1006, [0004]; EX1004, [0002]. Thus, POSITAs implementing lens systems as in Cho would have been motivated with a reasonable expectation of success to improve those systems with the CN182 shading ring, which provides an alternative, improved solution to the same problem. EX1003, ¶161.

As discussed *supra* Section VIII.B.4, POSITAs would have implemented CN182’s shading ring with a light trap, thus reducing glare caused by stray light reflections. The benefits of this modified CN182 shading ring would have motivated

POSITAs to use the same light trap implementation in lens systems as disclosed by Cho. A POSITA would have simply substituted the improved CN182 shading ring for each of Cho's spacers, to obtain the predictable result of improved stray-light reduction. EX1003, ¶162. A POSITA would have been motivated to do so to achieve the benefits of trapping light incident on the inner periphery of the shading ring, rather than simply redirecting it via an oblique surface as taught by Cho. *Id.* Additionally, the CN182 implementation would provide the further benefit of a roughened PET surface created by the CN182 etching process. Moreover, CN182 does this without the additional stamping steps required to create the oblique surfaces in Cho. *E.g.*, EX1006, [0024-25]. POSITAs would have had a reasonable expectation of success for reasons explained above as to Ground 1 and because the CN182 shading ring had similar dimensions and served the same purpose as the light-blocking spacers in Cho. For at least these reasons, POSITAs would have implemented the improved CN182 shading ring in place of the light-blocking spacers of the Cho lens system. EX1003, ¶162.

C. Claim 5

5. The light blocking sheet of claim 4, wherein a length parallel to the central axis of the air layer is d , and the following condition is satisfied:
 $5\text{ }\mu\text{m} < d < 49\text{ }\mu\text{m}$.

CN182 discloses a total shading ring thickness of $25\text{ }\mu\text{m}$. EX1004, [0013], [0018], [0027], [0037]. Cho discloses a similar three-layer spacer with a total

thickness of 25-80 μ m, where “a thickness of each outside layer” is “between 4 μ m and 15 μ m.” EX1006, [0020]. A POSITA have thus been motivated with a reasonable expectation of success to use carbon layers at least 4 μ m thick, as taught by Cho, resulting in a substrate layer of at most 17 μ m for a shading ring of 25 μ m total thickness. *See also supra* Section VIII.B.4.b). This yields a length parallel to the central axis of the air layer of at most 17 μ m, within the claimed range. EX1003, ¶163.

D. Claim 7

7. The light blocking sheet of claim 4, wherein a length parallel to the central axis of the air layer is d , a thickness of the light blocking sheet is t , and the following condition is satisfied:
 $0.12 < d/t < 0.67$.

CN182 and Cho render this claim obvious. The thickness of the CN182 shading ring (light blocking sheet) is $t=25\mu$ m. *E.g.*, EX1004, [0013]. Cho teaches outer layers at least 4 μ m thick, and up to 15 μ m thick, and POSITAs would have been motivated to use carbon layers 4-6 μ m thick. EX1006, [0020] (“a thickness of each outside layer ... may be between 4 μ m and 15 μ m”); *supra* Section VIII.B.4.b). A POSITA would have been motivated with a reasonable expectation of success to use 4-6 μ m outer carbon layers, to balance sufficient thickness for structural integrity with minimal surface area for reduced edge reflections. *Supra* Section VIII.B.4.b); EX1018, 1:34-40. This renders obvious CN182 implementations with a middle PET

layer of 13-17 μ m thickness and a PET layer of 13-16.74 μ m satisfies the recited condition, thus rendering the claim obvious. EX1003, ¶164.

E. Claim 10

1. Element 10.1

[10.1] An imaging lens module, comprising:

To the extent the preamble is limiting, Cho discloses “an imaging lens comprises a lens barrel, a plurality of lens elements and a spacer,” where such imaging lens “may be applied to a camera module of a portable electronic device” such as a mobile phone. EX1006, [0006], [0017]-[0018]. Further, CN182 teaches that “shading rings need to be placed inside the camera of high-pixel cell phones and digital cameras to adjust the aperture of the light and to block other stray light.” EX1004, [0002]. Thus, the improved CN182 shading ring, as implemented in Cho satisfies Element 10.1. EX1003, ¶165.

2. Element 10.2

[10.2] a barrel;

Cho discloses “a lens barrel.” EX1006, [0004] (“the imaging lens essentially comprises a lens barrel”), [0006], [0008], [0017]-[0018], [0021], [0027], FIG. 1.

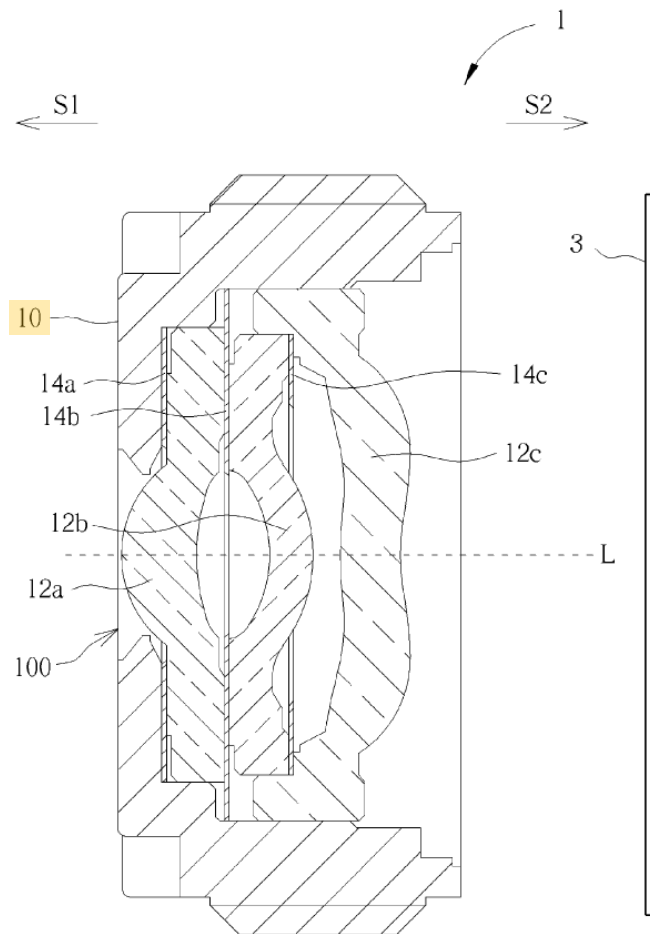


FIG. 1

EX1006, FIG. 1 (highlighting added). EX1003, ¶166.

3. Element 10.3

[10.3] an optical lens assembly disposed in the barrel; and

Cho discloses “lens elements ... disposed in the lens barrel.” EX1006, [0004], [0006], [0017], FIG. 1. A POSITA would understand that the lens elements of Cho comprise an “optical lens assembly” because light that “enters the lens barrel 10

along the optical axis L” and “forms an image on the imaging plane ... after passing through the lens elements 12a, 12b, 12c.” *Id.*, [0018], FIG. 1.

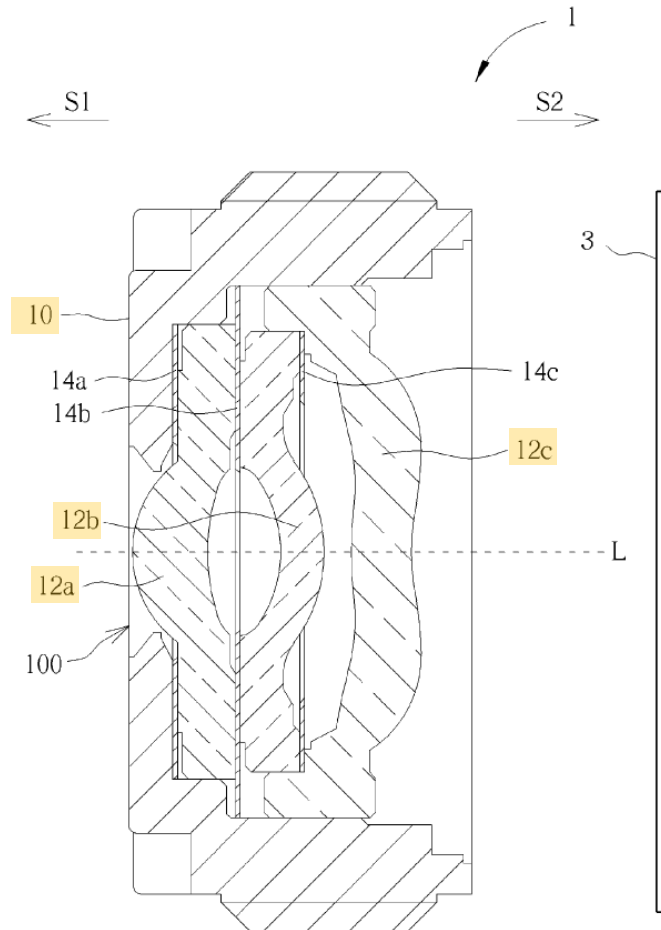


FIG. 1

EX1006, FIG. 1 (highlighting added). EX1003, ¶167.

4. Element 10.4

[10.4] the light blocking sheet of claim 1 disposed in the barrel.

CN182 renders obvious the light blocking sheet of claim 1. *Supra* Section VIII.B (claim 1). Cho discloses a “plurality of spacers ... disposed in the lens barrel 10.” EX1006, [0017], FIG. 1. CN182 teaches that “shading rings need to be placed inside the camera of high-pixel cell phones and digital cameras.” EX1004, [0002]. As explained above, POSITAs would have naturally implemented the CN182 shading ring (light blocking sheet) within a barrel such as Cho’s lens barrel 10 in order “to adjust the aperture of the light and to block other stray light” as taught by CN182, because doing so would reduce “glare, halo and flare and other undesirable effects caused by the existing shading rings due to the reflection from the inner-wall of the through-hole.” *Id.*, [0002]-[0003]; *supra* Section IX.B; EX1003, ¶168.

F. Claim 14

1. Element 14.1

[14.1] An electronic apparatus, comprising:

To the extent the preamble is limiting, the obvious CN182-Cho imaging lens module discussed above with respect to claim 10 was implemented in an electronic apparatus, such as a cell phone or other “mobile electronic device.” EX1006, [0004]; *see also* EX1004, [0002] (“shading rings need to be placed inside the camera of high-pixel cell phones and digital cameras”). EX1003, ¶169.

2. Element 14.2

[14.2] the imaging lens module of claim 10; and

CN182 and Cho render obvious the imaging lens module of claim 10. *Supra* Section IX.E (claim 10); EX1003, ¶170.

3. Element 14.3

[14.3] an image sensor disposed on an image surface of the imaging lens module.

Cho discloses an “imaging plane 3 ... disposed at the image side S2” of the “imaging lens 1 ... applied to a camera module of a portable electronic device” such as a “mobile phone.” EX1006, [0018]. Light “forms an image on the imaging plane 3,” which “may be a charge-coupled device (CCD) sensor or a complementary metal-oxide semiconductor (CMOS) sensor.” *Id.* Thus, POSITAs would have found it at least obvious that the combined CN182-Cho system included an image sensor disposed on an image surface of the imaging lens module. EX1003, ¶171. Indeed, such a sensor was required to achieve the entire purpose of the system: capturing images.

G. Claim 19

Claim 19 depends from claim 16 and recites the same claim elements as claim 7. EX1023, 2-3. CN182 and Cho render this claim obvious for the same reasons

discussed with regard to claims 7 and 16. *Supra* Sections VIII.L (claim 16), IX.D (claim 7); EX1003, ¶172.

H. Claims 20 and 22

Claim 20 is identical to claim 10 but recites claim 15 instead of claim 1. EX1023, 2-4. Claim 22 is identical to claim 14 but recites claim 20 instead of claim 10. EX1023, 3-4. CN182 and Cho render these claims obvious for the same reasons provided above. *Supra* Sections IX.E (claim 10), IX.F (claim 14), VIII.K (claim 15). EX1003, ¶¶173-179.

X. GROUND 3: CLAIMS 11-13 AND 21 ARE OBVIOUS OVER CN182 IN VIEW OF CHO AND TAKAHASHI

As explained below, claims 11-13 and 21 are obvious over CN182 in view of Cho and Takahashi.

A. Takahashi (EX1025)

U.S. Patent Publication No. 2015/0103226 (EX1025, “Takahashi”) was filed October 14, 2014, published April 16, 2015, and qualifies as prior art under Sections 102(a)(1-2). EX1025, Cover. Takahashi is analogous art to the ’660 patent because they are both in the same field of endeavor of blocking stray light to reduce glare in compact imaging lens modules. EX1001, 1:14-17, 1:21-32; EX1025, [0003]-[0015]; EX1003, ¶¶180-181.

Takahashi discloses an “optical element” used in a multi-lens assembly in “an electronic apparatus such as a digital camera [o]r a mobile phone.” *Id.*, [0003], [0010]-[0015], FIG. 1. This “optical element ... can prevent the occurrence of stray light by minimizing reflection of light at a surface of a light blocking layer.” *Id.*, [0010]. Specifically, a “light blocking portion” is formed by a “light blocking layer 16” and an “antireflection layer 17,” where the light blocking layer 16 is positioned at a surface of an optical lens to “prevent[] light ... from being incident to the” lens. *Id.*, [0035]-[0038]. The light blocking layer 16 contains “light blocking substances such as black pigments or dyes.” *Id.*, [0039]-[0040]. “The antireflection layer 17 prevents reflection of light at the surface of the light blocking layer 16.” *Id.*, [0041]. Takahashi explains that, by providing this antireflection layer on a surface of the light blocking layer, issues caused by oblique light, such as flare and ghosting, is minimized. *Id.*, [0042]-[0049]. EX1003, ¶182.

B. Claim 11

11. The imaging lens module of claim 10, wherein the first outer layer of the light blocking sheet further comprises a first surface corresponding to an object-side surface of the imaging lens module, the second outer layer of the light blocking sheet further comprises a second surface corresponding to an image-side surface of the imaging lens module, and at least one of the first surface and the second surface comprises an anti-reflection film coated thereon.

CN182, Cho, and Takahashi render this claim obvious. CN182 and Cho render obvious the imaging lens module of claim 10. *Supra* Section IX.E. The first

outer layer of the CN182 shading ring is a first surface corresponding to an object-side surface, and the second outer layer of the CN182 shading ring is a second surface corresponding to an image-side surface. EX1003, ¶183.

A POSITA would have been motivated to coat at least one of the first surface and the second surface with an anti-reflection film because doing so would help with “reducing the surface reflectance” of the outer surface, further aiding in the suppression of stray light. EX1007, 110; *supra* Section IV.C.3. It was well known that “an antireflection (AR) coating” is a “commonly used coating for plastic optics,” and multiple coatings are often used. *Id.*, 111; EX1011, 3.17; EX1003, ¶184.

Further, the placement of an anti-reflection film on the outer surface of a light-blocking sheet was well known to POSITAs. Takahashi discloses an “antireflection layer 17” on a surface of a “light blocking layer 16,” such that a “light blocking portion is constituted by the light blocking layer 16 and the antireflection layer 17.” EX1025, [0035], FIG. 2.

CN182, Cho, and Takahashi thus renders this claim obvious. EX1003, ¶187.

C. Claim 12

12. The imaging lens module of claim 11, wherein the anti-reflection film comprises a silicon dioxide material layer.

CN182, Cho, and Takahashi renders this claim obvious because silicon dioxide was a well-known material often used as an anti-reflection coating or film in optical systems. EX1024, [0073] (disclosing a “protective layer ... such as SiO₂,” silicon dioxide, as “an antireflection coating”); EX1026, [0014]-[0015] (disclosing silicon dioxide (SiO₂) as a layer of an anti-reflection film “coated on the object-side surface” of a lens to significantly reduce reflections on that surface); EX1011, 6.35 (discussing paints used as “standards for black coatings” that “consisted of pigments with approximately 20 percent carbon black and 80 percent silicon dioxide”); EX1027, 337 (listing SiO₂ as a coating material for anti-reflection coatings), 321-358 (discussing different processes for applying SiO₂ as an anti-reflection coating / film); EX1003, ¶188.

It would have been obvious to POSITAs to use a silicon dioxide material layer as an anti-reflection film coating to the at least one of the outer layers of the CN182 shading ring because silicon dioxide was a well-known and common material for anti-reflection film, and using silicon dioxide as the anti-reflection film would

further help reduce flare. *E.g.*, EX1011, 7.23 (illustrating silicon dioxide as a typical anti-reflection coating), 7.31-32 (same); EX1003, ¶189.

D. Claim 13

13. The imaging lens module of claim 11, wherein only one of the first surface and the second surface comprises the anti-reflection film coated thereon.

CN182, Cho, and Takahashi renders this claim obvious. A POSITA would have found it obvious to implement the CN182 shading ring with an anti-reflection film coated on at least one of the first surface and the second surface. *Supra* Section X.B (claim 11). A POSITA would have been motivated to coat only one of the first surface and the second surface with the anti-reflection film because doing so would reduce cost, compared to coating both surfaces with the anti-reflection film. EX1007, 113 (explaining that the “primary downside to the use of coatings is their cost” and that “[i]n order to reduce cost, as many pieces as possible should be coated in a single run”). It was well known that elements in a lens system may have different coatings on different surfaces, depending on their position and orientation relative to the object side and the image side of the lens module. *E.g.*, EX1007, 139. Further, Takahashi discloses providing the “antireflection layer 17” on only one side of the “light blocking layer 16.” EX1025, [0038], FIGS. 1-2; EX1003, ¶190.

E. Claim 21

Claim 21 depends from claim 20 and recites the same elements as claim 11. EX1023, 3-4. CN182, Cho, and Takahashi therefore render this claim obvious for the same reasons discussed above. *Supra* Sections X.B (claim 11), IX.H (claim 20); EX1003, ¶191.

XI. NO OBJECTIVE INDICIA OF NON-OBVIOUSNESS

There are no objective indicia of non-obviousness as to any challenged claim.

XII. CONCLUSION

Petitioner requests institution for claims 1-22 on Grounds 1-3 specified in this petition.

Respectfully submitted,

Dated: March 29, 2024

By: /Andrew M. Mason /
Andrew M. Mason (Reg. No. 64,034)
andrew.mason@klarquist.com
KLARQUIST SPARKMAN, LLP
One World Trade Center, Suite 1600
121 S.W. Salmon Street
Portland, Oregon 97204
Tel: 503-595-5300
Fax: 503-595-5301

Counsel for Petitioner

**CERTIFICATE OF COMPLIANCE WITH
TYPE-VOLUME LIMITATION PURSUANT TO 37 C.F.R. § 42.24**

This brief complies with the type-volume limitation of 37 C.F.R. § 42.24(a)(1)(i).

The brief contains 13,662 words, excluding the parts of the brief exempted by 37 C.F.R. § 42.24(a).

The brief has been prepared in a proportionally spaced typeface using Microsoft Word for O365 in a 14-point Times New Roman font.

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By: /Andrew M. Mason/

Andrew M. Mason (Reg. No. 64,034)
andrew.mason@klarquist.com
KLARQUIST SPARKMAN, LLP
One World Trade Center, Suite 1600
121 S.W. Salmon Street
Portland, Oregon 97204
Tel: 503-595-5300
Fax: 503-595-5301

Counsel for Petitioner

CERTIFICATE OF SERVICE
IN COMPLIANCE WITH 37 C.F.R. § 42.6(e)(4)

The undersigned certifies that the **Petition for *Inter Partes* Review of U.S. Patent No. 9,997,660 and Exhibits 1001 – 1032** were served on March 29, 2024, via **Express Mail** on the Patent Owner at the following address of record as listed on the USPTO Patent Center:

McClure, Qualey & Rodack, LLP
280 Interstate North Circle SE, Suite 530
Atlanta, GA 30339

By: /Andrew M. Mason/
Andrew M. Mason (Reg. No. 64,034)
andrew.mason@klarquist.com
KLARQUIST SPARKMAN, LLP
One World Trade Center, Suite 1600
121 S.W. Salmon Street
Portland, Oregon 97204
Tel: 503-595-5300
Fax: 503-595-5301

Counsel for Petitioner