

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

IPG PHOTONICS CORPORATION
Petitioner

v.

TRUMPF LASER UND SYSTEMTECHNIK GMBH
Patent Owner

Case No. IPR2026-00251
U.S. Patent No. 12,240,054

PETITION FOR *INTER PARTES* REVIEW OF
U.S. PATENT NO. 12,240,054

CHALLENGING CLAIMS 1–20
UNDER 35 U.S.C. § 312 AND 37 C.F.R. § 42.104

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1005	U.S. Patent No. 6,160,943 (“Davis”)
1006	WO2006/021609 (“Kalle”)
1007	U.S. Patent No. 4,000,416 (“Goell”)
1008	U.S. Patent No. 5,897,551 (“Everett”)
1009	510(k) Summary FDA Approval of StrateFire™ Reusable Optical Fiber
1010	U.S. Patent Application Publication 2008/0086118 (“Lai”)
1011	Optical Communications Essentials by Gerd Keiser (“Keiser”)
1012	U.S. Patent No. 4,465,335 (“Eppes”)
1013	Certified Translation of E.P. Patent No. 0,362,466 (“Hessel”)

Throughout the Petition, all annotations, coloring, and emphases have been added unless indicated otherwise.

LISTING OF CLAIMS

[1Pre] A system for generating a laser beam with different beam profile characteristics, the system comprising:

[1A] a multi-clad fiber having an inner fiber core and at least one outer ring core; and

[1B] a first optical fiber configured to guide a first input laser beam to the multi-clad fiber; and

[1C] a second optical fiber configured to guide a second input laser beam to the multi-clad fiber,

[1D] wherein the system is configured to couple at least one of: the first input laser beam at least into the inner fiber core of the multi-clad fiber, or the second input laser beam at least into the at least one outer ring core of the multi-clad fiber.

[2] The system of claim 1, wherein the system is configured to couple the first input laser beam only into the inner fiber core of the multi-clad fiber.

[3] The system of claim 1, wherein the system is configured to couple the second input laser beam only into the at least one outer ring core of the multi-clad fiber.

[4A] The system of claim 1, wherein the multi-clad fiber comprises one or more claddings respectively around the inner fiber core and the at least one outer ring core, and

[4B] wherein the system is configured such that no laser beam is coupled into the one or more claddings.

[5Pre] The system of claim 1, wherein the multi-clad fiber is configured to have at least one of:

[5A] the inner fiber core with a diameter of no greater than 200 μm ,

[5B] the at least one outer ring core with a diameter of no greater than 600 μm , or

[5C] an inner cladding with a thickness of no greater than 10 μm , the inner cladding being between the inner fiber core and the at least one outer ring core.

[6] The system of claim 1, wherein the multi-clad fiber comprises the inner fiber core with a refractive index n_1 , a first cladding with a refractive index n_2 , and an outer ring core with a refractive index n_3 , and the first cladding surrounds the inner fiber core and is between the inner fiber core and the outer ring core, and wherein $n_1 = n_3$ and $n_1 > n_2$.

[7] The system of claim 6, wherein the multi-clad fiber further comprises a second cladding surrounding the outer ring core, and wherein a refractive index n_4 of the second cladding is identical to the refractive index of the first cladding n_2 .

[8] The system of claim 1, wherein the multi-clad fiber comprises two or more outer ring cores, and the system is configured to couple two or more corresponding input laser beams into the two or more outer ring cores.

[9] The system of claim 1, wherein the system is configured to generate an output laser beam with a power of at least 1 kW.

[10Pre] The system of claim 1, further comprising a switchable device coupled between the first and second optical fibers and the multi-clad fiber,

[10A] wherein the switchable device is configured to electively couple the first input laser beam at least into the inner fiber core of the multi-clad fiber and the second input laser beam at least into the at least one outer ring core of the multi-clad fiber.

[11Pre] A method of generating a laser beam with different beam profile characteristics, the method comprising:

[11A] guiding a first input laser beam by a first optical fiber to a fiber end of a multi-clad fiber, wherein the multi-clad fiber has an inner fiber core and at least one outer ring core;

[11B] guiding a second input laser beam by a second optical fiber to the fiber end of the multi-clad fiber;

[11C] coupling the first input laser beam and the second input laser beam into the fiber end of the multi-clad fiber, comprising at least one of:

[11D] coupling the first input laser beam at least into the inner fiber core of the multi-clad fiber, or

[11E] coupling the second input laser beam at least into the at least one outer ring core of the multi-clad fiber; and

[11F] generating an output laser beam by interaction of the first input laser beam and the second input laser beam with the multi-clad fiber, wherein a beam profile characteristic of the output laser beam differs depending upon the coupling of the first input laser beam and the second input laser beam into the fiber end of the multi-clad fiber.

[12Pre] The method of claim 11, wherein coupling the first input laser beam at least into the inner fiber core of the multi-clad fiber comprises:

[12A] coupling the first input laser beam only into the inner fiber core of the multi-clad fiber.

[13Pre] The method of claim 11, wherein coupling the second input laser beam at least into the at least one outer ring core of the multi-clad fiber comprises:

[13A] coupling the second input laser beam only into the at least one outer ring core of the multi-clad fiber.

[14Pre] The method of claim 11, wherein the multi-clad fiber comprises one or more claddings respectively around the inner fiber core and the at least one outer ring core, and

[14A] wherein coupling the first input laser beam and the second input laser beam into the fiber end of the multi-clad fiber comprises:

[14B] coupling no laser beam into the one or more claddings.

[15Pre] The method of claim 11, wherein the multi-clad fiber comprises an inner cladding between the inner fiber core and the at least one outer ring core, and wherein the multi-clad fiber is configured to have at least one of:

[15A] the inner fiber core with a diameter of no greater than 200 μm ,

[15B] the at least one outer ring core with a diameter of no greater than 600 μm , or

[15C] the inner cladding with a thickness of no greater than 10 μm .

[16] The method of claim 11, wherein the multi-clad fiber comprises the inner fiber core with a refractive index n_1 , a first cladding with a refractive index n_2 , and an outer ring core with refractive index n_3 , and the first cladding surrounds the inner fiber core and is between the inner fiber core and the outer ring core, and wherein $n_1=n_3$ and $n_1>n_2$.

[17] The method of claim 16, wherein the multi-clad fiber further comprises a second cladding surrounding the outer ring core, and wherein a refractive index n_4 of the second cladding is identical to the refractive index of the first cladding n_2

[18] The method of claim 11, wherein the multi-clad fiber comprises two or more outer ring cores, and the method comprises: coupling two or more corresponding input laser beams into the two or more outer ring cores.

[19] The method of claim 11, wherein the output laser beam has a power of at least 1 kW.

[20] The method of claim 11, wherein coupling the first input laser beam and the second input laser beam into the fiber end of the multi-clad fiber comprises: electively coupling, by a switchable device coupled between the first and second optical fibers and the fiber end of the multi-clad fiber, one of the first input laser beam at least into the inner fiber core of the multi-clad fiber and the second input laser beam at least into the at least one outer ring core of the multi-clad fiber.

I. INTRODUCTION

IPG Photonics Corporation (“Petitioner”) respectfully requests *inter partes* review and cancellation of claims 1-20 of U.S. Patent No. 12,240,054 (the “’054 Patent”).

II. MANDATORY NOTICES

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

Petitioner identifies itself as a real party-in-interest (“RPI”).

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

The ’054 Patent is not currently asserted against Petitioner by Patent Owner.

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

Petitioner is filing a Power of Attorney appointing the practitioners associated with Customer Number 132,593. Petitioner designates the following lead and back-up counsel:

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D. Service Information (37 C.F.R. § 42.8(b)(4))

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III. FEES

Petitioner is concurrently electronically submitting the required fees for this Petition. The Board is authorized to charge Desmarais LLP's deposit account, No. 50-6822, for any fee deficiency.

IV. CERTIFICATION OF GROUNDS FOR STANDING

Petitioner certifies that the '054 Patent is available for *inter partes* review and that Petitioner is not barred or estopped from requesting *inter partes* review.

V. OVERVIEW OF CHALLENGE AND RELIEF REQUESTED

Under 37 C.F.R. §§ 42.22(a)(1) and 42.104(b)(1)-(2), Petitioner requests *inter partes* review and cancellation of claims 1–20 of the '054 Patent.

A. Identification of Prior Art

The '054 Patent claims priority to a number of earlier filed continuation and divisional applications that ultimately claim priority to PCT/EP2011/055484, filed April 8, 2011, which in turn claims priority to DE102010003750, which was filed

April 8, 2010. *See* EX1001, 1-2. Accordingly, this Petition applies pre-AIA provisions of 35 U.S.C. §§ 102, 103.

The following references are pertinent to the grounds of unpatentability:

Pat. Pub. No.	Publication/ Issue Date	Prior Art Under At Least (35 U.S.C.)
EP 1,284,672 (“Neuberger”) (EX1004)	December 27, 2006	102(a), 102(b)
U.S. Patent No. 6,160,943 (“Davis”) (EX1005)	December 12, 2000	102(a), 102(b)
WO 2006/021609 (“Kalle”) (EX1006)	March 2, 2006	102(a), 102(b)
U.S. Patent No. 4,000,416 (“Goell”) (EX1007)	December 28, 1976	102(a), 102(b)
U.S. Patent Application Publication 2008/0086118 (“Lai”) (EX1010)	April 10, 2008	102(a), 102(b)

B. Statutory Grounds of Unpatentability

Petitioner requests cancellation of Claims 1–20 of the ’054 Patent under 35 U.S.C. § 103 based on the following Grounds.

Ground	Claims	References
I	1-8, 10-18, 20	Neuberger, Davis
II	5, 15	Neuberger, Davis, Kalle
III	6-8, 16-18	Neuberger, Davis, Goell
IV	9-10, 19-20	Neuberger, Davis, Lai

This Petition demonstrates that there is a reasonable likelihood that Petitioner would prevail with respect to at least one of the challenged claims. 35 U.S.C. § 314(a).

VI. OVERVIEW OF THE '054 PATENT

The '054 Patent is directed to “[m]ethods and systems for generating a laser beam with different beam profile characteristics.” EX1001, Abstract. The claims are directed to the embodiment shown in Figure 6:

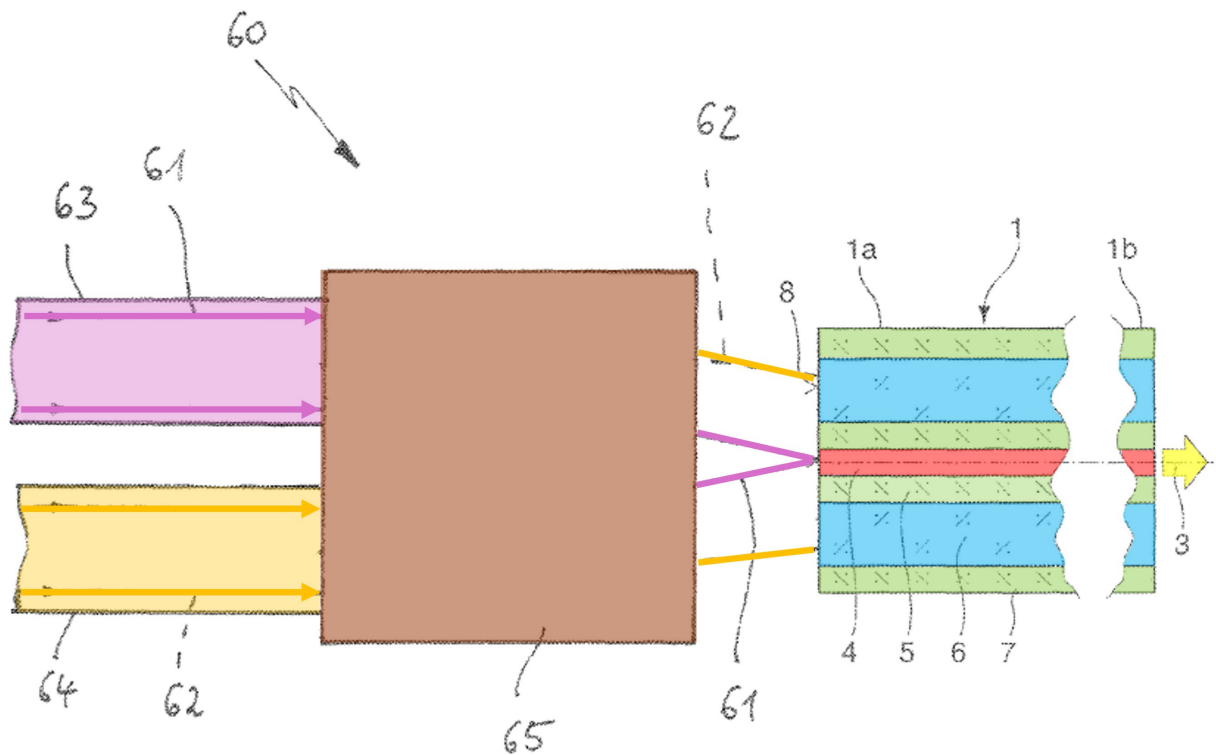


Fig. 6

EX1001, FIG. 6. EX1002, ¶49.

Figure 6 (above) shows “[a]n arrangement ... whereby, electively, a **first laser beam [61]** is **coupled** into the **inner fiber core [4]** of a double-clad fiber [1] and a different, **second laser beam [62]** is **coupled** into the **outer ring core [6]** of the double-clad fiber [1].” EX1001, 6:1-7. In one embodiment, the coupling between the input

beams and the multi-clad fiber can produce a smaller and higher-intensity output beam for cutting applications, and/or a larger and lower-intensity output beam for welding applications. EX1001, 2:48-57. The claims, however, are not limited to a particular field of use or application. EX1002, ¶49.

Figure 6 shows (1) a first input fiber 63 and a second input fiber 64; (2) a switchable device 65; and (3) a multi-clad output fiber 1 with an inner core 4 and an outer core 6, with cladding 5 surrounding each of the cores. See EX1001, 9:17-39, 2:34-38. The input fiber 63 carries a first input laser beam 61 and the second input fiber 64 carries a second input laser beam 62. Those input beams are coupled to the inner core 4 and outer core 6 of the multi-clad fiber 1 using the switchable device 65 to generate an output beam 3 with different beam characteristics depending on the interaction of the input beams and the cores of the multi-clad fiber. *Id.* The switchable device 65 can comprise prisms, plane-parallel plates, lenses, or diffractive optical elements, individually or in combinations. EX1001, 4:40-43. EX1002, ¶49.

The interaction between first input laser beam 61 and inner core 4 produces a relatively smaller and higher-intensity output, whereas the interaction between second input laser beam 62 and outer core 6 produces a relatively larger and lower-intensity output. Figure 6 shows free space between the input fibers and the multi-

clad output fiber. Such systems and methods were known long before the priority date of the '054 Patent. EX1002, ¶38-46.

A. Prosecution History

Claims 28-47 were examined after original claims 1-27 were cancelled in a Preliminary Amendment. EX1003, 60-64. The Examiner issued a Non-Final Office Action rejecting claims 28-33, 36, 38-43, and 46 on the grounds of non-statutory double patenting over U.S. Patent No. 10,281,656. EX1003, 169-180. In response, Applicant filed a Terminal Disclaimer to overcome the rejection. EX1003, 184-191. The Examiner then allowed the claims. EX1003, 262-268. EX1002, ¶51.

B. Effective Priority Date

The '054 Patent issued from U.S. Application No. 18/387,089 (“’089 App.”) filed November 6, 2023, which through a series of continuation and divisional applications ultimately claims priority to PCT EP/2011/055484, which claims foreign priority to a German patent DE102010003750, filed April 8, 2010. Petitioner applies April 8, 2010 as the effective priority date, but reserves the right to challenge the proper priority date in a different forum. EX1002, ¶53.

VII. LEVEL OF ORDINARY SKILL IN THE ART

A person of ordinary skill in the art (“POSITA”) as of the earliest claimed priority date of the '054 Patent would have had a Bachelor’s degree in Electronics, Electrical Engineering, Telecommunications, Optical Engineering, Fiber Optics, or

an equivalent field, and about 2-3 years of experience in the field of optics. Less professional experience can be substituted by additional education, and vice versa.

EX1002, ¶55.

VIII. CLAIM CONSTRUCTION

The Board “need[s] only construe terms ‘that are in controversy, and only to the extent necessary to resolve the controversy.’” *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor, Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017). Hence, Petitioner applies the plain and ordinary meaning of the claims terms for the purposes of this IPR. 37 C.F.R. § 42.100(b); *see also Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (*en banc*).

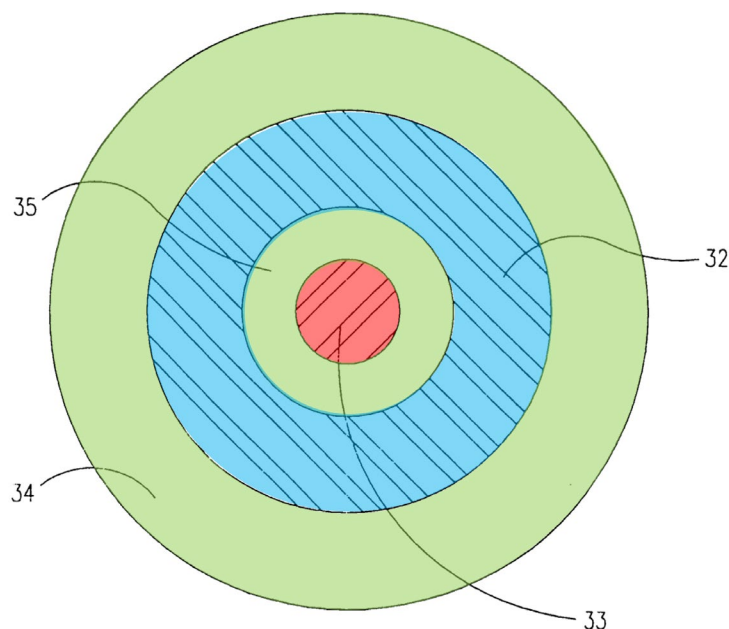
IX. OVERVIEW OF PRIMARY PRIOR ART REFERENCES

A. Neuberger

Neuberger is directed to “laser systems that transmit at least two wavelengths or power densities of light energy” using a single multicore output fiber to produce (1) higher-power density radiation for tissue cutting or ablating and (2) lower-power density radiation for tissue coagulation and/or bio-stimulation. EX1004, [0001], [0013]. Neuberger explains that “[s]olid state lasers, such as the Nd:YAG, have primarily been employed to achieve the desired optical power and wavelength for medical procedures,” whereas “diode lasers are cheap, small, and have lower power requirement.” EX1004, [0002]. Neuberger’s Figure 3 (below) shows an exemplary

multicore output fiber, which comprises an inner fiber core 33, inner cladding 35, outer fiber core 32, and outer cladding 34. *See id.*, [0021].

FIGURE 3



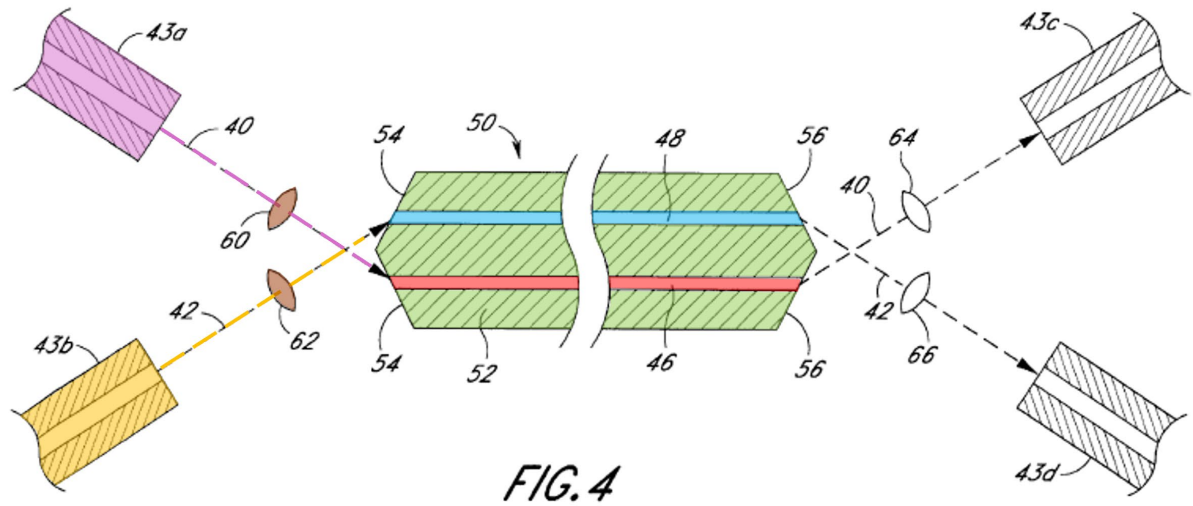
EX1004, FIG. 3. EX1002, ¶57.

B. Davis

Davis is directed to systems and methods for coupling different optical input beams into different cores of multicore optical fibers. *See* EX1005, 1:6-7, 4:51-61. Specifically, Davis teaches how to couple two or more distinct and “spatially separated light sources . . . into different cores of a multiple-core fiber.” EX1005, 2:59-61. Davis teaches that the input light sources may be many different types of lasers, such as Nd:YAG and diode lasers. EX1005, 4:51-66. Davis teaches using single core input fibers to guide the two or more input lasers through free space and

into different cores of a multicore output fiber. EX1005, 6:21-23 (“In this embodiment, however, all the inputs . . . involve the use of single-core fibers 43a-[b]. . .”), Figure 4. The multicore output fiber of Davis features “a plurality of cores surrounded by a **cladding**.” EX1005, 2:65-67, claims 1-12. EX1002, ¶58.

Figure 4 (below) shows single-core input fibers 43a and 43b coupling input beams 40 and 42 into cores 46 and 48 of optical output fiber 50. EX1005, 6:20-25. Furthermore, “optical elements such as lenses 60 and 62 may be used to focus the optical beams 40 and 42 onto individual cores 46 and 48.” EX1005, 5:43-45, 5:58-65. Optical elements 60 and 62 are arranged between the single-core fibers 43a and 43b and the multicore fiber 50 to provide elective coupling of the input beams to the multicore output fiber by “resting upon respective translation stages to control the alignment of the optical beams 40 and 42, which propagate along the optical paths within the cores 46 and 48.” EX1005, 5:45-50.



EX1005, FIG. 4. EX1002, ¶59.

X. GROUNDS

A. Ground I: Neuberger In Combination With Davis Renders Obvious Claims 1-8, 10-18, And 20

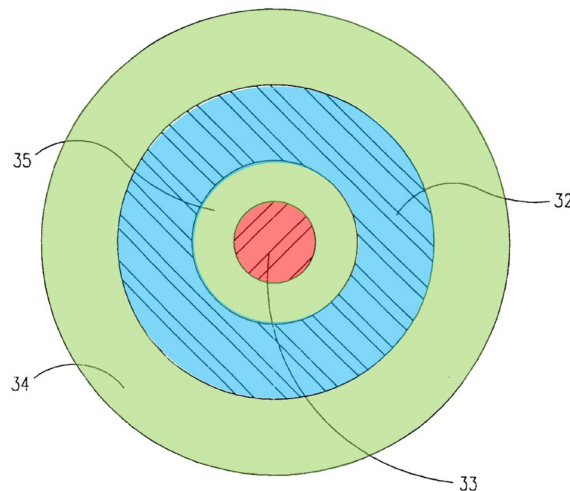
1. Claim 1

- a) [1Pre] A system for generating a laser beam with different beam profile characteristics, the system comprising:

Neuberger in combination with Davis renders obvious [1Pre]. Neuberger is directed to “laser systems that transmit at least two wavelengths or power densities of light energy through a single step index fiber system having at least two core sections.” EX1004, [0001]. Neuberger’s Figure 3 (below) shows a multicore output

fiber having an inner fiber core 33, inner cladding 35, outer fiber core 32, and outer cladding 34.

FIGURE 3



EX1004, FIG. 3, [0021]. EX1002, ¶60.

Neuberger teaches a laser system “that allows for efficient transmission of at least two power densities or at least two wavelengths.” EX1004, [0011]; *see also id.*, [0013], [0017]-[0019], [0021], claims 1, 2, 5, and 6. EX1002, ¶61.

Neuberger discloses that the system can choose a smaller or larger spot size for the output depending on the application (e.g., cutting or coagulation). EX1004, [0004] (“Thus, depending on the desired effect of a medical laser, a ***small or large*** spot size is chosen.”). EX1004, [0004]. The “[i]nner fiber core 33 transmits high power density radiation.” EX1004, [0021]. The “outer fiber core 32 ... transmits a second wavelength radiation.” *Id.* For example, the inner core radiation can be used to “cut or ablate tissue,” whereas the outer core radiation can be used to “coagulate

tissue.” *Id.*, [0002], [0004], [0012]-[0013], [0018]-[0019]; *see also id.* [0014] (“Briefly stated, the present invention provides a medical diode laser system that allows for simultaneous transmission of at least two wavelengths and at least two power densities. Radiation of a suitable wavelength for tissue cutting or ablating is coupled into an **inner fiber core** to produce an output beam with sufficient power density for ablation. Radiation of a suitable wavelength for tissue coagulation is introduced into an **outer fiber core** to produce another output beam with a lower power density appropriate for coagulation”).¹ Hence, Neuberger teaches “generating a laser beam with different beam profile characteristics.” EX1002, ¶¶62-63.

“Solid state lasers, such as the Nd:YAG” laser or “diode lasers,” are used as input light sources. EX1004, [0002]. Although Neuberger does not specify that the

¹ This is just like the '054 Patent’s description of “different beam profile characteristics” that generate a higher-intensity output beam for cutting (using the **inner core**) and a lower-intensity output beam for welding (using the **outer core**). *See* EX1001, 2:44-57; *see also id.*, 3:51-4:9, 6:47-53 (“To change the beam profile characteristics... it is possible ... to be coupled, ... electively either into the **inner fiber core 4** or into the **outer ring core 6** or both into the **inner fiber core 4** and into the **outer ring core 6** of the double-clad fiber 1.”), 7:34-38.

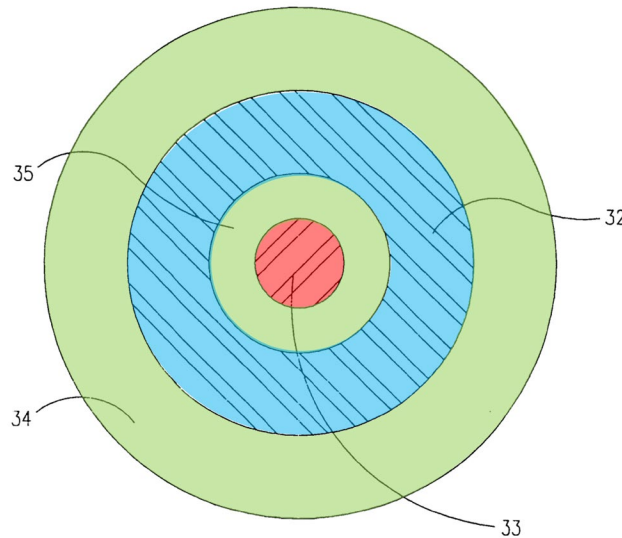
laser light sources enter Neuberger’s multicore fiber through the use of different input fibers (as claimed in [1B]-[1D]), this was well-known in the art. For example, Davis teaches that different single-core input fibers can couple different input laser beams from, for example, Nd:YAG or diode lasers, into different cores of a multicore fiber. *See* Section IX.B; *see also* EX1005, Abstract, 4:11-13, 5:6-10, 5:25-28, 5:51-58, 6:20-23. A POSITA would have had numerous reasons to combine the teaching of Neuberger with Davis with a reasonable expectation of success. *See* Section X.A.2. EX1002, ¶72-75.

b) [1A] a multi-clad fiber having an inner fiber core and at least one outer ring core; and

Neuberger discloses [1A]. In Figure 3, Neuberger discloses an exemplary multicore fiber with inner fiber core 33 and outer fiber core 32. Neuberger’s multicore fiber has multiple claddings—inner cladding 35 and outer cladding 34—and therefore satisfies the “multi-clad fiber” limitation. Moreover, Neuberger’s outer fiber core 32 is in the shape of a concentric ring, which satisfies the claimed requirement of an “outer ring core”. EX1004, Figure 3, [0013], [0021] (“[F]our *concentric* layers constitute the part of the optical fiber that transmits two wavelengths of radiation. Inner fiber core 33 transmits high power density radiation and is surrounded by inner cladding 35. Inner cladding 35 is surrounded by outer

fiber core 32, which transmits the second wavelength radiation. Outer cladding 34 forms the fourth layer and surrounds outer fiber core 32.”).

FIGURE 3



EX1004, FIG. 3. EX1002, ¶66.

- c) [1B] a first optical fiber configured to guide a first input laser beam to the multi-clad fiber; and
- [1C] a second optical fiber configured to guide a second input laser beam to the multi-clad fiber,
- [1D] wherein the system is configured to couple at least one of: the first input laser beam at least into the inner fiber core of the multi-clad fiber, or the second input laser beam at least into the at least one outer ring core of the multi-clad fiber.

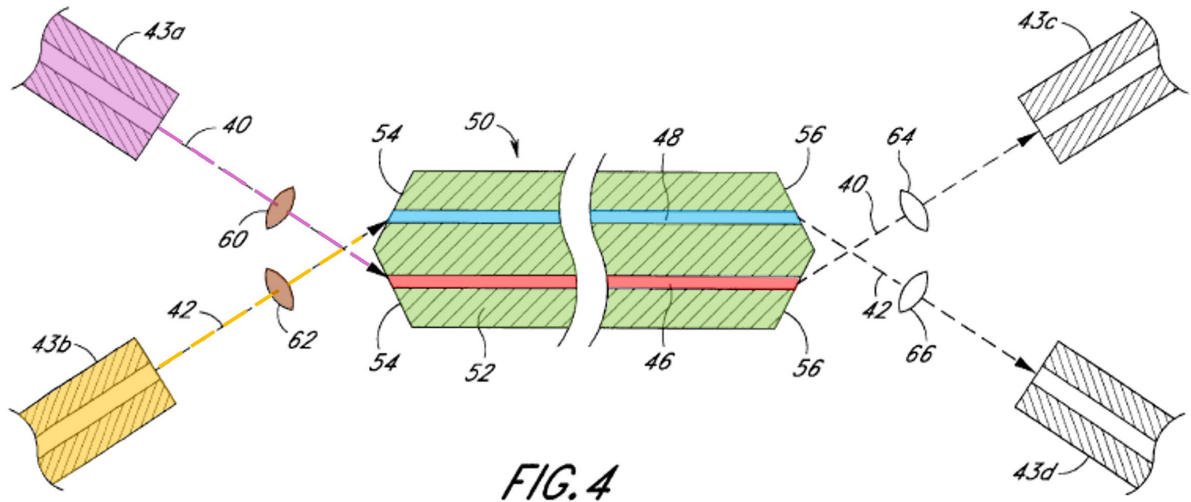
Neuberger in combination with Davis renders obvious [1B]-[1D]. Neuberger explains that a first laser beam and a second laser beam that have different power densities, wavelengths, and/or pulsing frequencies are transmitted through the

different cores of Neuberger’s multicore fiber. EX1004, claim 2 (“at least two laser sources are transmitted with at least two different power densities.”), claim 3 (“at least two laser sources operate at at least two different wavelengths.”), claim 4 (“said radiation from a first source is pulsed and from a second source is a continuous wave.”). Neuberger explains that Nd:YAG or diode lasers can be used to provide those first and second input laser beams. EX1004, [0002]. EX1002, ¶67.

Neuberger does not specify how the two different input laser beams are introduced into Neuberger’s multicore fiber. But it was well-known to configure the system to couple and/or guide a first input laser beam using a first optical fiber and a second input laser beam using a second optical fiber into the different cores of a multicore fiber at the fiber end. EX1002, ¶68.

As shown below in Figure 4, Davis teaches that a first input laser beam 40 from first optical fiber 43a is coupled into core 46 of multicore fiber 50 at the fiber end, and a different second input laser beam 42 from a different second optical fiber 43b is coupled into a different core 48 of multicore optical fiber 50 at the fiber end, using the lenses 60 and 62. See EX1005, 4:51-58 (“an optical beam 40 from an optical source 44 ... enters, via refraction, a core 46 of an optical fiber 50 (that includes a second core 48), in which the cores 46 and 48 are surrounded by a cladding 52... [t]he optical source 44 may be remotely situated from the optical fiber 50 ...”), 6:20-23. Like in Neuberger, Davis’ optical source may be “a laser diode,

... a Nd:YAG laser, or the like . . .” EX1005, 4:51-56; *see also* EX1004, [0002]
 (disclosing “Nd:YAG” as source).



EX1005, FIG. 4. EX1002, ¶69.

Although Davis’ multicore output fiber is a non-concentric multicore fiber, Neuberger teaches that concentric and non-concentric fibers were well-known to be interchangeable with one another. EX1002, ¶70.

FIGURE 3

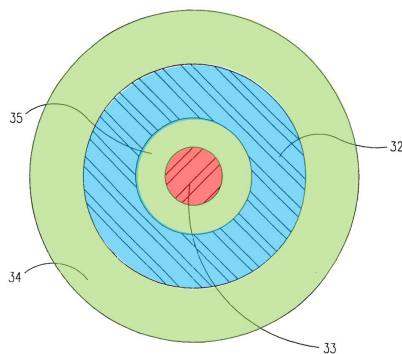


FIGURE 7

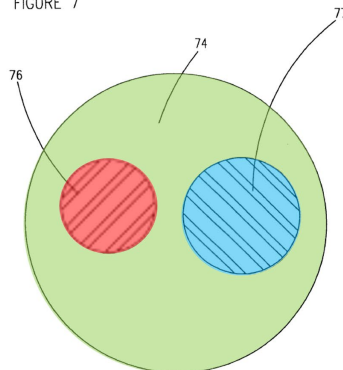
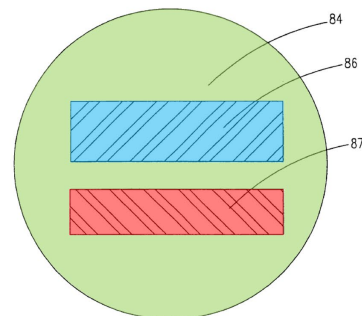
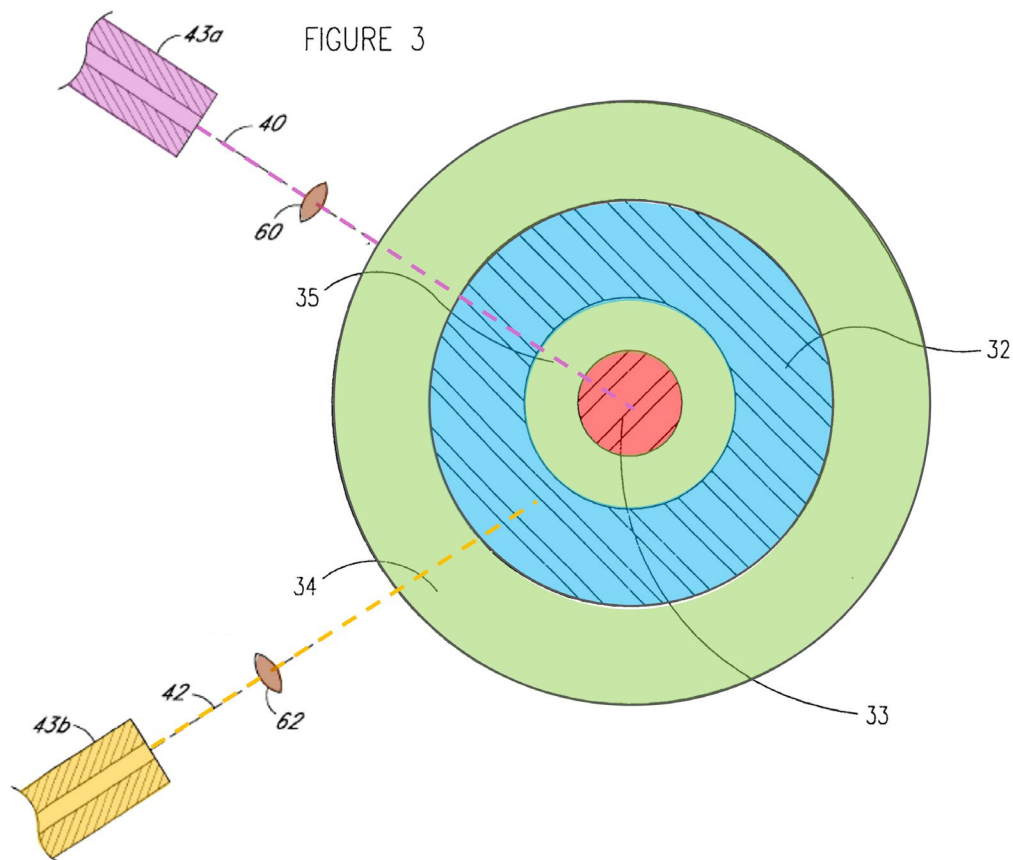


FIGURE 8



EX1004, FIGS. 3, 7, 8; *see also id.*, claims 9, 12, [0021], [0026].

Accordingly, it would have been obvious to a POSITA to combine Neuberger's concentric multicore output fiber with Davis' multiple single-core input fibers such that first input laser beam 40 from first optical fiber 43a couples into Neuberger's inner core 33 and second input laser beam 42 from second optical fiber 43b couples into Neuberger's outer ring core 32 at one fiber end of Neuberger's multicore fiber, as illustrated below.



See EX1005, FIG. 4 and EX1004, FIG. 3. EX1002, ¶71.

2. Reasons To Combine Neuberger With Davis

A POSITA would have had numerous reasons to combine Neuberger’s concentric multicore output fiber with Davis’ single-core input fibers that provide input beams to a multicore fiber with a reasonable expectation of success. EX1002, ¶72.

First, the combination amounts to nothing more than combining prior art elements according to known methods. Both Neuberger and Davis disclose multicore output fibers that transmit optical beams from optical sources, such as diode lasers and Nd:YAG lasers. EX1004, [0001]-[0002] (teaching use of “diode laser” and “Nd:YAG” in medical applications; “The present use of lasers in medical procedures and surgical applications is virtually unlimited.”), *id.*, [0003], [0004], [0010], [0012]; EX1005, 4:51-56 (similarly teaching use of “a laser diode [and] a Nd:YAG laser, or the like” as optical inputs into a multicore output fiber). Both Davis and Neuberger rely on the well-known phenomenon of total internal reflection to propagate light through different cores of a multicore fiber (the cores being surrounded by a lower refractive index cladding) and to generate output beams having different beam characteristics. EX1004, [0021] (“In operation, the fiber cores are both surrounded by lower refractive index material, which creates total internal reflection inside the individual fiber cores.”); EX1005, 2:67-3:2 (“...the

index of refraction of the cladding is lower than the indices of refraction of the cores to confine optical beams within the cores.”), *id.*, 3:22-27, 3:39-41, 3:50-53, claims 1-12. EX1002, ¶73.

Second, Davis teaches that a multicore output optical fiber can be **coupled** to a first input optical fiber and a second input optical fiber with optically mobile elements like **lenses** on translation stages between the input optical fibers and the multicore output fiber. EX1005, 4:12-13, 5:6-10, 5:25-26, 5:33-65, 6:20-23. A POSITA would have had a reasonable expectation of success in using Davis’ **coupling method** to yield the predictable result of a concentric core output optical fiber **coupled** to a first and second input optical fiber because it merely entails use of known optical fibers and lenses to **guide** and/or **couple** light into different cores of the multicore fiber. EX1002, ¶74.

Finally, Neuberger and Davis both teach the use of Nd:YAG or diode lasers. See EX1004, [0001], [0002], [0013]; EX1005, 4:51-66. Accordingly, a POSITA would have been motivated to try **coupling** the beams from Davis’ first and second input fibers (e.g., Nd:YAG and diode laser, respectively) to Neuberger’s concentric multicore fiber to deliver output beams having **different beam profile characteristics** (e.g., the beam from the inner core for cutting and the beam from the outer ring core for coagulation). EX1002, ¶75.

3. Claims 2 and 3

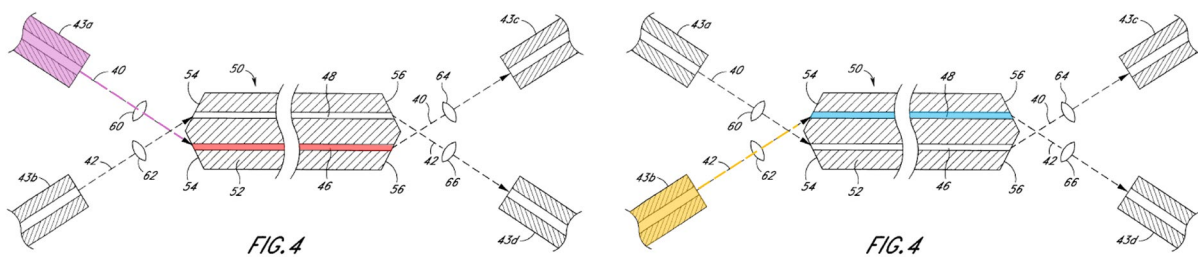
- a) [2] The system of claim 1, wherein the system is configured to **couple** the **first input laser beam** *only* into the **inner fiber core** of the multi-clad fiber.
- b) [3] The system of claim 1, wherein the system is configured to **couple** the **second input laser beam** *only* into the at least one **outer ring core** of the multi-clad fiber.

Neuberger and Davis render obvious the system of claim 1. *See* Section X.A.1. Neuberger and Davis further render obvious the added limitations of [2] and [3]. Davis teaches that input laser beams 40 and 42 are *only* **coupled** to the cores 46 and 48 of the multicore fiber, respectively. Davis explains that it was known to **couple** the input beams *only* to the cores and not into the **claddings**. EX1005, 1:12-22 (“Two cores 12 and 14 within a fiber 16 support respective propagating beams 18 and 20... The cores 12 and 14 are surrounded by a **cladding**... The index of refraction of the **cladding** 17 is lower than the indices of refraction of the cores 12 and 14 *so that optical energy is guided within the cores through total internal reflection.*”). EX1002, ¶76.

Davis emphasizes that the **cladding** has a lower refractive index than the cores in order “*to confine optical beams within the cores.*” EX1005, 2:67-3:2; *see also id.*, 3:39-41, 3:52-53, claims 1-12, 3:22-27 (“[T]he indices of refraction of the **cladding** and the indices of refraction of the cores are chosen such that optical radiation propagating within the cores is substantially restricted to propagating along

optical paths that pass through the cores and the ends of the cores.”). This phenomenon, in which light is totally reflected back from the medium with a lower refractive index into the medium with a higher refractive index, is called “total internal reflection.” EX1004, [0021], [0006]; *see also* EX1001, 6:43-46 (“On account of the lower refractive index of the cladding 5, 7, light is guided in the inner fiber core 4 and in the outer ring core 6 by means of total reflection.”). As its name implies, “*total* internal reflection” results in all light being substantially confined within the higher-refractive-index cores. EX1002, ¶77.

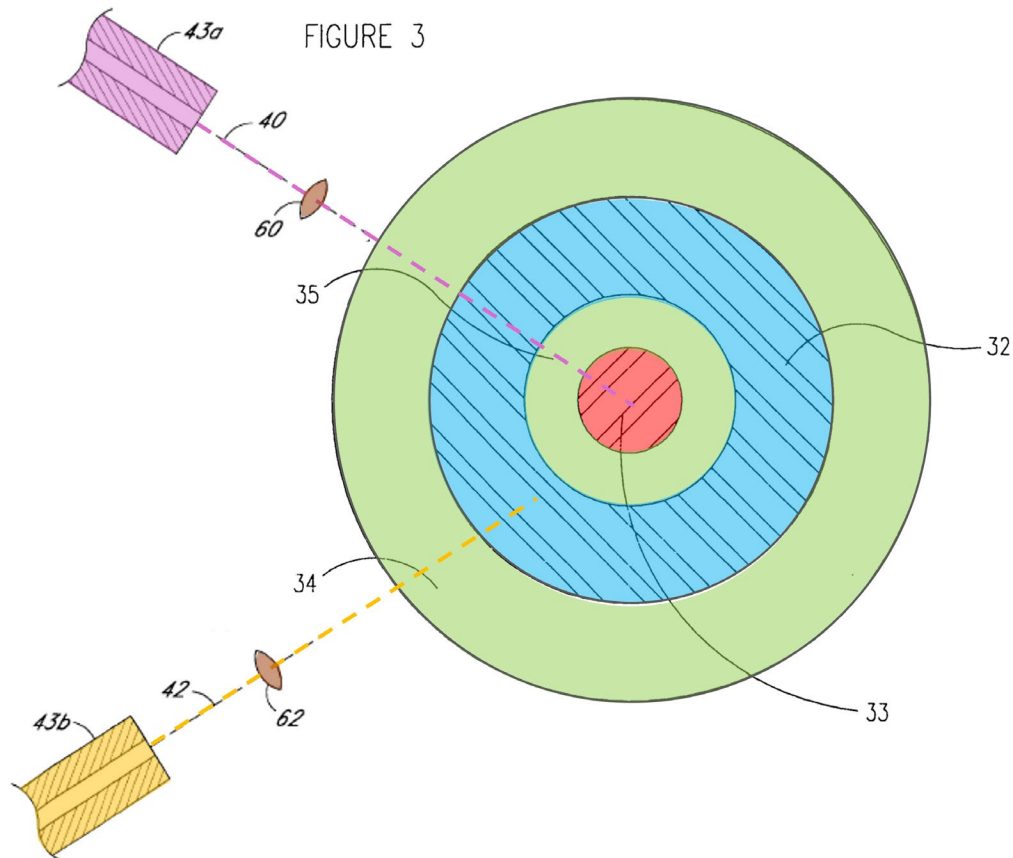
Davis’ Figure 4 shows that first input laser beam 40 is coupled **only** into core 46 of the multicore fiber and is not coupled into core 48 or cladding 52. Similarly, the second input laser beam 42 is coupled **only** into core 48 of the multicore fiber and is not coupled into core 46 or cladding 52. EX1005, 2:67-3:2, 3:39-41, 3:52-53, claims 1-12, 3:22-27.



EX1005, FIG. 4. EX1002, ¶78.

A POSITA would have been able to readily apply the teachings of Davis to Neuberger such that first input laser beam 40 from first optical fiber 43a is coupled

only into Neuberger's **inner core 33** and **second input laser beam 42** from **second optical fiber 43b** is **coupled** *only* into Neuberger's **outer ring core 32**, as illustrated below.



See EX1005, FIG. 4 and EX1004, FIG. 3. EX1002, ¶79. The resulting beams would appear nearly identical to the beam profiles shown in Figures 5A-5C of the '054 Patent. At a minimum, it would have been obvious to couple Davis' **first input beam** *only* into the **inner fiber core** of Neuberger's output fiber (to result in a beam profile

shown in Figure 5A of the '054 Patent), couple Davis' **second input beam** only into the **outer ring core** of Neuberger's output fiber (to result in a beam profile shown in Figure 5B of the '054 Patent), or to couple the **first input beam** only into the **inner fiber core** and the **second input beam** only into the **outer ring core** of Neuberger's output fiber (to result in a beam profile shown in Figure 5C of the '054 Patent).

In fact, a POSITA would have been motivated to do so because Neuberger teaches generating an output laser beam having two different beam profile characteristics using its **inner** and **outer** cores. EX1004, [0001], [0004], [0014], [0018], [0019], [0021]; *see also* Section X.A.1. A POSITA would have readily realized that crosstalk between the two cores would have been undesirable in order to ensure that the system electively uses one core for cutting and the other core for coagulation. EX1002, ¶80.

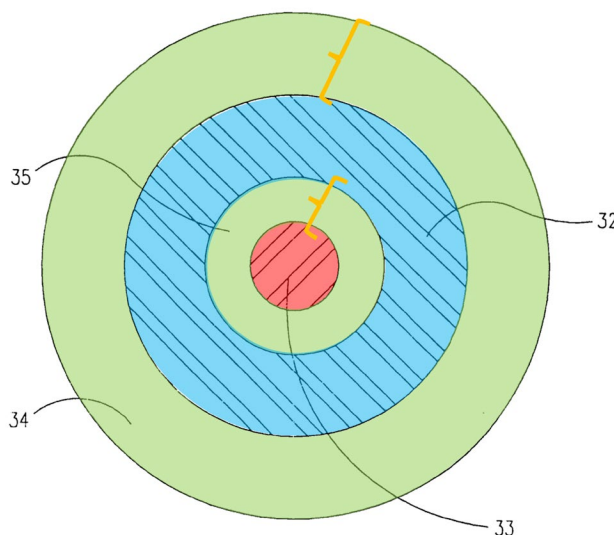
4. Claim 4

- a) [4A] The system of claim 1, wherein the multi-clad fiber comprises **one or more claddings** respectively **around** the **inner fiber core** and the at least one **outer ring core**, and
- b) [4B] wherein the system is configured such that no laser beam is **coupled** into the **one or more claddings**.

Neuberger and Davis render obvious the system of claim 1. *See* Section X.A.1. Neuberger and Davis further render obvious the added limitations of [4A]

and [4B]. Neuberger discloses that its multicore output fiber includes cladding 35 and cladding 34 around inner core 33 and outer ring core 32, respectively.

FIGURE 3



EX1004, FIG. 3; *see also* EX1004, [0014] (“[M]aterial functioning as an intermediary cladding separates the outer and inner fiber cores.”), [0021], claims 9 and 12. Davis also discloses an optical fiber wherein “the cores 46 and 48 are separated from one another and are surrounded by a cladding 52.” EX1005, 4:55-56; EX1002, ¶81.

Neuberger teaches that in certain embodiments, the refractive indices of the cores and claddings are chosen such that *all input radiation is confined within the cores* via total internal reflection. EX1004, [0006] (“*All* incident radiation is advantageously reflected back into the optical fiber core.”). EX1004, [0021] (“[T]he fiber cores are both surrounded by lower refractive index material, which creates

total internal reflection inside the individual fiber cores. This *total internal reflection* has the added advantage of diminished cross-talk between cores.”). EX1002, ¶82.

Davis similarly emphasizes that no laser beam is coupled into the cladding. *First*, Davis states it was known in the prior art that “the index of refraction of the cladding 17 is lower than the indices of refraction of the cores 12 and 14 so that optical energy is guided within the cores through *total internal reflection*.” EX1005, 1:19-22; *see also* EX1001, 6:43-46. As was well known, “total internal reflection” means that light is totally reflected back into higher refractive index cores and does not refract into the lower refractive index claddings. *Second*, Davis teaches it is desirable “to *confine* the optical beams *within the cores*.” EX1005, 2:65-3:2, 3:24-27, 3:39-41, 3:53-54, claims 1-12. (“[O]ptical radiation propagating within the cores is substantially restricted to propagating along optical paths that pass through the cores and the ends of the cores.”). Accordingly, both Neuberger and Davis teach that their input laser beams are not coupled into their claddings. EX1002, ¶83.

5. Claim 5

- a) [5Pre] The system of claim 1, wherein the multi-clad fiber is configured to have *at least one of*:
- b) [5A] the **inner fiber core** with a diameter of no greater than 200 μm ,
- c) [5B] the at least one **outer ring core** with a diameter of no greater than 600 μm , or
- d) [5C] an **inner cladding** with a thickness of no greater than 10 μm , the **inner cladding** being **between** the **inner fiber core** and the at least one **outer ring core**.

Neuberger and Davis render obvious [5Pre] for the reasons provided above in Section X.A.1 for [1Pre]. Neuberger and Davis also render obvious claim 5 because claim 5 requires only one of [5A], [5B], or [5C] to be met, and Neuberger in combination with Davis renders obvious at least [5A]. EX1002, ¶84.

Neuberger does not disclose the precise dimensions of its **inner fiber core**. Davis, however, teaches that it was well-known that cores in a multicore fiber have a diameter of less than 200 μm . EX1005, 4:63-64 (“[T]he **cores 46** and 48 may be, for example, **8 microns** in diameter”). It would have been obvious to utilize Davis’ core sizes for the **inner fiber core** of Neuberger’s multicore fiber because applying the diameters taught in Davis to the cores in Neuberger amounts to nothing more than applying a known technique—an 8 micron core diameter—to a known device ready for improvement—Neuberger’s multicore fiber—to yield predictable

results—Neuberger’s multicore fiber with an **inner fiber core** diameter of 8 microns. EX1002, ¶85.

Since both Neuberger and Davis are directed to multicore fibers that transmit Nd:YAG or diode lasers, (*see* EX1004, [0001], [0002], [0013]; EX1005, 4:51-66), it would have at least been obvious to try to utilize the core diameter of 8 microns taught by Davis for the **inner fiber core** diameter in Neuberger’s output fiber. EX1002, ¶86.

6. Claim 6

- a) [6] The system of claim 1, wherein the multi-clad fiber comprises the **inner fiber core** with a **refractive index n_1** , a **first cladding** with a **refractive index n_2** , and an **outer ring core** with a **refractive index n_3** , and the **first cladding surrounds** the **inner fiber core** and is **between** the **inner fiber core** and the **outer ring core**, and wherein **$n_1 = n_3$** and **$n_1 > n_2$** .

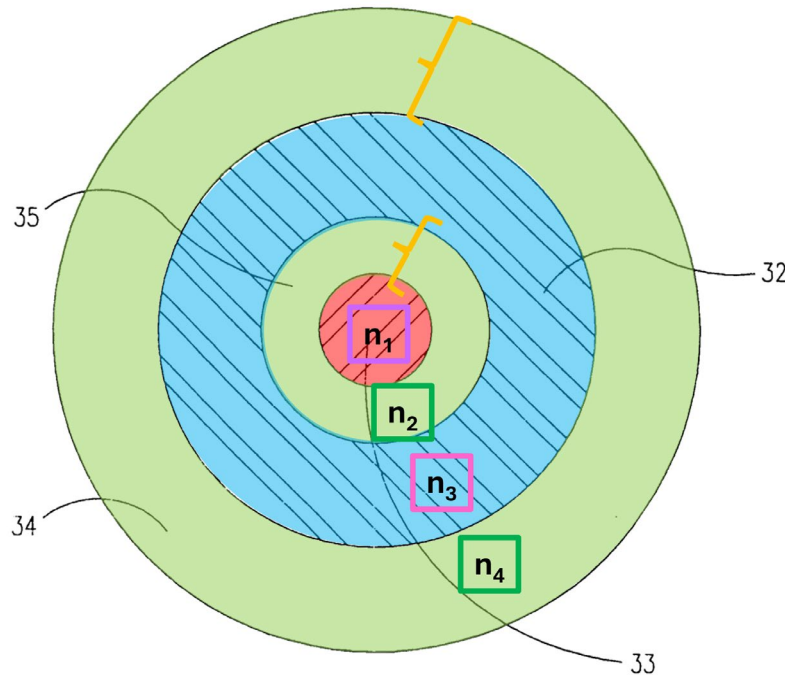
Neuberger and Davis render obvious the system of claim 1. *See* Section X.A.1. Claim [6] has two additional requirements with respect to the refractive indices of the **inner** and **outer** cores, and with respect to the refractive indices of the **inner core** and **inner cladding**. First, the **inner** and **outer** cores must have the **same refractive index ($n_1 = n_3$)**. Second, the refractive index of the **inner core** must be **higher than** the refractive index of the **inner cladding ($n_1 > n_2$)**. Neuberger in combination with Davis renders obvious [6]. EX1002, ¶87.

First, Neuberger teaches that n_1 and n_3 (the refractive indices of the cores) are both higher than n_2 and n_4 (the refractive indices of the claddings), thereby meeting the requirement that $n_1 > n_2$.² See EX1004, [0014] (“[T]he inner core has a larger refractive index than the inner cladding which in turn has a lower refractive index than the outer core, which is surrounded by an outer cladding also having a refractive index lower than the outer fiber core.”); see also EX1004, [0021] (“Inner fiber core 33 transmits high power density radiation and is surrounded by inner cladding 35. Inner cladding 35 is surrounded by outer fiber core 32, which transmits the second wavelength radiation. Outer cladding 34 forms the fourth layer and surrounds outer fiber core 32. The refractive index of inner fiber core 33 is larger than the refractive index of inner cladding 35 which also has a smaller refractive index than outer fiber core 32. Outer cladding, which forms the fourth concentric layer has a refractive index smaller than outer fiber core 32.”). EX1002, ¶88.

² Similarly, Davis explains that “the index of refraction of the cladding 17 is lower than the indices of refraction of the cores 12 and 14 so that optical energy is guided within the cores through total internal reflection.” EX1005, 1:19-22. Davis further teaches that the index of refraction of the cladding is lower than the indices of refraction of the cores. EX1005, 2:67-3:1, 3:39-40, 3:50-51, claims 1-12.

Second, although Neuberger does not specify the exact values of n_1 and n_3 (the refractive indices of the cores), it would have been obvious to use cores having the same refractive indices ($n_1=n_3$).

FIGURE 3



EX1004, FIG. 3. EX1002, ¶89.

Neuberger discloses for its non-concentric core embodiments that “[i]n both FIG. 7 and 8, the fiber cores may have **similar refractive indices**.” EX1004, [0026]; *But cf.* EX1004, [0023] (explicitly noting “FIG. 4-6 all have an inner core with a refractive index greater than the outer core which in turn has a greater refractive index than the cladding layer.”). It would have been obvious to utilize fiber cores

that have similar refractive indices for the concentric core embodiments of both Davis and Neuberger as well.³ EX1002, ¶89.

The combination amounts to nothing more than applying a known technique (setting the cores' refractive indices equal to one another by using the same materials for the two cores) to a known device ready for improvement (the multi-clad optical fiber of Neuberger and Davis that eliminate cross-talk between the cores) to yield predictable results (achieving total internal reflection in the two respective inner and outer fiber cores). EX1002, ¶91. EX1004, [0014], [0021], [0026]. EX1005, 3:20-27, claims 1-12

³ To the extent “similar refractive indices” does not explicitly teach $n_1=n_3$, it would have been obvious because Patentee has not claimed or demonstrated any criticality related to $n_1=n_3$. *See In re Peterson*, 315 F.3d 1325, 1330 (Fed. Cir. 2003) (“[A] prior art reference that discloses a range encompassing a somewhat narrower claimed range is sufficient to establish a prima facie case of obviousness.”); *see also In re Bergen*, 120 F.2d 329, 332 (CCPA 1941) (The court found the overlapping endpoint of the prior art and claimed range was sufficient to support an obviousness rejection, particularly when there was no showing of criticality of the claimed range). EX1002, ¶89-91.

At a minimum, it would have been obvious to try to make a multicore fiber using the same materials for the inner and outer fiber cores, as a POSITA would have expected to achieve more predictable fabrication conditions by having materials that are processed according to similar techniques by minimizing the different material properties present in the fiber. EX1002, ¶90-91.

A POSITA would have had a reasonable expectation of success making the two cores from identical materials to achieve $n_1=n_3$, so they “can be made by standard optical fiber processing techniques.” EX1007, 1:59-61. A POSITA would have understood that methods of making such multicore fibers were known since at least 1976. Goell, for example, teaches “[o]ne method for forming the multicore fiber could consist in the successive application of a number of layers of material by the process known as chemical vapor deposition ... [in which t]he material contributing to the higher index region [*i.e.*, cores] would be germania-silica glass, for example, and the material contributing to the lower index of refraction [*i.e.*, claddings] would be borosilicate glass.” EX1007, 1:62-2:2. Indeed, as discussed above, Goell mentions this fabrication process was a “standard optical fiber processing technique” even in 1976—more than three decades before the priority date of the ’054 Patent. It would therefore have been obvious to a POSITA to manufacture the output fiber using approaches such as those outlined in the background art as disclosed in Goell. EX1002, ¶90-91.

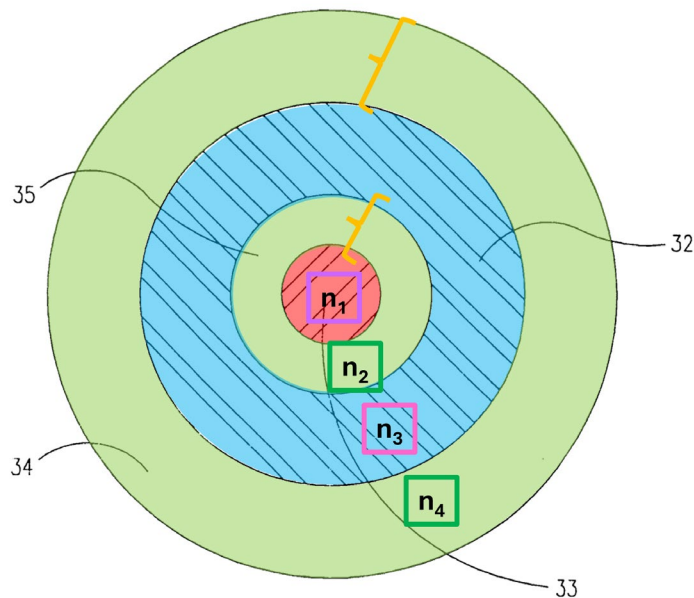
7. Claim 7

- a) [7] The system of claim 6, wherein the multi-clad fiber further comprises a **second cladding surrounding** the **outer ring core**, and wherein a **refractive index n_4** of the **second cladding** is **identical to** the **refractive index** of the **first cladding n_2** .

Neuberger and Davis render obvious the system of claim 6. See Section X.A.6. Neuberger renders obvious the added limitations of [7]. EX1002, ¶92.

As shown in Figure 3 below, Neuberger teaches a **second cladding surrounding** the **outer ring core**. See EX1004, [0021] (“**Outer cladding 34** forms the fourth layer and **surrounds** the **outer fiber core 32**.”).

FIGURE 3



EX1004, FIG. 3. EX1002, ¶93.

Neuberger also teaches that “[i]n operation, the fiber cores are both surrounded by lower refractive index material [note: *singular, not plural*], which creates total internal reflection inside the individual fiber cores. This total internal reflection has the added advantage of diminished cross-talk between cores.” See EX1004, [0021]. In other words, Neuberger teaches that both cores are surrounded by the same material, which teaches $n_2 = n_4$. EX1002, ¶94-95.

To the extent Patent Owner argues that Neuberger does not explicitly teach the exact values of n_2 and n_4 , it would have been obvious to use claddings that have the same refractive indices ($n_2 = n_4$). Neuberger teaches that refractive indices n_2 and n_4 are both lower than the refractive indices n_1 and n_3 , respectively. See EX1004, [0014] (“[T]he inner core has a larger refractive index than the inner cladding which ... has a lower refractive index than the outer core, which is surrounded by an outer cladding also having a refractive index lower than the outer fiber core.”); see also EX1004, [0021] (“The refractive index of inner fiber core 33 is larger than the refractive index of inner cladding 35 which ... has a smaller refractive index than outer fiber core 32. Outer cladding, which forms the fourth concentric layer has a refractive index smaller than outer fiber core 32.”). EX1002, ¶94-95.

Using claddings having the same refractive indices around the two cores of a multicore fiber was well-known. For example, Neuberger itself discloses for its nonconcentric core embodiments that “[i]n both FIG. 7 and 8, the fiber cores may

have similar refractive indices, but the cladding must have a smaller refractive index.” EX1004, [0026]. Indeed, as shown below in Figures 7 and 8, both cores are surrounded by the same cladding material, which a POSITA would have understood to teach or at least render obvious $n_2=n_4$ when applied to the concentric core embodiment shown in Figure 3.

FIGURE 3

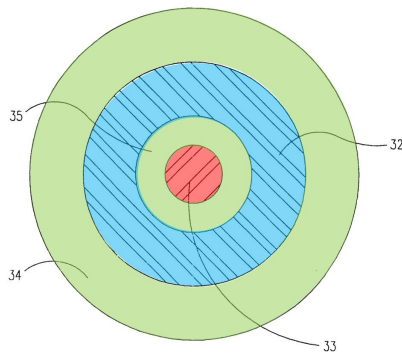


FIGURE 7

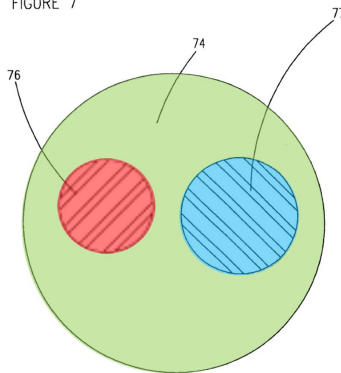
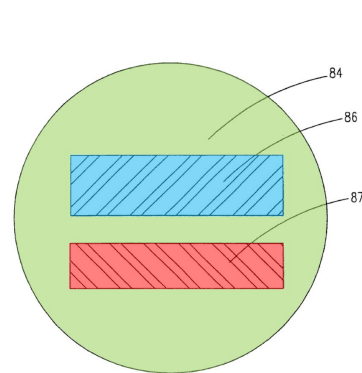


FIGURE 8



EX1004, FIGS. 3, 7, 8. EX1002, ¶95.

The combination amounts to nothing more than applying a known technique (making the claddings' refractive indices equal by using the same materials for the two claddings) to a known device ready for improvement (the multi-clad optical fiber of Neuberger and Davis that should have minimal cross-talk between the cores) to yield predictable results (achieving total internal reflection in the two respective inner and outer fiber cores). EX1002, ¶97-98. EX1004, [0026]. EX1005, 3:1-2, 3:20-27, 3:35-41, 3:48-54, 4:66-5:2, claims 1-12. EX1007, 1:40-42, 2:25-40, 2:49-52, claims 1, 2, and 4.

A POSITA would have had a reasonable expectation of success making the two claddings from identical materials to achieve $n_2=n_4$, so that they “can be made by standard optical fiber processing techniques.” EX1007, 1:59-61. A POSITA would have understood that methods of making such multicore fibers were known since at least 1976. Goell, for example, teaches “[o]ne method for forming the multicore fiber could consist in the successive application of a number of layers of material by the process known as chemical vapor deposition ... [in which t]he material contributing to the higher index region [*i.e.*, cores] would be germania-silica glass, for example, and the material contributing to the lower index of refraction [*i.e.*, claddings] would be borosilicate glass.” EX1007, 1:62-2:2. Indeed, as discussed above, Goell mentions this fabrication process was a “standard optical fiber processing technique” even in 1976—more than three decades before the priority date of the ’054 Patent. It would therefore have been obvious to a POSITA to manufacture the output fiber using the approaches outlined in the background art described by Goell. EX1002, ¶98.

8. Claim 8

- a) [8] The system of 1, wherein the multi-clad fiber comprises **two or more outer ring cores**, and the system is configured to couple two or more corresponding input laser beams into the **two or more outer ring cores**.

Neuberger in combination with Davis renders obvious the system of claim 1. *See* Section X.A.1. Neuberger in combination with Davis further renders obvious [8]. EX1002, ¶99.

Neuberger discloses that its multicore fiber may have **multiple outer ring cores** that transmit **additional** wavelengths of laser light. EX1004, [0017] (“The present invention provides a device that allows for concurrent transmission of **at least** two wavelengths or at least two power densities which can for example simultaneously cut or vaporize and coagulate tissue. ... Furthermore, the present invention is not limited to transmission of only two wavelengths or power densities. **Additional concentric layers** can be added to the fiber to transmit **additional** wavelengths.”). EX1002, ¶100.

Neuberger discloses two or more outer ring cores—the **outer ring core 32** in Figure 3 and the “[a]**dditional concentric layers**” in EX1004, [0017]. Those two or more **outer ring cores** couple to two or more corresponding input laser beams, because Neuberger states that the additional concentric layers “transmit additional wavelengths.” EX1004, [0017]. And because Neuberger teaches that “radiation of

suitable wavelengths” is coupled into the various cores of its multicore fiber, Neuberger teaches coupling two or more corresponding input laser beams into the **two or more outer ring cores**. EX1004, claim 1 (“a single optical delivery fiber (18) wherein said delivery fiber has **at least two core sections** (15, 16) of different cross-sectional area **to transmit radiation from at least two laser sources**, ... to achieve separately a beam of light output (12) to cut tissue, and... separately a laser light output (13) to coagulate or biostimulate tissue being cut.”); *see also id.*, [0013], [0014] (explaining that “[r]adiation of a suitable wavelength” is coupled into an “**inner fiber core**” and “**outer fiber core**”). EX1002, ¶101.

Indeed, coupling laser beams into multiple cores was well-known in the art. For example, Davis discloses “other embodiments work with fibers having **three or more cores**,” albeit that Davis’ multicore fiber is not concentric.⁴ EX1005, 6:14-15; Figures 11, 13; 8:26-30 (also noting “in principle the fiber may include an arbitrary number of cores.”). EX1005, 9:12-13 (“In general, the number of cores in a fiber determines the number of potential inputs and outputs.”). Davis also teaches that “an optical fiber is provided that comprises ... a plurality of cores within the

⁴ But as explained in Section X.A.1.c), Neuberger itself teaches the interchangeability of non-concentric and concentric multicore fibers. *See* EX1004, claims 9 and 12 and FIGS. 3, 7, and 8.

cladding, in which the indices of refraction of the cladding and the indices of refraction of the cores are chosen such that optical radiation propagating within the cores is substantially restricted to propagating along optical paths that pass through cores and the ends of the cores.” EX1005, 3:20-27. EX1002, ¶102.

Those disclosures in Neuberger—that it can “transmit additional wavelengths” from “at least” two laser sources via “[a]dditional concentric layers”—and Davis—that additional cores can be used to propagate optical radiation—renders obvious the added limitations of [8]. EX1002, ¶103.

9. Claim 10

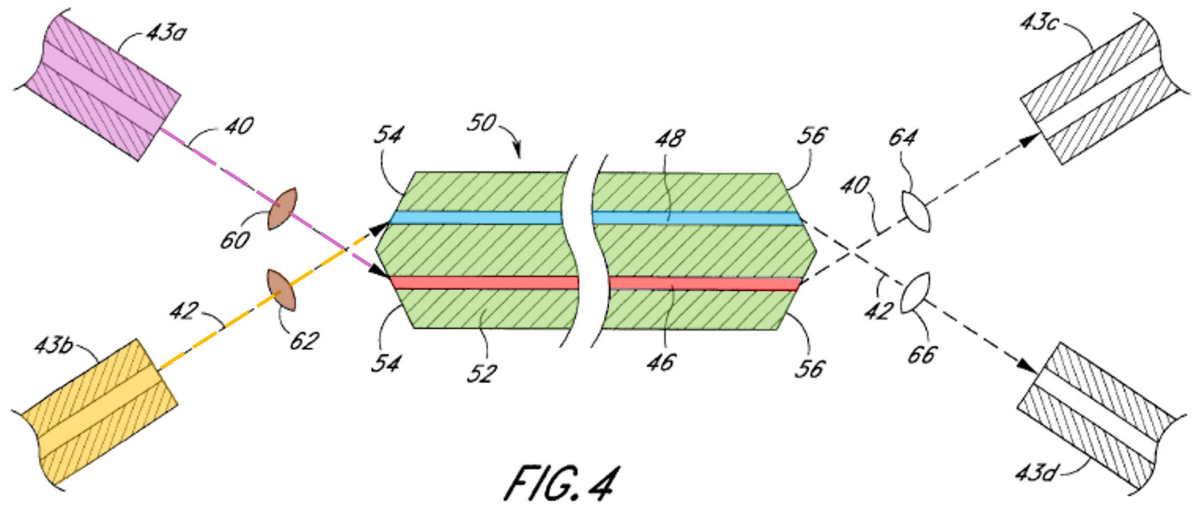
- a) [10Pre] The system of claim 1, further comprising a **switchable device coupled between the first and second optical fibers and the multi-clad fiber**,
- b) [10A] wherein the **switchable device** is configured to **electively couple the first input laser beam** at least into the **inner fiber core** of the multi-clad fiber and the **second input laser beam** at least into the at least one **outer ring core** of the multi-clad fiber.

Neuberger and Davis render obvious the system of claim 1. *See* Section X.A.1. Neuberger in combination with Davis renders obvious [10]. EX1002, ¶104.

At the outset, the '054 Patent explains that “[i]n a preferred embodiment ..., the **switchable device** is formed by **mobile optics**. ... The **mobile optics** can, for example, be prisms, plane-parallel (glass) plates, **convex and concave lenses**,

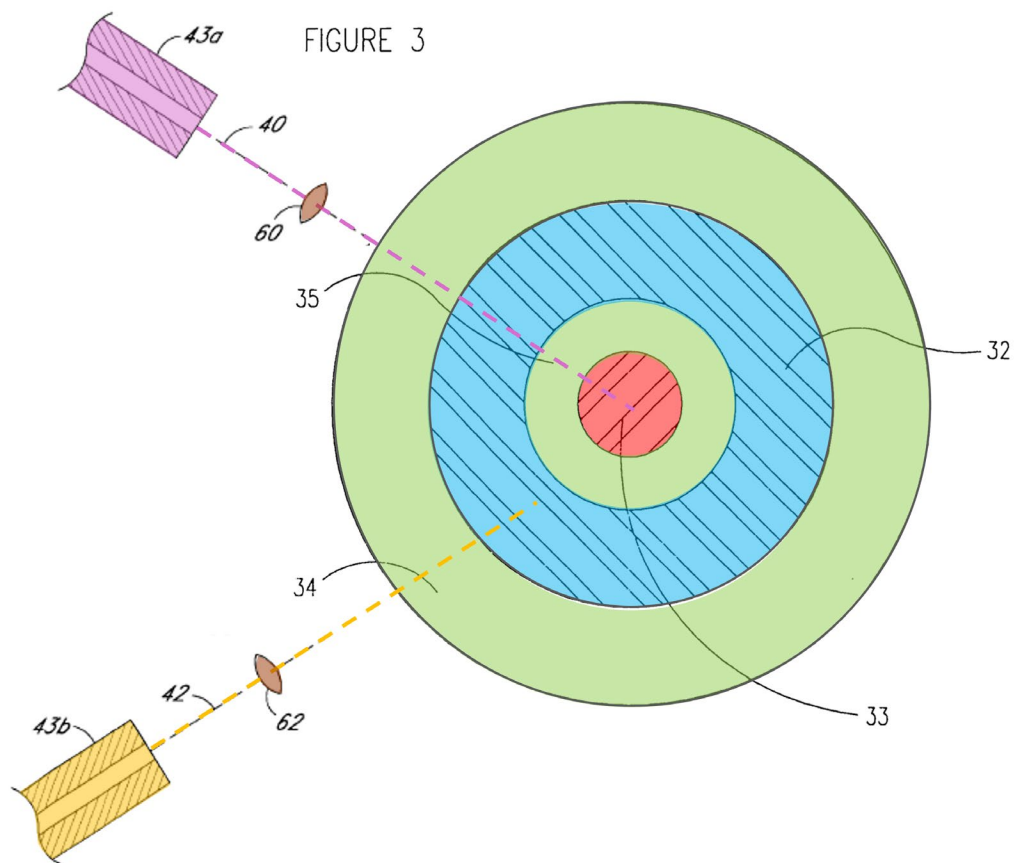
mirrors, diffractive optical elements, etc., *individually* or in combinations.”
EX1001, 4:40-43. EX1002, ¶105.

Davis similarly discloses “optical elements such as lenses 60 and 62 may be used to focus the optical beams 40 and 42 onto the individual cores 46 and 48.” EX1005, 5:43-45; *see also* EX1005, 5:58-65 (describing that “lenses 60 and 62 can be any type of focusing optical elements,” can “refer to either one kind of lens or a combination of lenses,” and can be “close enough” to fiber 50 to focus the beams onto their respective cores). The optical elements are mechanically aligned with the optical beams (40 and 42) and the respective cores (46 and 48) of the multicore fiber using mechanically mobile translation stages. EX1005, 5:46-50 (“...the various optical components may be fixed, for example, within respective mechanical mounts resting upon respective *translation stages* to control the alignment of the optical beams 40 and 42, which propagate along optical paths within the cores 46 and 48.”). In this way, lenses 60 and 62 can be moved through the translation stages to **electively couple** input beams 40 and 42 into either of cores 46 or 48 of the output fiber, as shown in Figure 4 of Davis.



EX1005, FIG. 4. EX1002, ¶106.

And as explained in Section X.A.2, a POSITA would have been able to readily apply the teachings of Davis to Neuberger such that a first input laser beam 40 from a first optical fiber 43a is electively coupled into the fiber end of Neuberger's inner core 33 with optical element 60 and a second input laser beam 42 from a second optical fiber 43b is electively coupled into the fiber end of Neuberger's outer ring core 32 with optical element 62, as illustrated below.



See EX1005, FIG. 4 and EX1004, FIG. 3. EX1002, ¶107.

10. Claim 11

- a) **[11Pre] A method of generating a laser beam with different beam profile characteristics, the method comprising:**

Neuberger in combination with Davis renders obvious [11Pre]. Neuberger in combination with Davis teaches generating a laser beam with different beam profile characteristics, such as for cutting and coagulating, as explained in Section X.A.1.a) for [1Pre]. *See also* Section X.A.2. EX1002, ¶108.

- b) **[11A] guiding a first input laser beam by a first optical fiber to a fiber end of a multi-clad fiber, wherein the multi-clad fiber has an inner fiber core and at least one outer ring core;**

Neuberger in combination with Davis renders obvious [11A] for the reasons provided in Sections X.A.1.b) and X.A.1.c) for [1A]-[1B]. *See also* Section X.A.2. EX1002, ¶109.

- c) **[11B] guiding a second input laser beam by a second optical fiber to the fiber end of the multi-clad fiber;**

Neuberger in combination with Davis renders obvious [11B] for the reasons provided in Section X.A.1.c) for [1C]. *See also* Section X.A.2. EX1002, ¶110.

- d) **[11C] coupling the first input laser beam and the second input laser beam into the fiber end of the multi-clad fiber, comprising at least one of:**

Neuberger in combination with Davis renders obvious [11C] for the reasons provided in Section X.A.1.c) for [1B]-[1D]. *See also* Section X.A.2. EX1002, ¶111.

- e) [11D] **coupling** the **first input laser beam** at least into the **inner fiber core** of the multi-clad fiber, or

Neuberger in combination with Davis renders obvious [11D] for the reasons provided in Section X.A.1.c) for [1B]-[1D]. *See also* Section X.A.2. EX1002, ¶112.

- f) [11E] **coupling** the **second input laser beam** at least into the at least one **outer ring core** of the multi-clad fiber; and

Neuberger in combination with Davis renders obvious [11E] for the reasons provided in Section X.A.1.c) for [1B]-[1D]. *See also* Section X.A.2. EX1002, ¶113.

- g) [11F] generating an **output laser beam** by interaction of the **first input laser beam** and the **second input laser beam** with the multi-clad fiber, wherein a **beam profile characteristic of the output laser beam differs** depending upon the **coupling** of the **first input laser beam** and the **second input laser beam** into the fiber end of the multi-clad fiber.

Neuberger in combination with Davis renders obvious [11F] for at least the reasons provided in Sections X.A.1.a), X.A.1.b), and X.A.1.c) for [1Pre]-[1D]. Additionally, as discussed in Sections X.A.1.a), X.A.1.b), and X.A.1.c), by using Davis' **coupling method** with Neuberger's multicore fiber, a **first input laser beam** 40 from a **first optical fiber** 43a interacts with Neuberger's **inner core** 33 to generate a smaller **circular beam profile with a higher-intensity output**. *See* Section X.A.1.a),

EX1004, [0014], [0021]. Similarly, by using Davis' **coupling method**, a **second input laser beam 42** from a **second optical fiber 43b** interacts with Neuberger's **outer ring core 32** to produce a larger **ring-shaped beam profile with a lower-intensity output**. See Section X.A.1.a), EX1004, [0014], [0021]. See also Section X.A.2. EX1002, ¶114.

11. Claim 12

- a) [12Pre] The method of claim 11, wherein **coupling** the **first input laser beam** at least into the **inner fiber core** of the multi-clad fiber comprises:

Neuberger in combination with Davis renders obvious [12Pre] for the reasons provided in Section X.A.1.c) for [1D]. See also Section X.A.2. EX1002, ¶115.

- b) [12A] **coupling** the **first input laser beam** *only* into the **inner fiber core** of the multi-clad fiber.

Neuberger in combination with Davis renders obvious [12A] for the reasons provided in Section X.A.3.a) for [2]. See also Section X.A.2. EX1002, ¶116.

12. Claim 13

- a) [13Pre] The method of claim 11, wherein **coupling** the **second input laser beam** at least into the at least one **outer ring core** of the multi-clad fiber comprises:

Neuberger in combination with Davis renders obvious [13Pre] for the reasons provided in Section X.A.1.c) for [1D]. See also Section X.A.2. EX1002, ¶117.

- b) [13A] **coupling** the **second input laser beam** only into the at least one **outer ring core** of the multi-clad fiber.

Neuberger in combination with Davis renders obvious [13A] for the reasons provided in Section X.A.3.b) for [3]. *See also* Section X.A.2. EX1002, ¶118.

13. Claim 14

- a) [14Pre] The method of claim 11, wherein the multi-clad fiber comprises **one or more claddings** respectively **around** the **inner fiber core** and the at least one **outer ring core**, and

Neuberger in combination with Davis renders obvious [14Pre] for the reasons provided in Section X.A.4.a) for [4A]. *See also* Section X.A.2. EX1002, ¶119.

- b) [14A] wherein **coupling** the **first input laser beam** and the **second input laser beam** into the fiber end of the multi-clad fiber comprises:

Neuberger in combination with Davis renders obvious [14A] for the reasons provided in Section X.A.1.c) for [1B]-[1C] and Section X.A.3 for [2] and [3]. *See also* Section X.A.2. EX1002, ¶120.

- c) [14B] **coupling** no laser beam into the one or more **claddings**.

Neuberger in combination with Davis renders obvious [14B] for the reasons provided in Section X.A.4.b) for [4B]. *See also* Section X.A.2. EX1002, ¶121.

14. Claim 15

- a) [15Pre] The method of claim 11, wherein the multi-clad fiber comprises an inner cladding between the inner fiber core and the at least one outer ring core, and wherein the multi-clad fiber is configured to have at least one of:
- b) [15A] the inner fiber core with a diameter of no greater than 200 μm ,
- c) [15B] the at least one outer ring core with a diameter of no greater than 600 μm , or
- d) [15C] the inner cladding with a thickness of no greater than 10 μm .

Neuberger in combination with Davis renders obvious [15] for the reasons provided in Section X.A.5 for [5]. *See also* Section X.A.2. EX1002, ¶122.

15. Claim 16

- a) [16] The method of claim 11, wherein the multi-clad fiber comprises the inner fiber core with a refractive index n_1 , a first cladding with a refractive index n_2 , and an outer ring core with refractive index n_3 , and the first cladding surrounds the inner fiber core and is between the inner fiber core and the outer ring core, and wherein $n_1=n_3$ and $n_1>n_2$.

Neuberger in combination with Davis renders obvious [16] for the reasons provided in Section X.A.6 for [6]. *See also* Section X.A.2. EX1002, ¶123.

16. Claim 17

- a) [17] The method of claim 16, wherein the multi-clad fiber further comprises a **second cladding surrounding** the **outer ring core**, and wherein a **refractive index n_4** of the **second cladding** is **identical** to the **refractive index** of the **first cladding n_2** .

Neuberger in combination with Davis renders obvious [17] for the reasons provided in Section X.A.7 for [7]. *See also* Section X.A.2. EX1002, ¶124.

17. Claim 18

- a) [18] The method of claim 11, wherein the multi-clad fiber comprises **two or more outer ring cores**, and the method comprises: coupling two or more corresponding input laser beams into the **two or more outer ring cores**.

Neuberger in combination with Davis renders obvious [18] for the reasons provided in Section X.A.8 for [8]. *See also* Section X.A.2. EX1002, ¶125.

18. Claim 20

- a) [20] The method of claim 11, wherein **coupling** the **first input laser beam** and the **second input laser beam** into the fiber end of the multi-clad fiber comprises: **electively coupling**, by a **switchable device coupled** between the **first** and **second optical fibers** and the fiber end of the multi-clad fiber, one of the **first input laser beam** at least into the **inner fiber core** of the multi-clad fiber and the **second input laser beam** at least into the at least one **outer ring core** of the multi-clad fiber.

Neuberger in combination with Davis renders obvious [20] for the reasons provided in Sections X.A.1.c) for [1B]-[1D] and X.A.9.a) and X.A.9.b) for [10Pre] and [10A]. *See also* Section X.A.2. EX1002, ¶126.

B. Ground II: Neuberger In Combination With Davis And Kalle Renders Obvious Claims 5 And 15

1. Claim 5

- a) [5Pre] The system of claim 1, wherein the multi-clad fiber is configured to have at least one of:

Neuberger and Davis render obvious [5Pre] for the reasons provided in Section X.A.1.a) for [1Pre]. Neuberger in combination with Davis and Kalle renders obvious the remaining limitations of claim 5 for three independent reasons. EX1002, ¶127.

- b) [5A] the inner fiber core with a diameter of no greater than 200 μm ,

Neuberger does not specify the precise dimensions of its inner fiber core. But as explained above in Section X.A.5.b), it would have been obvious to use an inner fiber core with a diameter of less than 200 μm in light of Davis. *See also* EX1005, 4:63-64 (“the cores 46 and 48 may be, for example, 8 microns in diameter”). But for avoidance of doubt, this Ground additionally demonstrates that inner fiber cores with diameters of less than 200 μm were well-known in the art. Kalle, for example, discloses an optical fiber that includes “a first core

section 11 ..., a barrier layer 12 ..., a second core section 13 ..., and a cladding 14 ...” EX1006, 15:21-23, claims 10, 24. Kalle discloses “the first core section (11) of the fiber (10) has a diameter (d_1) between 10 μm and 100 μm , or between 30 μm and 60 μm .” EX1006, claim 23. In one embodiment, “[t]he diameter of the first core section 11 is about 40 μm .” EX1006, 21:18-19.

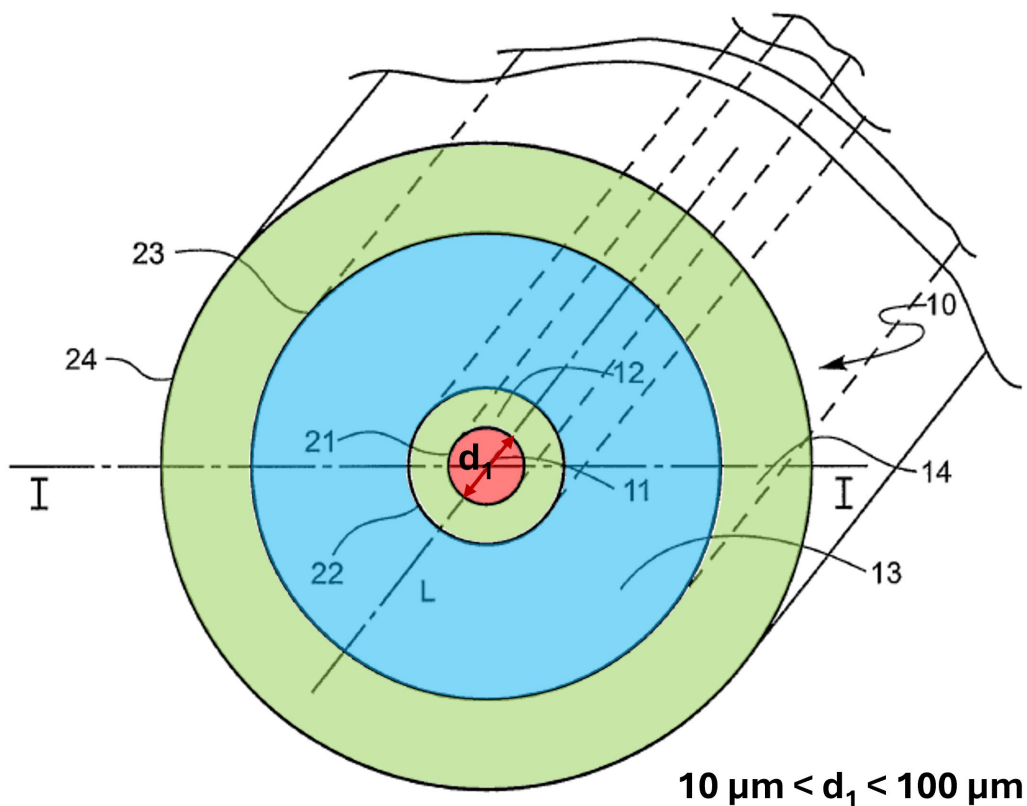


FIG. 1A

EX1006, FIG. 1A. EX1002, ¶128.

- c) [5B] the at least one **outer ring core** with a diameter of no greater than 600 μm , or

Second, Kalle demonstrates **outer ring cores** with diameters of less than 600 μm were well-known in the art. Kalle discloses that in one embodiment, “the diameter of the **second core section 12** is about 200 μm .” EX1006, 21:19-20. Kalle’s Figure 3 shows the diameter of the **second core section**, which has the shape of a ring (see EX1006, FIG. 1), is between 180 μm and 220 μm . All the **outer ring core** diameters disclosed in Kalle meet the claimed “diameter of no greater than 600 μm .”

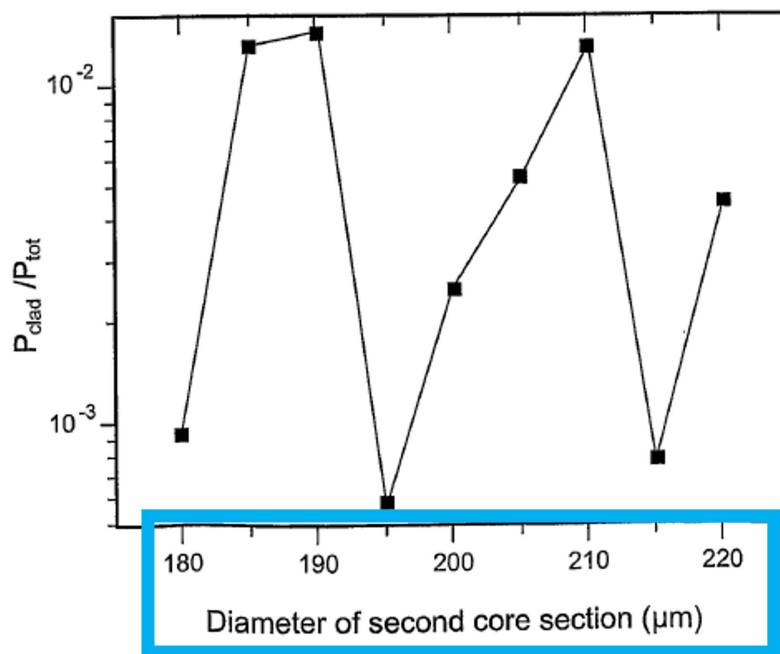


FIG. 3

EX1006, FIG. 3. EX1002, ¶129.

- d) [5C] an inner cladding with a thickness of no greater than 10 μm , the inner cladding being between the inner fiber core and the at least one outer ring core.

Third, Kalle demonstrates an inner cladding between the inner and outer cores with a thickness of less than 10 μm was well-known in the prior art. Kalle's optical fiber includes "a barrier layer (12)" "between said first core section (11) and said second core section (13)." EX1006, claims 1, 15, 5:20-21. Kalle discloses "[t]he thickness of the barrier layer is, for example, from 3 to 50 μm , preferably between 5 and 20 μm ." EX1006, 3:2-3, 15:3-5, claims 11, 25. In one embodiment, "the thickness of the barrier layer 12 is about 10 μm ..." EX1006, 21:19. Kalle's Figure 2 shows the barrier thickness is between 6 and 14 μm . Accordingly, Kalle's barrier thickness meets the claimed limitation of "thickness of no greater than 10 μm ." See *Ineos USA LLC v. Berry Plastics Corp.*, 783 F.3d 865, 869 (Fed. Cir. 2015) ("When a patent claims a range, as in this case, that range is anticipated by a prior art reference if the reference discloses a point within the range.") (citing *Titanium Metals Corp. v. Banner*, 778 F.2d 775, 782 (Fed. Cir. 1985); see also *In re Geisler*, 116 F.3d 1465, 1469-71 (Fed. Cir. 1997).

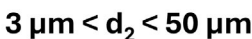


FIG. 1A

EX1006, FIG. 1A. EX1002, ¶130.



FIG. 2

EX1006, FIG. 2. EX1002, ¶130.

2. Reasons To Combine Neuberger And Davis Further With Kalle

A POSITA would have had numerous reasons to combine the teachings of Kalle—in particular, the diameters and thicknesses of Kalle’s cores and claddings—with the system of Neuberger and Davis with a reasonable expectation of success. Kalle teaches an optical fiber that has the same structure as Neuberger. The system of Kalle features “a first core section 11 ..., a barrier layer 12 ..., a second core section 13 ..., and a cladding 14” EX1006, 9:21-23, claims 10, 24. Additionally, like Neuberger’s multicore output fiber, Kalle’s fiber transmits light through its cores. EX1006, 20:9-10. “[T]he optical signal from the signal light source would be propagating in the first core section 11 of the optical fiber 10.” EX1006, 20:23-25. “The pump light is coupled into the composite fiber formed by the first core section 11 and at least the second core 13 by a coupling means.” Light coupled to the first core 11 would output a circular beam, whereas light coupled to the second core 13 would output a ring-shaped beam. Although Neuberger does not specify the dimensions of its concentric cores and claddings, Kalle teaches that the inner core diameter is between 10 μm and 100 μm , or between 30 μm and 60 μm (EX1006, 15:21-23, claims 10, 24), the ring-shaped core diameter is about 200 μm (EX1006, 21:19-20), and the thickness of the intermediate cladding is preferably between 5

and 20 μm (EX1006, 13:2-3, 15:3-5, claims 11, 25). All of those dimensions fall within the ranges claimed by the '054 Patent. EX1002, ¶131.

It would have been obvious to a POSITA to apply Kalle's dimensions to the system of Neuberger and Davis. It was well known to utilize optical fibers in medical applications having dimensions commensurate in size with those of Kalle. For example, the total diameter of an optical fiber used in gynecological sterilization at the time is less than 600 microns. EX1008, 5:35-40 ("The light transmitting conduit 14A is preferably a single, flexible light transmitting fiber, such as used in fiberoptic devices, and generally has a *total exterior diameter of about 600 microns or less.*"). As another example, optical fibers for ablating tissues in gastroenterology and general surgery had an *overall diameter between 400 and 1,000 microns.* EX1009, 10. This optical fiber, called StrateFire™ Reusable Optical Fiber, was approved for use by the Food and Drug Administration in June 1997—well over a decade before the priority date for the '054 Patent. Because both those medical applications are directed to the same problem as Neuberger and—like Kalle's system—have sub-millimeter total diameters, it would have been obvious for a POSITA to try utilizing the specific core and cladding dimensions taught by Kalle with the system of Neuberger and Davis. The combination would amount to nothing more than combining prior art elements (using Kalle's dimensions in Neuberger and Davis' multi-clad optical fiber) to yield predictable results (a multi-clad optical fiber

with the given dimensions that would be similar to known dimensions of optical fibers used in medical applications). EX1002, ¶132.

Indeed, since other medical fiber lasers at the time had the same total diameter as Kalle’s fiber, using one or more of the core/cladding dimensions taught by Kalle in the system of Neuberger and Davis would have been obvious to try for a POSITA with a reasonable expectation of success. EX1002, ¶133.

3. Claim 15

- a) [15Pre] The method of claim 11, wherein the multi-clad fiber comprises an **inner cladding** **between** the **inner fiber core** and the at least one **outer ring core**, and wherein the multi-clad fiber is configured to have at least one of:
- b) [15A] the **inner fiber core** with a diameter of no greater than 200 μm ,
- c) [15B] the at least one **outer ring core** with a diameter of no greater than 600 μm , or
- d) [15C] the **inner cladding** with a thickness of no greater than 10 μm .

Neuberger in combination with Davis renders obvious [15Pre] for the reasons provided in Section X.A.4.a) for [4A]. *See also* Section X.A.2. EX1002, ¶134.

Neuberger in combination with Davis and Kalle renders obvious [15A], [15B], and [15C] for the reasons provided in Sections X.B.1.b) for [5A], X.B.1.c) for [5B], and X.B.1.d) for [5C], respectively. *See also* Section X.B.2. EX1002, ¶135.

C. Ground III: Neuberger In Combination With Davis And Goell Renders Obvious Claims 6-8 And 16-18

1. Claim 6

- a) [6] The system of claim 1, wherein the multi-clad fiber comprises the **inner fiber core** with a **refractive index n_1** , a **first cladding** with a **refractive index n_2** , and an **outer ring core** with a **refractive index n_3** , and the **first cladding surrounds** the **inner fiber core** and is **between** the **inner fiber core** and the **outer ring core**, and wherein **$n_1 = n_3$** and **$n_1 > n_2$** .

Neuberger in combination with Davis and Goell renders obvious [6]. As explained in Section X.A.6, Neuberger in combination with Davis renders obvious [6]. However, for avoidance of doubt, Petitioner advances Ground III to show that a multicore fiber having **$n_1 = n_3$** was well-known in art. EX1002, ¶136.

Goell discloses a multicore output fiber with the same fundamental structure as Neuberger: from the center outwards, **an inner core** → **inner cladding** → **outer ring core** → **outer cladding**, as shown in Goell's Figure 1 below. See EX1007, claim 1 (“A multiple core optical fiber comprising: an **inner core** ...; an **inner cladding** ... **surrounding** said **inner core** ...; at least one **outer core** ... **surrounding** said **inner core** ...; and at least one **outer cladding layer** ... **surrounding** said **outer core**”).

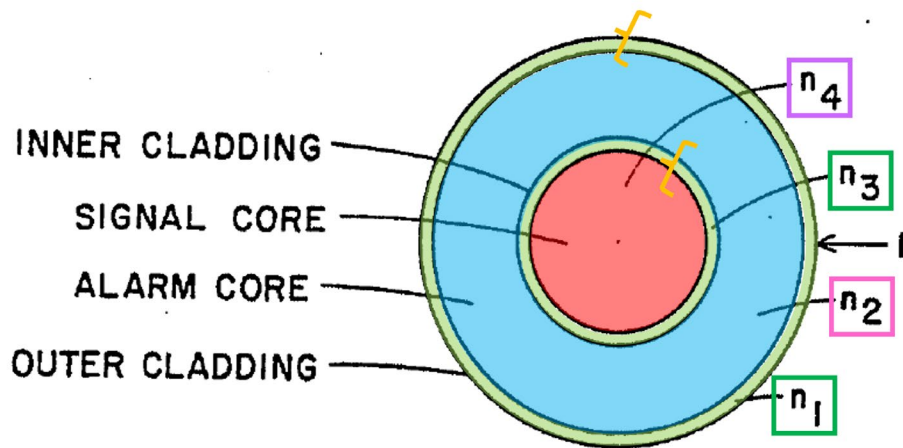


Fig. 1

EX1007, FIG. 1. EX1002, ¶137.

Goell teaches that in such concentric multicore output fibers the **inner** and **outer** ring cores have equal refractive indices—*i.e.*, $n_1 = n_3$ (which in Goell's nomenclature is $n_4 = n_2$). See EX1007, claim 2 (“The fiber of claim 1 wherein said **inner core** and **outer core** have the same index of refraction.”). EX1002, ¶138.

2. Reasons To Combine Neuberger And Davis Further With Goell

It would have been obvious to a POSITA to combine the teachings of Goell with Neuberger and Davis—in particular, to make Neuberger's **inner** and **outer** cores have the same refractive index—with a reasonable expectation of success. Neuberger and Goell both disclose multicore optical fibers that feature an **inner core**, an **outer core**, an **inner cladding** **between** the **inner** and **outer** cores, and an **outer**

cladding surrounding the outer core. EX1004, [0021], [0017]. EX1007, 2:23-44, 4:11-19, claim 1. EX1005, 4:51-61, 1:6-7, 2:59-61. EX1002, ¶139.

Neuberger, Davis, and Goell all teach using the inner and outer cores of the optical fiber transmit light. In particular, Neuberger, Davis, and Goell all avoid cross-talk between the inner and outer cores by using materials with higher refractive indices for the cores and materials with lower refractive indices for the claddings that surround those cores, such that light propagating through those cores is confined within them and does not leak into the cladding. EX1004, [0006] (“[A]ll incident radiation is advantageously reflected back into the optical fiber core.”); EX1007, 2:23-53 (“...Light energy transmitting through the alarm core will be confined within the cores since the inner cladding layer and outer cladding layer have lower indices of refraction...than the index of refraction of the alarm core...”); EX1005, 1:19-22, 2:65-3:2 (“[T]he index of refraction of the cladding is lower than the indices of refraction of the cores to confine optical beams within the cores.”), 2:24-27, 3:35-41, 3:48-53, claims 1-12. EX1002, ¶140.

Using the refractive index relationships explicitly disclosed in Goell with the system of Neuberger and Davis would have been obvious to a POSITA. The combination amounts to nothing more than combining prior art elements (multiclad optical fibers that transmit light through coaxial cores with no interference or cross-talk between the cores, with the refractive index relationships suggested in

Neuberger and explicitly specified in Goell) according to known methods to yield predictable results (the system of Neuberger and Davis in which the **inner core** and **outer core** have the **same index of refraction**, which is **greater than that of the claddings**). EX1002, ¶141. EX1004, [0026]. EX1005, 3:1-2, 3:20-27, 3:35-41, 3:49-53, 4:66-5:3, claims 1-12. EX1007, 1:40-42, 2:25-40, 2:49-52, claims 1, 2, and 4.

A POSITA would have had a reasonable expectation of success applying Goell’s teachings to Neuberger’s multicore output fiber. A POSITA would have understood that methods of making such multicore fibers were known since at least 1976. Goell teaches “[o]ne method for forming the multicore fiber could consist in the successive application of a number of layers of material by the process known as chemical vapor deposition ... [in which t]he material contributing to the higher index region [*i.e.*, cores] would be germania-silica glass, for example, and the material contributing to the lower index of refraction [*i.e.*, claddings] would be borosilicate glass.” EX1007, 1:62-2:2. Indeed, as discussed above, Goell mentions this fabrication process was a “standard optical fiber processing technique” even in 1976—more than three decades before the priority date of the ’054 Patent. It would therefore have been obvious to a POSITA to manufacture the output fiber using approaches, such as outlined in Goell. EX1002, ¶142.

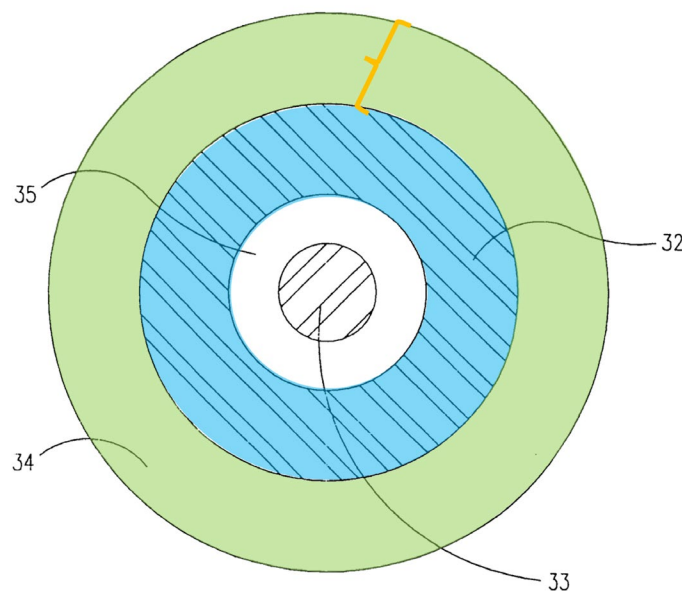
3. Claim 7

- a) [7] The system of claim 6, wherein the multi-clad fiber further comprises a second cladding surrounding the outer ring core, and wherein a refractive index n_4 of the second cladding is identical to the refractive index of the first cladding n_2 .

Neuberger and Davis render obvious the system of claim 6. *See* Section X.A.6. As explained in Section X.A.7, Neuberger in combination with Davis renders obvious [7]. However, for any avoidance of doubt, Petitioner advances Ground III to show that a multicore fiber having $n_2 = n_4$ was well-known in the art. Neuberger in combination with Davis and Goell renders obvious [7]. EX1002, ¶143.

Neuberger discloses that its multi-clad fiber includes a **second cladding**—**outer cladding 34**—**surrounding** the **outer ring core 32**.

FIGURE 3



EX1004, FIG. 3. EX1002, ¶144.

refractive index relationships to the system of Neuberger and Davis with a reasonable expectation of success. EX1002, ¶146.

A POSITA would have understood that methods of making such multicore fibers were known since at least 1976. Goell teaches “[o]ne method for forming the multicore fiber could consist in the successive application of a number of layers of material by the process known as chemical vapor deposition ... [in which t]he material contributing to the higher index region [*i.e.*, cores] would be germania-silica glass, for example, and the material contributing to the lower index of refraction [*i.e.*, claddings] would be borosilicate glass.” EX1007, 1:62-2:2. Indeed, as discussed above, Goell mentions this fabrication process was a “standard optical fiber processing technique” even in 1976—more than three decades before the priority date of the ’054 Patent. It would therefore have been obvious to a POSITA to manufacture the output fiber using approaches outlined in Goell. EX1002, ¶147.

4. Claim 8

- a) [8] The system of 1, wherein the multi-clad fiber comprises **two or more outer ring cores**, and the system is configured to couple two or more corresponding input laser beams into the **two or more outer ring cores**.

As explained above in Section X.A.8, Neuberger in combination with Davis renders obvious [8]. However, for any avoidance of doubt, Petitioner advances Ground III to show that a multicore fiber having **two or more outer ring cores** where

the system is configured to couple two or more corresponding input laser beams into the **two or more outer ring cores** was well-known in art. EX1002, ¶148.

Goell discloses “several layers of signal cores and alternative layers of alarm cores or, alternatively, ... a series of signal cores *each carrying separate information along distinct optical paths...*” EX1007, 4:11-19. Goell’s Figure 1a shows a multicore fiber having **three outer ring core layers** (in addition to an inner core).

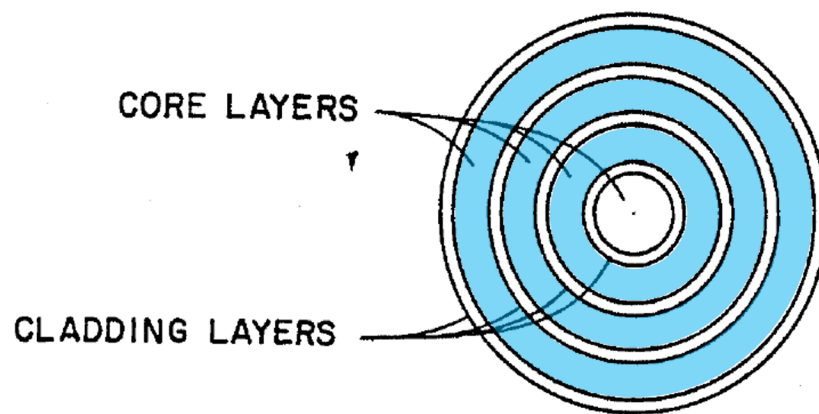


Fig. 1a

EX1007, Figure 1a. Just as Neuberger taught “additional concentric layers ... to transmit additional wavelengths,” EX1004, [0017], Goell teaches that each of the separate concentric ring cores “carr[ies] separate information.” EX1007, 4:11-19. EX1002, ¶149-150.

The combination amounts to nothing more than combining prior art elements (Neuberger’s concentric core fiber and Goell’s optical fiber comprising **multiple**

ring-shaped cores) according to known methods to yield the predictable result of an optical fiber with two or more outer rings, as contemplated by Neuberger to transmit additional wavelengths. EX1004, [0017]. EX1002, ¶151.

At a minimum, adding two or more outer cores to the system of Neuberger and Davis would have been obvious to try in light of the teachings of Neuberger and Goell, which teach that multiple outer ring cores were well-known in the art and in accordance with Neuberger's stated desire to transmit additional wavelengths using additional concentric layers. EX1004, [0017]. EX1002, ¶151.

5. Claim 16

- a) [16] The method of claim 11, wherein the multi-clad fiber comprises the inner fiber core with a refractive index n_1 , a first cladding with a refractive index n_2 , and an outer ring core with refractive index n_3 , and the first cladding surrounds the inner fiber core and is between the inner fiber core and the outer ring core, and wherein $n_1 = n_3$ and $n_1 > n_2$.

Neuberger in combination with Davis and Goell renders obvious [16] for the reasons provided in Section X.C.1 for [6]. *See also* Section X.C.2. EX1002, ¶152.

6. Claim 17

- a) [17] The method of claim 16, wherein the multi-clad fiber further comprises a **second cladding surrounding the outer ring core**, and wherein a **refractive index n_4 of the second cladding is identical to the refractive index of the first cladding n_2** .

Neuberger in combination with Davis and Goell renders obvious [17] for the reasons provided in Section X.C.3 for [7]. *See also* Section X.C.2. EX1002, ¶153.

7. Claim 18

- a) [18] The method of claim 11, wherein the multi-clad fiber comprises **two or more outer ring cores**, and the method comprises: coupling two or more corresponding input laser beams into the **two or more outer ring cores**.

Neuberger in combination with Davis and Goell renders obvious [18] for the reasons provided in Section X.C.4 for [8]. *See also* Section X.C.2. EX1002, ¶154.

D. Ground IV: Neuberger In Combination With Davis In Further Combination With Lai Renders Obvious Claims 9-10 And 19-20

1. Claim 9

- a) [9] The system of claim 1, wherein the system is configured to generate an **output laser beam with a power of at least 1 kW**.

Neuberger and Davis render obvious the system of claim 1. *See* Section X.A.1. Neuberger, Davis, and Lai further render obvious the added limitations of [9]. Neuberger discloses the use of multicore optical fibers as surgical lasers for

ablation and coagulation. EX1004, [0011], [0012] (“Another object of the present invention is to provide a medical diode laser system that allows for simultaneous coagulation, and cutting or ablating of tissue.”), [0017] (“The present invention provides a device that allows for concurrent transmission of at least two wavelengths or at least two power densities which can for example simultaneously cut or vaporize and coagulate tissue.”). EX1002, ¶155-156.

Lai similarly teaches a dual-wavelength surgical laser system that can be used for both ablation and coagulation. *See* EX1010, [0084] (“Laser system 500 is a dual-wavelength surgical laser system consisting of a **laser 510** for tissue explosive ablation and a **laser 520** for tissue coagulation.”).

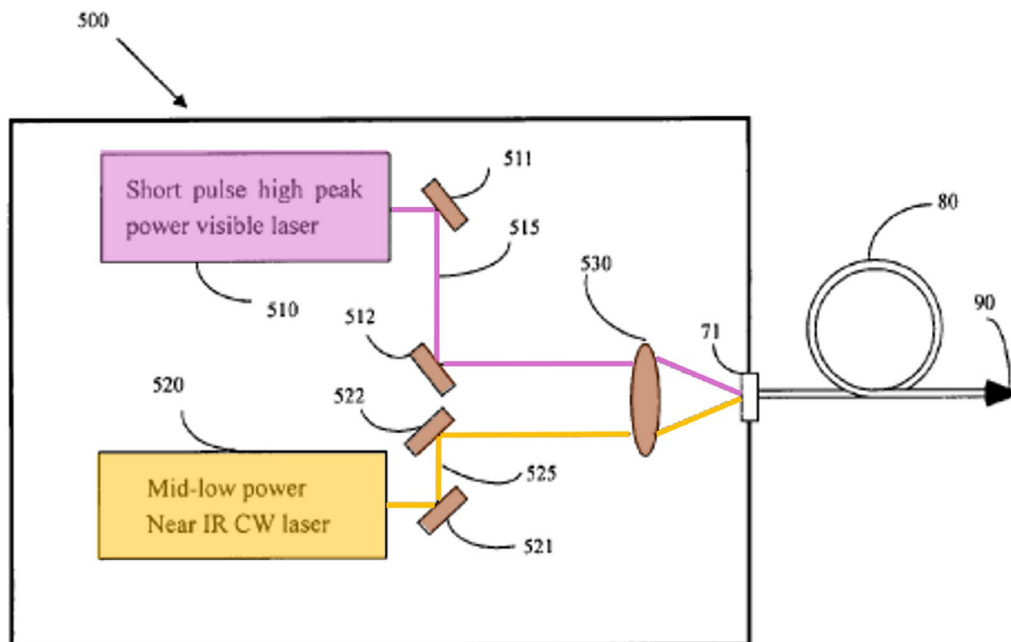


Figure 5

EX1010, FIG. 5. EX1002, ¶157.

Both Neuberger and Davis disclose the use of diode lasers and Nd:YAG lasers as input sources. EX1004, [0002] (“***Solid state lasers, such as the Nd:YAG,*** have primarily been employed to achieve the desired optical power and wavelength for medical procedures in the fields of dermatology, plastic surgery, ophthalmology, otolaryngology, neurological surgery, gastroenterology, urology, gynecology, and general surgery. ... ***Diode lasers*** are attractive substitutes for these solid state lasers because diode lasers are cheap, small, and have low power requirements. ... To obtain effective power, these lasers are typically combined to form an array on one or more substrates.”), EX1005, 4:51-56 (“One embodiment of the invention is illustrated in FIG. 3A, in which an **optical beam 40** from an optical source 44 (such as ***a laser diode***, a Ti:Sapphire laser, ***a Nd:YAG laser***, or the like) enters, via refraction, a **core 46** of an optical fiber 50 (that includes a **second core 48**), in which the cores **46** and **48** are surrounded by a **cladding 52**.”). EX1002, ¶157.

Lai similarly teaches the use of continuous Nd:YAG or diode lasers with output powers between 5-30 W that can be used for coagulation and a diode-pumped solid state Nd:YAG laser that can **output power as high as 60-200 kW** that can be used for ablation. See EX1010, [0084] (“The **laser 510** can be either [diode-pumped solid state] laser system 100, 200, 300, or 400. The **laser 520** can be continuous wave 1064 nm Nd:YAG laser, ... 800-1000 nm diode laser, 800-100[0] nm fiber-coupled diode laser,... For best hemostasis, the **laser 520** shall have 5-30 W average

power on target tissues.”), [0062] (“The laser system 100 is a ***diode-pumped Nd:YAG laser***.”), [0065] (“To obtain laser pulses with pulse width less than 150 ns and ***output peak power 60-200 kW*** at 532 nm, the Nd:YAG laser rod shall have a small diameter between 2 mm to 5 mm.”), [0073] (“All combined efforts enable the laser system to produce sub-150 ns pulses with higher than ***60 kW peak power*** at 532 nm.”) EX1002, ¶157.

2. Reasons To Combine Neuberger And Davis Further With Lai

A POSITA would have been motivated to combine Neuberger and Davis with Lai with a reasonable expectation of success. The systems of Neuberger, Davis, and Lai all utilize some form of diode laser and/or Nd:YAG lasers. EX1004, [0002] (“Solid state lasers, ***such as the Nd:YAG***, have primarily been employed to achieve the desired optical power and wavelength for medical procedures.... ***Diode lasers*** are attractive substitutes...”); EX1005, 4:51-57 (“optical source 44 (such as a ***laser diode***, ... a ***Nd:YAG laser***, or the like)...”); EX1010, [0062] (“The laser system 100 is a ***diode-pumped ND:YAG laser*** ...”), [0084] (“The laser 510 can be either laser system 100... The laser 520 can be continuous wave 1064 nm ***Nd:YAG laser***, ... 800-1000 nm ***diode laser***, ...”). EX1002, ¶158.

Furthermore, Neuberger and Lai are both directed towards the same application, dual-wavelength surgical lasers for cutting and/or coagulating

biological tissues. *See* EX1004, [0011], [0012] (“Another object of the present invention is to provide a medical diode laser system that allows for simultaneous ***coagulation, and cutting or ablating of tissue.***”), [0017] (“The present invention provides a device that allows for concurrent transmission of at least two wavelengths or at least two power densities which can for example ***simultaneously cut or vaporize and coagulate tissue.***”); EX1010, [0084] (“Laser system 500 is a dual-wavelength surgical laser system consisting of ***a laser 510 for tissue explosive ablation and a laser 520 for tissue coagulation.***”). Indeed, just like Neuberger, Lai teaches that either continuous or pulsed lasers can be utilized. EX1004, [0029] (“In yet another embodiment of the present invention pulsed laser radiation is used for ablation, and continuous wave radiation is used for coagulation purposes. ... In this alternative, the **inner core area** (in the concentric core arrangement described above) is used to transmit the pulsed radiation, while the surrounding **outer core** carries the continuous wave radiation.”), claim 4 (“wherein said radiation from a first source is pulsed and from a second source is a continuous wave.”); EX1010, [0062], [0084] (“The laser 510 can be either [diode-pumped Nd:YAG] laser system 100, 200, 300, or 400 [that is quasi-CW Q-switched and intracavity-frequency-doubled to produce a laser output 90 of short pulses and high pulse fluence]. The laser 520 can be continuous wave 1064 nm Nd:YAG laser, ... 800-1000 nm diode laser...”). The combination amounts to nothing more than combining well-known prior art

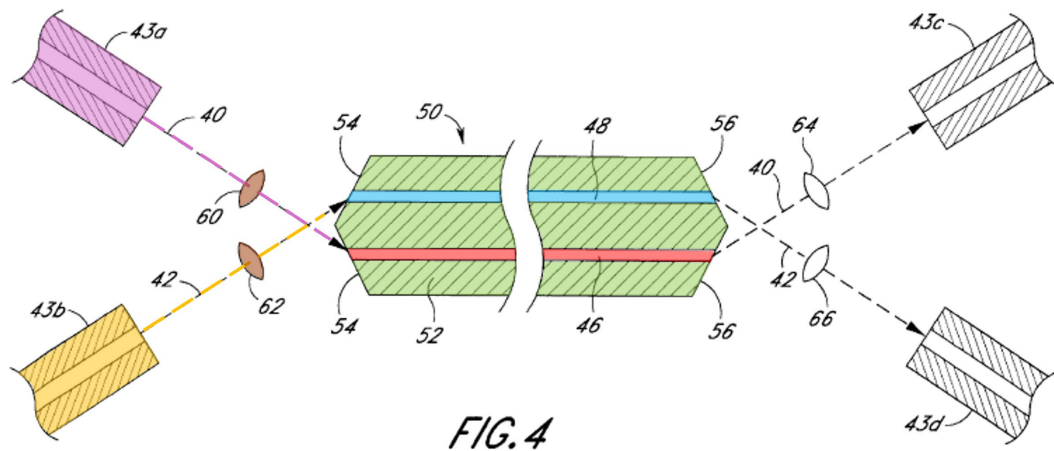
elements—Neuberger’s multicore output fiber that transmits two different wavelengths for surgical applications using the same types of lasers taught in Neuberger but in the specific configuration taught by Lai to achieve output powers that would have been suitable for either coagulation or ablation—the latter of which would predictably produce an output laser beam having powers that exceed 1 kW with a reasonable expectation of success. Accordingly, a POSITA would have been motivated to utilize the teachings of Lai to utilize Lai’s “short pulse high peak power visible laser” for ablation purposes as Neuberger teaches the same type of desire to achieve ablation using a similar type of laser. *See* EX1010, Figure 5. EX1002, ¶159-161.

3. Claim 10

- a) [10Pre] The system of claim 1, further comprising a switchable device coupled between the first and second optical fibers and the multi-clad fiber,
- b) [10A] wherein the switchable device is configured to electively couple the first input laser beam at least into the inner fiber core of the multi-clad fiber and the second input laser beam at least into the at least one outer ring core of the multi-clad fiber.

Neuberger and Davis render obvious the system of claim 1. *See* Section X.A.1. Neuberger in combination with Davis in further combination with Lai renders obvious [10]. EX1002, ¶162.

As explained in Sections IX.B and X.A.9.b), Davis discloses “optical elements such as lenses 60 and 62 may be used to focus the optical beams 40 and 42 onto the individual cores 46 and 48.” EX1005, 5:43-45; *see also* EX1005, 5:58-65 (describing that “lenses 60 and 62 can be any type of focusing optical elements,” can “refer to either one kind of lens or a combination of lenses,” and can be “close enough” to fiber 50 to focus the beams onto their respective cores). The optical elements are mechanically aligned with the optical beams (40 and 42) and the respective cores (46 and 48) of the multicore fiber using mechanically mobile translation stages. EX1005, 5:46-50 (“...the various optical components may be fixed, for example, within respective mechanical mounts resting upon respective translation stages to control the alignment of the optical beams 40 and 42, which propagate along optical paths within the cores 46 and 48.”). In this way, lenses 60 and 62 can be moved through the translation stages to **electively couple** input beams 40 and 42 into either of cores 46 or 48 of the output fiber, as shown in Figure 4 of Davis.



EX1005, FIG. 4. EX1002, ¶163.

Lai teaches that additional **optical elements** can be utilized to **electively couple** a first input laser beam 40 from a first optical fiber 43a into the fiber end of Neuberger's **inner core 33** and **electively couple** a second input laser beam 42 from a second optical fiber 43b into the fiber end of Neuberger's **outer ring core 32**.

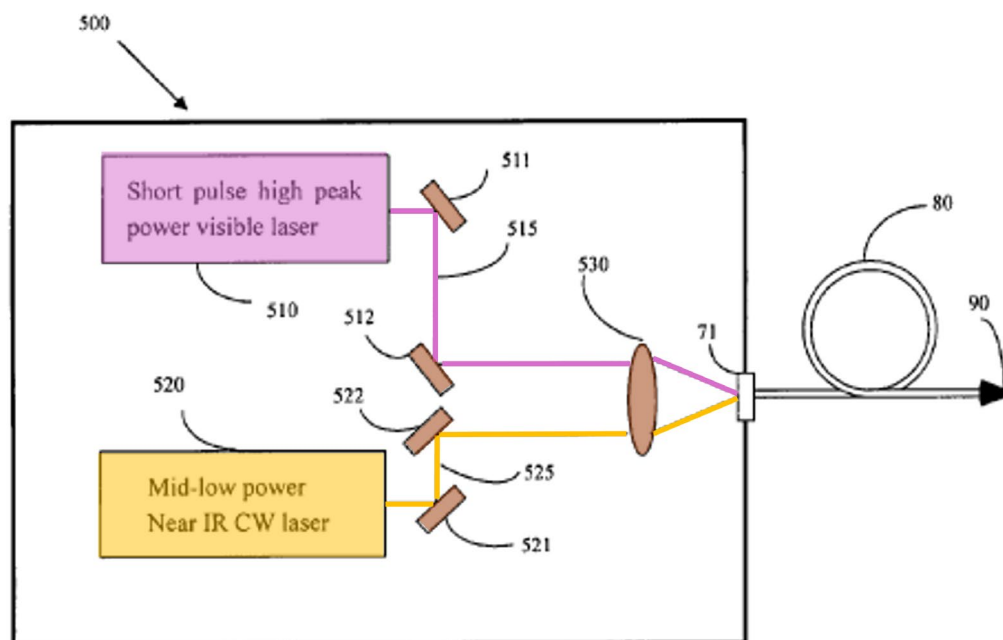
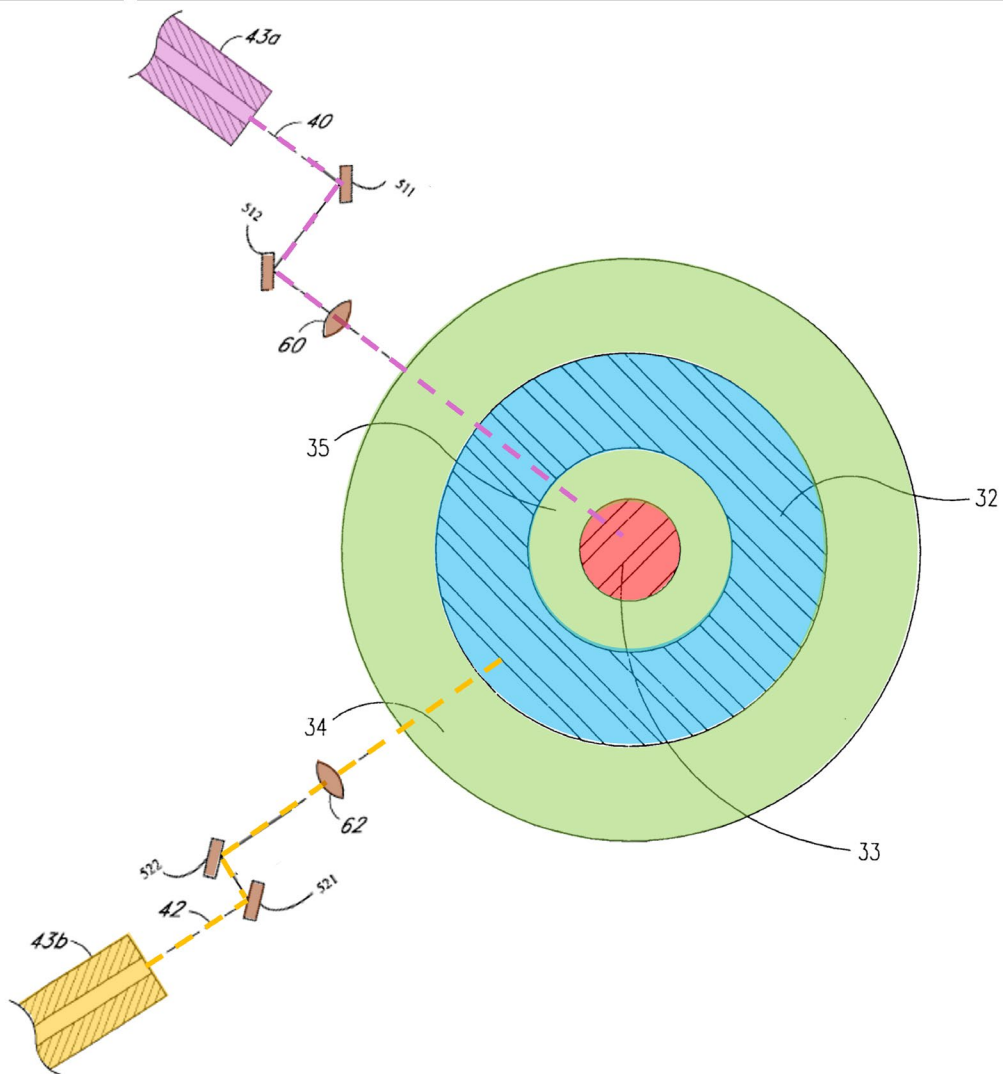


Figure 5

EX1010, FIG. 5. As shown, in addition to the focal lens 530, Lai teaches that “[t]he output beam 515 from the laser 510 propagates in free space and is guided by tuning mirrors 511 and 512 to fiber coupling lens 530. The output beam 525 from the laser 520 propagates in free space and is guided by tuning mirrors 521 and 522 to focal lens 530. After focal lens 530, the beam 515 and beam 525 are both coupled into fiber coupler 71, enter fiber 80 and exit at exit 90.” EX1010, [0084]. EX1002, ¶164-165.

It would have been obvious to utilize such additional optical components, like tuning mirrors 511, 512, 521, and 522 taught by Lai, in conjunction with Davis’ lenses 60 and 62 to achieve the same elective coupling to the inner and outer cores of Neuberger’s multicore output fiber, such as schematically illustrated below.



See EX1010, FIG. 5, EX1005, FIG. 4-6, and EX1004, FIG. 3. EX1002, ¶164.

It would have been a trivial modification to additionally utilize such well-known **mirror elements** to achieve the same predictable result of **coupling** desired laser beams into the desired cores of Neuberger's multicore fiber with a reasonable expectation of success. EX1002, ¶165.

4. Claim 19

- a) [19] The method of claim 11, wherein the output laser beam has a power of at least 1 kW.

Neuberger in combination with Davis in further combination with Lai renders obvious [19] for the reasons provided above in Section X.D.1 for [9]. *See also* Section X.D.2. EX1002, ¶166.

5. Claim 20

- a) [20] The method of claim 11, wherein **coupling** the **first input laser beam** and the **second input laser beam** into the fiber end of the multi-clad fiber comprises: **electively coupling**, by a **switchable device coupled** between the **first** and **second optical fibers** and the fiber end of the multi-clad fiber, one of the **first input laser beam** at least into the **inner fiber core** of the multi-clad fiber and the **second input laser beam** at least into the at least one **outer ring core** of the multi-clad fiber.

Neuberger in combination with Davis in further combination with Lai renders obvious [20] for the reasons provided in Sections X.D.3.a) and X.D.3.b) for [10Pre] and [10A]. *See also* Section X.D.2. EX1002, ¶167.

XI. CONCLUSION

Petitioner respectfully requests that the Board institute *inter partes* review, hold the challenged claims unpatentable, and cancel the challenged claims.

Petition for *Inter Partes* Review of U.S. Patent No. 12,240,054
Claims 1–20

Dated: February 20, 2026

Respectfully submitted,

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IPG Photonics Corp.

CERTIFICATION UNDER 37 C.F.R. § 42.24(d)

I hereby certify that this Petition for *Inter Partes* Review of U.S. Patent No. 12,240,054 has, excluding the portions exempted under 37 C.F.R. § 42.24(a), 13,290 words as counted by the word-processing system used to prepare this document, in compliance with 37 C.F.R. § 42.24(d).

Dated: February 20, 2026

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CERTIFICATE OF SERVICE

Under 37 C.F.R. §§ 42.6(e) and 42.105, the undersigned certifies that on February 20, 2026, complete copies of the foregoing and any accompanying exhibits were caused to be served by sending them via Federal Express Priority Overnight shipping, which is at least as fast and reliable as U.S. Priority Mail Express, to the correspondence address of record for U.S. Patent No. 12,240,054 as indicated in Patent Center:

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