

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

OPTICIS CO., LTD.,

Petitioner,

v.

INNEOS LLC,

Patent Owner.

U.S. Patent No. 7,198,416
Filing Date: January 27, 2005
Issue Date: April 3, 2007
Title: Optical combiner device

Inter Partes Review No.: (Unassigned)

Attorney Client Privileged/Work Product

DECLARATION OF ALAN E. WILLNER, PH.D.

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I, Alan E. Willner, hereby declare as follows:

I. INTRODUCTION

1. I have been retained by counsel for Petitioner, Opticis Co., Ltd. (“Opticis”), to serve as a technical expert witness in this matter.

2. I understand that this declaration will be submitted in support of a Petition for *Inter Partes* Review (IPR) filed by Opticis, which challenges claims 1, 2, 6, 7, and 9 (the “Challenged Claims”) of U.S. Patent No. 7,198,416 (the “’416 Patent,” EX1001). I have been informed that Inneos LLC (“Patent Owner”) is the purported owner of the ’416 Patent.

3. The facts and opinions expressed herein are true and accurate to the best of my knowledge and understanding based on the information I have reviewed to date.

II. QUALIFICATIONS

4. In formulating my opinions, I have relied on my knowledge, training, and experience in the relevant field, which I will summarize briefly. A more detailed account of my background, education, experience, and publications is set forth in my curriculum vitae (CV), which is included as Exhibit A.

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5. I have personal knowledge of the facts and opinions set forth in this declaration and believe them to be true. If called upon to do so, I would testify competently thereto. I have been warned that willful false statements and the like are punishable by fine or imprisonment, or both.

6. I am being compensated for my time at my current standard consulting hourly rate of \$425. I am also being reimbursed for expenses that I may incur during the course of this work. My compensation is not contingent upon the results of my study and analysis, the substance of my opinions, or the outcome of any proceeding involving the Challenged Claims. I have no financial interest in the outcome of this matter or in any litigation involving the '416 Patent.

7. For more than 35 years, I have been involved in several areas of optical technologies, including devices, subsystems, systems, and networks for communications, sensing, and signal processing applications. A key technology that I have worked with is wavelength multiplexing.

8. I have M.S. and Ph.D. degrees in Electrical Engineering from Columbia University, earned in 1984 and 1988, respectively. There, I received the Edwin Howard Armstrong Foundation Memorial Award for being the highest-ranked Electrical Engineering master's student. Additionally, I earned a B.A. in Physics

(1982) and an Honorary Doctorate of Humane Letters (Honoris Causa) (2012) from Yeshiva University.

9. Since 1992, I have been Assistant, Associate, and Full Professor at the University of Southern California (USC). I have also been the Director of the Optical Communications Laboratory at USC since 1992. I am currently a Distinguished Professor and the Andrew & Erna Viterbi Professorial Chair in the Ming Hsieh Department of Electrical and Computer Engineering of the Viterbi School of Engineering at USC.

10. From 1988 to 1990, I worked at AT&T Bell Laboratories as a Postdoctoral Member of the Technical Staff in the Photonics Networks and Components Research Department. From 1990 to 1992, I worked as a Member of the Technical Staff in the Photonics Research Department at Bell Communications Research (Bellcore). My work at both companies focused on wavelength-division-multiplexed (WDM) communication systems.

11. From 1999 to 2002, I co-founded and served as CTO of Phaethon Communications, a company whose technology was acquired by Teraxion and that created the ClearSpectrum® dispersion compensator product line. ClearSpectrum®

was marketed to WDM equipment manufacturers and has been deployed in many commercial systems worldwide.

12. I have received various awards and honors. For example, I received the National Science Foundation Presidential Faculty Fellows Award from the White House, one of 30 recipients in 1994 in all areas of science and engineering. I am also a Member of the U.S. National Academy of Engineering, an International Fellow of the U.K. Royal Academy of Engineering, and a Fellow of the National Academy of Inventors. Moreover, I was the recipient of a Fulbright Foundation Senior Scholars Award, Guggenheim Foundation Fellowship, Packard Foundation Fellowship, and U.S. Dept. of Defense Vannevar Bush Faculty Fellowship (formerly the Defense Security Science and Engineering Faculty Fellowship).

13. Additional awards and honors that I have received include the following: Institute of Electronic and Electrical Engineers (IEEE) Eric Sumner Award for achievement in communications technology; IEEE Photonics Society Engineering Achievement Award; Optica (formerly Optical Society of America, OSA) Paul Forman Engineering Excellence Award; SPIE President's Award; IEEE Photonics Society Distinguished Traveling Lecturer Award; Optica Hopkins Leadership Award; Egleston Medal for Distinguished Engineering Achievement

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from the Columbia University Engineering Alumni Association; Institution of Engineering & Technology (IET) J.J. Thomson Medal for Electronics; Ellis Island Medal of Honor; Civilian Service Commendation Medal from the U.S. Dept. of the Army; IEEE Photonics Society Distinguished Service Award; and IEEE Globecom Best Paper Award. I also received the USC Associates Award for University-Wide Creativity in Research (highest university research award) and the USC Associates Award for University-Wide Excellence in Teaching (highest university teaching award). I am also a Fellow of the American Association for the Advancement of Science (AAAS), American Physical Society, IEEE, IET, Optica, and SPIE.

14. I have served in various professional activities, including: Co-Chair of the U.S. National Academies Committee on the “Optics and Photonics Study: Essential Technologies for Our Nation”; President of the IEEE Photonics Society (~6,000 members); President of Optica (~20,000 members); Co-Chair of the Science and Engineering Counsel of Optica; Chair of the IEEE Technical Activities Board Ethics and Member Conduct Committee; General & Program Co-Chair of the Conference on Lasers and Electro-Optics (CLEO); Chair of the National Photonics Initiative; Program Chair of Telecommunications Engineering at SPIE's Photonics West; General Co-Chair of the IEEE Photonics Society Topical Meeting on

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Broadband Networks; and Chair of the Unclassified Technical Program for the IEEE MILCOM Conference.

15. My editorial positions have included the following: Editor-in-Chief of the IEEE/OSA Journal of Lightwave Technology (JLT); Editor-in-Chief of OSA Optics Letters; Editor-in-Chief of the IEEE Journal of Selected Topics in Quantum Electronics; Associate Editor of the IEEE Journal of Selected Areas in Communications (JSAC) Series on Optical Networks; and Guest Editor of JLT and the IEEE JSAC for the Joint Special Issue on Multiple-Wavelength Technologies & Networks.

16. I have been a Member of the U.S. Army Science Board and a Member of the Defense Sciences Research Council (a 16-member body that provided reports to DARPA Director & Office Directors). I have also served on many technical advisory boards, especially for small companies.

17. I have >1700 publications, including 1 book, ~10 edited books, ~25 book chapters, ~54 keynotes/plenaries, >450 referred journal papers, and >300 invited papers/presentations. I am a named inventor on >45 published U.S. patents in the fields of optical technologies, communication systems, signal processing, and

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networks. According to Google Scholar, my publications have been cited over 40,000 times.

18. I have published hundreds of papers with the words “wavelength” or “WDM” in the title, not to mention many hundreds more that involve optical wavelength-dependent technologies in the papers themselves. One noteworthy example is a paper published in *WDM Solutions Magazine* (Alan E. Willner, "Tunable Compensators Master Chromatic-Dispersion Impairments," *WDM Solutions Magazine*, pp. 51-62, July 2001). This paper received the 2001 Eddy Paper Award from Pennwell Publications for the Best Contributed Technical Article, and the selection committee considered papers from across all 30 magazines in Pennwell's Advanced Technology Division.

19. Over the past approximately 35 years, I have taught full and short courses (at universities and international conferences) on a variety of subjects, including optical fiber communication systems. I have taught thousands of students, including >60 graduate students who obtained their Ph.D. degrees under my guidance.

20. I have testified as an expert at trial or by deposition 7 times during the previous four years, as described in the following list:

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- *Capella Photonics v. Infinera*, 2:20-CV-0077-JRG (E.D. Tex.)
- *Cosemi v. Everpro, Logitech, Fibbr, and Facebook*, 337-TA-1233, “Certain Active Optical Cables and Products Containing the Same” (ITC)
- *Unified Patents v. OPTIC 153*, IPR2021-00932 (PTAB)
- *Branch Banking and Trust Co. v. Hitachi Vantara Corp.*, 1:19-CV-1168 (M.D.N.C.)
- *Zhejiang Crystal-Optech Co. v. Viavi Solutions Inc.*, IPR2022-01183 (PTAB)
- *Viavi Solutions Inc. v. Zhejiang Crystal-Optech Co.*, 2:21-CV-0378-JRG (E.D. Tex.)
- *WSOU Investments, LLC D/B/A Brazos Licensing and Development v. Xilinx, Inc.*, 20-cv-1231-GBW-JLH (D. Del.)

21. I consider myself to be an expert in the field relevant to the subject matter of the ’416 Patent and to have the capability to understand and assess the relevant art and the level of skill and experience of a person of ordinary skill in the art (“POSITA”) to which the ’416 Patent is directed as of the time of the earliest priority date (July 17, 2003). *See* below, Section VII(D)(i) (describing a POSITA in the field relevant to the subject matter of the ’416 Patent).

III. MATERIALS CONSIDERED

22. The analysis that I provide in this Declaration is based on my experience, as well as the documents I have considered, including the ’416 Patent

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(EX1001). I have also reviewed the prosecution history of the '416 Patent (EX1002) and the materials listed and discussed below.

23. My opinions are also based upon my knowledge, education, experience, research, and training in the field that I have accumulated over the years.

IV. SUMMARY OF OPINIONS

24. It is my opinion that the Challenged Claims of the '416 Patent would have been obvious to a POSITA as of the '416 Patent's earliest asserted priority date.

25. The optical combiner of the '416 Patent – including its particular combination of lasers, collimating lenses, focusing lens, and optical fiber – was well known in the field by July 2003. By this time, such devices were an important part of research and development for academics and industry, in particular, due to the increased communication needs – brought about in part by the growth of the Internet – in the mid-1990s and later. By this time, optical combiners using radial arrangements of lasers and collimating lenses, together with a focusing lens focusing the output onto an optical fiber, were well known.

26. As I understand the prosecution history, the examiner in this case allowed the claims over an anticipatory reference because the Applicant swore behind the reference, alleging a priority date as early as July 17, 2003. There is

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nothing particularly special about this date. Even if the examiner were correct to discard Bhandarkar (EX1013) as prior art¹, there remained prior art and background technology at that time, spurred in part by the increased communication needs brought about by the growth of the Internet in the mid-1990s and later, which, in my opinion, taught the optical combiner of the '416 Patent. The Challenged Claims recite a known arrangement of optical components (collimating lenses and a focusing lens) for multiplexing light of different wavelengths from different sources onto an optical fiber.

27. Furthermore, having collimated light from the collimating lenses pass through separate radial sectors of a focusing lens (as opposed to, for example, a linear arrangement of collimating lenses) was also known. As I explain below, the requirement of separate radial sectors is a by-product of having the collimating

¹ As I have been informed that the '416 Patent may not be entitled to the July 17, 2003 priority date, and that Bhandarkar (EX1013) would thus be prior art, I address that reference below in Ground 5. For Grounds 1-4, I have assumed for the sake of argument that the '416 Patent is entitled to this priority date.

lenses radially arranged about a center axis of the focusing lens, which was known in the art.

28. In sum, the various elements claimed by the '416 Patent, and shown in the references (e.g., EX1004, EX1005, EX1006, EX1013), were well known and, at this time in the field, generally interchangeable such that a POSITA would have been motivated to combine them and have had a reasonable expectation of success.

29. I understand that the Petition includes five Grounds, which are summarized below:

<u>Ground</u>	<u>Reference(s)</u>	<u>Basis</u>	<u>Claim(s)</u>
Ground 1	Kurita (EX1004)	§ 103	1, 2, 6, 7, 9
Ground 2	Kurita (EX1004) in view of LaMarche (EX1005) and/or Lemoff (EX1006)	§ 103	1, 2, 6, 7, 9
Ground 3	Lemoff (EX1006)	§ 103	1, 2, 6, 7, 9
Ground 4	Lemoff (EX1006) and LaMarche (EX1005)	§ 103	1, 2, 6, 7, 9
Ground 5	Bhandarkar (EX1013)	§ 103	1, 2, 6, 7, 9

30. In my opinion, the Challenged Claims of the '416 Patent would have been obvious on each of these Grounds. The details of my opinions are set forth

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below. As the prior art demonstrates, each element of the Challenged Claims is disclosed or at least rendered obvious, as is their claimed arrangement.

V. LEGAL STANDARDS

31. I am a technical expert and not a lawyer. Therefore, in formulating the opinions and conclusions set forth in this Declaration, I have been provided with an understanding of the prevailing principles of U.S. patent law that govern the issues of patent claim construction and obviousness.

32. I have been informed that a determination of whether the claims of a patent would have been obvious to a POSITA in view of prior art is a two-step analysis: (1) determining the meaning and scope of the claims, and (2) comparing the properly construed claims to the prior art. I have followed that framework in providing the opinions and analysis set forth herein.

A. Claim Construction

33. I understand that the primary focus in determining the meaning of a claim limitation is to consider the intrinsic evidence of record, which includes the claims, the specification, and the prosecution history, from the perspective of a POSITA. I understand that claims must be adequately grounded in the specification

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and the meaning of claim terms must be discerned in the context of the disclosed invention and in the field of art.

34. I further understand that extrinsic evidence, which includes information external to the patent's claims, specification, and prosecution history, such as expert and inventor testimony, dictionaries, and textbooks, may also be considered, but may not be used to contradict or override the intrinsic evidence.

35. I also understand that the words used in a claim are generally given their plain and ordinary meaning as understood by a POSITA in question at the time of the invention. If a disputed term has no previous meaning to those of ordinary skill in the art, the meaning must be found elsewhere in the patent, including the meaning given by the term's usage in the specification.

B. "Means-Plus-Function" Claims

36. I have been informed that a somewhat different claim construction analysis applies with respect to means-plus-function claim elements. As to such claim elements, I am informed that a claim element can be expressed in a manner that recites a means or step for performing a specified function without the recital of structure, material, or acts in support thereof. I am further informed that, for such a claim, the claim is to be construed to cover the structure, material, or acts described

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in the patent specification for performing the recited function and equivalents thereof. Thus, in construing such claims, one must consult the patent specification in order to determine the relevant structures for performing the recited function.

37. Therefore, I am informed that one must first determine whether an asserted claim element invokes the means-plus-function framework. I further understand that if the word “means” appears in a claim element in association with a function, one should presume that such claim element is a means-plus-function element.

38. To summarize, I am informed and understand that to construe claim elements identified as means-plus-function elements, one must: a) identify the function of the element; b) identify the structure, material and/or acts in the patent specification corresponding with the function; and c) define the claim element to mean the structures, materials and/or acts disclosed in the patent specification and their structural equivalents.

C. Obviousness

39. I have been informed that a person cannot obtain a patent on an invention if the differences between the invention and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was

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made to a POSITA. I have been informed that a conclusion of obviousness may be founded upon more than a single item of prior art. I have been further informed that obviousness is determined by evaluating the following factors: (1) the scope and content of the prior art, (2) the differences between the prior art and the claim at issue, (3) the level of ordinary skill in the pertinent art, and (4) secondary considerations of non-obviousness. In addition, the obviousness inquiry should not be done in hindsight. Instead, the obviousness inquiry should be done through the eyes of a POSITA at the time of the alleged invention.

40. In considering whether certain prior art renders a particular patent claim obvious, I have been informed that I can consider the scope and content of the prior art, including the fact that one of skill in the art would regularly look to the disclosures in patents, trade publications, journal articles, conference papers, industry standards, product literature and documentation, texts describing competitive technologies, requests for comment published by standard setting organizations, and materials from industry conferences, as examples. I have been informed that for a prior art reference to be proper for use in an obviousness analysis, the reference must be “analogous art” to the claimed invention. I have been informed that a reference is analogous art to the claimed invention if: (1) the reference is from

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the same field of endeavor as the claimed invention (even if it addresses a different problem); or (2) the reference is reasonably pertinent to the problem faced by the inventor (even if it is not in the same field of endeavor as the claimed invention). I understand that in order for a reference to be “reasonably pertinent” to the problem, it must logically have commended itself to an inventor’s attention in considering the problem. In determining whether a reference is reasonably pertinent, one should consider the problem faced by the inventor, as reflected either explicitly or implicitly, in the specification. All of the references I considered in forming my opinions in this IPR are well within the range of references a POSITA would have consulted to address the type of problems addressed by the claims of the ’416 Patent.

41. I have been informed that, in order to determine if a claim would have been obvious based on a combination of prior art elements, a clear articulation of the reason(s) why a claim would have been obvious must be provided. Specifically, I am informed that, under the U.S. Supreme Court’s decision in *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 401 (2007) (“KSR”), a combination of multiple items of prior art renders a patent claim obvious when there was an apparent reason for one of ordinary skill in the art, at the time of the invention, to combine the prior art, which can include, but is not limited to, any of the following rationales: (A)

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combining prior art methods according to known methods to yield predictable results; (B) substituting one known element for another to obtain predictable results; (C) using a known technique to improve a similar device in the same way; (D) applying a known technique to a known device ready for improvement to yield predictable results; (E) trying a finite number of identified, predictable potential solutions, with a reasonable expectation of success; (F) identifying that known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art; or (G) identifying an explicit teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine the prior art references to arrive at the claimed invention. I am also informed that, where there is a motivation to combine, claims may be prima facie obvious provided a POSITA would have had a reasonable expectation of success regarding the proposed combination.

42. I am informed that the existence of an explicit teaching, suggestion, or motivation to combine known elements of the prior art is a sufficient, but not a necessary, condition to a finding of obviousness. This so-called “teaching-

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suggestion-motivation” test is not the exclusive test and is not to be applied rigidly in an obviousness analysis. In determining whether the subject matter of a patent claim would have been obvious, neither the particular motivation nor the avowed purpose of the patentee controls. Instead, the important consideration is the objective reach of the claim. In other words, if the claim extends to what is obvious, then the claim is invalid. I am further informed that the obviousness analysis often necessitates consideration of the interrelated teachings of multiple patents, the effects of demands known to the technological community or present in the marketplace, and the background knowledge possessed by a POSITA. All of these issues may be considered to determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent.

43. I am also informed that, in conducting an obviousness analysis, a precise teaching directed to the specific subject matter of the challenged claim need not be sought out because it is appropriate to take account of the inferences and creative steps that a POSITA would employ. The prior art considered can be directed to any need or problem known in the field of endeavor at the time of invention and can provide a reason for combining the elements of the prior art in the manner claimed. In other words, the prior art need not be directed towards solving the same

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specific problem as the problem addressed by the patent. Further, the individual prior art references themselves need not all be directed towards solving the same problem. I am informed that, under the KSR obviousness standard, common sense is important and should be considered. Common sense teaches that familiar items may have obvious uses beyond their primary purposes.

44. I also am informed that the fact that a particular combination of prior art elements was “obvious to try” may indicate that the combination was obvious even if no one attempted the combination. If the combination was obvious to try (regardless of whether it was actually tried) or leads to anticipated success, then it is likely the result of ordinary skill and common sense rather than innovation. I am further informed that in many fields it may be that there is little discussion of obvious techniques or combinations, and it often may be the case that market demand, rather than scientific literature or knowledge, will drive the design of an invention. I am informed that an invention that is a combination of prior art must do more than yield predictable results to be non-obvious.

45. I am informed that for a patent to be obvious, the claim must be obvious to a POSITA at the time of the alleged invention. I am informed that the factors to consider in determining the level of ordinary skill in the art include (1) the

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educational level and experience of people working in the field at the time the invention was made, (2) the types of problems faced in the art and the solutions found to those problems, and (3) the sophistication of the technology in the field. *See* §VII.D.i below.

46. I am informed that it is improper to combine references where the references teach away from their combination. I am informed that a reference may be said to teach away when a POSITA, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the patent applicant. In general, a reference will teach away if it suggests that the line of development flowing from the reference's disclosure is unlikely to be productive of the result sought by the patentee. I am informed that a reference teaches away, for example, if (1) the combination would produce a seemingly inoperative device, or (2) the references leave the impression that the product would not have the property sought by the patentee. I also am informed, however, that a reference does not teach away if it merely expresses a general preference for an alternative invention but does not criticize, discredit, or otherwise discourage investigation into the invention claimed.

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47. I am informed that even if a prima facie case of obviousness is established, the final determination of obviousness must also consider “secondary considerations” if presented. I understand that, in most instances, the patentee raises these secondary considerations of non-obviousness. In that context, the patentee argues a purported invention would not have been obvious in view of these considerations, which include: (a) commercial success of a product due to the merits of the claimed invention; (b) a long-felt, but unsatisfied need for the invention; (c) failure of others to find the solution provided by the claimed invention; (d) deliberate copying of the invention by others; (e) unexpected results achieved by the invention; (f) praise of the invention by others skilled in the art; (g) lack of independent simultaneous invention within a comparatively short space of time; and (h) teaching away from the invention in the prior art.

48. I am further informed that secondary considerations evidence is only relevant if the offering party establishes a connection or nexus between the evidence and the claims. The nexus cannot be based on prior art features. While I understand that the Patent Owner here has not offered any secondary considerations evidence at this time, I reserve the right to supplement my opinions in the event that the Patent Owner raises secondary considerations during the course of this proceeding.

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D. Priority Date based on a Provisional Application

49. I have been informed that when a reference patent is considered prior art under 35 U.S.C. § 102(e) based on the filing date of its corresponding provisional application, that a reference patent is only entitled to claim the benefit of the filing date of its provisional application if the disclosure of the provisional application provides support for the claims in the reference patent in compliance with 35 U.S.C. § 112, ¶ 1. If the provisional application provides support for the claims, then the priority date of the patent is the provisional filing date. If not, the patent's priority date is the filing date of the non-provisional application.

50. I have been informed that there is written description support if a patent specification describes the claimed invention in sufficient detail that one skilled in the art can reasonably conclude that the inventor had possession of the claimed invention. I have also been informed that, while there is no *in haec verba* requirement, claims or claim limitations must be supported in the specification through express, implicit, or inherent disclosure. I have been informed that there is support for the claimed invention to be enabled if any person skilled in the art can make and use the invention without undue experimentation.

VI. TECHNOLOGY BACKGROUND

51. In this section, I provide a brief overview of the background art as understood by a POSITA as of July 17, 2003.

52. I understand that the '416 Patent issued from an application filed on January 7, 2005; that it claims priority to a provisional application filed on February 4, 2004; and that during prosecution, Applicant swore behind a reference by asserting a priority date as early as July 17, 2003. While I understand that Opticis does not concede that the Challenged Claims are entitled to either the July 17, 2003 priority date asserted during prosecution, or even the provisional priority date of February 4, 2004, I am applying the July 17, 2003 date to be conservative.² If one or more of the claims are entitled only to a later priority date, it will not affect my analysis of the background art.

² This is for purposes of the technology background. Ground 5, as discussed below, is based on the '416 Patent being entitled priority only to either the provisional application date or the non-provisional application date.

A. Wavelength Division Multiplexing

53. “Wavelength division multiplexing” or “WDM” very often refers to technologies in which multiple independent data-carrying optical carrier waves of different wavelengths are multiplexed into a single fiber. Because information is carried on optical signals of different wavelengths that can be combined/separated and do not – to first order – interact, it can be simultaneously transmitted on the same fiber without significant interference, thereby increasing capacity.

54. “Optical multiplexing device[s] which spatially combine[] multi-wavelength light from a plurality of lasers into an optical fiber” for use in “optical communication” are known, and have been known since before the alleged invention of the '416 Patent. EX1001, 1:13-16 (background of the invention). Such devices are used because, among other reasons, “[b]y transmitting several channels at different optical wavelengths into a fiber (i.e., wavelength division multiplexing, or WDM), bandwidth may be more efficiently utilized.” EX1001, 1:31-34 (background of the invention).

55. Although wavelength division multiplexing (WDM) dates back to well before the dramatic growth of the Internet, the technology took off in the mid-1990s due to the increased communication needs brought about, in part, by the explosion

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of the Internet. EX1008 at 14. By 1998, there was intense interest in research and development related to WDM: “Long-distance providers see WDM as their saving grace, a technology that will allow them to use their existing infrastructure, since WDM works on most existing fiber, to realize a huge bandwidth boost.” EX1008 at 14. One way to improve bandwidth in such systems is to provide for enhanced optical components. EX1008 at 15. Accordingly, improving optical components in a WDM device intended for optical communications was something that a person of ordinary skill in the art at the time of the alleged invention would have been highly motivated to do.

56. As WDM involves combining multi-wavelength light from multiple sources, the use of WDM devices for optical communications typically necessitates coupling multiple wavelengths into an optical fiber. Among the techniques that were known at the time to accomplish this are lens-based systems, as described in the immediately following subsection.

B. Lenses for Coupling Light of Multiple Lasers

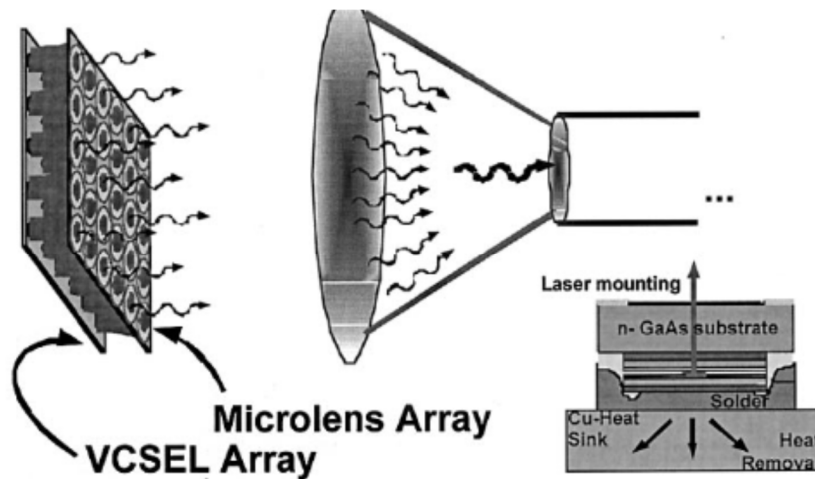
57. As noted in the '416 Patent, known devices for coupling light of multiple lasers included optical combiners that “utilize[] collimators [i.e., collimating lenses] and a focusing lens to concentrate multiple output beams to

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increase power density; see Lee et al U.S. Pat. No. 5,377,287.” EX1001, 1:56-59 (background of the invention). The device described in Lee et al U.S. Pat. No. 5,377,287, for example, “combines the outputs of, for example, 19 passive optical fibers arranged concentrically together with 19 collimating lenses and a Fresnel focusing lens.” EX1001, 1:59-62 (background of the invention). Lee was not unique in this respect, as coupling the outputs of multiple lasers into fiber using collimating lenses and a focusing lens was common by the time of the alleged invention of the ’416 Patent.

58. For example, the article “Collimating Diode Laser Beams from a Large-Area VSCEL-Array Using Microlens Array,” by Chen et al., had the same laser-collimating-focusing-fiber setup as that described in the ’416 Patent. *See* EX1011 at Abstract, FIG. 2. In the system of Chen, a 2-dimensional array of lasers was “coupled ... to a matched microlens array to individually collimate light from each laser.” *Id.* at Abstract. And “[u]sing a 1-cm diameter F2 lens, [they] were able to focus the collimated beams to a spot of 400 um in diameter and to couple more than 75% of the array power into a 1-mm core fiber,” as illustrated in FIG. 2 of Chen:

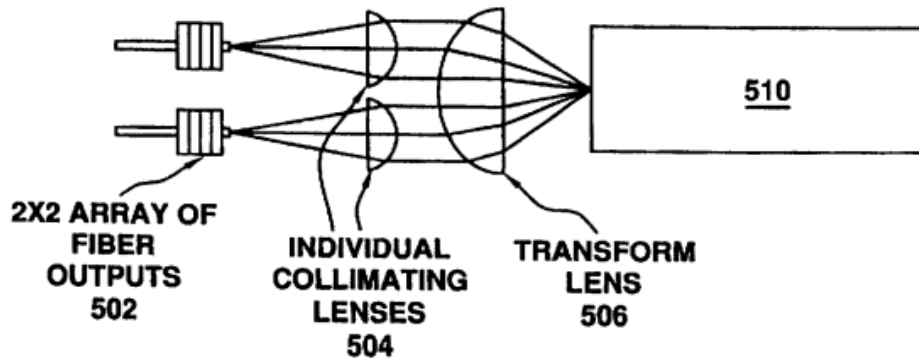
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See id. As discussed in more detail below, including collimating lenses between the source and focusing lens was a common way to maximize efficiency. *Id.* at 507.

59. U.S. Patent No. US 5,715,270 to Zediker et al. (“Zediker”) (EX1007), which issued February 3, 1998, is another example of the same laser-collimating-focusing-fiber setup described in the ’416 Patent. Zediker “relates generally to diode laser array systems,” and “[m]ore specifically, ... to high efficiency, high power direct diode laser systems.” EX1007, 1:6-9. FIG. 9 of Zediker is reproduced below.

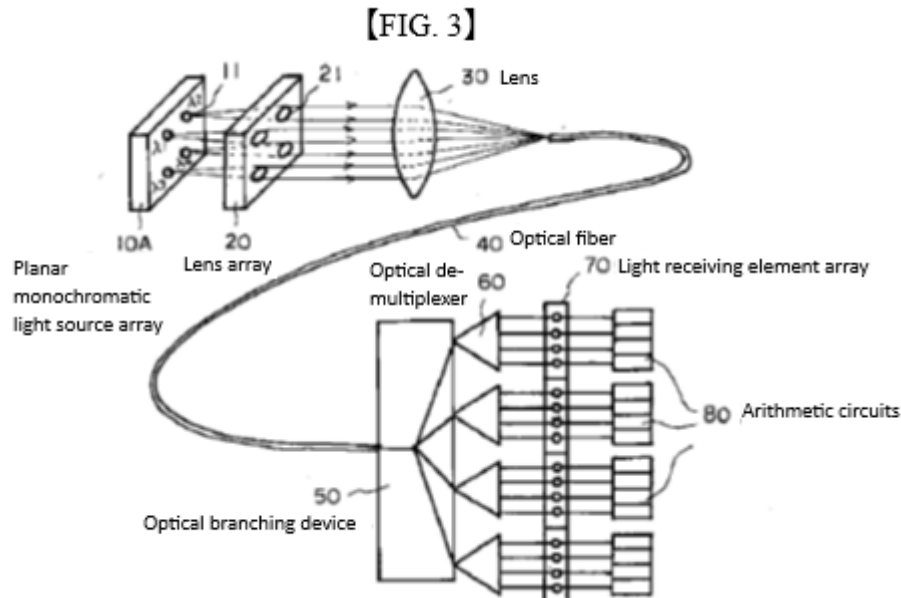
FIG.9



60. FIG. 9 of Zediker depicts an example system having a 2x2 array of fiber outputs 502 (also described as N fiber outputs 502); and N collimating lenses 504 which receive output beams from 502; and a transform lens 506 which focuses the N output beams onto a single spot, which is laser head 510. EX1007, FIG. 9, 9:10-25. The patent further explains that laser rod 510 “advantageously can be replaced by either a rare-earth doped optical fiber or a dye laser, i.e., any laser amplifying medium can be serially coupled to head 500.” EX1007, 9:22-25. Just like the ’416 Patent, the arrangement shown above in FIG. 9 has a 2x2 array of light sources 502, with associated collimating lenses 504, that pass laser light to radial sectors of a focusing lens 506 for focusing into a fiber 510. The component setup of ’416 Patent was commonplace by 2003.

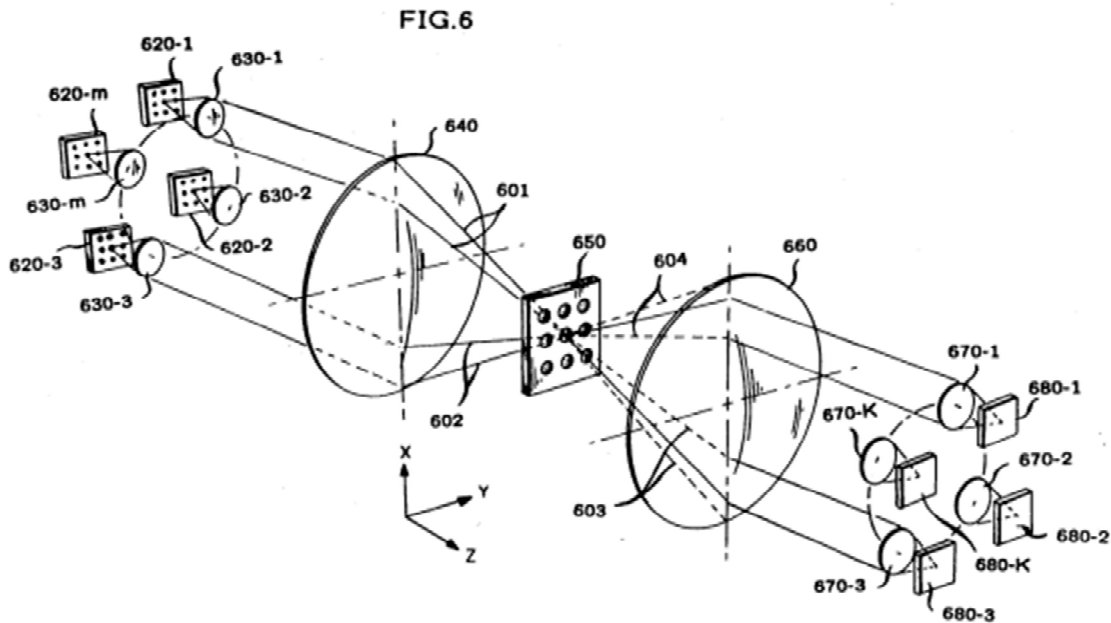
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61. Additionally, the references used in the grounds of the accompanying IPR Petition, and that I will address in more detail in subsequent sections of my report, provide for such lens-based optical devices specifically for WDM. Kurita (EX1004), LaMarche (EX1005), and Lemoff (EX1006) each use a lens arrangement. For example, Kurita discloses a lens array 20 for collimating light from light source array 10A and a lens 83 for focusing that light onto an optical fiber 40, as shown in FIG. 3 reproduced below.



62. Likewise, LaMarche discloses a circular array of lenses 630-1 through 630-M that collimate light received from an array of light sources 620-1 through

620-M into pupil lens 640 which converges the beams on its focal plane, as shown in FIG. 6 reproduced below.



63. Similarly, Lemoff discloses optical imaging element 220, which is a bi-convex lens which images the signal received from the light emitting area (apertures 120) to the signal-receiving area (the core of optical fiber 50), as shown in FIG. 2 reproduced below. Lemoff further discloses that “[v]arious embodiments of the invention may use optical imaging elements that include a plano-convex lens, a graded-index (GRIN) lens, a diffractive optical element, a Fresnel lens, another type of lens, or any arrangement of one or more optical components functioning to image

the optical signal components from the signal-emitting area onto the signal-receiving area.” EX1006, 6:16-22.

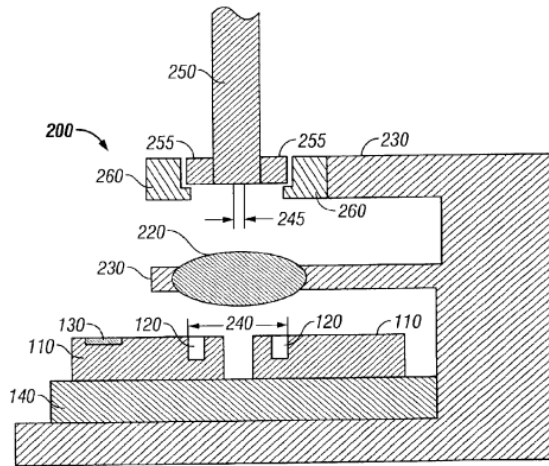


FIG. 2

64. In short, and as confirmed by the admitted prior art of the '416 Patent, contemporary journal articles and patent references, and the specific references used in the grounds in the accompanying IPR Petition, the use of multi-lens designs in WDM devices was well known as of the time of the alleged invention of the '416 Patent. In particular, as confirmed by these sources, it was well known to use a set of collimating lenses in conjunction with a focusing lens. That is, these are standard optical components, their combination was well known, and it was well within the skill of a POSITA to arrange these components together within the context of an optical device that multiplexes light from multiple sources into a single optical fiber.

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Thus, there was nothing inventive about the particular source–collimating lenses–focusing lens–optical fiber arrangement of the '416 Patent.

C. Coupling Efficiency

65. A reason that collimating lenses were commonly used is for improving coupling efficiency.

66. One key consideration in the design of optical devices is coupling efficiency, and, in particular, all other things being equal, the desire to improve coupling efficiency subject to other engineering trade-offs. Coupling loss, in connection with a WDM device that couples multiple wavelengths of light into an optical fiber, refers to the part of an input signal that does not reach the optical fiber. Such losses may result from different physical means. The desire to improve coupling efficiency, and the reasons for coupling loss, would have been well known to a POSITA at the time of the alleged invention.

67. For example, the optical literature describes that coupling efficiency may be improved with a two-lens system: “Couplers with two lenses show a higher coupling efficiency than one lens coupler, because the necessary refraction of the laser diode beam is divided between both lenses. The result is a lower aberration loss of the first lens (at the laser diode) and still negligible loss of the second lens.”

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EX1010 at 48; *see also id.* at 46 (“It is well known that coupling units with only a single lens always exhibit a lower coupling efficiency than couplers with two lenses....”).

68. Kurita confirms that reducing optical losses is an important goal. *See* Kurita (EX1004) at ¶[0005] (“The objects of the present invention lie in providing light connections elements and light connection devices by attempting to reduce the number of component parts and the costs as well as attempting to hold down optical losses.”) Similarly, Lemoff confirms that efficient coupling between a signal emitter (such as the laser diode light source) and the optical conduit (such as the optical fiber) is desirable. *See* Lemoff (EX1006) at 4:66-5:2 (“An efficient coupling between the optical signal emitter and the optical conduit, is usually desirable. That is, a substantial portion of each of the optical signal components emitted should enter the optical conduit.”)

69. Similarly, another article from an optical journal confirms that providing a microlens array and a focusing lens to cause the light from a vertical-cavity surface-emitting laser (VCSEL) array to converge onto a fiber results in high coupling efficiency. *See* EX1011 at 506 (describing results as within 20% of

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theoretical limit), 508 (describing use of microlens array for collimating followed by a F2 lens to converge beam onto 400 μm spot of fiber core).

VII. THE '416 PATENT

A. Summary of the '416 Patent

70. U.S. Patent No. 7,198,416 to Ray et al. (“the '416 Patent”) is titled “Optical combiner device,” and was filed on January 27, 2005. I understand that the '416 Patent claims priority to Appl. No. 60/541,573, which was filed February 4, 2004. I further understand that, during prosecution, the Applicant asserted an even earlier priority date, as I discuss in the section describing the prosecution history. *See below, Section VII(C).*

71. The '416 Patent is directed to an optical multiplexing device which spatially combines multi-wavelength light from a plurality of lasers into an optical fiber. '416 Patent, 1:13-16. The '416 Patent admits that “wavelength division multiplexed optical communication systems” were known “[i]n [the] prior art,” and that it was known that “transmitting several channels at different optical wavelengths into a fiber (i.e., wavelength division multiplexing, or WDM)” allowed for “bandwidth” to “be more efficiently utilized.” '416 Patent, 1:21-34.

72. The '416 Patent admits "[t]he prior art ... includes an optical power combiner which utilizes collimators and a focusing lens to concentrate multiple output beams to increase power density," referring to U.S. Pat. No. 5,377,287 to Lee et al. '416 Patent, 1:56-59. The '416 Patent distinguishes its invention from that of the Lee patent by noting that "[t]he present invention, in contrast [with the concentrically arranged optical fibers and collimating lenses of Lee], uses a separate radial sector of the focusing lens to focus each separate laser output." '416 Patent, 1:65-67.

73. The '416 Patent provides a number of embodiments. The first embodiment is shown in FIGS. 1-4. EX1001, 2:46-54, 3:7-49. FIGS. 1 and 3 are reproduced below.

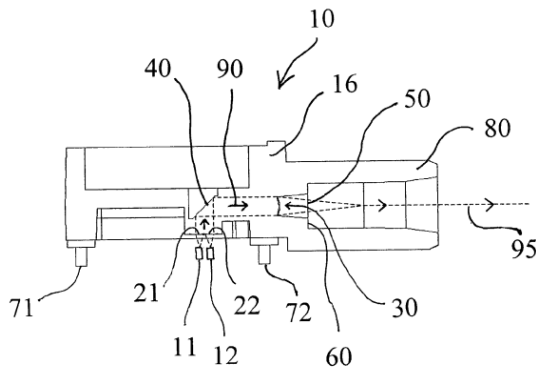


Fig. 1

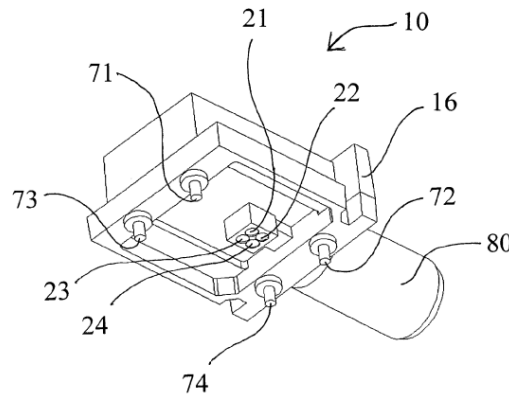


Fig. 3

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74. As shown and described, the first embodiment is an optical combiner 10 having four spaced-apart collimating lenses 21, 22, 23, 24 and output focusing lens 30. Lasers 11, 12 are located at the focal point of the collimating lenses, reflected off a prism 40, and focused by focusing lens 30 onto a single spot at which a single optical fiber (not shown) is stopped by fiber stop or seat 60 formed in ferrule 80. EX1001, 3:7-49.

75. A second embodiment is shown in FIGS. 5-6. EX1001, 2:54-58, 3:50-60. FIGS. 5-6 are reproduced below.

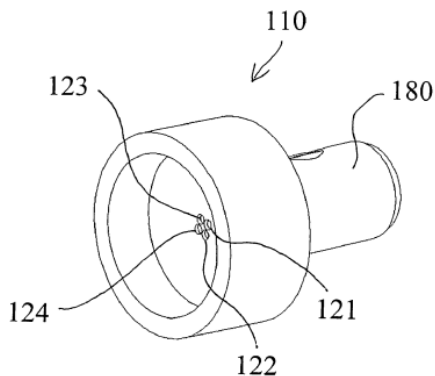


Fig. 5

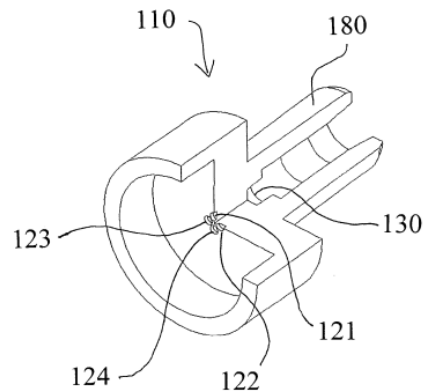


Fig. 6

76. As shown and described, the second embodiment is an optical combiner 110 which does not include a prism for translating the optical beams from one axis to another (as did the first embodiment). As in the first embodiment, there is a two-dimensional array of four lenses 121, 122, 123, 124 for collimating the input light signals from a two-dimensional, two-by-two, array of lasers (not shown), a single focusing lens 130, and a fiber connector 180 that allows one to place a fiber optic cable into the pre-aligned connector. EX1001, 3:50-60.

77. A third embodiment is shown in FIGS. 7-9. EX1001, 2:59-65, 3:61-4:34. FIGS. 7-8 are reproduced below.

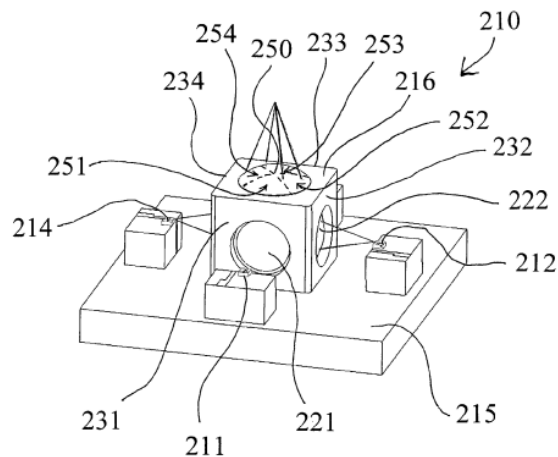


Fig. 7

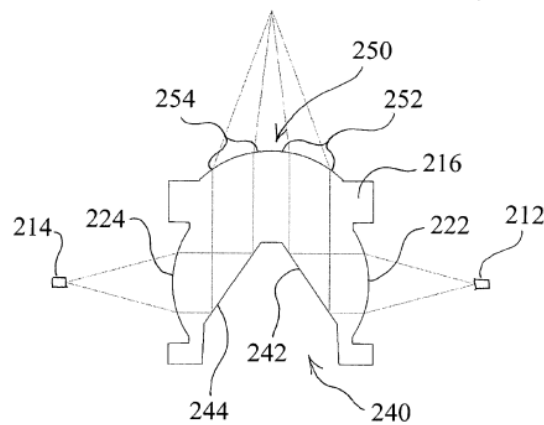
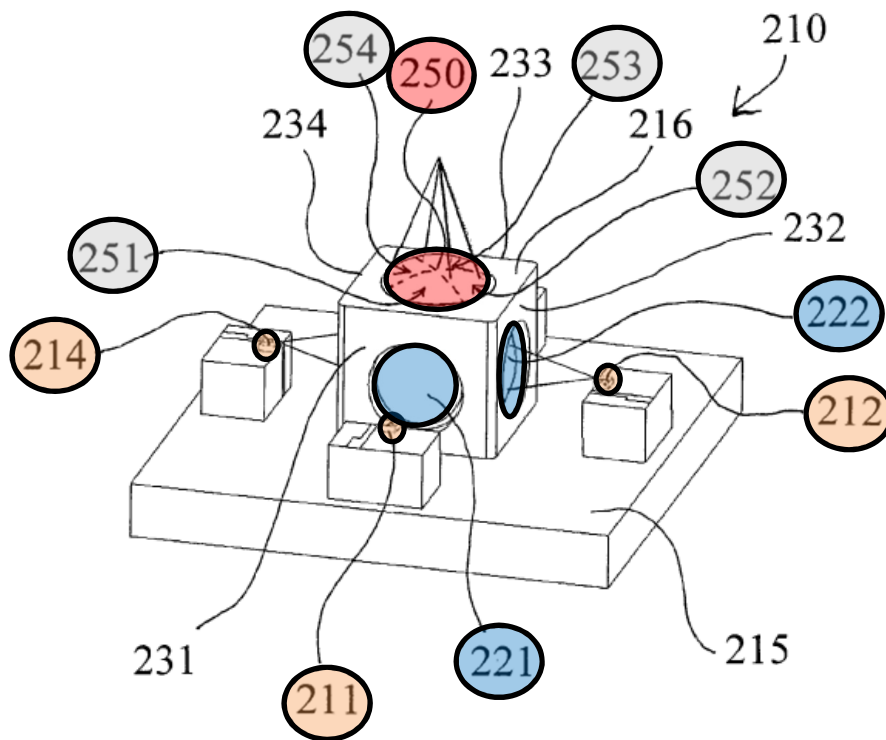


Fig. 8

78. In this embodiment, four lasers 211-214 (three are shown) direct their output beams towards corresponding collimating lenses 221, 222 (two are shown), which in turn direct the output towards focusing lens 250 having four pie-shaped radial quadrants 251-254. EX1001, 5:14-6:4. An annotated version of FIG. 7 is further provided below, coloring the lasers 211, 212, and 214 orange; the collimating lenses 221, 222 blue; the focusing lens 250 red; and the radial sectors 251, 252, 253, and 254 grey. (The colored areas below have also been made partially transparent so that the original drawing can be seen through them.)



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79. In the third embodiment, the lasers 211, 212, 213, and 214 are arranged in a circular array, each with a different wavelength. The lasers are co-planar, and their output is directed to the center of the circular array. Coupling optic 216 is a singular monolithic optical block, having four collimated lenses formed in its four sidewalls; a focusing lens formed in the top surface, having four pie-shaped quadrants; and prisms formed on four inclined surfaces in a recess that reflect the collimated light. EX1001, 3:61-4:34.

80. A fourth embodiment is shown in FIGS. 10-11. EX1001, 2:66-3:2, 4:35-52. FIGS. 10-11 are reproduced below.

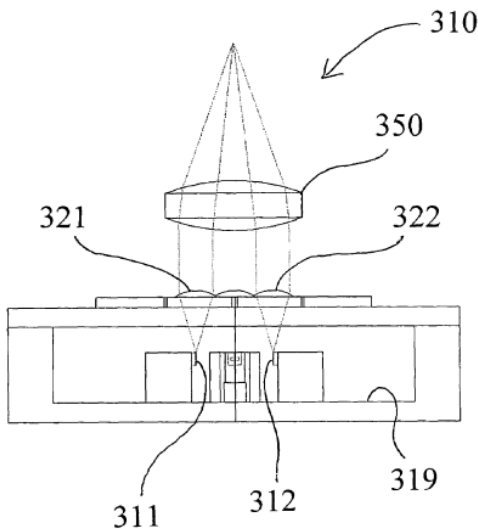


Fig. 10

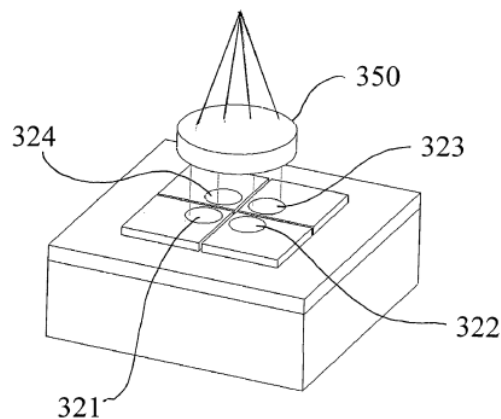


Fig. 11

Opticis Ex. 1003, p. 46

81. The fourth embodiment is an optical combiner 310 having separately molded collimating lenses 321-324 and output lens 350, i.e., a two-piece molded module. Four lasers (of which 311 and 312 are visible) have output beams directed through the collimating lenses and travel directly through the focusing lens without being redirected by a prism.

82. After presenting these four embodiments, the '416 Patent summarizes the "Key Features" of the alleged invention as follows:

Manufacturing throughput Replication procedures are extremely fast, thus reducing the overall cost of the manufactured device.

Passive Alignment All of the optical components within the multiplexer could utilize passive alignment mechanisms.

Monolithic Coupling Optics Each optical coupling and redirection component is integrated within a single monolithic plastic-molded device in most embodiments.

Cost Reduction Fewer parts are required such as filters and reflector blocks.

Offset Launch Spots may be focused on a section of the fiber which is offset from the center of the fiber, thus creating an offset launch condition, which is known by those skilled in the art to produce a better condition for resisting modal partition noise.

EX1001, 4:55-5:3.

83. Following the "Key Features," the '416 Patent identifies several potential applications, including: 1) Wavelength division

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multiplexing/demultiplexing (WDM); 2) Optical signal routing; 3) Spectroscopy; 4) Biological and chemical integrated optical sensors; and 5) Optical computing. EX1001, 5:5-10.

84. Having described the '416 Patent initially, I will now turn to the aspect of separate radial sectors (or quadrants) that the patent discusses. As an initial matter, claim 1 requires "*said focusing means having n separate radial sectors on its surface, and each of said n collimated beams passes through a separate one of said n sectors of said focusing means*"; claim 2 "*each radial sector is a pie-shaped quadrant*"; and claim 7 requires "*said focusing means having four separate quadrants on its surface, and each of said four collimated beams passes through a separate one of said quadrants of said focusing means.*" Accordingly, the general term used here is "*radial sector*," with "*quadrant*" being used in the special case where the number of n lasers and n collimating lenses is equal to four.

85. The specification itself, apart from the claims, uses the term "*radial sector*" only in three places: once in the Abstract and twice in the Background and Brief Summary of the Invention. EX1001, Abstract ("The laser output beams are separately passed through separate radial sectors of the focusing lens."); 1:65-67 ("The present invention, in contrast, uses a separate radial sector of the focusing lens

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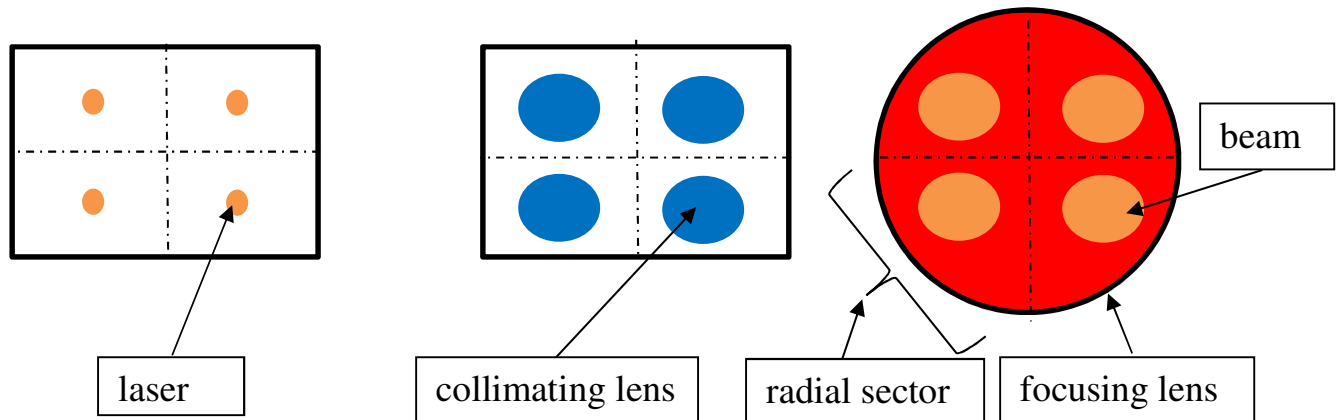
to focus each separate laser output.”); 2:34-37 (“A further object is to provide an optical combiner wherein a single focusing lens is utilized to uniformly and efficiently combine n separate wavelength channels by passing each channel through a separate radial sector of the focusing lens.”). The term “*quadrants*” is used only expressly in connection with the third embodiment, when describing the “four pie-shaped radial quadrants 251-254” shown in FIG. 7 (251-254) and FIG. 8 (252, 254). EX1001, 4:6-31.

86. Considering the disclosure in the '416 Patent, and the claim language at issue, one of skill in the art would recognize that the radial sectors or quadrants are not separate physical structures, or physically demarcated, on the surface of the focusing lens. Rather, they are conceptual regions of the focusing lens, as illustrated for example by the dashed line in FIG. 7 that divides the different quadrants on the surface of focusing lens 250. Further, although the '416 Patent does not describe these radial sectors or quadrants for the first, second, or fourth embodiment (referring only to the radial quadrants for the third embodiment), the first, second, and fourth embodiments each have separate radial sectors or quadrants by virtue of the radial arrangement of the lasers and collimating lenses.

87. It would be clear to a POSITA that the '416 Patent's references to radial sectors, quadrants, and light passing through separate sectors of the focusing lens, are not based on features of the focusing lens itself, but reflect the spatial locations of the beams and the arrangement of the various components, including the arrangement of the lasers, collimating lenses, and prism relative to the focusing lens.

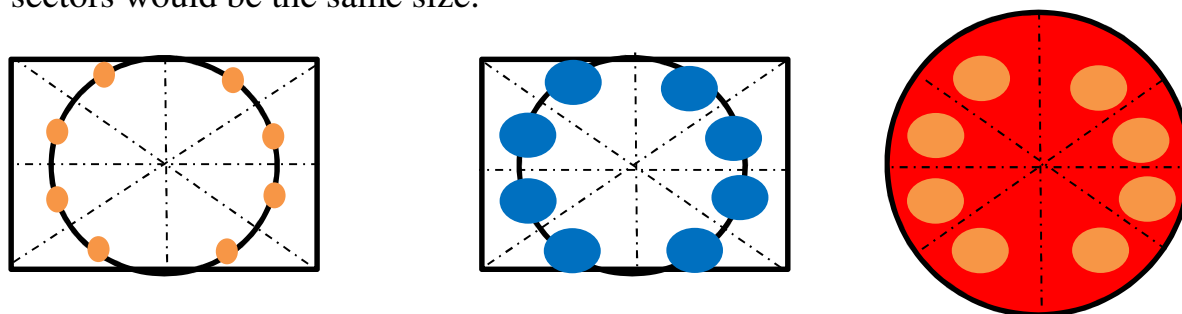
88. For example, the left schematic diagram below shows a two-by-two array of **lasers** in top view. The middle schematic diagram below shows a two-by-two array of **collimating lenses** in top view. (A collimating lens will result in collimated light, i.e., a beam of light that has parallel rays, with minimal divergence and convergence of light rays.) The right schematic diagram below shows a **focusing lens** in top view, with four quadrants (radial sectors) on the surface of the focusing lens indicated by the horizontal and vertical black lines. If the lasers and collimating lenses are aligned with each other, such that the output of the lasers is directed to the collimating lenses, and the collimating lenses are in turn radially arranged around the focusing lens, then the collimated light from each collimating lens will pass through one and only one of the quadrants (radial sectors), with the collimated light from each collimating lens passing through a separate one of the quadrants (radial sectors). This is shown by the orange circles in the right schematic diagram.

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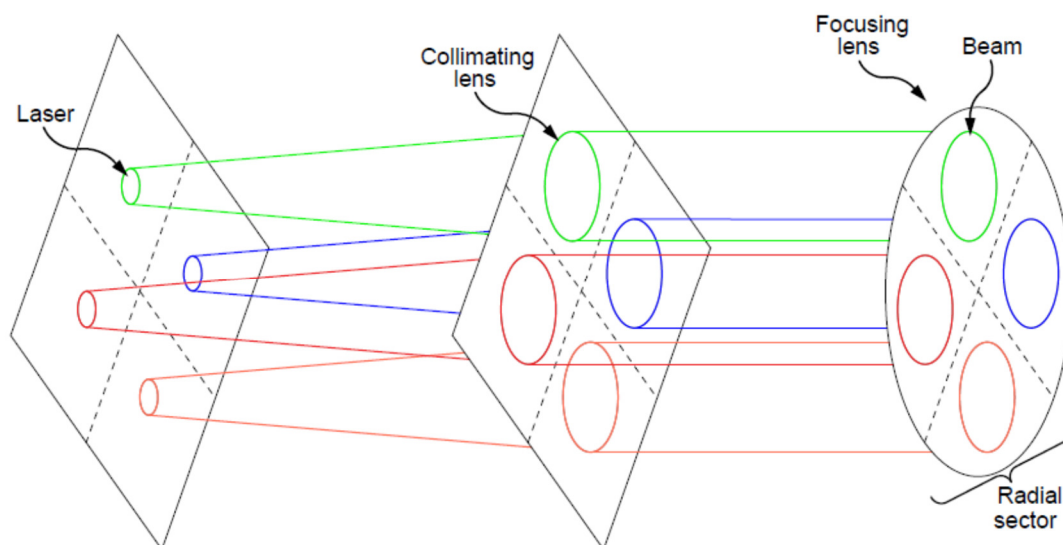


89. As another example, the left schematic diagram below shows eight radially arranged **lasers** in plan view. The middle schematic diagram below shows eight radially arranged **collimating lenses** in plan view. The right schematic diagram below shows a **focusing lens** in plan view, with eight radial sectors on the surface of the focusing lens indicated by the black lines. If the lasers and collimating lenses are aligned with each other, such that the output of the lasers is directed to the collimating lenses, and the collimating lenses are in turn radially arranged around the focusing lens, then the collimated light from each collimating lens will pass through one and only one of the radial sectors, with the collimated light from each collimating lens passing through a separate one of the radial sectors. The radial sectors are not called quadrants here, because “quadrant” is a term reserved for when there are four equally spaced radial sectors. This is shown by the orange circles in the right schematic diagram. As shown, while the lasers and collimating lenses each

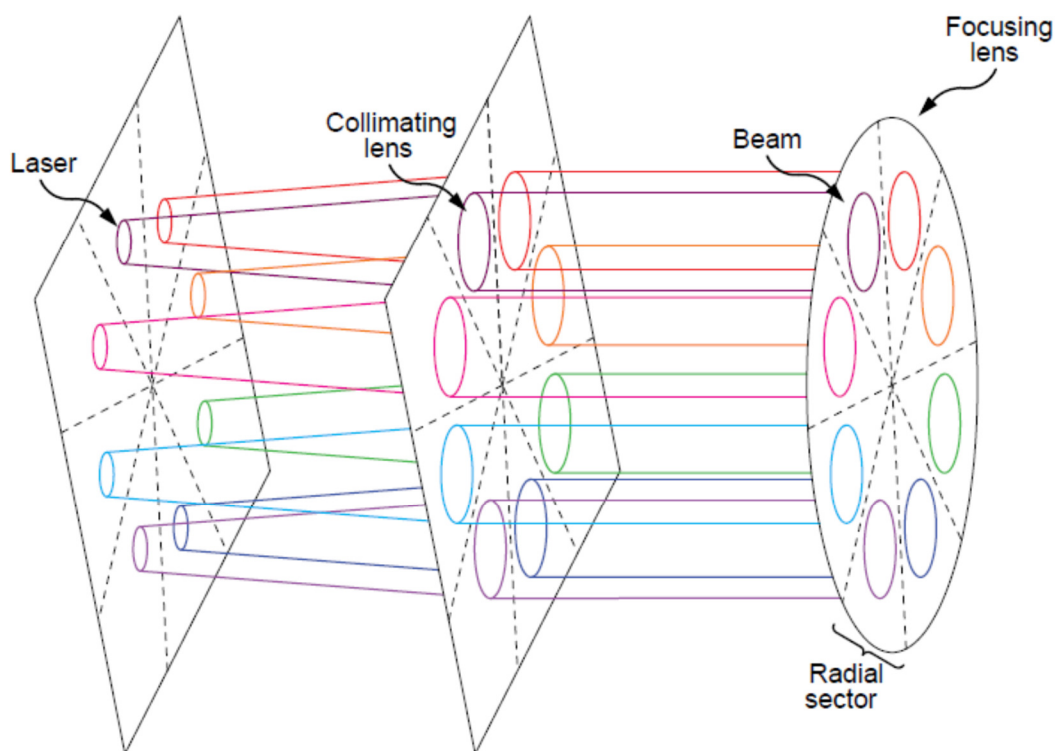
have a common distance r from the center of the circle they are placed around, they are not equally spaced around the circle, and therefore the radial sectors are not the same size. Of course, they could also be equally spaced, in which case the radial sectors would be the same size.



90. A perspective view of each of these examples is shown below, further illustrating the separate radial sectors in each:



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91. The drawings above are schematic diagrams for illustration purposes, and may not be perfectly to scale.

B. The Challenged Claims (Claims 1, 2, 6, 7, 9)

92. A complete listing of the Challenged Claims is provided below. The claims have been annotated with numbered brackets to identify each claim element. Claims 1 and 7 are independent claims in the '416 Patent. Claim 1 is provided first, followed by its dependent claims; and then claim 7, followed by its dependent claims.

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Claim 1

[1.0] An optical combiner [1.1] usable in data communication systems for multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength, [1.2] for transmission into and through a stopped single optical fiber, comprising:

[1.3] a plurality of n collimating lenses, [1.4] said lenses being spaced apart and positioned to receive and collimate the output of said n laser output beams, said n laser output beams have n different output wavelengths, and

[1.5] focusing means for focusing said n collimated output beams onto a single spot at said stopped single optical fiber, [1.6] said focusing means having n separate radial sectors on its surface, and each of said n collimated beams passes through a separate one of said n sectors of said focusing means whereby said n output beams having n different wavelengths are coupled into said single fiber.

EX1001, 5:23-40 (bracketing added). Claims 2 and 6 depend from claim 1, and read as follows:

Claim 2

The optical combiner of claim 1 wherein $n=4$ and wherein said four lasers and four collimating lenses are each formed in a two-dimensional, two by two array, wherein said focusing means is a single focusing lens, and wherein each radial sector is a pie-shaped quadrant.

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Claim 6

The optical combiner of claim 1 wherein said optical combiner does not require the use of dielectric filters or waveguides.

EX1001, 5:41-45, 6:16-19.

Claim 7

[7.0] An optical combiner [7.1] usable in data communication systems for multiplexing the outputs of a plurality of lasers wherein each of said outputs has a different wavelength, [7.2] for transmission into and through a stopped single optical fiber, comprising:

[7.3] an array of four lasers, formed in a two-dimensional, two by two array, each of said lasers having an output beam with a different wavelength,

[7.4] an array of four collimating lenses, said lenses being formed in a two-dimensional, two by two array and positioned to receive and collimate the output of said laser output beams, and

[7.5] focusing means for focusing said collimated output beams onto a single spot at said stopped single optical fiber, [7.6] said focusing means having four separate quadrants on its surface, and each of said four collimated beams passes through a separate one of said quadrants of said focusing means whereby said output beams of said four lasers are coupled into said single fiber.

Opticis Ex. 1003, p. 55

EX1001, 6:19-39 (bracketing added). Claim 9 depends from claim 7, and reads as follows:

Claim 9

The optical combiner of claim 7 wherein said optical combiner does not require the use of dielectric filters or waveguides.

EX1001, 6:45-47.

93. Independent claims 1 and 7 are similar in scope. The main difference is that claim 7 requires four lasers, collimating lenses, and quadrants on the surface of the focusing means, similar to dependent claim 2 which sets $n=4$ and requires two-by-two arrays of lasers and collimating lenses. Claim 1, on the other hand, requires a plurality of n lasers, collimating lenses, and radial sectors on the surface of the focusing means. Claim 2 therefore is very similar to claim 7.

94. To illustrate, claims 1-2 are shown to the left-hand side below, and claim 7 is shown to the right-hand side below. *Italics text* is identical between claims 1-2 and claim 7. **Bold text** denotes text differences between the claims, but the difference is not significant to the claim scope. Underlined text shows a difference in claim scope. The **colored text** below indicates language from dependent claim 2 found in independent claim 7. The differences are explained after the chart below.

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1. An optical combiner usable in data communication systems for multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength, for transmission into and through a stopped single optical fiber, comprising:	7. An optical combiner usable in data communication systems for multiplexing the outputs of a plurality of lasers wherein each of said outputs has a different wavelength, for transmission into and through a stopped single optical fiber, comprising:
	an array of four lasers, formed in a two-dimensional, two by two array, each of said lasers having an output beam with a different wavelength,
a plurality of n collimating lenses, said lenses being spaced apart and positioned to receive and collimate the output of said n laser output beams, said n laser output beams have n different output wavelengths, and	an array of four collimating lenses, said lenses being formed in a two-dimensional, two by two array and positioned to receive and collimate the output of said laser output beams, and
<i>focusing means for focusing said n collimated output beams onto a single spot at said stopped single optical fiber, said focusing means having n separate radial sectors on its surface, and each of said n collimated beams passes through a separate one of said n sectors of said focusing means whereby said n output beams having n different wavelengths are coupled into said single fiber.</i>	<i>focusing means for focusing said collimated output beams onto a single spot at said stopped single optical fiber, said focusing means having four separate quadrants on its surface, and each of said four collimated beams passes through a separate one of said quadrants of said focusing means whereby said output beams of said four lasers are coupled into said single fiber.</i>
2. The optical combiner of claim 1 wherein n=4 and wherein said <i>four lasers and four collimating lenses are each formed in a two-dimensional, two</i>	

<i>by two array</i> , <u>wherein said focusing means is a single focusing lens, and wherein each radial sector is a pie-shaped quadrant.</u>	
--	--

95. The main differences between claims 1-2, on the one hand, and claim 7, on the other hand, relate to the limitation of four lasers and collimating lenses each in a two-by-two array being introduced in dependent claim 2 versus being introduced initially in independent claim 7. Thus, there are minor grammatical differences (shown in bold above) that do not affect the claim scope. Additionally, claim 2 contains requirements (shown underlined above) that (1) “said focusing means is a single focusing lens” and (2) “each radial sector is a pie-shaped quadrant.” The only focusing means shown in the ’416 Patent is a single focusing lens; and it follows from there being four quadrants in claim 7 based on a two-by-two array of lasers that the quadrants are pie-shaped. Thus, claim 2 and claim 7 have substantially the same scope. Notwithstanding, at most, claim 2 is narrower than claim 7, and prior art that reads on claim 2 would therefore also necessarily read on claim 7.

C. Prosecution History

96. As stated before (*see* Section VII(A)), I understand that the ’416 Patent issued from Appl. No. 11/044,475, which was filed January 27, 2005. I also

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understand that the '416 Patent claims priority to Provisional Appl. No. 60/541,573, which was filed February 4, 2004. The '416 Patent issued April 3, 2007.

97. A non-final Office Action was mailed October 5, 2005. EX1002, p. 137. The examiner rejected claims 1, 2, 6, 7, and 9 as being anticipated by 2005/0069013 to Bhandarkar et al., and indicated that claims 3-5 and 8 contained allowable subject matter. EX1002, pp. 139-141. Patent Owner submitted a reply, amending the claims to add that the optical combiner is “*usable in data communication systems*” and that “*said n laser output beams have n different wavelengths.*” EX1002, pp. 68-70. Patent Owner further submitted inventor declarations attempting to swear behind the anticipatory Bhandarkar et al. reference, claiming conception as early as July 17, 2003. EX1002, pp. 71-73.

98. A final Office Action was mailed July 5, 2005. EX1002, pp. 56. The examiner maintained the rejection and rejected the evidence of conception as it relates to different wavelengths and each of the collimated beams being refracted at the same angle. EX1002, pp. 58-59. Patent Owner filed a response, amending the claims to remove the reference to each of the collimating beams being refracted at the same angle, and adding a requirement “*whereby said n output beams having n*

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different wavelengths are coupled into said single fiber.” EX1002, p. 32-34. Patent Owner further submitted supplemental inventor declarations. EX1002, pp. 35-39.

99. With the supplemental inventor declarations, a Notice of Allowance was mailed on April 9, 2007. EX1002, p. 18.

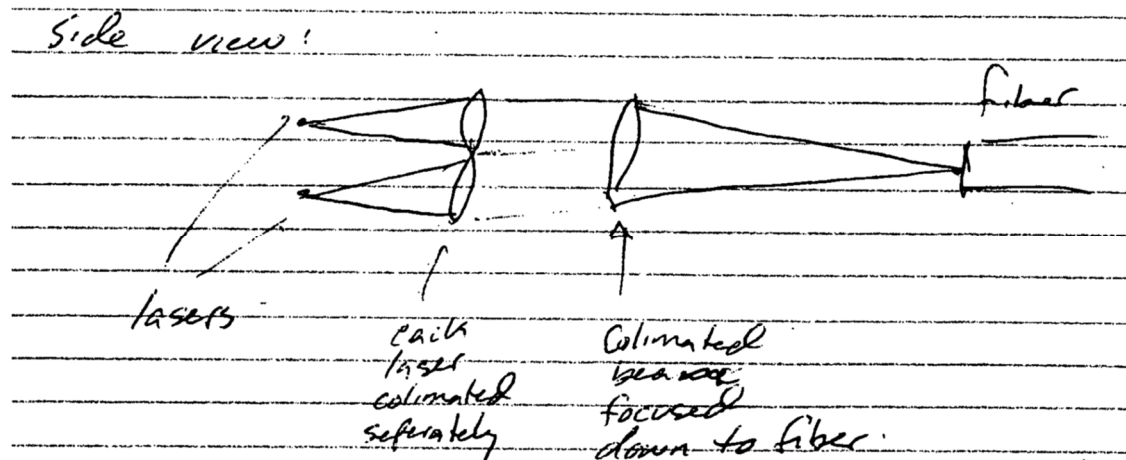
* * *

100. There is nothing significant about the July 2003 priority date that was raised during prosecution. That is, although it allowed the applicant to avoid the anticipatory Bhandarkar reference that the examiner raised, it is my opinion that there was still prior art available at the time from prior to July 2003 that taught the claimed devices. This is demonstrated, for example, by the grounds disclosed here, and the references discussed in the technology background (Section VII) of this report. As explained in the technology background, wavelength division multiplexing for optical data communications took off as both a commercial and research priority in the mid- to late-1990s, and therefore there were various prior art references – including both patent publications and non-patent literature – that discussed devices similar to what the ’416 Patent claims.

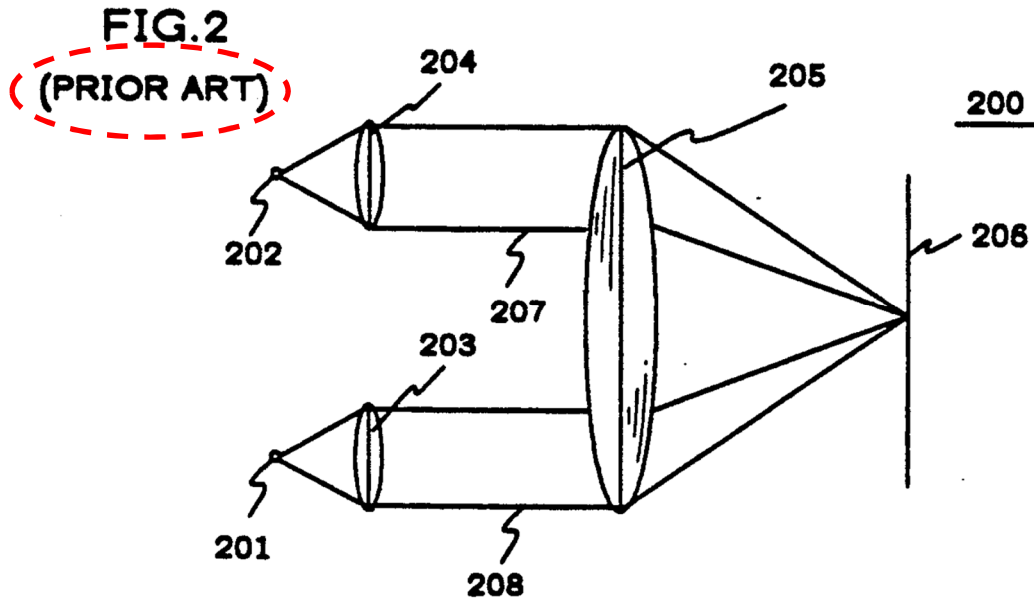
101. I also offer the following observations regarding the declarations provided by the inventors. The first inventor, Curtis A. Ray, explained during

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prosecution that the “concept” of the ’416 Patent occurred to him on July 17th, 2003, as recorded in his lab notebook. EX1002 at 75; *see also id.* at 71 (“The declarations filed herewith show that the invention herein was conceived on July 17, 2003.”). An image, taken from his notebook, of this conception is reproduced below:

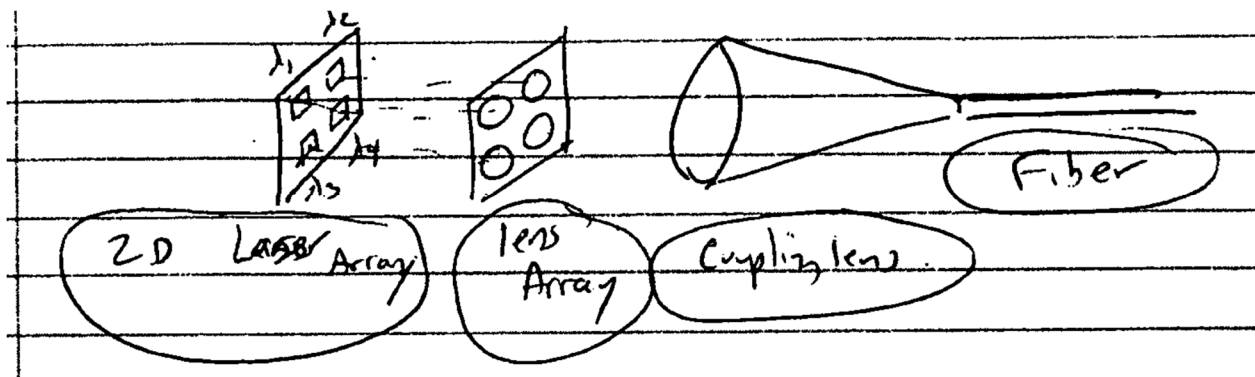


EX1002 at 79. I note, however, that this arrangement of “lasers,” where “each laser [is] col[l]imated separately,” and “col[l]imated beams [are] focused down to [a] fiber” was a known arrangement in the prior art by 2003. *See* Section VI. Indeed, the LaMarche reference provides a similar illustration, acknowledging it as “Prior Art”:



EX1005, FIG. 2 (annotated).

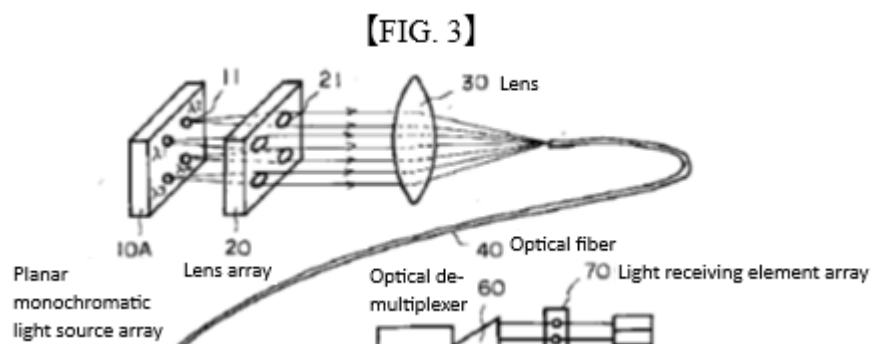
102. A second inventor on the '416 Patent, Eric. B. Grann, explained that another image showed the ideas that they had allegedly conceived that day:



EX1002 at 126; *see also id.* at 119 (“The sketch at the bottom of page 11 indicates the use of four separate wavelength, each wavelength in a separate quadrant of a coupled lens. The top sketch shows the use of a two-dimensional laser array coupled

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to a lens array and then through a coupling lens to a fiber.”). This illustration of the stated invention of the '416 Patent is strikingly similar to the device of Kurita (Ground 1):



EX1003, FIG. 3 (cropped) (with light source array 10, lens array 20, and lens 30 coupling light into fiber 40). This also shows that this setup was standard in the prior art by 2003.

103. Finally, I understand that there is a question as to whether Bhandarkar is prior art given the priority date issue. If Bhandarkar does predate the '416 Patent (as I am informed by Counsel), then the '416 Patent should not have issued. Bhandarkar discloses the same arrangement of lasers, collimating lenses, and focusing lens for WDM communications as the '416 Patent. *See* Section VIII(A)(v).

D. Claim Construction

i. Definition of a Person of Ordinary Skill in the Art

104. I understand that the patent claims must be considered through the eyes of a hypothetical “person of ordinary skill in the art,” or POSITA. I understand that a POSITA is not a specific or real individual, but rather a hypothetical individual having the qualities reflected by the following criteria: (a) the type of problems encountered in the art; (b) prior art solutions to those problems; (c) the rapidity with which innovations are made; (d) the sophistication of the technology; and (e) the education level of active workers in the field. Furthermore, a POSITA would be familiar with the entire prior art literature. I have been instructed to assume for purposes of this proceeding that the relevant time period is July 17, 2003.

105. In my opinion, a POSITA in the relevant field (*i.e.*, optical multiplexing devices) as of the asserted July 17, 2003, priority date of the '416 Patent would have had at least a bachelor's degree in electrical engineering, physics, or a related field, and at least 2 years of practical experience in optical technologies. These descriptions are approximate, and a higher level of education or skill might make up for less experience, and vice-versa.

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106. I have both a Ph.D. and ~35 years of experience in industry and academia (see Appendix A), and I am well acquainted with the level of ordinary skill that would be required to implement the optical devices described in the '416 Patent. I am also capable of rendering informed opinions as to the understanding of a POSITA as of the time of the alleged invention, including the meaning of terms found in the asserted claims.

107. I am qualified as a POSITA, both now and as of the time of the invention.

ii. Claim Construction Standard

108. For purposes of this proceeding, I was instructed to apply the claim construction standard set forth above in §§V.A-B.

109. I understand that certain claims of the '416 Patent include means-plus-function elements. With respect to those claim elements, I was instructed to apply the claim construction standard set forth above in Section V.B.

iii. Construction of terms from the '416 Patent

110. Below I separately address the term "*focusing means*" of independent claims 1 and 7, the term "stopped" of independent claims 1 and 7, and the remaining claim terms of the challenged claims.

1. Construction of “*focusing means*”

111. I have been informed that the term “*focusing means*” (appearing initially in independent claims 1 and 7 and later in dependent claim 2) should be construed as a means-plus-function term under § 112, ¶ 6. I understand that construction of a term as a means-plus-function term under § 112, ¶ 6 is based on the legal standards set out above. See Section V(B).

112. The term “*means*” is modified by functional language introduced by the linking word “*for*” – i.e., “*focusing means for focusing said n collimated output beams onto a single spot at said stopped single optical fiber*” (claim 1), and “*focusing means for focusing said collimated output beams onto a single spot at said stopped single optical fiber*” (claim 7). In my opinion, in the context of these claims, the term “*focusing means*” does not specify sufficient structure, and there is not sufficient structure recited in these claims for performing the claimed function. Claim 1 specifies that the focusing means have “*n separate radial sectors on its surface*” and claim 7 specifies that the focusing means have “*four separate quadrants on its surface.*” But the existence of separate radial sectors or quadrants on a surface of the focusing means is not structure for performing the claimed function.

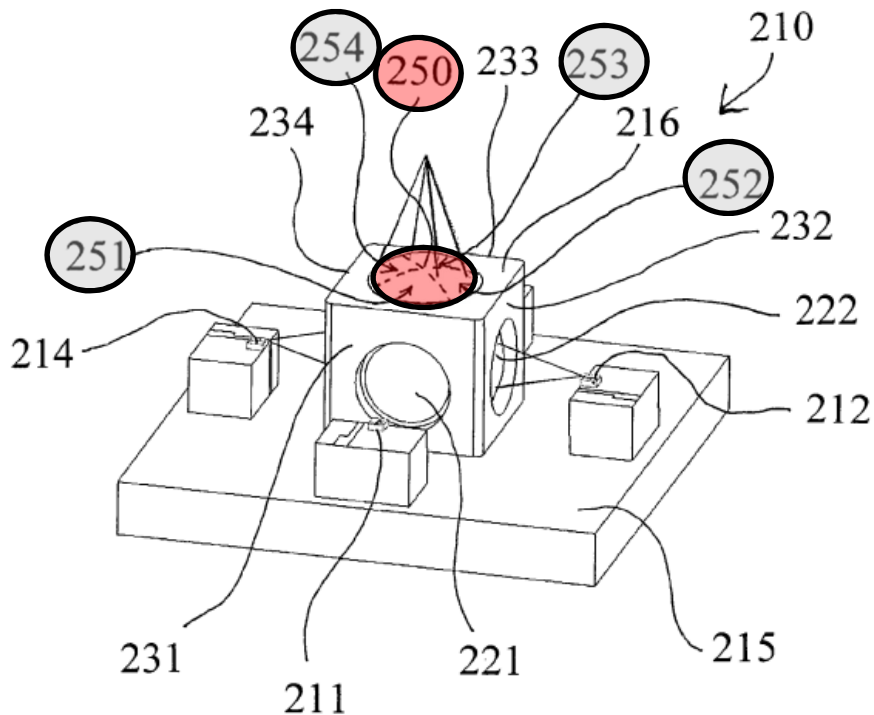
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113. I understand that where a term is a means-plus-function term, it should be construed to cover the corresponding structure described in the specification and equivalents thereof. The corresponding structure described in the specification for the “*focusing means*” is one of the focusing lenses 30, 130, 250, and 350. *See* EX1001, FIGS. 1-4, 3:7-49 (first embodiment, focusing lens 30); FIGS. 5-6, 3:50-60 (second embodiment, focusing lens 130); FIGS. 7-9, 3:61-4:34 (third embodiment, focusing lens 250); FIGS. 10-11, 4:35-52 (fourth embodiment, focusing lens 350). This identification of corresponding structure also agrees with that made by Patent Owner in the Complaint for the accompanying litigation, where Patent Owner identified the structure of the “*focusing means*” (to the extent it was construed to be a means-plus-function term) as being Figs 1-4 and corresponding text (focusing lens 30), Figs 5-6 and corresponding text (focusing lens 130), Figs. 7-9 and corresponding text (focusing lens 250), and/or Figs 10-11 and corresponding text (focusing lens 350). *See* EX1012, p. 6 n.2 (structure identified by Patent Owner).

114. I further observe that the corresponding structure described in the specification of the '416 Patent refers to “four pie-shaped radial quadrants 251-254” that are on “[t]he surface of focusing lens 250,” and which are in turn illustrated by

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FIG. 7. EX1001, FIG. 7 (reference numerals 251-254), 4:6-8. The '416 Patent does not indicate that the separate “*quadrants*” or “*radial sectors*” (cf. claim 2’s requirement that “*each radial sector is a pie-shaped quadrant*”) are structural. Rather, the separate “*quadrants*” or “*radial sectors*” appear to be conceptual regions of the focusing lens, as illustrated for example by the dashed line in FIG. 7 that divides the different quadrants on the surface of focusing lens 250. *See above, Section VII(A).* FIG. 7 is reproduced below, and annotated to show the focusing lens 250 in red and the separate quadrants 251-254 in grey. (The colored areas have also been made partially transparent so the original drawing can be seen through them.)



115. I also note that challenged dependent claim 2 appears to confirm that the corresponding structure of the focusing means is a focusing lens. Claim 2 requires that “*said focusing means is a single focusing lens.*”³

³ To the extent that the “focusing means” is not construed as a means-plus-function term, that would not affect my analysis below . The prior art described means for focusing as claimed, and indeed, as I explain below in each ground, the means in the prior art is substantially similar to what the ’416 Patent discloses.

2. Construction of “stopped”

116. The term “stopped” is found in claims 1 and 7, as highlighted in the following excerpts from the claims:

Claim 1: “multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength, for transmission into and through a *stopped* single optical fiber” and “focusing means for focusing said n collimated output beams onto a single spot at said *stopped* single optical fiber”

Claim 7: “multiplexing the outputs of a plurality of lasers wherein each of said outputs has a different wavelength, for transmission into and through a *stopped* single optical fiber” and “focusing means for focusing said collimated output beams onto a single spot at said *stopped* single optical fiber.”

As I explain in detail below, a POSITA would have understood this term to mean “fixed” in the context of the '416 Patent.

117. As an initial matter, the term “stopped” is not typically used to describe optical fibers in this field, including with respect to either transmission into a fiber or the focusing of beams onto a fiber. As such, and in my opinion, “stopped” does not have a plain and ordinary meaning as understood by a POSITA at the time of the

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invention. Therefore, I have been asked to consider the meaning of the term stopped in the context of the specification and claims of the '416 Patent.⁴

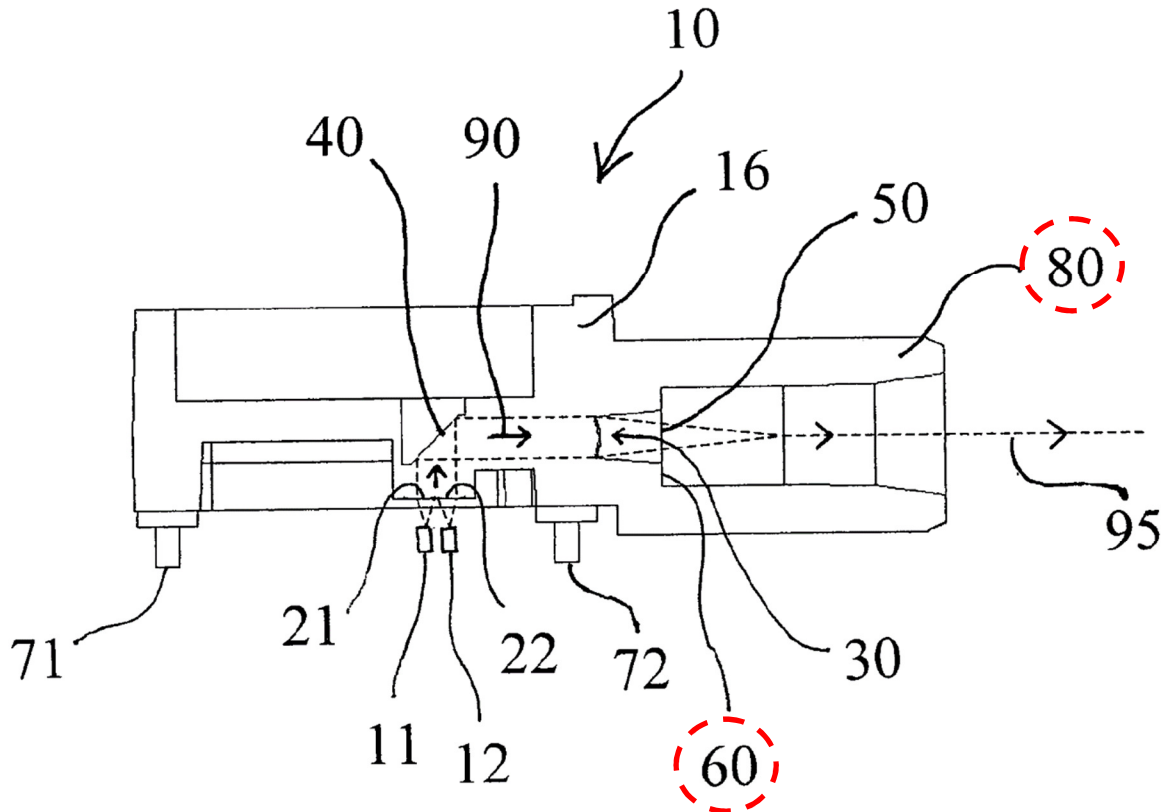
118. Starting with the claim language itself, the claims refer to “transmission into and through a *stopped* single optical fiber” and “focusing ... collimated output beams onto a single spot at said *stopped* single optical fiber.” See claims 1 and 7 (emphasis added). In both cases – transmission into/through and focusing onto a single spot – it would be clear to a POSITA that the single optical fiber would need to be fixed in place. An optical fiber being spatially fixed was well known to be important in optical systems since light needed to be coupled into a very small waveguiding fiber core, and any non-negligible movement could cause significant optical power loss and performance degradation. A “stopped” single optical fiber would not be free or otherwise able to significantly move about.

119. This is consistent with the use of the term in the specification text and drawings of the '416 Patent for at least two reasons.

120. First, the specification describes “a single optical fiber (not shown)” that is “stopped by fiber stop or seat 60 formed in ferrule 80.” EX1001, 3:13-15; see

⁴ The term does not appear to have been addressed during prosecution.

also id. at 3:23-24 (“the fiber (not shown) inserted into ferrule 80, seated at the fiber stop 60”) and FIG. 1:



(annotations added). A seat and ferrule arrangement is (and was in 2003 before the earliest possible priority date of the '416 Patent) a common way to fix an optical fiber in place. *See, e.g.*, EX1006 at 5:58-20 (“During assembly, the end of optical fiber 250 is inserted into ferrule 255, which surrounds and secures the end of the fiber.”). In the example above, the fiber would be inserted into the ferrule 80,

abutting against seat 60, and thus held in place – lateral movement constrained by the ferrule 80 and longitudinal movement limited by the seat 60.

121. Second, the specification discusses the “stopped” fiber in connection with alignment:

Lasers 11,12 are located at the focal points of the input lenses and the light is collimated, reflected off a prism 40 and focused by the focusing lens 30 onto a spot at which a single optical fiber (not shown) is **stopped by fiber stop or seat 60 formed in ferrule 80**. Pins 71,72,73,74 are located to aid in affixing the combiner device 10 to the support (not shown) for the lasers. **The integrated ferrule 80 enables one to place an output fiber optic cable into the pre-aligned connector.**

EX1001, 3:11-18 (emphasis added). As discussed above, having the input of the optical fiber fixed in place was important for proper alignment.

122. In summary, based on how the term is used in the claims and specification, a POSITA would have understood that “stopped” means “fixed.” I note that “fixed” is used here in a spatial sense, i.e., such that movement in a spatial dimension is substantially limited.

3. Construction of other terms

123. The remaining claim terms of the challenged claims should be given their plain and ordinary meaning for the following reasons.

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124. First, other than the “*focusing means*” term, there are no other means-plus-function terms to consider. Lasers, lenses, and the other terms at issue are structural terms in this art, such that § 112, ¶ 6 is not applicable.

125. Second, the remaining technical terms of the claims should receive their plain meaning. For example, “*lasers*,” “*optical fiber*,” “*collimating lenses*,” “*wavelengths*” and so on are all well understood, and are used in the context of the claims and the specification in their usual way in this art.

126. In my opinion, therefore, other than my analysis of specific terms above, a POSITA would not have seen any terms in the Challenged Claims of the ’416 Patent that are re-defined, or given a meaning other than their plain and ordinary meaning, in the patent specification or prosecution history.

VIII. THE CHALLENGED CLAIMS OF THE ’416 PATENT ARE UNPATENTABLE

127. I provide exemplary citations to the exhibits below. While I try to cite the relevant portions directly in the text, portions of each exhibit that are near to the cited portions, that provide context to it, or are similar to the cited portion, such as by describing the same or similar element in the same or a similar embodiment, are encompassed by each of the citations below. For example, if I cite to a given figure of a patent, both the corresponding description of that figure in the patent, and other

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figures showing different views of the same device or element are also encompassed by my citation. Similarly, if all or part of a claim element finds antecedent basis in another claim element, citations for the other claim element providing antecedent basis are also encompassed for that claim element.

A. The Prior Art

i. The Admitted Prior Art

128. The Background of the '416 Patent explains that wavelength division multiplexed optical communications was known as of the time of the alleged invention, that in such communications, many different optical wavelength carriers provide independent communication channels in a single optical fiber, and that such systems provide for improved bandwidth both because they use optical fibers (which improves upon coaxial cables) and because they utilize multiple wavelengths (i.e., multiplexing):

In prior art wavelength division multiplexed optical communication systems, many different optical wavelength carriers provide independent communication channels in a single optical fiber. Future computation and communication systems place ever-increasing demands upon communication link bandwidth. It is generally known that optical fibers offer much higher bandwidth than conventional coaxial communications; furthermore a single optical channel in a fiber waveguide uses a small fraction of the available bandwidth of the fiber (typically a few GHz out of several tens of THz). By transmitting several channels at different optical wavelengths into a fiber (i.e.,

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wavelength division multiplexing, or WDM), this bandwidth may be more efficiently utilized.

EX1001, 1:21-34.

129. The Background goes on to describe that prior art optical multiplexing devices combine or separate multiple light signals with varying optical wavelengths:

Prior art optical multiplexing devices combine or separate multiple light signals with varying optical wavelengths. Such optical multiplexing devices have applications for both dense and course wavelength division multiplexing (DWDM & CWDM) for both multi-mode and signal-mode fiber optic data communications and telecommunications. Multiple wave-length light sources are combined into a single optical path for transmission.

EX1001, 1:35-42.

130. The Background also describes an example of a prior art optical combiner, based on U.S. Patent No. 5,377,287 to Lee et al. *See* EX1001, 1:56-2:10. The Background admits that this prior art optical combiner includes “collimators and a focusing lens to concentrate multiple output beams to increase power density.”

EX1001, 1:56-59.

131. But then the Background distinguishes the optical combiner described in Lee et al. by noting that the alleged invention of the '416 Patent (unlike the optical combiner described in Lee et al.) “uses a separate radial sector of the focusing lens

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to focus each separate laser output.” EX1001, 1:65-67. It is on this basis that the ’416 Patent alleges its invention is distinguished from the prior art:

The prior art also includes an optical power combiner which utilizes collimators and a focusing lens to concentrate multiple output beams to increase power density; see Lee et al U.S. Pat. No. 5,377,287. The Lee et al device combines the outputs of, for example, 19 passive optical fibers arranged concentrically together with 19 collimating lenses and a Fresnel focusing lens. The Lee et al design does not achieve isolation from unwanted reflections or a uniform coupling efficiency between each fiber optic input and the single output. The present invention, in contrast, uses a separate radial sector of the focusing lens to focus each separate laser output. Each laser output beam of the present invention therefore has the same degree of refraction as it passes through the focusing lens; this feature simultaneously creates a uniform coupling efficiency (as shown below) and prevents unwanted reflections back through the optical pathway to the input lasers. Furthermore, the Lee et al combiner does not multiplex n different wavelength channels, as does the present invention. Therefore, for the above reasons, the Lee et al combiner simply is not effective for communication purposes, which is the primary purpose of the present invention.

EX1001, 1:56-2:10.

132. Also, according to the ’416 Patent, another problem with the prior art was that prior art devices were “typically designed using dielectric filters requiring alignment or expensive waveguides.” EX1001, 1:43-46.

133. Accordingly, a POSITA would recognize that the ’416 Patent admits that at least the following claim features were known in the art: Claim Element [1.0] (“[a]n optical combiner”), Claim Element [1.1] (“usable in data communication

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systems for multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength”), Claim Element [1.2] (“for transmission into and through a stopped single optical fiber”), Claim Element [1.3] (“a plurality of n collimating lenses”), Claim Element [1.4] (“said lenses being spaced apart and positioned to receive and collimate the output of said n laser output beams, said n laser output beams have n different output wavelengths”), and Claim Element [1.5] (“focusing means for focusing said n collimated output beams onto a single spot at said stopped single optical fiber”). The similar elements corresponding to claim 7 are likewise recognized by the '416 Patent as being known in the art.

134. While I do not rely exclusively on these admissions below for these claim elements, because they are consistent with the state of art in the technology area at the time of the alleged invention, the admissions further confirm the obviousness of the Challenged Claims.

ii. Kurita

135. Japanese Patent No. 2,848,279 to Kurita et al. (“Kurita”) (EX1004) published January 20, 1999, and is titled “Optical connection element and optical connection device.” I am informed that Kurita is prior art to the '416 Patent under at least §§ 102(a) and 102(b) based on its publication date of January 20, 1999.

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136. Kurita is a Japanese patent, published in Japanese. Since I do not read Japanese, I have relied on the certified English translation that appears after the Japanese version in the enclosed exhibit EX1004.

137. Kurita “relates to light connection elements and light connection devices for inputting laser lights into and outputting them out of optical fibers that are used with multistage switch networks inside optical computers and switchboards, with optical communications, laser processing, etc.” EX1004, ¶[0001] (Field of Industrial Application). The patent confirms that “wavelength multiplexing optical communications” are known, and that, where high output is required, “it may be necessary to couple lights emitted from plural light sources into a single fiber.” EX1004, ¶[0002] (Conventional Technology). In particular, Kurita describes a conventional wavelength multiplexing switch using conventional technology, with respect to FIGS. 4-5. EX1004, ¶¶[0002]-[0003] (Conventional Technology).

138. Kurita explains that the problem it is solving is that, in the prior art multiplexing switch it describes, “the lights from plural monochromatic light sources are focused and multiplexed with separate individual optical systems” so that there is “an increased number of parts in order to build separate optical systems resulting in high optical losses in order to allow the lights to pass through these parts.”

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EX1004, ¶[0004] (Problem to be Solved by the Invention). Of course, high optical losses (i.e., poor coupling efficiency) are not, and were not, desirable. Kurita also identified other problems, such as the prior art multiplexing switch being labor intensive and costly. EX1004, ¶[0004] (Problem to be Solved by the Invention).

139. Accordingly, one of the aims of Kurita is “to reduce the number of component parts and the costs as well as attempting to hold down optical losses.” EX1004, ¶[0005] (Objects of the Invention). Kurita then sets out the means to solve the problem, which includes a light connection element that has an array of light emitting portions, an array of lenses formed one-to-one with the light emitting portions and for collimating the output of the light emitting portions, and a lens for converging the light onto a single optical fiber. EX1004, ¶[0006] (Means to Solve the Problem). The array of light emitting portions may be formed by lasers where each light emitting portion emits a different wavelength. EX1004, ¶[0007] (Means to Solve the Problem). Kurita (EX1004) explains the operation of this device as follows:

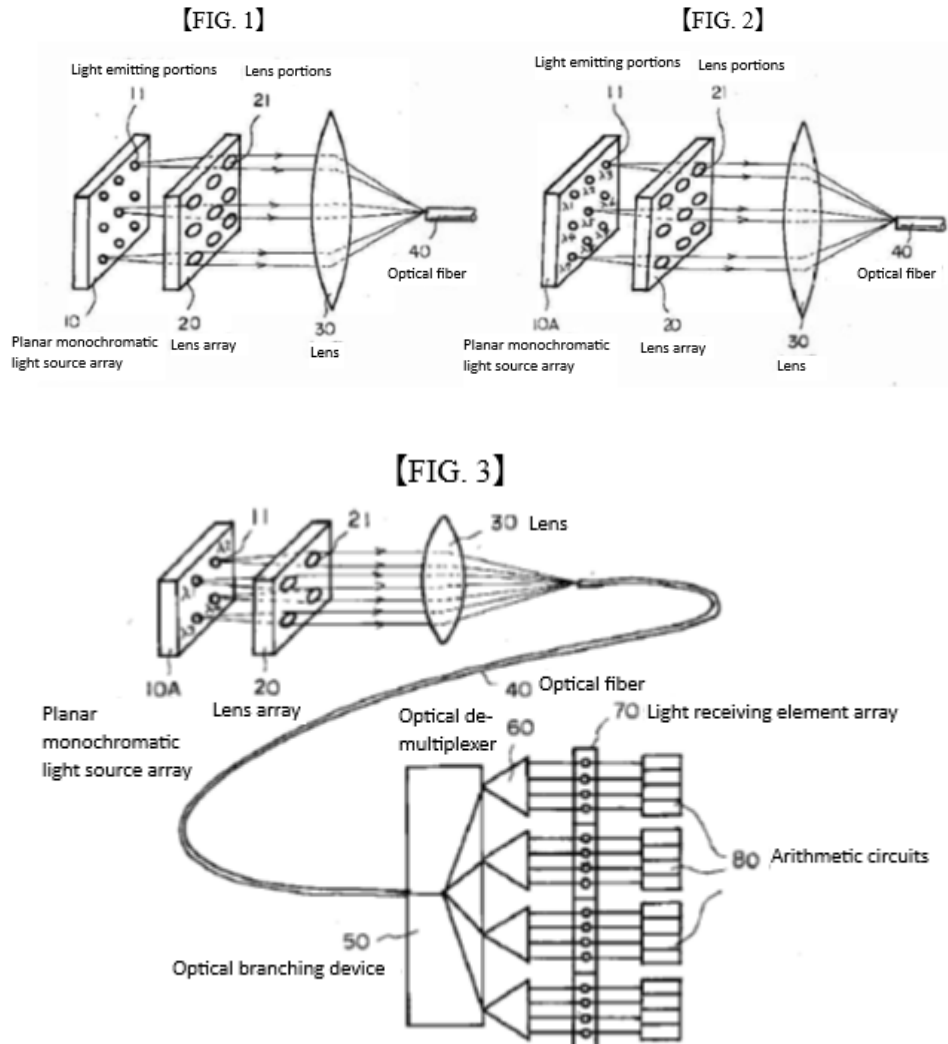
As the lights emitted at the light emitting portions of the planar monochromatic light source array are each collimated at the lens portions of the lens array to be made into parallel beams, and as the individual beams are converged on one point with the lens to be entered into one end portion of a single optical fiber, the lights from

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the individual light emitting portions entered are multiplexed to become integrated to be transmitted through the above-mentioned single optical fiber.

EX1004, ¶[0009] (Operation).

140. Kurita then provides more detail with some examples of the invention, in the context of FIGS. 1-3. I am reproducing FIGS. 1-3 below.



141. In FIG. 1, which “is a conceptual configuration diagram for one example of optical multiplexer as light connection element,” the “optical multiplexer is composed of a planar monochromatic light source array 10 with surface emitting lasers, etc., a lens array 20 with flat-sheet microlenses, etc., a lens 30 for converging the lights from the lens array, and an optical fiber 40.” EX1004, ¶[0010] (Examples). Plural lens portions 21 of the lens array 20 and plural light emitting portions 11 of the monochromatic light source 10 are placed at corresponding planar positions. The lights from the individual light emitting portions 11 are collimated with the lens portions 21 of the lens array 20 to be made into parallel beams, and the individual beams are converged at one point with the lens 30 to be entered into one end portion of the optical fiber 40. Thus, the lights from the individual light emitting portions 11 are multiplexed to become integrated to be transmitted through the optical fiber 40. EX1004, ¶¶[0010]-[0011] (Examples). According to this design, there are less components than in the optical multiplexer shown in FIG. 4, and “on account of the number of components through which each of the lights is passed through being small, it becomes possible to hold down optical losses.” EX1004, ¶[0012] (Examples).

142. The optical multiplexer of FIG. 2 is similar to that shown in FIG. 1. The primary difference is that there is a monochromatic light source array 10A (instead of monochromatic light source array 10). In the light source array 10A, each of the light emitting portions 11 has a different wavelength (illustrated, for example, as λ_1 through λ_9 in FIG. 2). EX1004, ¶[0013] (Examples). The patent also explains that “the wavelength of the light emitted from each of the light emitting portions 11 can be varied with the composition of an active layer and the length of a resonator being fabricated while being controlled partially and individually,” while “the lens array 20, the lens 30, and the optical fiber 40, [are] the same ones as in the first example shown in FIG. 1....” EX1004, ¶[0013] (Examples).

143. A third example of an optical multiplexer, similar to the first two, is provided in FIG. 3. In this example, both the light emitting portions and the collimating lens array are two-by-two arrays, having respectively four light emitting portions and four collimating lenses. With this two-by-two array, aligned along the center focal axis, Kurita has a separate radial sector of the focusing lens to focus each separate laser output onto the optical fiber, just like the alleged invention of the '416 Patent. *See* discussion above at Section VII(A) (describing radial sectors in

context of the '416 Patent); Section V(B)(iii) (describing radial sectors in context of Kurita).

144. Whereas the earlier examples did not show what the other end of the optical fiber 40 was coupled to, in this example “at the other end of the above-mentioned optical fiber, there is a composition of an optical branching device 50 such as a star coupler, optical multiplexers 60 composed of diffraction grating, a light receiving element array 70 wherein silicon PIN detectors are one-dimensionally arrayed, and arithmetic circuits 80 for deciphering the signals optically-received by the individual light receiving elements.” EX1004, ¶[0015] (Examples).

iii. LaMarche

145. U.S. Patent No. 5,078,499 to LaMarche (“LaMarche”) (EX1005) issued January 7, 1992, and is titled “Optical interconnection arrangement.” I am informed that LaMarche is prior art to the '416 Patent under at least §§ 102(a) and 102(b) based on its issuance date of January 7, 1992.

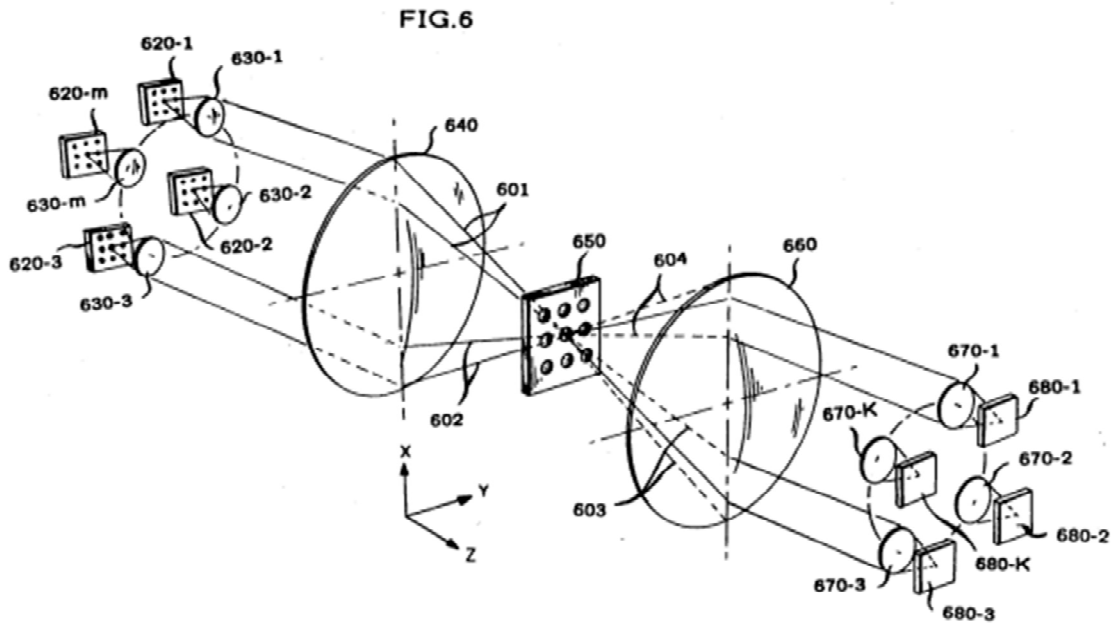
146. LaMarche discloses an optical interconnection arrangement. Specifically, LaMarche teaches that the “invention overcomes the drawbacks of the prior art methods of interconnections by using in a new manner a non-collinear arrangement of lenses, i.e., the optical axes of two or more lenses are parallel, but

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offset in the radial direction.” EX1005, 2:13-17 (Summary of the Invention). The patent further teaches that this design results in improved coupling efficiency, reduced physical complexity, as well as having other advantages such as being able to achieve high-bandwidth connections. *Cf.* EX1005, 1:11-2:20 (Background of the Invention), 2:17-23 (Summary of the Invention).

147. LaMarche discusses multipoint to multipoint interconnections, by utilizing the concept of pupil division. EX1005, 3:3-8. Its teaching of a non-collinear arrangement of lenses has applications outside of just multipoint to multipoint interconnections, however, and includes, *e.g.*, other types of multipoint interconnections such as multipoint to single point. For example, a person of ordinary skill in the art would understand from LaMarche that non-collinear (radial) arrangement of lenses can improve limitations that result from coupling loss and physical complexity, as well as having other advantages such as being able to achieve high-bandwidth connections in a variety of applications. *Cf.* EX1005, 1:11-2:20 (Background of the Invention), 2:17-23 (Summary of the Invention).

148. FIG. 6 of LaMarche is reproduced below.



149. The rectangular areas 620-1 through 620-M are $N \times N$ arrays of light emitting devices, with rectangular areas 680-1 through 680-K being arrays of light detecting devices. As shown, there is a one-to-one mapping (i.e., $M=K$). EX1005, 4:43-60. If $N=1$ for each of the arrays of light emitting devices, then M beams would be focused to a common location in element 650. Moreover, and as depicted in FIG. 6, one laser would correspond to one beam, one collimating lens, and one separate sector on the pupil lens 640. Further, LaMarche teaches that the “optical signals simultaneously impinging on the light detecting devices may be either time division multiplexed or wavelength division multiplexed.” EX1005, 5:20-22.

150. Continuing with FIG. 6 of LaMarche, input probe lenses 630-1 through 630-M are placed in a position corresponding to the light emitting devices 620-1 through 620-M, and act to collimate the light received from the arrays of light emitting devices 620-1 through 620-M. EX1005, 6:26-37. The input probe lenses 630-1 through 630-M are placed around the perimeter of the pupil lens 640. In doing so, collimated beamlets from each of input probe lenses 630-1 through 630-M pass through a separate sector of the pupil lens 640. See EX1005, 6:57-7:7 (explaining beamlets 601 and 602); *see also id.*, 3:17-20 (referring to light rays passing through the lens “utilizing separate portions of a single lens”). With its radial arrangement of light emitting devices 620 and collimating lenses 630, aligned along the center focal axis, LaMarche has a separate radial sector to focus each separate output, just like the alleged invention of the ’416 Patent. *See* discussion above at Section VII(A) (describing radial sectors in context of the ’416 Patent); Sections V(C)(iii), V(D)(iv) (describing radial sectors in context of LaMarche).

iv. Lemoff

151. U.S. Patent No. US 6,870,195 to Lemoff et al. (“Lemoff”) (EX1006) issued March 22, 2005, based on an application filed on February 21, 2003, and is titled “Array of discretely formed optical signal emitters for multi-channel

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communication.” I am informed that Lemoff is prior art to the ’416 Patent under at least § 102(e) based on its filing date of February 21, 2003.

152. Lemoff discloses an optical signal emitter for a multi-channel, wavelength division multiplexed (WDM) optical communication system. EX1006, Abstract. Lemoff begins by explaining that fiber optic networks “have come into widespread use for telecommunications and data communications” “[i]n recent years,” and that “[d]ue to ever-increasing demand for faster data transmission rates, efforts have been directed to the development of high-capacity optical communication systems.” EX1006, 1:7-13. One drawback of current solutions, the patent explains, is the high precision and cost necessitated by typical optical multiplexer solutions. EX1006, 1:34-48. Thus, Lemoff explains, “[t]he invention provides a multi-channel optical signal emitter for a wavelength division multiplexed (WDM) communication system that combines multiple signal components into a multi-channel optical signal without using an optical multiplexer or other device external to the emitter.” EX1006, 1:52-56.

153. FIGS. 1A, 1B, and 2 of Lemoff are reproduced below.

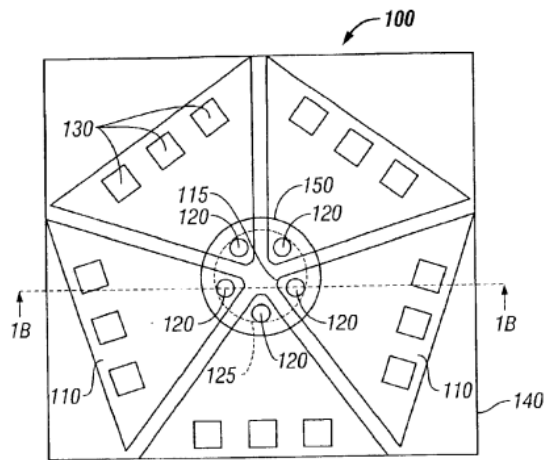


FIG. 1A

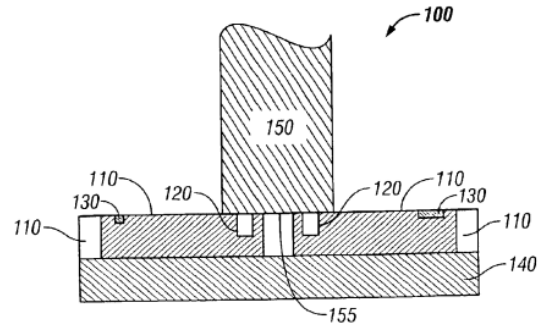


FIG. 1B

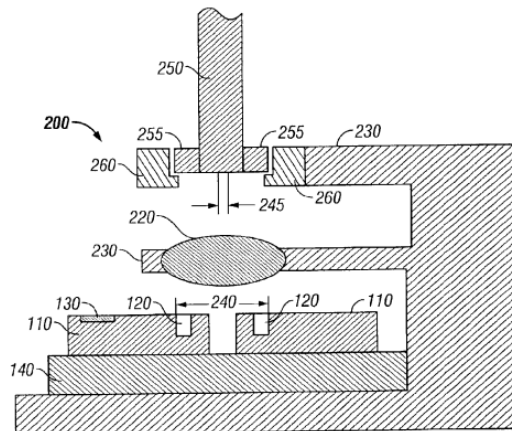


FIG. 2

154. An example of the multi-channel optical signal emitter described in Lemoff is shown in FIGS. 1A and 1B. As shown, five semiconductor die 110 are used; each includes an emission aperture 120 that emits an optical signal that is a component of the multi-channel optical signal and which define a circular signal-emitting-area 125 having emission apertures 120 equally spaced just inside the

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circumference of the circular signal-emitting area 125. An optical conduit 150 (e.g., a core of an optical fiber) is shown, which employs direct butt coupling to the signal-emitting area 125. EX1006, 2:54-3:43. Although five die are shown, “various numbers of die may be used to generate optical signal components that form a single optical signal and couple to the same optical conduit.” EX1006, 3:66-4:2. Further, “the number of die that can be used is related to the geometry of the individual die,” which geometry may “among other possible shapes, [include] a parallelogram, a trapezoid, or a triangle.” EX1006, 4:2-5, 4:18-20.⁵ Lemoff (EX1006) further explains that “[t]he emission aperture of each die is part of an opto-electronic device within the die” and such devices may “include, but are not limited to, light emitting diodes, semiconductor lasers, and vertical cavity surface emitting lasers (VCSELs).” EX1006, 2:39-47. Further, each die may emit a different wavelength. EX1006, 4:59-62.

155. Additionally, “[s]ome embodiments of the invention include an optical imaging element, such as a lens, that is configured to image the optical signal

⁵ I have removed a seemingly errant opening parenthesis that appears at column 4, line 3, without a corresponding closing parenthesis.

components emitted from the signal-emitting area into the optical conduit.” EX1006, 5:15-18. For example, FIG. 2 shows an example optical signal emitter similar to that shown in FIGS. 1A and 1B, having an optical imaging element 220, which (as shown) “is a simple bi-convex lens configured to image the optical signal components emitted from the signal-emitting area into the signal-receiving area, that is, from emission apertures 120 into the core of optical fiber 50.” EX1006, 6:8-11. Although a simple bi-convex lens is shown, Lemoff expressly teaches that other imaging elements may include multiple lenses, such as an arrangement of one or more optical components:

Various embodiments of the invention may use optical imaging elements that include a plano-convex lens, a graded-index (GRIN) lens, a diffractive optical element, a Fresnel lens, another type of lens, or any arrangement of one or more optical components functioning to image the optical signal components from the signal-emitting area onto the signal-receiving area.

EX1006, 6:16-22.

v. Bhandarkar

156. U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. (“Bhandarkar”) (EX1013), was published on March 31, 2005, is based on an application filed September 28, 2004, and is titled “Method and Apparatus for Wavelength Division Multiplexing.” Bhandarker also claims priority to provisional

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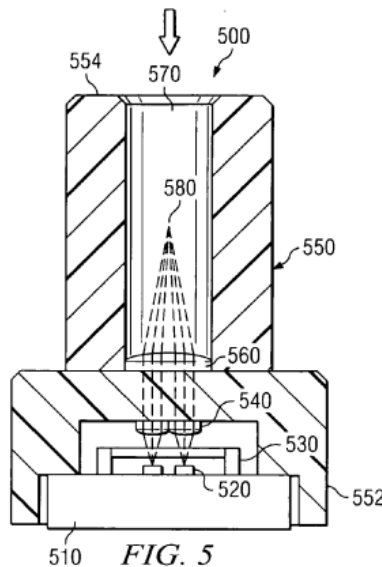
Appl. No. 60/506,795 (the '795 Application"), which was filed on September 29, 2003. I am informed by Counsel that Bhandarkar is prior art to the '416 Patent under at least § 102(e) for two reasons: first, based on the '795 Application's filing date which pre-dates the date of the '416 Patent's related provisional application; and second, based on Bhandarkar's non-provisional application's filing date which pre-dates the date of the '416 Patent's related non-provisional application.

157. As I noted above, Bhandarker was raised by the examiner during prosecution. See Section VII(C).

158. Bhandarker discloses an apparatus and method of Wavelength Division Multiplexing (WDM), including a plurality of lasers, a plurality of collimating lenses and a single focusing lens. Each lens of the plurality of lenses is positioned so as to collimate a beam of light emitted by a laser of the plurality of lasers. The focusing lens is positioned to focus a plurality of collimated beams of light received from the plurality of lenses into substantially a point of light. The WDM multiplexer includes a receptacle that houses the plurality of lasers, the plurality of collimating lenses and the focusing lens. EX1013, Abstract.

159. FIG. 5 of Bhandarkar provides one exemplary embodiment. FIG. 5 is reproduced below:

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160. As shown, “the WDM multiplexer 500 includes a substrate 510 upon which are positioned an array of GSE lasers 520 in a hermetic enclosure 530. In one exemplary embodiment, the array of GSE lasers 520 is a 2×2 array in which four GSE lasers 520 are provided for generating light beam signals at four different wavelengths that are to be multiplexed together.” EX1013, ¶[0038]. Additionally, there is “an array of collimating lenses 540,” “with the collimating lens array 540 being positioned to align with the array of GSE lasers 520.” EX1013, ¶[0039]. Further, “[a] narrower portion 554 of the receptacle 550 provides a mechanism for connecting the WDM multiplexer 500 to a fiber optic connector (not shown) that carries the multiplexed signal to the outside world.” EX1013, ¶[0039].

161. Bhandarkar further explains that “collimating lens array 540 is a 2×2 array of collimating lenses that are positioned such that each lens in the collimating lens array 540 is aligned with a respective one of the GSE lasers in the 2×2 array of GSE lasers 520.” EX1013, ¶[0040]. Bhandarkar explains the operation of the device as follows:

In operation, the GSE lasers in the **array of GSE lasers 520** emit light beam signals through the hermetic enclosure 530, which is transparent to the light beam signals. These light beam signals are captured by the collimating lenses of the collimating lens array 540. **Since there is a one to one correspondence between GSE lasers and collimating lenses in the arrays 520 and 540, each collimating lens captures the light beam signal from its corresponding GSE laser.** As shown in FIG. 5, the collimating lenses adjust the direction of the light beam signals from being divergent, i.e. spreading, to a direction that is parallel with the axis of the lenses (the vertical straight lines illustrated in FIG. 5). This redirects the light beam signals so that they are caught by the single focusing lens 560. Transmission from the collimating lens array 540 and focusing lens 560 is within the material of the molded receptacle 550 which is transparent at the operating wavelengths.

The focusing lens 560 receives the light beam signals from all of the collimating lenses in the collimating lens array 540 and multiplexes them into a single light beam signal.

Essentially, the focusing lens 560 focuses each of the light beam signals to a focal point 580 causing the light beam signals to be combined and multiplexed into a single light beam signal. This single light beam signal generated by the focusing lens 560 travels down the channel 570 so that it may pass to a fiber optic connector (not shown) **for transmission through a fiber optic medium or the like.** The primary application of this embodiment of the

present invention is to provide 10 Gigabit Ethernet capability over 300 meters in accordance with IEEE 802.3ae—LX4 standard. Thus, the WDM multiplexer 500 may be utilized to provide multimode 10 Gigabit Ethernet **data communication using multiplexed light beam signals**.

EX1013 ¶¶[0042]-[0043] (emphasis added).

162. To the extent that the '416 Patent is entitled to the priority date of its provisional, I understand that in order for Bhandarkar to be considered prior art, the provisional application of Bhandarkar must provide written description support for its claims, as described above. See Section V(D). The drawings and description of the provisional application are similar to the Bhandarkar patent. Further, the claims included in the provisional application are also similar to the claims of the Bhandarkar patent. In reviewing these materials, I find that there is support for at least claim 1 of the Bhandarkar patent based on the provisional application. For example, claims 1 and 3 of the provisional application compare to claim 1 of the Bhandarkar patent very closely, and support claim 1 of the Bhandarkar patent:

Bhandarkar (EX1013)	Bhandarkar Provisional Application (EX1015)
1. A laser-enabled multiplexing system, comprising: a plurality of grating-outcoupled surface emitting (GSE) lasers;	1. A laser-enabled multiplexing system, comprising: a first plurality of lasers;

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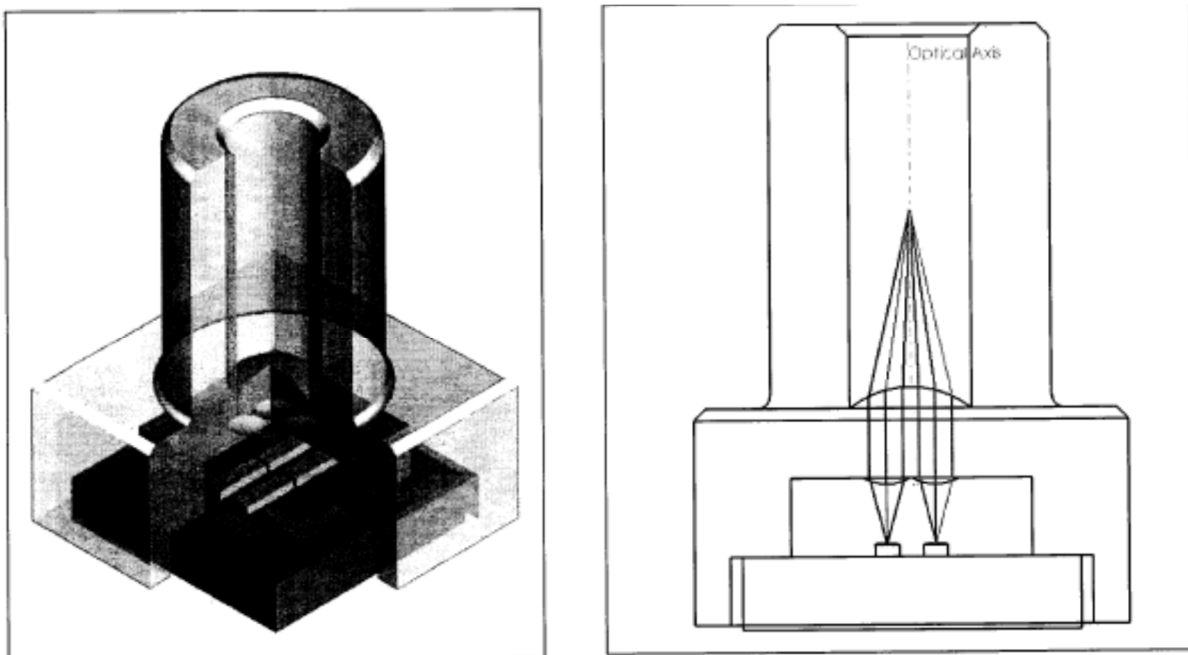
a plurality of lenses, each lens of the plurality of lenses being positioned so as to collimate a beam of light emitted by a GSE laser of the plurality of GSE lasers; and a focusing lens positioned to focus a plurality of collimated beams of light received from the plurality of lenses into substantially a point of light.	a second plurality of lenses, each lens of said second plurality of lenses positioned so as to collimate a beam of light emitted by a laser of said first plurality of lasers; and a third lens, said third lens positioned to focus a plurality of collimated beams of light received from said second plurality of lenses into substantially a point of light.
	3. The laser-enabled multiplexing system of Claim 1, wherein said first plurality of lasers comprises a plurality of Grating-outcoupled Surface Emitting (GSE) lasers.

163. Similarly, the provisional application explains that “[t]he WDM Mux ... consists of an array of GSE lasers attached to a substrate, a matching array of collimating lenses, and a single focusing lens.” EX1013, p. 18. Further, “[t]he divergent laser beam emitted by each laser is collimated by the corresponding collimating lens,” “[t]he multiple collimated beams are then focused by the single focusing lens into a single spot that is suitable for coupling into an optical fiber,” and “[a] preferred embodiment shown in the accompanying figure, consists of a 2x2 rectangular array of GSE lasers, each laser at a different wavelength, to yield a four

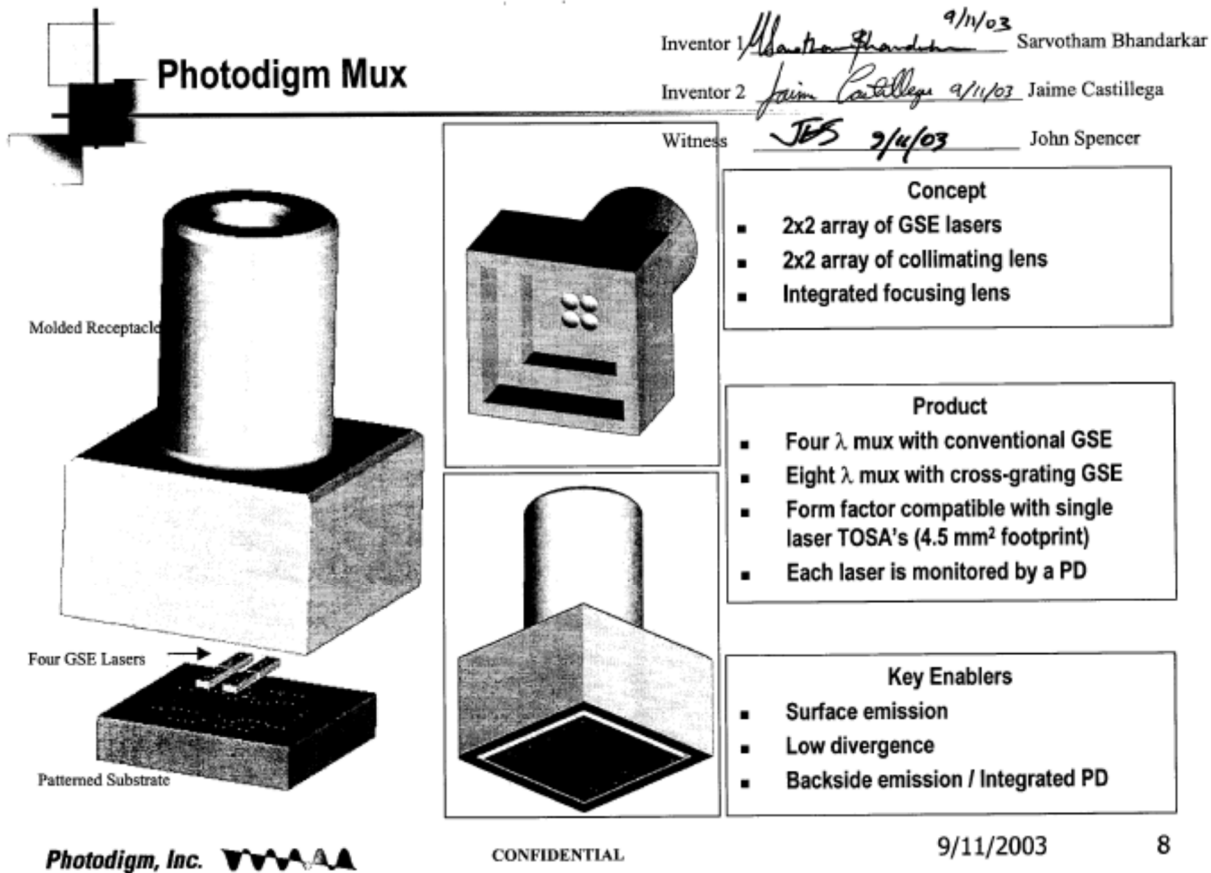
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λ mux.” EX1013, p. 18. The provisional further refers to “a radial arrangement of eight GSE lasers and eight collimating lenses.” EX1013, p. 18.

164. In addition, the provisional application includes images (similar to those of the Bhandarkar patent), that also provide support for at least claim 1. A few of those images are reproduced below:



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165. The other claims of the Bhandarkar patent are also supported by the claims, figures, and specification of the provisional application. I also understand that the Bhandarkar provisional application must contain the subject matter being relied on for showing that the '416 Patent is obvious. As I explain in connection with Ground 5 below, it does, and in particular, the Bhandarkar provisional includes all the subject matter of the Bhandarkar patent that is necessary for teaching the Challenged Claims of the '416 Patent.

Bhandarkar patent claims	Bhandarkar Provisional Application
1. A laser-enabled multiplexing system, comprising: a plurality of grating-outcoupled surface emitting (GSE) lasers; a plurality of lenses, each lens of the plurality of lenses being positioned so as to collimate a beam of light emitted by a GSE laser of the plurality of GSE lasers; and a focusing lens positioned to focus a plurality of collimated beams of light received from the plurality of lenses into substantially a point of light.	Claim 1 (“A laser-enabled multiplexing system, comprising: a first plurality of lasers; a second plurality of lenses, each lens of said plurality of lenses positioned so as to collimate a beam of light emitted by a laser of said first plurality of lasers; and a third lens, said third lens positioned to focus a plurality of collimated beams of light received from the second plurality of lenses into substantially a point of light”); Claim 3 (“wherein said first plurality of lasers comprises a plurality of Grating-outcoupled Surface Emitting (GSE) lasers”); Title (“GSE Laser Enabled WDM Mux”); pp. 1-17 (providing further details); p. 18 (“The WDM Mux proposed in this disclosure consists of an array of GSE lasers attached to a substrate, a matching array of collimating lenses, and a single focusing lens. The divergent laser beam emitted by each laser is collimated by the corresponding collimating lens. The multiple collimated beams are then focused by the single focusing lens

	into a single spot that is suitable for coupling into an optical fiber.”).
2. The laser-enabled multiplexing system of claim 1, further comprising: a receptacle for coupling the point of light to an optical fiber.	See claim 1 above. Claim 5 (“a receptacle for coupling said point of light to an optical fiber”).
3. The laser-enabled multiplexing system of claim 1, wherein at least one GSE laser of the plurality of GSE lasers, at least one lens of the second plurality of lenses, and the focusing lens are arranged in a confocal configuration.	See claim 1 above. Claim 6 (“wherein at least one of said said first plurality of lasers, at least one of said of second plurality of lenses, and said third lens are arranged in a confocal configuration.”).
4. The laser-enabled multiplexing system of claim 2, wherein the plurality of lenses, the focusing lens, and the receptacle are fabricated as a single unit.	See claim 2 above. Claim 7 (“wherein said second plurality of lenses, said third lens, and said receptacle are fabricated as a single unit”).
5. The laser-enabled multiplexing system of claim 1, wherein the plurality of GSE lasers comprises a 2-by-2 rectangular array of GSE lasers.	See claim 1 above. Claim 9 (“wherein said first plurality of lasers comprises a 2-by-2 rectangular array of lasers”).
6. The laser-enabled multiplexing system of claim 5, wherein the plurality of lenses comprises a 2-by-2 rectangular array of lenses.	See claim 5 above. Claim 10 (“wherein said second plurality of lenses comprises a 2-by-2 rectangular array of lenses”).

7. The laser-enabled multiplexing system of claim 1, wherein the plurality of GSE lasers comprises an n-by-n array of GSE lasers.	See claim 1 above. Claim 11 (“wherein said first plurality of lasers comprises an n-by-n array of lasers”).
8. The laser-enabled multiplexing system of claim 7, wherein the plurality of lenses comprises an n-by-n array of lenses.	See claim 7 above. Claim 12 (“wherein said second plurality of lenses comprises an n-by-n array of lenses”).
9. The laser-enabled multiplexing system of claim 1, wherein the plurality of GSE lasers comprises a radial array of GSE lasers.	See claim 1 above. Claim 13 (“wherein said first plurality of lasers comprises a radial array of lasers”).
10. The laser-enabled multiplexing system of claim 1, wherein the plurality of GSE lasers comprises a radial array of 8 GSE lasers.	See claim 1 above. Claim 14 (“wherein said first plurality of lasers comprises a radial array of 8 lasers”).
11. The laser-enabled multiplexing system of claim 1, wherein the plurality of lenses comprises a radial array of 8 lenses.	See claim 1 above. Claim 15 (“wherein said second plurality of lenses comprises a radial array of 8 lenses”).
12. The laser-enabled multiplexing system of claim 1, further comprising: a substrate, wherein the plurality of GSE lasers are attached to the substrate.	See claim 1 above. Claim 16 (“a substrate, said first plurality of lasers attached to said substrate”).
13. The laser-enabled multiplexing system of claim 1, wherein the	See claim 1 above.

multiplexing system comprises a Wavelength Division Multiplexer (WDM).	Claim 17 (“wherein said multiplexing system comprises a Wavelength Division Multiplexer (WDM)”).
14. The laser-enabled multiplexing system of claim 1, further comprising: at least one photodetector, wherein the at least one photodetector is coupled to at least one GSE laser of the plurality of GSE lasers so as to monitor an energy output from the at least one GSE laser.	See claim 1 above. Claim 18 (“at least one photodetector, said at least one photodetector coupled to at least one laser of said first plurality of lasers so as to monitor an energy output from said at least one laser”).
15. The laser-enabled multiplexing system of claim 1, further comprising: at least one photodetector, wherein the at least one photodetector is integrated into at least one GSE laser of the plurality of GSE lasers.	See claim 1 above. Claim 19 (“wherein said at least one photodetector is integrated into said at least one laser of said first plurality of lasers”).
16. The laser-enabled multiplexing system of claim 1, further comprising: at least one photodetector, wherein the at least one photodetector is operable to receive a backside emission of energy from at least one GSE laser of the plurality of GSE lasers.	See claim 1 above. Claim 20 (“wherein said at least one photodetector is operable to receive a backside emission of energy from said at least one laser of said first plurality of lasers”).

17. An output monitor for a laser-enabled multiplexing system, comprising: a plurality of lasers; a substrate attached to the plurality of lasers for mounting the plurality of lasers, the substrate including a transparent portion; and a plurality of photodetectors, each photodetector of the plurality of photodetectors being located adjacent to the transparent portion of the substrate on a side of the substrate opposite that of the plurality of lasers so as to receive a backside emission of energy from at least one laser of the plurality of lasers.	Claim 21 (“An output monitor for a laser-enabled multiplexing system, comprising: a plurality of lasers; a substrate attached to said plurality of lasers for mounting said plurality of lasers, said substrate including a transparent portion; and a plurality of photodetectors, each photodetector of said plurality of photodetectors being located adjacent to said transparent portion of said substrate on a side of said substrate opposite that of said plurality of lasers so as to receive a backside emission of energy from at least one laser of said plurality of lasers.”). See also pp. 12-18.
18. An output monitor for a laser-enabled multiplexing system, comprising: a plurality of lasers, each laser of the plurality of lasers including an outcoupler region; a substrate attached to the plurality of lasers for mounting the plurality of lasers, the substrate including a portion not attached to each outcoupler region of each laser of the plurality of lasers; and	Claim 22 (“An output monitor for a laser-enabled multiplexing system, comprising: a plurality of lasers, each laser of said plurality of lasers including an outcoupler region; a substrate attached to said plurality of lasers for mounting said plurality of lasers, said substrate including a portion not attached to each outcoupler region of each laser of said plurality of lasers; and

a plurality of photodetectors, each photodetector of the plurality of photodetectors located adjacent to a corresponding outcoupler region of each laser of the plurality of lasers so as to receive a backside emission of energy from at least one laser of the plurality of lasers.	a plurality of photodetectors, each photodetector of said plurality of photodetectors located adjacent to a corresponding outcoupler region of each laser of said plurality of lasers so as to receive a backside emission of energy from at least one laser of said plurality of lasers.”). See also pp. 12-18.
19. A method for multiplexing a plurality of laser beams, comprising the steps of: emitting a beam of light from each grating-coupled surface emitting (GSE) laser of a plurality of GSE lasers; collimating each beam of light emitted from each GSE laser of the plurality of GSE lasers; and focusing the plurality of collimated beams of light into substantially a point of light.	Claim 23 (“A method for multiplexing a plurality of laser beams, comprising the steps of: emitting a beam of light from each laser of a plurality of lasers; collimating each said beam of light emitted from each said laser of said plurality of lasers; and focusing said plurality of collimated beams of light into substantially a point of light.”); Claim 24 (“wherein said plurality of lasers comprises a plurality of GSE lasers”). See also pp. 12-18.
20. A method of making a laser-enabled multiplexing system, comprising the steps of: providing a plurality of lasers, wherein each laser of the plurality of lasers emits a beam of light;	See claim 17 above. The description shows how to make such a laser-enabled multiplexing system. See also pp. 12-18.

attaching a substrate to the plurality of lasers, the substrate including a transparent portion; and providing a plurality of photodetectors located adjacent to the transparent portion of the substrate on a side of the substrate opposite that of the plurality of lasers, wherein the photodetectors receive a backside emission of energy from at least one laser of the plurality of lasers.	
21. The method of claim 20, wherein the plurality of lasers comprises a plurality of GSE lasers.	The description and claims contemplate the plurality of lasers being GSE lasers. E.g., claim 24 (“plurality of GSE lasers”).
22. A method of making a laser-enabled multiplexing system, comprising: providing a plurality of lasers, wherein each laser of the plurality of lasers emits a beam of light from an outcoupler region; attaching a substrate to the plurality of lasers, the substrate including a portion not attached to each the outcoupler regions of each laser of the plurality of lasers; and providing a plurality of photodetectors, each photodetector being adjacent to a corresponding outcoupler region of a laser of the	See claim 18 above. The description shows how to make such a laser-enabled multiplexing system. See also pp. 12-18.

plurality of lasers, wherein at least one photodetector of the plurality of photodetectors receives a backside emission of energy from at least one laser of the plurality of lasers.	
23. The method of claim 22, wherein the plurality of lasers comprises a plurality of GSE lasers.	The description and claims contemplate the plurality of lasers being GSE lasers. E.g., claim 24 (“plurality of GSE lasers”).
24. A method of providing a laser-enabled multiplexing system, comprising: providing a plurality of grating-coupled surface emitting (GSE) lasers; providing a plurality of lenses, each lens of the plurality of lenses being positioned so as to collimate a beam of light emitted by a GSE laser of the plurality of GSE lasers; and providing a focusing lens positioned to focus a plurality of collimated beams of light received from the plurality of lenses into substantially a point of light.	See claim 1 above. The description shows how to make such a laser-enabled multiplexing system. See also pp. 12-18.

B. Ground 1 – The Challenged Claims would have been obvious over Kurita

166. Kurita (EX1004) discloses or renders obvious every element of the Challenged Claims of the ’416 Patent. *See* §§VIII.A.ii and VIII.A.iii; *see also* claim

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charts below. It is my opinion that the Challenged Claims would have been obvious over Kurita.

167. To the extent it is argued that Kurita does not expressly disclose a limitation of the Challenged Claims, it would have been obvious over Kurita's disclosure, to a POSITA at the time of the purported invention. *See* §§VI.A-D (Technology Background); §VIII.A.i (Admitted Prior Art).

168. As a visual aid to assist in the analysis below of this ground, as well as in the other grounds, I use a color scheme to identify certain claim elements and related components. In particular, I identify the lasers and the laser output (e.g., “*the outputs of a plurality of n lasers*”) in orange; the optical fiber (e.g., “*a stopped single optical fiber*”) in green; the collimating lenses (e.g., “*a plurality of n collimating lenses*”) in blue; and the focusing means (e.g., “*focusing means*”) in red. I may use this color scheme in certain places to draw emphasis to the appropriate element, while in other places I may omit the coloring scheme.

**i. Kurita (Ground 1) discloses or suggests Claim Elements
[1.0], [1.1], and [1.2]**

'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. ("Kurita") (EX1004)
[1.0] <i>An optical combiner</i>	To the extent this is a claim limitation, Kurita (Ground 1) discloses "[a]n optical combiner." The optical connection element and device of Kurita is an optical combiner. It combines multiple wavelength inputs into a single optical fiber output. <i>See, e.g.</i>, EX1004 (Kurita): FIGS. 1-3 (showing light emitting portions 11 being combined, via other elements such as lens portions 21 and lens 30, to optical fiber 40); ¶[0009] ("As the lights emitted at the light emitting portions of the planar monochromatic light source array are each collimated at the lens portions of the lens array to be made into parallel beams, and as the individual beams are converged on one point with the lens to be entered into one end portion of a single optical fiber, the lights from the individual light emitting portions entered are multiplexed to become integrated to be transmitted through the above-mentioned single optical fiber."); ¶[0018] ("Here, each of the above-mentioned examples illustrates one example of the present invention, and it is possible to apply the present invention as light connection elements or light connection devices in various optical devices that would require a composition that would allow plural lights to be multiplexed to be entered into a single optical fiber.").

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'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. ("Kurita") (EX1004)
[1.1] <i>usable in data communication systems for multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength,</i>	To the extent this is a claim limitation, Kurita (Ground 1) discloses an optical combiner "<i>usable in data communication systems for multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength.</i>" Kurita expressly notes that it can be used for optical communications (i.e., "<i>in data communication systems</i>"), and that it involves multiplexing multi-wavelength laser light sources. <i>See, e.g., EX1004 (Kurita):</i> FIGS. 1-3 (reference numerals 10, 10A, 11); ¶[0001] ("The present invention relates to light connection elements and light connection devices for inputting laser lights into and outputting them out of optical fibers that are used with multistage switch networks inside optical computers and switchboards, with optical communications, laser processing, etc."); ¶[0007] ("Here, plural light emitting portions may be composed as a planar monochromatic light source array wherein they emit lights each of which has a wavelength differing from others. And, specifically, a planar monochromatic light source array is composed of surface emitting lasers and the lens array of flat-sheet microlenses respectively."); ¶[0008] ("And, the wavelength multiplex switch as the light connection device according to the present invention is composed of a planar monochromatic light source array wherein plural light emitting portions are integrally array-formed and each of the

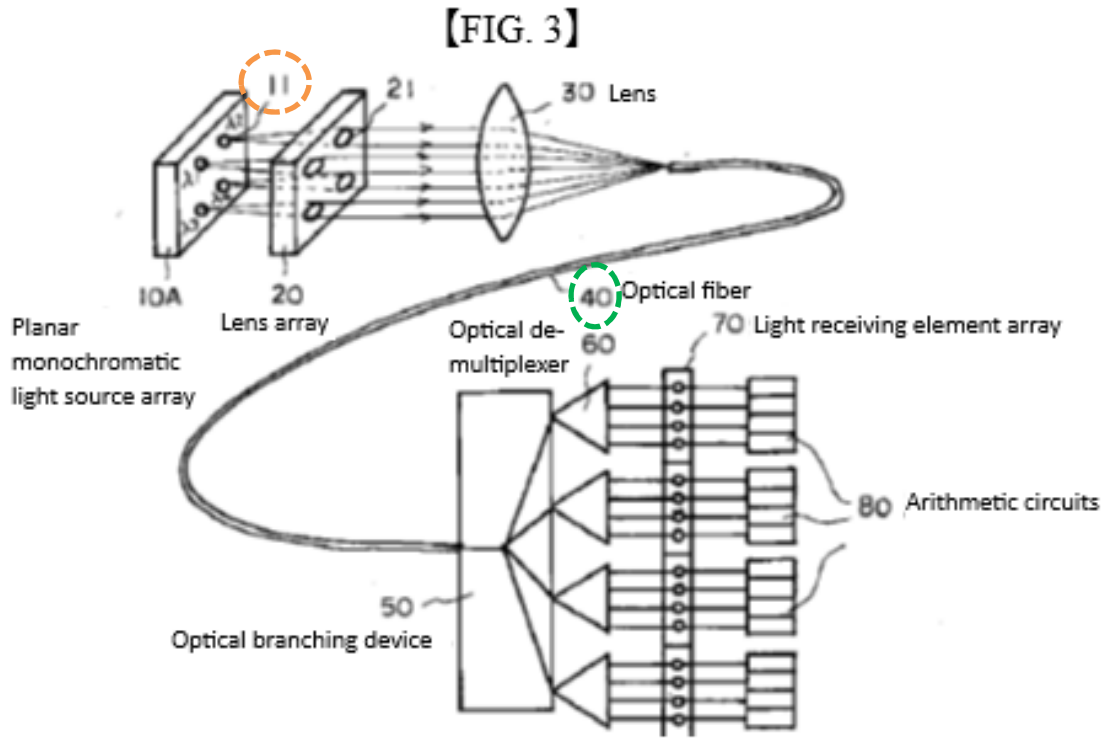
'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. (“Kurita”) (EX1004)
	light emitting portions emits light having a wavelength differing from others....”); ¶[0010] (“This optical multiplexer is composed of a planar monochromatic light source array 10 with surface emitting lasers....”); ¶[0013] (“This optical multiplexer is composed of a planar monochromatic light source array 10A integrally having plural light emitting portions 11 each of which is of a different wavelength....”).
[1.2] <i>for transmission into and through a stopped single optical fiber, comprising:</i>	To the extent this is a claim limitation, Kurita (Ground 1) discloses an optical combiner “<i>for transmission into and through a stopped single optical fiber.</i>” Kurita expressly notes that the outputs of the light source are transmitted through a single optical fiber. <i>See, e.g.,</i> EX1004 (Kurita): FIGS. 1-3 (reference numeral 40); ¶[0009] (“As the lights emitted at the light emitting portions of the planar monochromatic light source array are each collimated at the lens portions of the lens array to be made into parallel beams, and as the individual beams are converged on one point with the lens to be entered into one end portion of a single optical fiber, the lights from the individual light emitting portions entered are multiplexed to become integrated to be transmitted through the above-mentioned single optical fiber.”); ¶[0011] (“[T]he individual beams are converged at one point with the lens 30 to be entered into one end

'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. ("Kurita") (EX1004)
	portion of the optical fiber 40 . It results in the lights from the individual light emitting portions 11 entered being multiplexed to become integrated to be transmitted through the optical fiber 40 .”).

169. To the extent that the preamble is limiting, Kurita discloses an optical combiner that has all of the properties noted in Claim Elements [1.0], [1.1], and [1.2].

170. For instance, with respect to Claim Element [1.0], Kurita is directed to an *optical combiner*. See, e.g., EX1004, ¶¶[0001], [0007]-[0011], [0013].

171. Additionally, Kurita discloses that its devices are *usable in data communication systems for multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength* (Claim Element [1.1]), and *for transmission into and through a stopped single optical fiber* (Claim Element [1.2]). With reference to FIG. 3, the optical device taught in Kurita couples light from different lasers (each of the **plural light emitting portions 11**) having different wavelengths (λ_1 , λ_2 , λ_3 , and λ_4) onto a single stopped optical fiber (**optical fiber 40**), via plural lens portions 21 that collimate the light and direct it to the lens 30 for converging the light onto the optical fiber 40:



Kurita explains that this device can be used in optical communications. *See, e.g.*, EX1004, ¶[0001]. Kurita further explains that the device is an “optical multiplexer” that causes the light from the lasers to be integrated into and transmitted through an optical fiber. *See, e.g.*, EX1004, ¶[0001], [0007]-[0011], [0013], [0015]. In the example of FIG. 3, the light is transmitted into and through the optical fiber 40 to optical branching device 50. *See, e.g.*, EX1004, FIG. 3 and ¶[0015].

172. While Kurita refers to a single optical fiber 40, it does not explicitly use the term “stopped single optical fiber.” Even so, Kurita teaches, or would have

suggested, a stopped optical fiber, as that term would be understood by a POSITA. *See* Section VII(D)(ii). A “stopped” optical fiber is an optical fiber that is fixed. *See id.* It would have been readily apparent to a POSITA that the fiber 40 of Kurita is fixed in place. *See* EX1004, FIG. 3 and ¶[0016] (“lights of differing wavelengths of λ_1 through λ_4 at the individual light emitting portions which are collimated with the lens array 20, converged onto one end of the optical fiber 40 with the lens 30, and coupled to the optical fiber 40 to be propagated through the inside of the optical fiber 40”). Kurita states “the individual beams are converged *at one point* with the lens 30 to be entered into one end portion of the optical fiber.” EX1004, ¶[0013] (emphasis added). If the optical fiber was not (spatially) fixed (i.e., “stopped”), then this requirement of Kurita wouldn’t make much sense. If the optical fiber were not fixed, it would be highly problematic for the beams converging at the “one point” (i.e., the location of the optical fiber for coupling light into) to converge onto one end of the optical fiber 40. Fixing the optical fiber therefore allows for proper operation of the device in Kurita, and without fixing the optical fiber, there could be a high and variable amount of coupling loss, which would degrade the operation of the device in Kurita. Accordingly, a POSITA would have recognized that Kurita

teaches, or would have suggested, a stopped single optical fiber, as stated in claim element [1.2].

173. To the extent that Patent Owner argues that a “stopped optical fiber” requires a structure having similarity to the stated examples of a “fiber stop or seat 60 formed in ferrule 60” described in the ’416 Patent (*see* EX1001, 3:11-15), it would have been obvious to a POSITA at the time of the alleged invention that such a structure would have been used in the setup of Kurita. This is so because a POSITA would recognize that the optical fiber 40 should not be floating free in space, but rather, that the optical fiber 40 would be secured, and using a seat or ferrule was (and still is) a typical way to secure an optical fiber.

174. Accordingly, and for all of these reasons, in my opinion, Kurita (Ground 1) discloses, or would have suggested, Claim Elements [1.0], [1.1], and [1.2].

ii. Kurita (Ground 1) discloses or suggests Claim Elements [1.3] and [1.4]

’416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. (“Kurita”) (EX1004)
[1.3] <i>a plurality of n collimating lenses,</i>	Kurita (Ground 1) discloses “ <i>a plurality of n collimating lenses.</i> ”

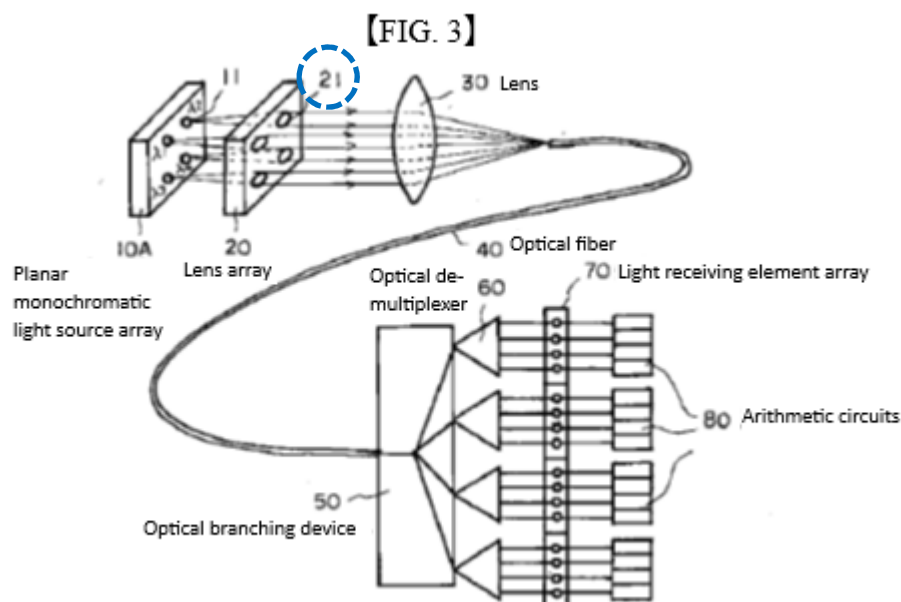
'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. (“Kurita”) (EX1004)
	The individual lens portions 21, of the lens array 20, are the plurality of collimating lenses. <i>See, e.g., EX1004 (Kurita):</i> FIGS. 1-3 (reference numeral 20, 21); ¶[0011] (“And, by correspondingly placing the light emitting portions 11 of the planar monochromatic light source array 10 at the focal positions of the individual lens portions 21 of the lens array 20, the lights from the individual light emitting portions 11 are collimated with the lens portions 21 of the lens array 20 to be made into parallel beams, and the individual beams are converged at one point with the lens 30 to be entered into one end portion of the optical fiber 40.”); ¶[0015] (“This multiplexing switch is provided with a planar monochromatic light source array 10A wherein plural light emitting portions 11 having fixed oscillation wavelengths are arrayed, a lens array 20 having plural lens portions 21 corresponding to the individual light emitting portions 11, a lens 30 for focusing the lights from the individual lens portions 21, and an optical fiber 40, this composition being set forth to be similar to the second example shown in FIG. 2.”).
[1.4] <i>said lenses being spaced apart and positioned to receive and collimate the output of said n laser output beams, said n laser output</i>	Kurita (Ground 1) discloses <i>said lenses being spaced apart and positioned to receive and collimate the output of said n laser output beams, said n laser output beams have n different output wavelengths, and.”</i>

'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. ("Kurita") (EX1004)
<i>beams have n different output wavelengths, and</i>	The lens portions 21 are in an array (and are placed at corresponding planar positions to the light emitting portions 11. The lens portions 21 collimate the light from the light emitting portions 11, where each light emitting portion 11 may have a different wavelength. <i>See, e.g., EX1004 (Kurita):</i> FIGS. 1-3 (reference numerals 10, 10A, 11, 20, 21); ¶[0010] ("Plural light emitting portions 11 of the planar monochromatic light source 10 and plural lens portions 21 of the lens array 20 are placed at respectively corresponding planar positions."); ¶[0011] ("[T]he lights from the individual light emitting portions 11 are collimated with the lens portions 21 of the lens array 20 to be made into parallel beams, and the individual beams are converged at one point with the lens 30 to be entered into one end portion of the optical fiber 40."); ¶[0013] ("This optical multiplexer is composed of a planar monochromatic light source array 10A integrally having plural light emitting portions 11 each of which is of a different wavelength....").

175. Kurita discloses an optical combiner that has the requirements of Claim Elements [1.3] and [1.4].

176. With respect to Claim Element [1.3], the individual lens portions 21, of the lens array 20, are a *plurality of n collimating lenses*:

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EX1004, FIG. 3 (annotations added).

177. And as required by Claim Element [1.4] and illustrated above in FIG. 3, they are *spaced apart and positioned to receive and collimate the output of said n laser output beams*. The lens portions 21 are spaced apart because, as shown in FIG. 3, there are gaps (spaces) between the lens portions 21. They are positioned to receive and collimate the output of the laser output beams because the **lens portions 21** (in **lens array 20**) are placed at corresponding planar positions compared to the **light emitting portions 11** (in **light source array 10 or 10A**), and the **lens portions** (in **lens array 20**) receive and collimate **light** from the **light emitting portions 11** (in **light source array 10 or 10A**). Further, each of the **light emitting portions 11** emits light

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in a different wavelength. EX1004, FIGS. 1-3, [0010], [0011], [0013], [0015]. The different wavelengths are identified in FIG. 3 as λ_1 , λ_2 , λ_3 , and λ_4 .

178. Accordingly, and for all of these reasons, in my opinion, Kurita (Ground 1) discloses, or would have suggested, Claim Elements [1.3] and [1.4].

iii. Kurita (Ground 1) discloses or suggests Claim Elements [1.5] and [1.6]

'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. ("Kurita") (EX1004)
[1.5] <i>focusing means for focusing said n collimated output beams onto a single spot at said stopped single optical fiber,</i>	Kurita (Ground 1) discloses "<i>focusing means for focusing said n collimated output beams onto a single spot at said stopped single optical fiber.</i>" The lens 30 for converging light is the focusing means (corresponding to the focusing lens structure described in the '416 Patent's specification). Lens 30 focusses the light from the collimated output beams into a single optical fiber. See, e.g., EX1004 (Kurita): See, e.g., FIGS. 1-3 (reference numeral 30); ¶[0009] ("As the lights emitted at the light emitting portions of the planar monochromatic light source array are each collimated at the lens portions of the lens array to be made into parallel beams, and as the individual beams are converged on one point with the lens to be entered into one end portion of a single optical fiber, the lights from the individual light emitting portions entered are multiplexed to become integrated to be transmitted through the above-mentioned single optical fiber.");

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'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. ("Kurita") (EX1004)
	¶[0010] ("This optical multiplexer is composed of a planar monochromatic light source array 10 with surface emitting lasers, etc., a lens array 20 with flat-sheet microlenses, etc., a lens 30 for converging the lights from the lens array, and an optical fiber 40."); ¶[0011] ("And, by correspondingly placing the light emitting portions 11 of the planar monochromatic light source array 10 at the focal positions of the individual lens portions 21 of the lens array 20, the lights from the individual light emitting portions 11 are collimated with the lens portions 21 of the lens array 20 to be made into parallel beams, and the individual beams are converged at one point with the lens 30 to be entered into one end portion of the optical fiber 40. It results in the lights from the individual light emitting portions 11 entered being multiplexed to become integrated to be transmitted through the optical fiber 40."); ¶[0013] ("This optical multiplexer is composed of a planar monochromatic light source array 10A integrally having plural light emitting portions 11 each of which is of a different wavelength, a lens array 20 integrally having plural lens portions 21 corresponding to the above-mentioned individual light emitting portions 11, a lens 30 for converging the lights from the above-mentioned individual lens portions 21, and an optical fiber 40.");
[1.6] <i>said focusing means having n separate radial sectors on its surface, and</i>	Kurita (Ground 1) discloses " <i>a plurality of n collimating lenses.</i> "

'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. ("Kurita") (EX1004)
<i>each of said n collimated beams passes through a separate one of said n sectors of said focusing means whereby said n output beams having n different wavelengths are coupled into said single fiber.</i>	Kurita discloses a two-by-two array of lasers and collimating lenses (FIG. 3). (This corresponds to the two-by-two array structures disclosed and claimed in the '416 Patent.) As a result of the two-by-two array of lasers and collimating lenses, the collimated beams pass through separate radial sectors on the surface of the lens 30. See, e.g., EX1004 (Kurita): FIG. 3 ¶[0009] ("As the lights emitted at the light emitting portions of the planar monochromatic light source array are each collimated at the lens portions of the lens array to be made into parallel beams, and as the individual beams are converged on one point with the lens to be entered into one end portion of a single optical fiber, the lights from the individual light emitting portions entered are multiplexed to become integrated to be transmitted through the above-mentioned single optical fiber."); ¶[0013] ("This optical multiplexer is composed of a planar monochromatic light source array 10A integrally having plural light emitting portions 11 each of which is of a different wavelength....").

179. With respect to Claim Element [1.5], Kurita discloses *focusing means for focusing said n collimated output beams onto a single spot at said stopped single optical fiber*. The structure corresponding to the focusing means in the '416 Patent is a focusing lens, and thus the focusing means refers to a focusing lens and

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equivalents thereof, as I explained above in Section VII(D)(iii)(2), and Kurita discloses a focusing lens 30.

180. The *lens* 30 of Kurita converges (i.e., focuses) light from the output of the lens array 20 onto a single optical fiber 40 and therefore is a focusing lens *for focusing said n collimated output beams onto a single spot at said stopped single optical fiber*. EX. 1004, FIGs. 1-3, ¶¶[0009]-[0011], [0015], ¶[0013] (“a **lens 30** for converging the **lights** from the above-mentioned individual lens portions 21, and an **optical fiber 40**”); ¶[0014] (“With this optical multiplexer, the lights of differing wavelengths ... are individually collimated ... to be made into parallel beams, which are subsequently converged into **one point** with the lens 30 and entered into one end of the optical fiber 40.”) (emphasis added).

181. The structure of lens 30 may also be compared to the corresponding structure disclosed in the '416 Patent. The structure of the lens 30 (of Kurita) is equivalent to, e.g., the structure of the focusing lens 250/350 (of the '416 Patent) shown in FIGS. 7-9 (focusing lens 250) and 10-11 (focusing lens 350) of the '416 Patent. Compare Kurita FIG. 1 (lens 30) with '416 Patent, FIGS. 7 (focusing lens 250) and 10 (focusing lens 350), each of which is reproduced below with an annotation identifying the corresponding focusing lens:

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【FIG. 1】

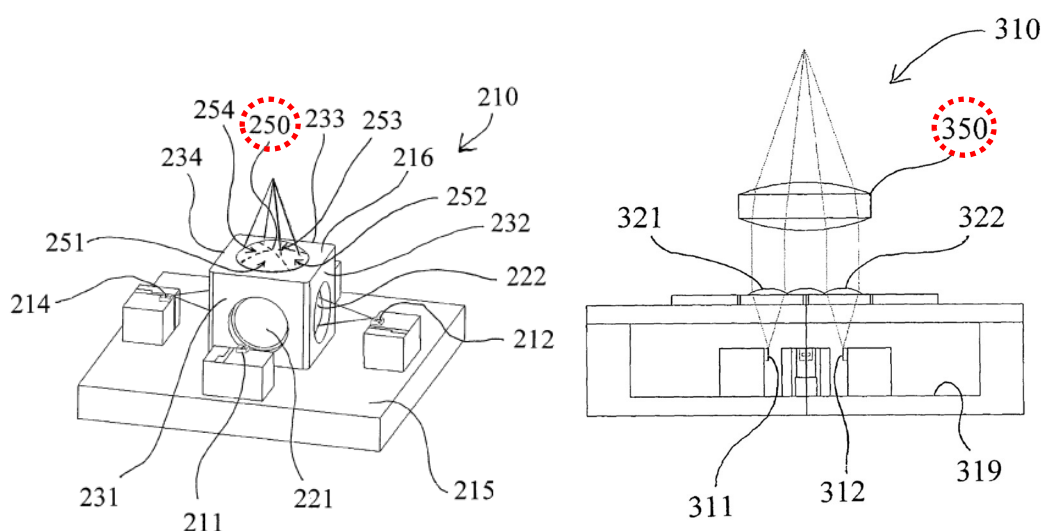
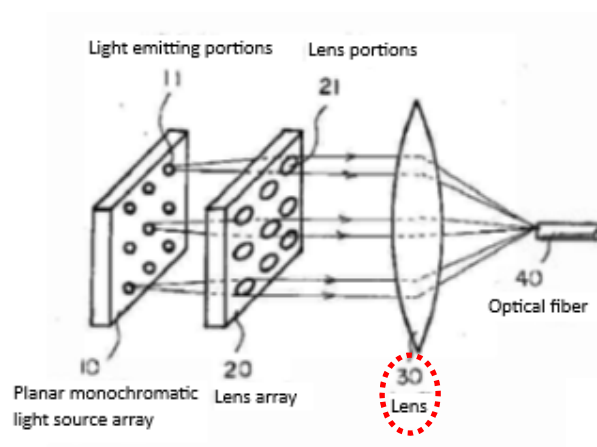


Fig. 7

Fig. 10

I understand that Patent Owner has taken the position in the corresponding litigation that “*focusing means*” should not be interpreted under 35 U.S.C. § 112, ¶6. Even if the term is considered to have sufficient structure in the claims, that does not affect

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my analysis here. The disclosed structure of the “*focusing means*” is a focusing lens, and claim 2 shows that the “*focusing means*” must include at least a single focusing lens. *See* claim 2 (“said focusing means is a single focusing lens”). Because the structure I have identified in the prior art is a single focusing lens, it satisfies the “*focusing means*” claim element, regardless of whether it is interpreted as a means-plus-function term.

182. In particular, taking the example of Kurita where there is a two-by-two array of plural light emitting portions 11 and a two-by-two array of plural lens portions 21 (such as allowed by the embodiments of FIGS. 1-2 and expressly shown by FIG. 3), collimated light from the plural lens portions 21 (of lens array 20) passes through the lens 30. In particular, collimated light from each of the lens portions 21 will pass through a separate radial sector on the surface of the lens 30. This is because the two-by-two array of lens portions 21 results in radially arranged lenses that will each pass their respective collimated light to a separate radial portion (or sector) of the lens 30. EX1004, FIGS. 1-3, ¶¶[0009]-[0013].

183. To the extent it is argued that Kurita does not expressly disclose that “said focusing means ha[s] n separate radial sectors on its surface, and each of said n collimated beams passes through a separate one of said n sectors of said focusing

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means whereby said n output beams having n different wavelengths are coupled into said single fiber,” this would have been obvious to a POSITA at the time of the invention. As an initial matter, as I have explained, the separate radial sectors are achieved as a result of the arrangement of the lasers and collimating lenses radially with respect to a center focal axis of the focusing lens. See above, Section VII(A). Therefore, a POSITA would have understood Kurita to teach this claim element. For example, the arrangement shown in FIG. 3 of Kurita appears to show an optical combiner having four lasers (the four light emitting portions 11) and four collimating lenses (the four lens portions 21) that are radially arranged, in a two-by-two array, with respect to a center focal axis of the focusing lens (lens 30). First, a POSITA would understand, e.g., based on the drawing of FIG. 3, and the various refraction angles of the different light rays out of lens 30, that the arrays of lasers and collimating lenses are arranged on-axis, i.e., with a center axis of the focusing lens 30. Second, Kurita discloses that an aperture of lens 30 is of area equal to or greater than the area encompassing each of the light emitting portions 11 and lens portions 21. EX1004, ¶[0010] (“As for the lens 30, that having an aperture equal to or greater than the area encompassing the individual light emitting portions 11 of the above-mentioned planar monochromatic light source array 10 and the individual lens

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portions 21 of the lens array 20 is used.”), claim 1 (“a lens having an aperture equal to or greater than the area encompassing the above-mentioned lens array”). In the case where the aperture is specifically equal to the area encompassing the light emitting portions 11 and lens portions 21, a POSITA would understand that the collimated light passes through a separate radial sector of the focusing lens, because otherwise (i.e., if the array of lenses is offset from the center of the focusing lens), collimated light would be lost.

184. In addition to a POSITA understanding that Kurita discloses this arrangement, it also would have been obvious. Alignment of the collimating lenses around the center focal axis of the focusing lens was typical as of the time of the invention, it would have improved efficiency of the system by limiting signal losses, *e.g.*, through efficient low-angle (*i.e.*, relative to the fiber end face normal) optical coupling into fiber (*i.e.*, high angle coupling typically has higher coupling loss than low-angle coupling), and at any event would have been a known technique that would have improved the device. For example, a POSITA would have known that coupling can be improved when the angle of light relative to the fiber normal from the focusing lens into the fiber end-face is small, *e.g.*, based on the numerical aperture. Furthermore, a POSITA would have known that if the alignment of the

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beams were not around the center focal axis of the focusing lens, then the coupling efficiency could be decreased since the refractive angle of the outer beams relative to the fiber would be larger.

185. Accordingly, and for all of these reasons, in my opinion, Kurita (Ground 1) discloses, or would have rendered obvious, Claim Elements [1.5] and [1.6].

iv. Kurita (Ground 1) discloses or renders obvious Claim 2

'416 Claim 2	Japanese Patent 2,848,279 to Kurita et al. ("Kurita") (EX1004)
<i>The optical combiner of claim 1 wherein $n=4$ and wherein said four lasers and four collimating lenses are each formed in a two-dimensional, two by two array, wherein said focusing means is a single focusing lens, and wherein each radial sector is a pie-shaped quadrant.</i>	Kurita (Ground 1) discloses "<i>The optical combiner of claim 1 wherein $n=4$ and wherein said four lasers and four collimating lenses are each formed in a two-dimensional, two by two array, wherein said focusing means is a single focusing lens, and wherein each radial sector is a pie-shaped quadrant.</i>" See citations for claim 1 above. Kurita discloses that both light source array 10A and lens array 20 may be a two-by-two array. Thus, there are four light emitting portions 11 (four lasers) and four lens portions 21 (four collimating lenses). See, e.g., EX1004 (Kurita): FIG. 3 (identifying two-by-two array of light source array 10A and lens array 20). ¶[0015] ("FIG. 3 being a conceptual configuration diagram for the element in the third example

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'416 Claim 2	Japanese Patent 2,848,279 to Kurita et al. ("Kurita") (EX1004)
	according to the present invention, this one is an example whereby a light connection device is composed as a 4×4 wavelength multiplexing switch.”).

186. Kurita discloses all of the various aspects of claim 2.

187. First, Kurita discloses that both **light source array 10A** and **lens array 20** may be a two-by-two array, as shown for example in FIG. 3 and as permitted by the embodiments of FIGS. 1-2 also. Thus, in this embodiment from Kurita, there are **four light emitting portions 11** (four lasers) and **four lens portions 21** (four collimating lenses) – i.e., “*wherein $n=4$ and wherein **said four lasers** and **four collimating lenses** are each formed in a two-dimensional, two by two array.*”

188. Second, Kurita uses focusing means that are *a single focusing lens*. See, e.g., EX1004, FIG. 1-3 (lens 30). A single lens 30 focusses the collimated light onto the optical fiber 40. EX1004, FIG. 3, ¶[0015]; *see also* above, Section VIII(B)(i)-(iv) (addressing claim 1).

189. Third, the lens 30 has four equally shaped radial sectors, which are therefore pie-shaped quadrants. That is, because of the two-by-two array formation, *each radial sector is a pie-shaped quadrant*. This follows from the arrangement of

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the **light emitting portions 11** and **lens portions 21** being arranged radially around the lens 30, centered on the focal axis of lens 30, as I discussed in connection with claim element [1.6] above. This arrangement is shown in FIG. 3.

190. Moreover, it would be obvious to a POSITA when arranging a two-by-two array of **light emitting portions 11** and **lens portions 21** to make them radially arranged with respect to a center focal axis of the focusing lens (lens 30), as I explained in connection with Claim Element [1.6].

191. Accordingly, and for all of these reasons, in my opinion, Kurita (Ground 1) discloses, or would have rendered obvious, Claim 2.

v. Kurita (Ground 1) discloses or renders obvious Claim 6

'416 Claim 6	Japanese Patent 2,848,279 to Kurita et al. ("Kurita") (EX1004)
<i>The optical combiner of claim 1 wherein said optical combiner does not require the use of dielectric filters or waveguides.</i>	Kurita (Ground 1) discloses "<i>The optical combiner of claim 1 wherein said optical combiner does not require the use of dielectric filters or waveguides.</i>" See citations for claim 1 above. Kurita discloses reducing the number of component parts needed, and discloses a device without dielectric filters or waveguides. <i>See, e.g., EX1004 (Kurita):</i> FIGS. 1-3 (lack of dielectric filters or waveguides);

'416 Claim 6	Japanese Patent 2,848,279 to Kurita et al. (“Kurita”) (EX1004)
	¶[0004] (“【Problem to be Solved by the Invention】 As such, while with the conventional light connection element the lights from plural monochromatic light sources are focused and multiplexed with separate individual optical systems and coupled to a single optical fiber, it presented a problem of an increased number of parts in order to build separate optical systems resulting in high optical losses in order to allow the lights to pass through these parts. And, on account of a large number of parts being needed, it increases installation man-hours, and presents a problem in terms of the cost aspect as well.”); ¶[0005] (“【Objects of the Invention】 The objects of the present invention lie in providing light connections elements and light connection devices by attempting to reduce the number of component parts and the costs as well as attempting to hold down optical losses.”).

192. Kurita discloses an optical combiner that does not have dielectric filters or waveguides, and hence *does not require the use of dielectric filters or waveguides*. This is apparent from looking at the figures, as well as the corresponding description in the text. Additionally, Kurita explains that an object of the invention (similar to what the '416 Patent says) is to reduce the number of component parts and cost

compared to prior art designs. EX1004, FIGS. 1-3, ¶¶[0004]-[0005]; *cf.* EX1001, 2:21-26 (discussing providing a “compact and cost effective optical combiner”).

193. Accordingly, and for all of these reasons, in my opinion, Kurita (Ground 1) discloses, or would have rendered obvious, Claim 6.

vi. Kurita (Ground 1) discloses or renders obvious Claim 7 (Claim Elements [7.0], [7.1], [7.2], [7.3], [7.4], [7.5], and [7.6])

'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. (“Kurita”) (EX1004)
[7.0] <i>An optical combiner</i>	See above for Claim Element [1.0].
[7.1] <i>usable in data communication systems for multiplexing the outputs of a plurality of lasers wherein each of said outputs has a different wavelength,</i>	See above for Claim Element [1.1]
[7.2] <i>for transmission into and through a stopped single optical fiber, comprising:</i>	See above for Claim Element [1.2]
[7.3] <i>an array of four lasers, formed in a two-dimensional, two by two array, each of said lasers having an output beam with a different wavelength,</i>	See above for Claim Element [1.1], Claim 2

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'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. ("Kurita") (EX1004)
<i>[7.4] an array of four collimating lenses, said lenses being formed in a two-dimensional, two by two array and positioned to receive and collimate the output of said laser output beams, and</i>	See above for Claim Element [1.3], [1.4], Claim 2
<i>[7.5] focusing means for focusing said collimated output beams onto a single spot at said stopped single optical fiber,</i>	See above for Claim Element [1.5]
<i>[7.6] said focusing means having four separate quadrants on its surface, and each of said four collimated beams passes through a separate one of said quadrants of said focusing means whereby said output beams of said four lasers are coupled into said single fiber.</i>	See above for Claim Element [1.6], Claim [2]

194. As explained above at Section VII(B), claim 2 is narrower than (or possibly co-extensive with) claim 7. Therefore, the analysis above for claim 2, which sets $n=4$ and requires two-by-two arrays of lasers and collimating lenses,

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applies equally here to claim 7, which also requires two-by-two arrays of lasers and collimating lenses. That is, Kurita discloses an optical combiner (the optical connection element and device of Kurita) with lasers (light emitting portions 11), collimating lenses (lens portions 21) to collimate light from the lasers, a focusing lens (lens 30) to focus the collimated light onto a single stopped optical fiber (optical fiber 40). In particular, the example of FIG. 3 of Kurita shows four light emitting portions and four collimating lenses, each in a two-by-two array.

195. Accordingly, and for all of these reasons, in my opinion, Kurita (Ground 1) discloses, or would have rendered obvious, Claim 7.

vii. Kurita (Ground 1) discloses or renders obvious Claim 9

'416 Claim 9	Japanese Patent 2,848,279 to Kurita et al. ("Kurita") (EX1004)
<i>The optical combiner of claim 7 wherein said optical combiner does not require the use of dielectric filters or waveguides.</i>	See above for Claim 6, 7.

196. Claim 9 depends from claim 7, but other than the dependency from a different independent claim contains the same additional requirement as claim 6. Therefore, the analysis above for claim 6 applies equally here to claim 9.

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197. Accordingly, and for all of these reasons, in my opinion, Kurita (Ground 1) discloses, or would have rendered obvious, Claim 9.

C. Ground 2 – The Challenged Claims would have been obvious over Kurita in view of LaMarche and/or Lemoff

198. Kurita (EX1004) in view of LaMarche (EX1005) and/or Lemoff (EX1006) disclose or suggest every element of the Challenged Claims of the '416 Patent. *See* §§VIII.A.ii, VIII.A.iii, and VIII.A.iv; *see also* claim charts below. It is my opinion that the Challenged Claims would have been obvious over Kurita and LaMarche and/or Lemoff.

199. To the extent it is argued that Kurita in view of LaMarche and/or Lemoff do not literally disclose a limitation of the Challenged Claims, it would have been obvious over Kurita's and LaMarche's and/or Lemoff's disclosures to one of skill in the art at the time of the alleged invention. *See* §§VI.A-D (Technology Background); §VIII.A.i (Admitted Prior Art).

200. As explained above, it is my opinion, that Kurita teaches or would have suggested every element of the challenged claims. However, in the alternative, I rely on LaMarche for two purposes. First, the perspective view shown in FIG. 6 of LaMarche confirms my explanation above that a radial arrangement of light sources and collimating lenses would result in the light passing through separate radial

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sectors of the focusing lens, including in the two-by-two array shown in Kurita FIG.

3. Second, I rely on LaMarche for its teachings of using radial arrangements of light sources and collimating lenses around a center focal axis of a focusing lens. LaMarche teaches that you can arrange an arbitrary number of light sources (the M NxN arrays of light emitting devices) and collimating lenses (the M input probe lenses) around a center focal axis of a focusing lens. EX1005, FIG. 6, 4:43-6:2.

201. Also, and in the alternative, I rely on Lemoff as teaching the use of a seat and ferrule arrangement for securing an optical fiber. *E.g.*, EX1006, FIG. 2, 5:55-6:2. Lemoff can be used to supplement the teachings of Kurita alone, or with the combination of Kurita and LaMarche.

i. A POSITA would have been motivated to combine Kurita and LaMarche

202. With respect to Ground 2, a POSITA would have been motivated to use LaMarche's teachings of a radial arrangement of collimating lenses, in the light connection element of Kurita, such that the collimated light from each of the collimating lenses passes through a separate radial sector of a focusing lens.

203. In particular, the embodiment shown in FIG. 3 of Kurita includes a two-by-two array of four radially arranged lens portions 21 (i.e., collimating lenses), and it would be a natural extension to apply LaMarche's teaching of a radial arrangement

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for an arbitrary number M of collimating lenses (input probe lenses 630-1 through 630-M in LaMarche). LaMarche further teaches, and would have suggested to a POSITA at the time of the invention, that the radial (or non-collinear) arrangement it provides for results in improved coupling efficiency, reduced physical complexity, as well as having other advantages such as being able to achieve high-bandwidth connections. Cf. EX1005, 1:11-2:20 (Background of the Invention), 2:17-23 (Summary of the Invention).

204. Both Kurita and LaMarche are in the same field (i.e., optical technologies); and they each teach optical devices utilizing similar components, such as light sources, collimating lenses, and a focusing lens. *See, e.g.*, EX1004, FIGS. 1-3, ¶¶[0010]-[0018]; EX1005, FIG. 6, 4:43-6:2. *See also* §§VIII(A)(ii) and VIII(A)(iii).

205. Similarly, Kurita and LaMarche are analogous art to the '416 Patent. As described in the paragraph above, both are directed to optical devices and utilize similar components, such as light sources, collimating lenses, and a focusing lens. EX1004, FIGS. 1-3, ¶¶[0010]-[0018]; EX1005, FIG. 6, 4:43-6:2. The '416 Patent, likewise, is directed to optical devices utilizing similar components as both Kurita and LaMarche. EX1001, FIGS. 1-11, 3:8-4:52. And both Kurita and LaMarche are

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reasonably pertinent to the problem addressed by the '416 Patent (i.e., providing an optical combiner, and particularly, one that uses a radial arrangement of light sources and collimating lenses). EX1001 ('416 Patent), 1:43-2:10; EX1004 (Kurita), FIG. 3, ¶[0015]; EX1005 (LaMarche), FIG. 6, 4:43-6:2.

206. At least three rationales support applying LaMarche's teachings to the light connection element of Kurita.

207. One rationale is applying a known technique (LaMarche's radial arrangement of collimating lenses, such that the collimated light from each of the collimating lenses passes through a separate radial sector of a focusing lens) to a known device (Kurita's light connection element) ready for improvement, to yield predictable results (e.g., a functioning optical device).

208. Another rationale is combining prior art elements (LaMarche's radial arrangement of collimating lenses, such that the collimated light from each of the collimating lenses passes through a separate radial sector of a focusing lens, with Kurita's light connection element) according to known methods (arranging elements of an optical device) to yield predictable results (e.g., a functioning optical device).

209. Another rationale is some teaching, suggestion, or motivation in the prior art that would have led a POSITA to modify the prior art reference or to

combine prior art reference teachings to arrive at the claimed invention. In particular, LaMarche teaches that its radial arrangement of collimating lenses, such that the collimated light from each of the collimating lenses passes through a separate radial sector of a focusing lens, will result in improved coupling efficiency, reduced physical complexity, as well as having other advantages such as being able to achieve high-bandwidth connections. *Cf.* EX1005, 1:11-2:20 (Background of the Invention), 2:17-23 (Summary of the Invention).

210. In each case, the techniques or elements from LaMarche are straightforward to apply to or combine with Kurita, and would predictably result in a functioning optical device. Indeed, Kurita already has collimating lenses, and in the case of FIG. 3 they are already radially arranged. Therefore, applying the teaching from LaMarche that the collimating lenses are radially arranged, such that the collimated light from each of the collimating lenses passes through a separate radial sector of a focusing lens, would predictably result in a functioning optical device.

**ii. A POSITA would have been motivated to combine Kurita,
or Kurita and LaMarche, with Lemoff**

211. With respect to Ground 2, a POSITA would have been motivated to use Lemoff's teachings of a receptacle and ferrule arrangement for securing an optical

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fiber, in the light connection element of Kurita, such that the optical fiber in Kurita is secured by the receptacle and ferrule arrangement for receiving the output beams that have been focused onto a single spot.

212. In particular, the embodiment shown in FIG. 3 of Kurita includes an optical fiber 40, and it would be a natural extension to apply Lemoff's teaching of a receptacle and ferrule arrangement for securing an optical fiber. Lemoff further teaches that the receptacle and ferrule arrangement form a connector "by means of which various optical fibers may be plugged into or removed from optical signal emitter 200 when the emitter is initially installed in an optical communication system or when maintenance is performed." EX1006, 5:63-6:2.

213. Both Kurita and Lemoff are in the same field (i.e., optical technologies); and they each teach optical devices utilizing similar components, such as light sources and lenses. *See, e.g.*, EX1004, FIGS. 1-3, ¶¶[0010]-[0018]; EX1006, FIGS. 1A, 2, 2:54-6:36. *See also* §§VIII(A)(ii) and VIII(A)(iv).

214. Similarly, Kurita and Lemoff are analogous art to the '416 Patent. As described in the paragraph above, both are directed to optical devices and utilize similar components, such as light sources and lenses. EX1004, FIGS. 1-3, ¶¶[0010]-[0018]; EX1006, FIGS. 1A, 2, 2:54-6:36. The '416 Patent, likewise, is directed to

optical devices utilizing similar components as both Kurita and Lemoff. EX1001, FIGS. 1-11, 3:8-4:52. And both Kurita and Lemoff are reasonably pertinent to the problem addressed by the '416 Patent (i.e., providing an optical combiner, and particularly, one that uses a radial arrangement of light sources and collimating lenses). EX1001 ('416 Patent), 1:43-2:10; EX1004 (Kurita), FIG. 3, ¶[0015]; EX1006 (Lemoff), FIGS. 1A, 2, 2:54-6:36.

215. At least three rationales support applying Lemoff's teachings to the light connection element of Kurita.

216. One rationale is applying a known technique (Lemoff's teaching of a receptacle and ferrule arrangement for securing an optical fiber) to a known device (Kurita's light connection element) ready for improvement, to yield predictable results (e.g., a functioning optical device).

217. Another rationale is combining prior art elements (Lemoff's teaching of a receptacle and ferrule arrangement for securing an optical fiber) according to known methods (arranging elements of an optical device) to yield predictable results (e.g., a functioning optical device).

218. Another rationale is some teaching, suggestion, or motivation in the prior art that would have led a POSITA to modify the prior art reference or to

combine prior art reference teachings to arrive at the claimed invention. In particular, Lemoff teaches that the receptacle and ferrule arrangement form a connector “by means of which various optical fibers may be plugged into or removed from optical signal emitter 200 when the emitter is initially installed in an optical communication system or when maintenance is performed.” EX1006, 5:63-6:2. Being able to have optical fibers plugged into or removed from the light connection element of Kurita is an improvement, as it allows for an efficient and straightforward approach for attaching an optical fiber in a substantially fixed spatial position for light coupling. Moreover, one optical fiber may be replaced with another according to a different use case or circumstance.

219. In each case, the techniques or elements from Lemoff are straightforward to apply to or combine with Kurita, and would predictably result in a functioning optical device. Indeed, Kurita already has an optical fiber 40 positioned to receive light from the focusing lens 30. Therefore, applying the teaching from Lemoff of a receptacle and ferrule arrangement for securing an optical fiber would predictably result in a functioning optical device. Additionally, the teaching from Lemoff remains applicable whether or not the teaching from

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LaMarche is applied; and, likewise, the teaching from LaMarche remains applicable, whether or not the teaching from Lemoff is applied.

iii. Kurita with LaMarche and/or Lemoff (Ground 2) discloses or renders obvious Claim 1 (Claim Elements [1.0], [1.1], [1.2], [1.3], [1.4], [1.5], and [1.6])

'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. (“Kurita”) (EX1004) and U.S. Patent 5,078,499 to LaMarche (“LaMarche”) (EX1005)
[1.0] <i>An optical combiner</i>	See claim chart for Ground 1, above.
[1.1] <i>usable in data communication systems for multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength,</i>	See claim chart for Ground 1, above.
[1.2] <i>for transmission into and through a stopped single optical fiber, comprising:</i>	See claim chart for Ground 1, above.
[1.3] <i>a plurality of n collimating lenses,</i>	See claim chart for Ground 1, above.
[1.4] <i>said lenses being spaced apart and positioned to receive and collimate the output of said n laser output beams, said n laser output beams have n different output wavelengths, and</i>	See claim chart for Ground 1, above.

'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. ("Kurita") (EX1004) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
[1.5] <i>focusing means for focusing said n collimated output beams onto a single spot at said stopped single optical fiber,</i>	See claim chart for Ground 1, above.
[1.6] <i>said focusing means having n separate radial sectors on its surface, and each of said n collimated beams passes through a separate one of said n sectors of said focusing means whereby said n output beams having n different wavelengths are coupled into said single fiber.</i>	See claim chart for Ground 1, above. LaMarche discloses input probe lenses 630-1 through 630-M (corresponding to the number M of light emitting devices 620-1 through 620-M). The input probe lenses in LaMarche are the collimating lenses. LaMarche teaches that these are arranged radially, and that beams from each input probe lens pass through the pupil lens 640, which is a focusing lens. See, e.g., EX1005 (LaMarche): FIG. 6 (reference numerals 630-1 through 630-M) 2:13-18 ("This invention overcomes the drawbacks of the prior art methods of interconnections by using in a new manner a non-collinear arrangement of lenses, i.e., the optical axes of two or more lenses are parallel, but offset in the radial direction."). 5:27-37 ("Each of the M N×N arrays of light emitting devices, 620-1 through 620-M, is placed at the focal plane of input probe lenses, 630-1 through 630-M, respectively. Input probe lenses, 630-1 through 630-M, have a focal length of f_p. Thus, light that is emitted from a light emitting device is collimated by its respective input probe lens, wherein the resulting collimated beamlet

'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. (“Kurita”) (EX1004) and U.S. Patent 5,078,499 to LaMarche (“LaMarche”) (EX1005)
	propagates with propagation directions of an angle θ with respect to the optical sagittal plane and an angle α with respect to the optical tangential plane of its respective input probe lens.”). 5:49-53 (“Each input probe lens and its associated array of light emitting devices is positioned around the perimeter of pupil lens 640. The optical axis of each input probe lenses is parallel with and a radial distance, r, away from the optical axis of pupil lens lens 640.”). 6:56-61 (“Beamlets from two of the possible M light emitting device arrays, positioned in the second row and second column of each array, are shown in FIG. 6. Beamlets 601 and 602 converge at the focal plane of pupil lens 640. Similarly, this occurs for all other beamlets from the other light emitting devices and, for the sake of simplicity, these beamlets are not shown.”). Claims 3-4 (referring to “radial distance” of first and second input probe lenses). <i>See, e.g.</i>, EX1006 (Lemoff): FIG. 2 (reference numerals 255, 260); 5:55-6:2 (“Optical signal emitter 200 also includes receptacle 260, optical fiber 250 and ferrule 255, which together function in a manner similar to that of optical conduit 150, as shown in FIG. 1. During assembly, the end of optical fiber 250 is inserted into ferrule 255, which surrounds and secures the end of the fiber. Then, end of optical fiber 250 and

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'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. (“Kurita”) (EX1004) and U.S. Patent 5,078,499 to LaMarche (“LaMarche”) (EX1005)
	the bottom of the ferrule may be, but need not be, polished together to form a smooth surface, which aids the coupling efficiency. The fiber and ferrule assembly is then inserted into receptacle 260, which surrounds and secures the fiber and ferrule assembly. Receptacle 260 and ferrule 255 constitute a connector, by means of which various optical fibers may be plugged into or removed from optical signal emitter 200 when the emitter is initially installed in an optical communication system or when maintenance is performed.”).

220. Kurita discloses all of the various aspects of claim 1, as explained above with respect to Ground 1.

221. In addition, with respect to Ground 2 and claim element [1.6], LaMarche expressly teaches a radial arrangement of collimating lenses. This is similar to the radial, two-by-two arrangement of FIG. 3 of Kurita. Moreover, LaMarche teaches this radial arrangement for an arbitrary number of M input probe lenses 630-1 through 630-M. EX1005, FIG. 6, 2:13-18, 5:27-37, 5:49-53, 6:56-61. LaMarche further teaches that this radial (also referred to as non-collinear) arrangement of lenses results in improved coupling efficiency, reduced physical complexity, as well as having other advantages such as being able to achieve high-

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bandwidth connections. *Cf.* EX1005, 1:11-2:20 (Background of the Invention), 2:17-23 (Summary of the Invention). As can be seen by FIG. 6, the collimated light from each of input probe lenses 630-1 through 630-M will pass through a separate radial section of the pupil lens 640, owing to the radial arrangement of the input probe lenses 630-1 through 630-M. *See* EX1005, 5:23-53 (explaining symmetry of light detecting and light emitting devices, and that optical axis of each input probe lens is the same radial distance r away from the optical axis of the pupil lens).

222. Thus, it is obvious in view of Kurita that light from each of the four lens portions 21 (which collimate light) formed in a two-by-two array (such as shown in FIG. 3) will pass through a separate radial sector of the lens 30. This is due to the radial arrangement of the lens portions 21. This fact is further confirmed by LaMarche, which shows a radial arrangement of input probe lenses 630-1 through 630-M (which collimate light), and shows visually in FIG. 6 that the collimated light from the input probe lenses 630-1 through 630-M will pass through a separate radial sector of the pupil lens 640. Moreover, a POSITA would have been motivated to modify Kurita in view of LaMarche to have a radial arrangement of lens portions 21 for an arbitrarily sized lens array 20, such that the collimated light from each of the collimating lenses passes through a separate radial sector of a focusing lens. *See*

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Section VIII(B)(i). For example, doing so may result in improved coupling efficiency, reduced physical complexity, as well as having other advantages such as being able to achieve high-bandwidth connections. *Cf.* EX1005, 1:11-2:20 (Background of the Invention), 2:17-23 (Summary of the Invention).

223. I note here that the light sources in LaMarche, i.e., 620-1 through 620-M, are disclosed as being arrays of light emitting devices of a size $N \times N$. A POSITA would understand that N is arbitrary in LaMarche, and that in some cases $N=1$, in which case the light sources 620-1 through 620-M each correspond to a single laser (similar to the illustrations in other figures with a single light emitting device for each light source, as in FIG. 4). Each laser would thus correspond to one beam, one collimating lens, and one separate radial sector on the focusing lens. However, even in the case where $N>1$, the teaching from LaMarche that I am relying on here is still applicable to Kurita. In particular, LaMarche confirms that the collimated light from the input probe lenses 630-1 through 630-M will pass through a separate radial sector of the pupil lens 640, whether the collimated light through each input probe is the result of one laser or an array of $N \times N$ lasers. Moreover, in the combination of Kurita and LaMarche, I am relying on Kurita for the laser elements. In the combination, each of these light sources (the lasers in Kurita) has a corresponding collimating lens

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(the input probe lenses 630-1 through 630-M in LaMarche) positioned to receive and collimate light from the light source.

224. Additionally, to the extent that it is argued that Kurita does not teach or suggest a *stopped* optical fiber, it would have been obvious to a POSITA based on the teachings of Lemoff. Lemoff teaches a receptacle 260 and ferrule 255 (as shown in FIG. 2 of Lemoff), for securing an optical fiber. Specifically, Lemoff teaches that the receptacle 260 and ferrule 255 constitute a connector “by means of which various optical fibers may be plugged into or removed from optical signal emitter 200 when the emitter is initially installed in an optical communication system or when maintenance is performed.” EX1006, 5:63-6:2. A POSITA would have been motivated to use the receptacle and ferrule arrangement of Lemoff in the light connection element of Kurita for purposes of securing the optical fiber 40. This would improve the coupling efficiency, as it would help ensure the light would be focused onto the optical fiber 40.

225. Accordingly, and for all of these reasons, in my opinion, Kurita and LaMarche and/or Lemoff (Ground 2) disclose, or would have rendered obvious, Claim 1.

iv. Kurita with LaMarche and/or Lemoff (Ground 2) discloses or renders obvious Claim 2

'416 Claim 2	Japanese Patent 2,848,279 to Kurita et al. (“Kurita”) (EX1004) and U.S. Patent 5,078,499 to LaMarche (“LaMarche”) (EX1005)
<i>The optical combiner of claim 1 wherein $n=4$ and wherein said four lasers and four collimating lenses are each formed in a two-dimensional, two by two array, wherein said focusing means is a single focusing lens, and wherein each radial sector is a pie-shaped quadrant.</i>	See claim 1, above. See claim chart for Ground 1, above. See, e.g., EX1005 (LaMarche): 5:49-53 (“Each input probe lens and its associated array of light emitting devices is positioned around the perimeter of pupil lens 640. The optical axis of each input probe lenses is parallel with and a radial distance, r , away from the optical axis of pupil lens 640.”).

226. Kurita discloses all of the various aspects of claim 2, as explained above with respect to Ground 1. See also the discussion of claim 1 for Ground 2.

227. Additionally, with respect to Ground 2, LaMarche teaches that the input probe lenses 630-1 through 630-M (i.e., the collimating lenses) are each a radial distance r (i.e., each are the same distance r) from the optical axis of pupil lens 640. EX1005, 5:49-53. Where, as here, “ $n=4$ ” (where n , in the claim language, refers to the number of lasers and collimating lenses), that results in a two-by-two array of input probe lenses. Accordingly, in view of this teaching, it would have been

obvious to a POSITA at the time of the invention to arrange the light emitting portions 11 and lens portions 21 radially around the lens 30, in a two-by-two array, centered on the focal axis of lens 30, such that the resulting four radial sections on the surface of the focusing lens are each a pie-shaped quadrant. For example, it would have been obvious to a POSITA at the time of the invention for the light emitting portions 11 and lens portions 21 to be equally spaced along the circle that they form, resulting in each of the radial sectors having the same size.

228. Accordingly, and for all of these reasons, in my opinion, Kurita and LaMarche (Ground 2) disclose, or would have rendered obvious, Claim 2.

v. Kurita with LaMarche and/or Lemoff (Ground 2) discloses or renders obvious Claim 6

'416 Claim 6	Japanese Patent 2,848,279 to Kurita et al. ("Kurita") (EX1004) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
<i>The optical combiner of claim 1 wherein said optical combiner does not require the use of dielectric filters or waveguides.</i>	See claim 1, above. See claim chart for Ground 1, above.

229. Kurita discloses claim 6, as explained above with respect to Ground 1. See also the discussion of claim 1 for Ground 2. Nothing in LaMarche, Lemoff, or

the combination of LaMarche and/or Lemoff with Kurita, requires the use of dielectric filters or waveguides.

230. Accordingly, and for all of these reasons, in my opinion, Kurita and LaMarche (Ground 2) disclose, or would have rendered obvious, Claim 6.

vi. Kurita with LaMarche and/or Lemoff (Ground 2) discloses or renders obvious Claim 7 (Claim Elements [7.0], [7.1], [7.2], [7.3], [7.4], [7.5], and [7.6])

'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. (“Kurita”) (EX1004) and U.S. Patent 5,078,499 to LaMarche (“LaMarche”) (EX1005)
[7.0] <i>An optical combiner</i>	See above for Claim Element [1.0].
[7.1] <i>usable in data communication systems for multiplexing the outputs of a plurality of lasers wherein each of said outputs has a different wavelength,</i>	See above for Claim Element [1.1]
[7.2] <i>for transmission into and through a stopped single optical fiber, comprising:</i>	See above for Claim Element [1.2]
[7.3] <i>an array of four lasers, formed in a two-dimensional, two by two array, each of said lasers having an output beam with a different wavelength,</i>	See above for Claim Element [1.1], Claim 2

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'416 Claim Limitation	Japanese Patent 2,848,279 to Kurita et al. ("Kurita") (EX1004) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
[7.4] <i>an array of four collimating lenses, said lenses being formed in a two-dimensional, two by two array and positioned to receive and collimate the output of said laser output beams, and</i>	See above for Claim Element [1.3], [1.4], Claim 2
[7.5] <i>focusing means for focusing said collimated output beams onto a single spot at said stopped single optical fiber,</i>	See above for Claim Element [1.5]
[7.6] <i>said focusing means having four separate quadrants on its surface, and each of said four collimated beams passes through a separate one of said quadrants of said focusing means whereby said output beams of said four lasers are coupled into said single fiber.</i>	See above for Claim Element [1.6], Claim [2]

231. As explained above at Section VII(B), claim 2 is narrower than (or possibly co-extensive with) claim 7. Therefore, the analysis above for claim 2,

which sets $n=4$ and requires two-by-two arrays of lasers and collimating lenses, applies equally here to claim 7, which also requires two-by-two arrays of lasers and collimating lenses. That is, Kurita in view of LaMarche, discloses an optical combiner (the optical connection element and device of Kurita) with lasers (light emitting portions 11), collimating lenses (lens portions 21) to collimate light from the lasers, a focusing lens (lens 30) to focus the collimated light onto a single stopped optical fiber (optical fiber 40). In particular, the example of FIG. 3 of Kurita shows four light emitting portions and four collimating lenses, each in a two-by-two array.

232. Accordingly, and for all of these reasons, in my opinion, Kurita and LaMarche (Ground 2) disclose, or would have rendered obvious, Claim 7.

vii. Kurita with LaMarche and/or Lemoff (Ground 2), discloses or renders obvious Claim 9

'416 Claim 9	Japanese Patent 2,848,279 to Kurita et al. ("Kurita") (EX1004) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
<i>The optical combiner of claim 7 wherein said optical combiner does not require the use of dielectric filters or waveguides.</i>	See above for Claim 6, 7.

233. Claim 9 depends from claim 7, but other than the dependency from a different independent claim contains the same additional requirement as claim 6. Therefore, the analysis above for claim 6 applies equally here to claim 9.

234. Accordingly, and for all of these reasons, in my opinion, Kurita and LaMarche (Ground 2) disclose, or would have rendered obvious, Claim 9.

D. Grounds 3 and 4 – The Challenged Claims would have been obvious over Lemoff alone, and alternatively, over Lemoff in view of LaMarche

235. Lemoff (EX1006) alone (Ground 3), and Lemoff (EX1006) and LaMarche (EX1005) in combination (Ground 4) disclose or suggest every element of the Challenged Claims of the '416 Patent. *See* §§VIII.A.ii and VIII.A.iii; *see also* claim charts below. It is my opinion that the Challenged Claims would have been obvious over Lemoff alone or in combination with LaMarche.

236. To the extent it is argued that either Lemoff alone or Lemoff with LaMarche do not literally disclose a limitation of the Challenged Claims, it would have been obvious over Lemoff's disclosure alone, or Lemoff's and LaMarche's disclosures, respectively, to one of skill in the art at the time of the purported invention. *See* Sections VI(A)-(D) (Technology Background); Section VIII(A)(i) (Admitted Prior Art).

237. As explained with respect to Ground 3, it is my opinion, that Lemoff teaches or would have suggested every element of the challenged claims. Although Lemoff suggests the use of collimating lenses (*e.g.*, EX 1005, 6:16-21, below at Section VIII(D)(iii)), they are not shown in the figures or expressly discussed in the text. Thus, I rely on LaMarche for its teachings regarding collimating lenses in Ground 4. Further, as discussed with respect to Ground 2, LaMarche teaches using radial arrangements of light sources and collimating lenses around a center focal axis of a focusing lens, including in a two-by-two array. LaMarche teaches that you can arrange an arbitrary number of light source arrays (M) and collimating lenses (M) around a center focal axis of a focusing lens. EX1005, FIG. 6, 4:43-6:2.

i. A POSITA would have been motivated to combine Lemoff and LaMarche

238. With respect to Ground 4, LaMarche is used to show “[1.3] *a plurality of n collimating lenses, [1.4] said lenses being spaced apart and positioned to receive and collimate the output of said n laser output beams.*” A POSITA would have been motivated to use LaMarche’s teachings of a radial arrangement of collimating lenses, in the optical signal emitter 200 of Lemoff.

239. In particular, the optical imaging element 220 (see, *e.g.*, FIG. 2) of Lemoff may include, *e.g.*, “any arrangement of one or more optical components

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functioning to image the optical signal components from the signal-emitting area onto the signal-receiving area.” EX1006, 6:16-22. It would be a natural extension to apply LaMarche’s teaching of a radial arrangement for an arbitrary number M of collimating lenses (input probe lenses 630-1 through 630-M in LaMarche) coupled to the focusing lens (pupil lens 640) to the optical imaging element 220 of Lemoff. LaMarche further teaches that the radial (or non-collinear) arrangement it provides for results in improved coupling efficiency, reduced physical complexity, as well as having other advantages such as being able to achieve high-bandwidth connections. *Cf.* EX1005, 1:11-2:20 (Background of the Invention), 2:17-23 (Summary of the Invention). See also my discussion above, at Section VI(C), discussing the advantages of coupling efficiency as well as the use of collimating lenses and a focusing lens being well known in the industry at the time of the invention for improving coupling efficiency.

240. Both Lemoff and LaMarche are in the same field (i.e., optical technologies); and they each teach optical devices utilizing similar components, such as light sources and lenses. *See, e.g.*, EX1006, FIGS. 1A, 2, 3:19-22, 4:59-62, 6:7-11; EX1005, FIG. 6, 4:43-6:2. *See also* §§VIII(A)(iii) and VIII(A)(iv).

241. Similarly, Lemoff and LaMarche are analogous art to the '416 Patent. As described in the paragraph above, both are directed to optical devices and utilize similar components, such as light sources and lenses. EX1006, FIGS. 1A, 2, 3:19-22, 4:59-62, 6:7-11; EX1005, FIG. 6, 4:43-6:2. The '416 Patent, likewise, is directed to optical devices utilizing similar components as both Lemoff and LaMarche. EX1001, FIGS. 1-11, 3:8-4:52. And both Lemoff and LaMarche are reasonably pertinent to the problem addressed by the '416 Patent (i.e., providing an optical combiner, and particularly, one that uses a radial arrangement of light sources and collimating lenses). EX1001 ('416 Patent), 1:43-2:10; EX1006 (Lemoff), FIG. 1A, 2, 3:19-25, 6:7-22; EX1005 (LaMarche), FIG. 6, 4:43-6:2.

242. At least three rationales support applying LaMarche's teachings to the optical signal emitter 200 of Lemoff.

243. One rationale is applying a known technique (LaMarche's radial arrangement of collimating lenses) to a known device (Lemoff's optical signal emitter) ready for improvement, to yield predictable results (e.g., a functioning optical device).

244. Another rationale is combining prior art elements (LaMarche's radial arrangement of collimating lenses with Lemoff's optical signal emitter) according

to known methods (arranging elements of an optical device) to yield predictable results (e.g., a functioning optical device).

245. Another rationale is some teaching, suggestion, or motivation in the prior art that would have led a POSITA to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention. In particular, LaMarche teaches that its radial arrangement of collimating lenses will result in improved coupling efficiency, reduced physical complexity, as well as having other advantages such as being able to achieve high-bandwidth connections. *Cf.* EX1005, 1:11-2:20 (Background of the Invention), 2:17-23 (Summary of the Invention). Additionally, Lemoff teaches that you would want efficient coupling. EX1006, 4:66-5:2. LaMarche also teaches that it improves coupling loss by using a radial arrangement of collimating lenses. EX1005, 2:13-17.

246. In each case, the techniques or elements from LaMarche are straightforward to apply to or combine with Lemoff, and would predictably result in a functioning optical device. Indeed, Lemoff already teaches that optical imaging element 220 may include, e.g., any arrangement of one or more optical components functioning to image the optical signal components from the signal-emitting area onto the signal-receiving area, and as shown in FIG. 1A and also described, the

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emission apertures 120 are already radially arranged. *E.g.*, EX1006, 3:19-25. Therefore, applying the teaching from LaMarche that the collimating lenses are radially arranged would predictably result in a functioning optical device. To be clear, it would have been understood by a POSITA at the time of the invention that the combination of the collimating lenses and a focusing lens as proposed in Ground 4 will function to image the optical signal components from the signal-emitting area onto the signal-receiving area of Lemoff and therefore comports with its teaching related to the optical imaging element 220.

**ii. Lemoff (Ground 3), and Lemoff and LaMarche (Ground 4),
disclose or suggest Claim Elements [1.0], [1.1], and [1.2]**

'416 Claim Limitation	U.S. Patent 6,870,195 to Lemoff et al. ("Lemoff") (EX1006) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
[1.0] <i>An optical combiner</i>	To the extent this is a claim limitation, Lemoff (Ground 3) and Lemoff and LaMarche (Ground 4) disclose "[a]n optical combiner." The optical signal emitter of Lemoff is an optical combiner. It combines multiple wavelength inputs into a single optical fiber output. <i>See, e.g.</i>, EX1006 (Lemoff): FIG. 2 (reference numeral 200); 1:52-56 ("The invention provides a multi-channel optical signal emitter for a wavelength division multiplexed (WDM) communication system that

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'416 Claim Limitation	U.S. Patent 6,870,195 to Lemoff et al. (“Lemoff”) (EX1006) and U.S. Patent 5,078,499 to LaMarche (“LaMarche”) (EX1005)
	combines multiple signal components into a multi-channel optical signal without using an optical multiplexer or other device external to the emitter.”)
[1.1] <i>usable in data communication systems for multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength,</i>	To the extent this is a claim limitation, Lemoff (Ground 3) and Lemoff and LaMarche (Ground 4) disclose an optical combiner “<i>usable in data communication systems for multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength.</i>” Lemoff expressly notes that it can be used for data communications (i.e., “<i>in data communication systems</i>”), and that it involves multiplexing multi-wavelength laser light sources. See, e.g., EX1006 (Lemoff): FIG. 1A, 2 (reference numeral 110); Abstract (“An optical signal emitter for a multi-channel, wavelength division multiplexed (WDM) optical communication system is disclosed.”); 1:52-56 (“The invention provides a multi-channel optical signal emitter for a wavelength division multiplexed (WDM) communication system that combines multiple signal components into a multi-channel optical signal without using an optical multiplexer or other device external to the emitter.”); 4:39-47 (“The emission aperture of <i>each die</i> is part of an <i>opto-electronic device</i> within the die. The <i>opto-electronic device</i> is configured to emit a component of the <i>multi-channel optical signal</i> from

'416 Claim Limitation	U.S. Patent 6,870,195 to Lemoff et al. ("Lemoff") (EX1006) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
	the emission aperture. In various embodiments of the invention, various types of opto-electronic devices may be used. Suitable opto-electronic devices include, but are not limited to, light emitting diodes, semiconductor lasers, and vertical cavity surface emitting lasers (VCSELs)."); 4:59-63 ("In some embodiments of the invention, the optical signal component that is emitted by each die has a wavelength different from that of the optical signal component emitted by any other die.").
[1.2] <i>for transmission into and through a stopped single optical fiber, comprising:</i>	To the extent this is a claim limitation, Lemoff (Ground 3) and Lemoff and LaMarche (Ground 4) disclose an optical combiner "<i>for transmission into and through a stopped single optical fiber.</i>" Lemoff expressly notes that the outputs of the light source are transmitted through a single optical fiber. <i>See, e.g.,</i> EX1006 (Lemoff): FIG. 2 (reference numeral 250); 2:54-58 ("Optical signal emitter 100 emits a multi-channel optical signal with five independent components into an optical fiber."); 5:58-60 ("During assembly, the end of optical fiber 250 is inserted into ferrule 255, which surrounds and secures the end of the fiber."); 6:3-6 ("Emission apertures 120 form the signal-emitting area, the size of which is indicated by diameter 240. The end of the core portion of optical

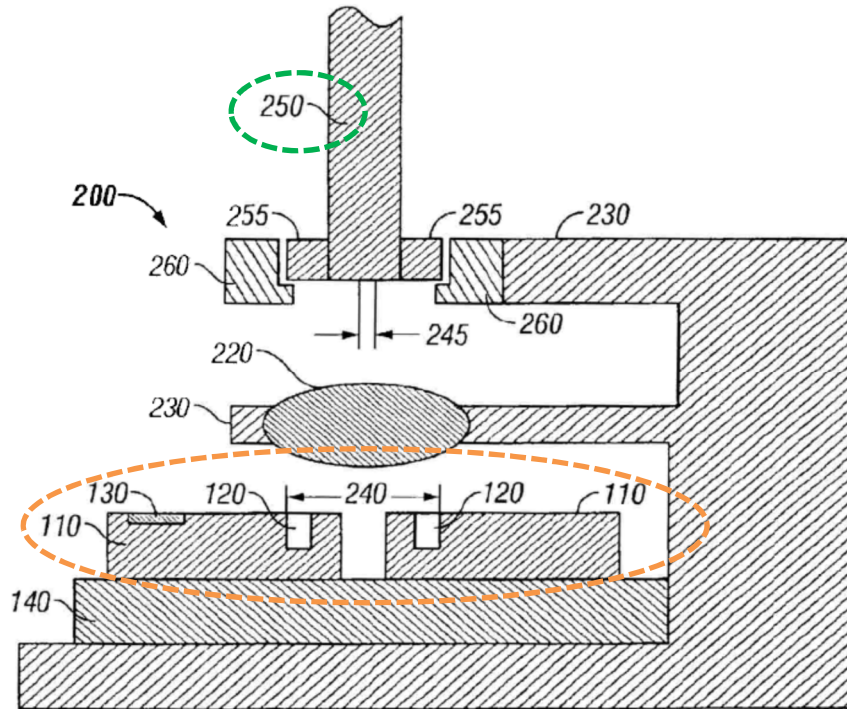
'416 Claim Limitation	U.S. Patent 6,870,195 to Lemoff et al. ("Lemoff") (EX1006) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
	fiber 250 forms the signal-receiving area the size of which is indicted by diameter 245.”).

247. To the extent that the preamble is limiting, Lemoff discloses an optical combiner that has all of the properties noted in Claim Elements [1.0], [1.1], and [1.2].

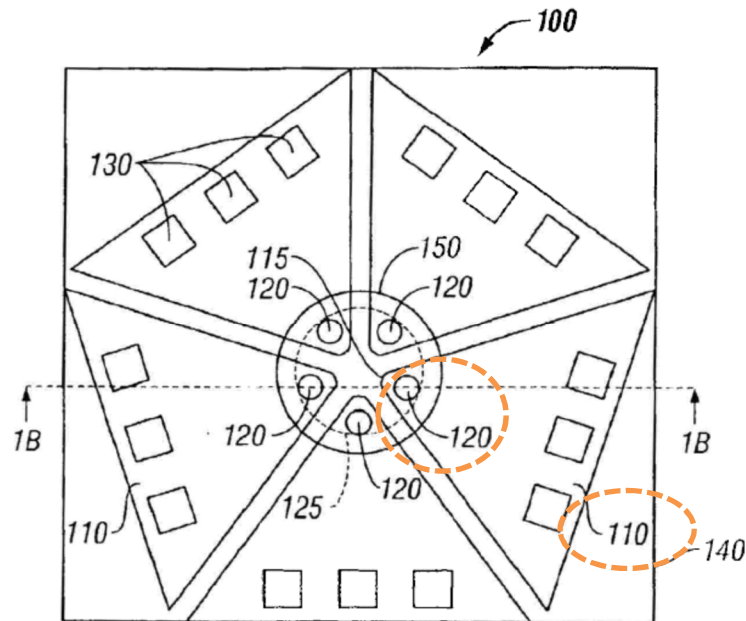
248. For instance, with respect to Claim Element [1.0], Lemoff is directed to an *optical combiner*. See, e.g., EX1006, 1:52-56 (“The invention provides a multi-channel optical signal emitter for a wavelength division multiplexed (WDM) communication system that combines multiple signal components into a multi-channel optical signal without using an optical multiplexer or other device external to the emitter.”).

249. Additionally, Lemoff discloses that its devices are *usable in data communication systems for multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength* (Claim Element [1.1]), and *for transmission into and through a stopped single optical fiber* (Claim Element [1.2]).

250. The optical device taught in Lemoff couples light from different lasers (each of the die 110 having emission aperture 120) having different wavelengths onto a single stopped optical fiber (optical fiber 250):



EX1006, FIG. 2; *see id.* at 4:59-63 (“In some embodiments of the invention, the optical signal component that is emitted by each die has a wavelength different from that of the optical signal component emitted by any other die.”). A top-view of the plurality of lasers (5 in this example) that provide the light is shown below:



EX1006, FIG. 1A; *see also id.* at 4:39-47 (“Suitable opto-electronic devices include, but are not limited to, light emitting diodes, semiconductor lasers, and vertical cavity surface emitting lasers (VCSELs).”).

251. The light is coupled into and through optical fiber 250 via optical imaging element 220, which images the optical signal components emitted from the signal-emitting area into the signal-receiving area, that is, from emission apertures 120 into the core of optical fiber 250.

252. Lemoff explains that the disclosed device can be used in data communications – the device is “for a multi-channel, wavelength division multiplexed (WDM) optical communication system” and causes the light from the

lasers to be integrated into and transmitted through an optical fiber. *See, e.g.*, EX1006, FIG. 2, 2:54-58, 5:58-60, 6:3-6.

253. While Lemoff refers to an optical fiber 250, it does not explicitly use the term “stopped optical fiber.” Even so, Lemoff discloses a stopped optical fiber. A “stopped” optical fiber is an optical fiber that is (spatially) fixed, such as shown in FIG. 2 of Lemoff depicting the optical fiber 250 in a ferrule 255 that is inserted into receptacle 260 that surrounds and secures the fiber and ferrule assembly. Lemoff explains that “receptacle 260 and ferrule 255 constitute a connector, by means of which various optical fibers may be plugged into or removed from optical signal emitter 200 when the emitter is initially installed in an optical communication system or when maintenance is performed.” EX1006, 5:65-7:2. This is a substantially similar structure as used in the ’416 Patent, which illustrates a “fiber stop or seat 60 formed in ferrule 60” described in the ’416 Patent. EX1001, 3:11-15. Lemoff expressly discloses ferrule 255, which together with the receptacle 260, form a connector for the optical fiber 250.

254. Accordingly, and for all of these reasons, in my opinion, Lemoff alone (Ground 3) and Lemoff and LaMarche (Ground 4) disclose, or would have rendered obvious, Claim Elements [1.0], [1.1], and [1.2].

**iii. Lemoff (Ground 3), and Lemoff and LaMarche (Ground 4),
disclose or suggest Claim Elements [1.3] and [1.4]**

'416 Claim Limitation	U.S. Patent 6,870,195 to Lemoff et al. ("Lemoff") (EX1006) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
[1.3] <i>a plurality of n collimating lenses,</i>	Lemoff (Ground 3) and Lemoff and LaMarche (Ground 4) disclose "<i>a plurality of n collimating lenses.</i>" Lemoff discloses that optical imaging element 220 may include any arrangement of one or more optical components to image the optical signal components from the signal-emitting area onto the signal-receiving area. Lemoff also discloses that an efficient coupling between the optical signal emitter and the optical conduit is desirable. LaMarche discloses <i>input probe lenses 630-1 through 630-M</i>, which are the <i>collimating lenses</i>. <i>See, e.g., EX1006 (Lemoff):</i> FIG. 2 (reference numeral 220); 4:12-15 ("Optical signal emitter 200 also includes housing 230, which secures receptacle 260, optical imaging element 220 and substrate 140 and which holds them in alignment with each other."); 4:66-5:2 ("An efficient coupling between the optical signal emitter and the optical conduit, is usually desirable. That is, a substantial portion of each of the optical signal components emitted should enter the optical conduit."); 6:16-23 ("Various embodiments of the invention may use optical imaging elements that include a plano-convex lens, a graded-index (GRIN) lens, a

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'416 Claim Limitation	U.S. Patent 6,870,195 to Lemoff et al. ("Lemoff") (EX1006) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
	diffractive optical element, a Fresnel lens, another type of lens, or any arrangement of one or more optical components functioning to image the optical signal components from the signal-emitting area onto the signal-receiving area."); <i>See, e.g.,</i> EX1005 (LaMarche): FIG. 6 (reference numerals 630-1 through 630-M); 5:27-37 ("Each of the M N×N arrays of light emitting devices, 620-1 through 620-M, is placed at the focal plane of input probe lenses, 630-1 through 630-M, respectively. Input probe lenses, 630-1 through 630-M, have a focal length of f_p. Thus, light that is emitted from a light emitting device is collimated by its respective input probe lens, wherein the resulting collimated beamlet propagates with propagation directions of an angle θ with respect to the optical sagittal plane and an angle α with respect to the optical tangential plane of its respective input probe lens.").
[1.4] <i>said lenses being spaced apart and positioned to receive and collimate the output of said n laser output beams, said n laser output beams have n different output wavelengths, and</i>	Lemoff (Ground 3) and Lemoff and LaMarche (Ground 4) disclose "<i>said lenses being spaced apart and positioned to receive and collimate the output of said n laser output beams, said n laser output beams have n different output wavelengths, and.</i>" Lemoff discloses that optical imaging element 220 may include any arrangement of one or more optical components to image the optical signal components from the signal-emitting area onto the signal-receiving area. Lemoff also discloses that an

'416 Claim Limitation	U.S. Patent 6,870,195 to Lemoff et al. ("Lemoff") (EX1006) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
	efficient coupling between the optical signal emitter and the optical conduit is desirable. LaMarche discloses input probe lenses 630-1 through 630-M, which are the collimating lenses. <i>See, e.g.</i>, EX1006 (Lemoff): FIG. 2 (reference numerals 120, 220); 2:62-65 ("Each die 110 includes an emission aperture 120 that emits an optical signal that is a component of the multi-channel optical signal."); 4:59-62 ("In some embodiments of the invention, the optical signal component that is emitted by each die has a wavelength different from that of the optical signal component emitted by any other die."); 4:39-47 ("The emission aperture of each die is part of an optoelectronic device within the die. The optoelectronic device is configured to emit a component of the multi-channel optical signal from the emission aperture. In various embodiments of the invention, various types of optoelectronic devices may be used. Suitable opto-electronic devices include, but are not limited to, light emitting diodes, semiconductor lasers, and vertical cavity surface emitting lasers (VCSELs)."). <i>See, e.g.</i>, EX1005 (LaMarche): FIG. 6 (reference numerals 630-1 through 630-M); 5:27-37 ("Each of the M N×N arrays of light emitting devices, 620-1 through 620-M, is placed at

'416 Claim Limitation	U.S. Patent 6,870,195 to Lemoff et al. (“Lemoff”) (EX1006) and U.S. Patent 5,078,499 to LaMarche (“LaMarche”) (EX1005)
	the focal plane of input probe lenses, 630-1 through 630-M , respectively. Input probe lenses, 630-1 through 630-M , have a focal length of f_p . Thus, light that is emitted from a light emitting device is collimated by its respective input probe lens , wherein the resulting collimated beamlet propagates with propagation directions of an angle θ with respect to the optical sagittal plane and an angle α with respect to the optical tangential plane of its respective input probe lens.”).

255. Lemoff alone, and Lemoff in view of LaMarche, disclose an optical combiner that has the requirements of Claim Elements [1.3] and [1.4].

256. With respect to Claim Element [1.3], Lemoff suggests a *plurality of n collimating lenses*. Specifically, while Lemoff depicts optical element 220 as a single lens in FIG. 2, it further explains optical imaging element 220 that may include any arrangement of one or more optical components functioning to image the optical signal components from the signal-emitting area onto the signal-receiving area:

Various embodiments of the invention may use **optical imaging elements that include** a plano-convex lens, a graded-index (GRIN) lens, a diffractive optical element, a Fresnel lens, **another type of lens**, **or any arrangement of one or more optical components** functioning

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to image the optical signal components from the signal-emitting area onto the signal-receiving area.

EX1006, 6:16-23 (emphasis added). A POSITA would be motivated, based on this disclosure and general background knowledge, to use collimating lenses in addition to the focusing lens depicted in the figures.

257. It was well known to utilize collimating lenses (one for each light source), paired with a focusing lens, in order to image optical signal components. For example, it was known that utilizing collimating lenses in this manner would improve coupling efficiency. *See* above, Section VI(C). It was also known to pair collimating lenses with the light sources, such as in an array of collimating lenses. *See* above, Section VI(B). Therefore, a POSITA would have been motivated at the time of the invention to include a plurality of collimating lenses (one for each of the light emitting apertures 120) and a focusing lens (such as the simple bi-convex lens shown, or one of the other lenses described) as part of the optical imaging element 220. In doing so, such lenses would be spaced apart and positioned to receive and collimate light because they would be aligned appropriately with the light emitting apertures 120. A POSITA would arrange the lenses like this because doing so could

improve the coupling efficiency, and maximizing efficiency is specifically noted in Lemoff itself. *See* EX1006, 6:23-25, 5:15-59.

258. In the field of optics, it is (and was as of the time of the invention) desirable to align a light emitter (e.g., emission apertures 120) and a light receiver (e.g., an end of optical fiber 250), in order to improve the efficiency of light transmission from the light emitter to the light receiver. Lemoff discloses aligning the substrate 140 (on which the light emitting opto-electronic devices are disposed) and the optical imaging element 220 (which is configured to receive light beams from the opto-electronic devices). *See, e.g.*, EX1006, FIG. 2, 4:12-15 (“Optical signal emitter 200 also includes housing 230, which secures receptacle 260, optical imaging element 220 and substrate 140 and which holds them in alignment with each other.”).

259. But even when the light emitter and the light receiver are aligned, the efficiency of the light transmission from the emitter to the receiver may not be ideal, e.g., due to divergence of light in the pathway between the emitter and receiver. To reduce the divergence of light, it is well known in the field of optics to use collimating lenses. *E.g.*, above, Section VI(C) (explaining that using collimating lenses in conjunction with a focusing lens can improve coupling efficiency).

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Collimating lenses may be configured to receive diverged light and output straight (parallel) light corresponding to the diverged light. Therefore, it would have been obvious to use the known technique of using collimating lenses to convert light emitted from the opto-electronic devices of Lemoff to straight (parallel) light in order to improve the efficiency of the light transmission from the opto-electronic devices and to the optical imaging element 220.

260. The modification of Lemoff would result in having a collimating lens above each of the emission apertures 120 shown in FIG. 2, such that the collimating lenses collimate light from the emission apertures 120 and output collimated light to the optical imaging element 220.

261. Given the stated goal of improved efficiency (*see* EX1006, 4:66-5:2), the obvious "one or more optical components" for the optical imaging element (*see* EX1006, 6:16-23) are a plurality of lenses – specifically, collimating lenses plus a focusing lens.

262. Additionally, and alternatively, it would have been obvious to include collimating lenses in Lemoff based on the teachings of LaMarche.

263. LaMarche discloses the concept of placing a collimating lens (630-1 through 630-m) in front of each of a plurality of light sources. *See, e.g.*, EX1005, 5:27-37; *see also*:

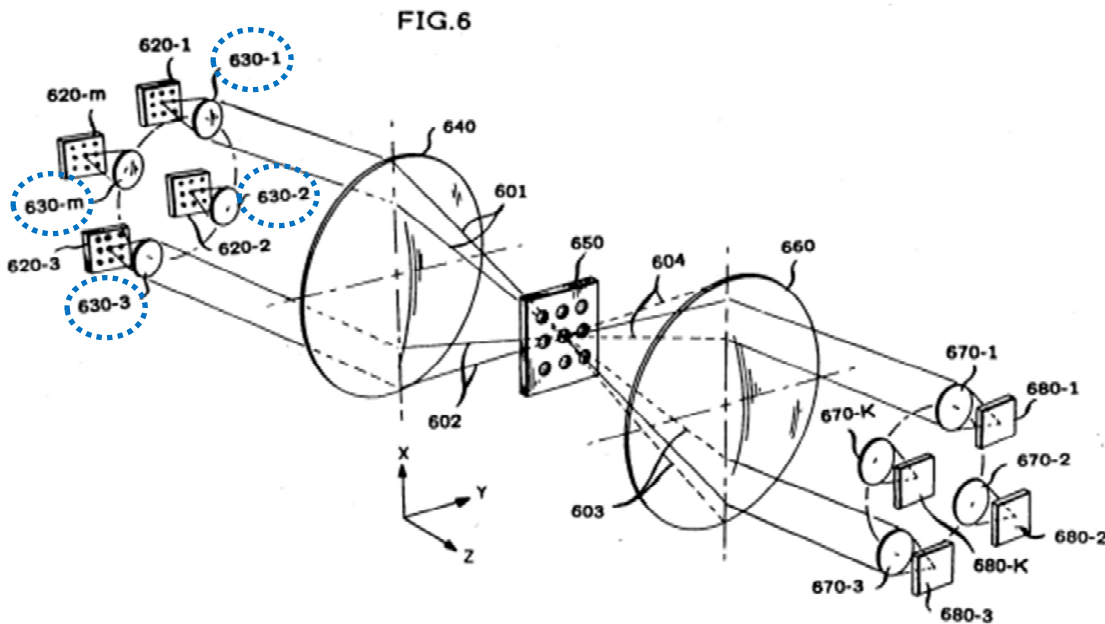


FIG. 6. It would have been obvious to a POSITA at the time of the invention to modify the optical combiner taught by Lemoff to include a collimating lens above each of the emission apertures 120 in FIG. 2, in order to achieve the predictable result of ensuring that the light from the emission apertures 120 reach the optical imaging element 220 in the same direction such that the optical imaging element 220 focuses the light at the same point. In doing so, such lenses would be spaced apart and positioned to receive and collimate light because they would be aligned

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appropriately with the light emitting apertures 120. A POSITA would arrange the lenses like this because doing so could improve the coupling efficiency, and maximizing efficiency is specifically noted in Lemoff itself. *See* EX1006, 6:23-25, 5:15-59. It is also the way the lenses 630-1 through 630-m are arranged in LaMarche.

264. Accordingly, and for all of these reasons, in my opinion, Lemoff alone (Ground 3) and Lemoff and LaMarche (Ground 4) disclose, or would have rendered obvious, Claim Elements [1.3] and [1.4].

**iv. Lemoff (Ground 3), and Lemoff and LaMarche (Ground 4),
disclose or suggest Claim Elements [1.5] and [1.6]**

'416 Claim Limitation	U.S. Patent 6,870,195 to Lemoff et al. ("Lemoff") (EX1006) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
[1.5] <i>focusing means for focusing said n collimated output beams onto a single spot at said stopped single optical fiber,</i>	Lemoff (Ground 3) and Lemoff and LaMarche (Ground 4) disclose "<i>focusing means for focusing said n collimated output beams onto a single spot at said stopped single optical fiber.</i>" The optical imaging element 220 for imaging the optical signal components is the focusing means (corresponding to the focusing lens structure described in the '416 Patent's specification). Optical imaging element 220 focusses the light from the collimated output beams into a single optical fiber.

'416 Claim Limitation	U.S. Patent 6,870,195 to Lemoff et al. ("Lemoff") (EX1006) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
	<i>See, e.g.</i>, EX1006 (Lemoff): FIG. 2 (reference numeral 220); 2:20-23 ("FIG. 2 shows a cross sectional view of a second example of the invention, in which a lens focuses independent components of a multi-channel optical signal into an optical fiber...."); 6:7-11 ("Optical signal emitter 200 also includes optical imaging element 220 which is a simple bi-convex lens configured to image the optical signal components emitted from the signal-emitting area into the signal-receiving area, that is, from emission apertures 120 into the core of optical fiber 50."). <i>See, e.g.</i>, EX1005 (LaMarche): FIG. 6 (reference numeral 640); 5:49-53 ("Each input probe lens and its associated array of light emitting devices is positioned around the perimeter of pupil lens 640. The optical axis of each input probe lenses is parallel with and a radial distance, <i>r</i>, away from the optical axis of pupil lens 640.").
[1.6] said focusing means having <i>n</i> separate radial sectors on its surface, and each of said n collimated beams passes through a separate one of said <i>n</i> sectors of said focusing means whereby said n output beams having <i>n</i>	Lemoff (Ground 3) and Lemoff and LaMarche (Ground 4) disclose "<i>a plurality of n collimating lenses.</i>" Lemoff discloses that emission apertures 120 are arranged radially, around the circular signal-emitting area 125 and adjacent to each other (FIG. 1A). As a result of the radial arrangement of the emission apertures 120, and the corresponding

'416 Claim Limitation	U.S. Patent 6,870,195 to Lemoff et al. ("Lemoff") (EX1006) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
<i>different wavelengths are coupled into said single fiber.</i>	arrangement of the collimating lenses, the collimated beams pass through separate radial sectors on the surface of the optical imaging element 220. LaMarche discloses input probe lenses 630-1 through 630-M (corresponding to the number M of light emitting devices 620-1 through 620-M). The input probe lenses in LaMarche are the collimating lenses. LaMarche teaches that these are arranged radially, and that beams from each input probe lens pass through the pupil lens 640, which is a focusing lens. <i>See, e.g., EX1006 (Lemoff):</i> FIGS. 1A and 2 (reference numerals 120, 220, 250); 3:19-22 ("Emission apertures 120 of all die 110 collectively define signal-emitting area 125. Signal-emitting area 125 is circular and emission apertures 120 are equally spaced just inside its circumference."); 4:59-62 ("In some embodiments of the invention, the optical signal component that is emitted by each die has a wavelength different from that of the optical signal component emitted by any other die."); 6:3-6 ("Emission apertures 120 form the signal-emitting area, the size of which is indicated by diameter 240. The end of the core portion of optical fiber 250 forms the signal-receiving area the size of which is indicated by diameter 245.");

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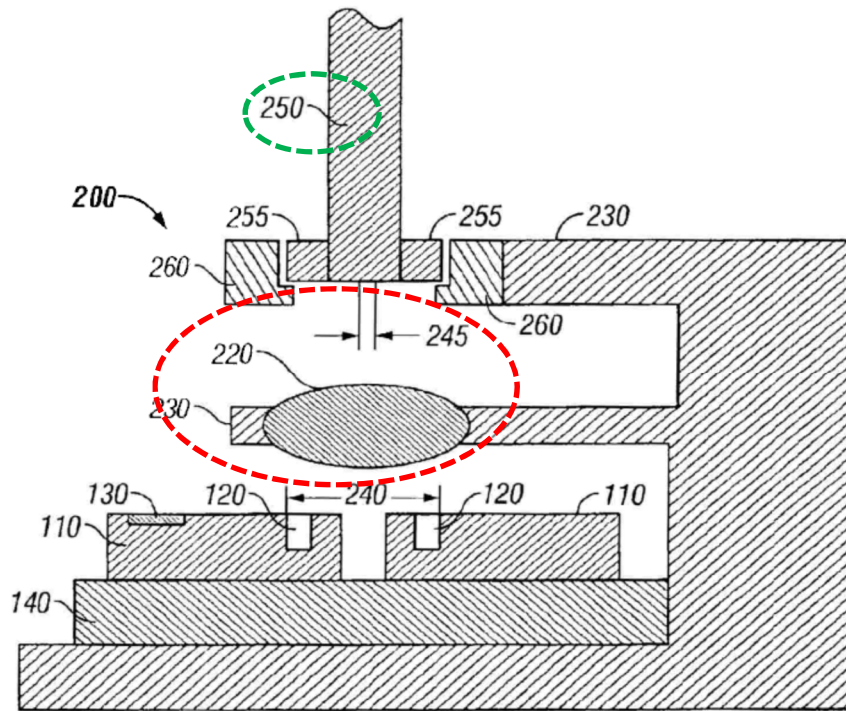
'416 Claim Limitation	U.S. Patent 6,870,195 to Lemoff et al. ("Lemoff") (EX1006) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
	6:7-11 ("Optical signal emitter 200 also includes optical imaging element 220 which is a simple bi-convex lens configured to image the optical signal components emitted from the signal-emitting area into the signal-receiving area, that is, from emission apertures 120 into the core of optical fiber 50."); 6:25-29 ("That is, optical imaging element 220 should have a magnification factor that is equal to or less than diameter 245 of the signal-receiving area divided by diameter 240 of the signal-emitting area."). <i>See, e.g., EX1005 (LaMarche):</i> FIG. 6 (reference numerals 630-1 through 630-M) 2:13-18 ("This invention overcomes the drawbacks of the prior art methods of interconnections by using in a new manner a non-collinear arrangement of lenses, i.e., the optical axes of two or more lenses are parallel, but offset in the radial direction."). 5:27-37 ("Each of the M N×N arrays of light emitting devices, 620-1 through 620-M, is placed at the focal plane of input probe lenses, 630-1 through 630-M, respectively. Input probe lenses, 630-1 through 630-M, have a focal length of f_p. Thus, light that is emitted from a light emitting device is collimated by its respective input probe lens, wherein the resulting collimated beamlet propagates with propagation directions of an angle θ with respect to the optical sagittal plane and an

'416 Claim Limitation	U.S. Patent 6,870,195 to Lemoff et al. ("Lemoff") (EX1006) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
	angle α with respect to the optical tangential plane of its respective input probe lens.”). 5:49-53 (“Each input probe lens and its associated array of light emitting devices is positioned around the perimeter of pupil lens 640. The optical axis of each input probe lenses is parallel with and a radial distance, r, away from the optical axis of pupil lens lens 640.”). 6:56-61 (“Beamlets from two of the possible M light emitting device arrays, positioned in the second row and second column of each array, are shown in FIG. 6. Beamlets 601 and 602 converge at the focal plane of pupil lens 640. Similarly, this occurs for all other beamlets from the other light emitting devices and, for the sake of simplicity, these beamlets are not shown.”). Claims 3-4 (referring to “radial distance” of first and second input probe lenses).

265. With respect to Claim Element [1.5], Lemoff and Lemoff in view of LaMarche disclose *focusing means for focusing said n collimated output beams onto a single spot at said stopped single optical fiber*. The structure corresponding to the focusing means in the '416 Patent is a focusing lens, and thus the focusing means refers to a focusing lens and equivalents thereof, as I explained above in Section VII(D)(iii)(2), and Lemoff discloses a focusing lens 220.

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266. The optical imaging element 220 of Lemoff focuses light onto a single optical fiber 250 and therefore is a focusing lens:



EX1006, FIG. 2. Specifically, the optical imaging element 220 focuses the light onto a single spot at the optical fiber 250. EX1006, 6:3-6 (“Emission apertures 120 form the signal-emitting area, the size of which is indicated by diameter 240. The end of the core portion of optical fiber 250 forms the signal-receiving area the size of which is indicated by diameter 245.”), 6:25-29 (“That is, optical imaging element 220 should have a magnification factor that is equal to or less than diameter 245 of the signal-receiving area divided by diameter 240 of the signal-emitting area.”).

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267. The structure of optical imaging element 220 may also be compared to the corresponding structure disclosed in the '416 Patent. The structure of the optical imaging element 220 (of Lemoff) is equivalent to, e.g., the structure of the focusing lens 250/350 (of the '416 Patent) shown in FIGS. 7-9 (focusing lens 250) and 10-11 (focusing lens 350) of the '416 Patent. Compare Lemoff FIG. 2 (imaging element 220) with '416 Patent, FIGS. 7 (focusing lens 250) and 10 (focusing lens 350), each of which is reproduced below with an annotation identifying the corresponding focusing lens:

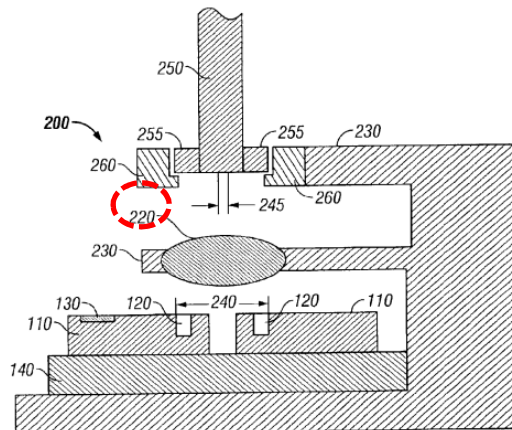


FIG. 2

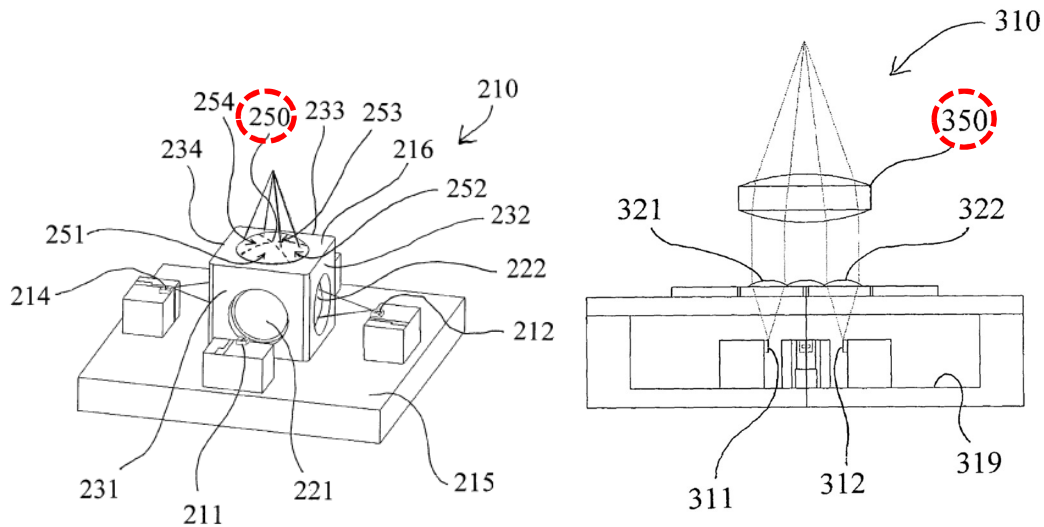


Fig. 7

Fig. 10

I understand that Patent Owner has taken the position in the corresponding litigation that “*focusing means*” should not be interpreted under 35 U.S.C. § 112, ¶6. Even if the term is considered to have sufficient structure in the claims, that does not affect my analysis here. The disclosed structure of the “*focusing means*” is a focusing lens, and claim 2 shows that the “*focusing means*” must include at least a single focusing lens. *See* claim 2 (“said focusing means is a single focusing lens”). Because the structure I have identified in the prior art is a single focusing lens, it satisfies the “*focusing means*” claim element, regardless of whether it is interpreted as a means-plus-function term.

268. Specifically, as noted above for Claim Elements [1.3] and [1.4], a POSITA would have been motivated at the time of the invention to include a plurality of collimating lenses (one for each of the light emitting apertures 120) and a focusing lens (such as the simple bi-convex lens shown, or one of the other lenses described) as part of the optical imaging element 220. Therefore, in the proposed combination, the optical imaging element 220 has a collimating lenses part and a focusing lens part, which collectively form the “arrangement of one or more optical components” that comprise the optical imaging element 220. Reference to optical imaging element 220 here, unless otherwise noted or made clear by context, refers specifically to the focusing lens part of the optical imaging element 220. The focusing lens part of the optical imaging element 220 focuses the collimated beams as collimated by the collimating lenses part of the optical imaging element 220.

269. In particular, taking the example of FIG. 1A where there are five emitting apertures 120 that are radially arranged, and would therefore be five radially arranged collimating lenses (since the collimating lenses part of optical imaging element 220 aligns with the emitting apertures 120 as noted above for Claim Elements [1.3] and [1.4]), collimated light from the collimating lens part of optical imaging element 220 passes through the focusing lens part of optical imaging

element 220. In particular, collimated light from each of the lenses of the collimating lens part of optical imaging element 220 will pass through a separate radial sector on the surface of the focusing lens part of optical imaging element 220. This is because the radial array of collimating lenses will each pass their respective collimated light to a separate radial portion (or sector) of the focusing lens part of optical imaging element 220. EX1006, FIGS. 1A, 2, 3:19-22, 4:59-62, 6:7-11. In this respect, Lemoff alone teaches, or would have suggested Claim Element [1.6] (*“said focusing means having n separate radial sectors on its surface, and each of said n collimated beams passes through a separate one of said n sectors of said focusing means whereby said n output beams having n different wavelengths are coupled into said single fiber”*).

270. In addition, with respect to Ground 4, LaMarche expressly teaches a radial arrangement of collimating lenses. This is similar to the radial arrangement of emission apertures 120 taught by Lemoff. The arrangement of emission apertures 120, and the collimating lenses, as shown by Ground 3 make apparent that the collimated light would pass through separate radial sectors of the focusing lens. This fact is further confirmed by LaMarche, which shows a radial arrangement of input probe lenses 630-1 through 630-M (which collimate light), and shows visually in

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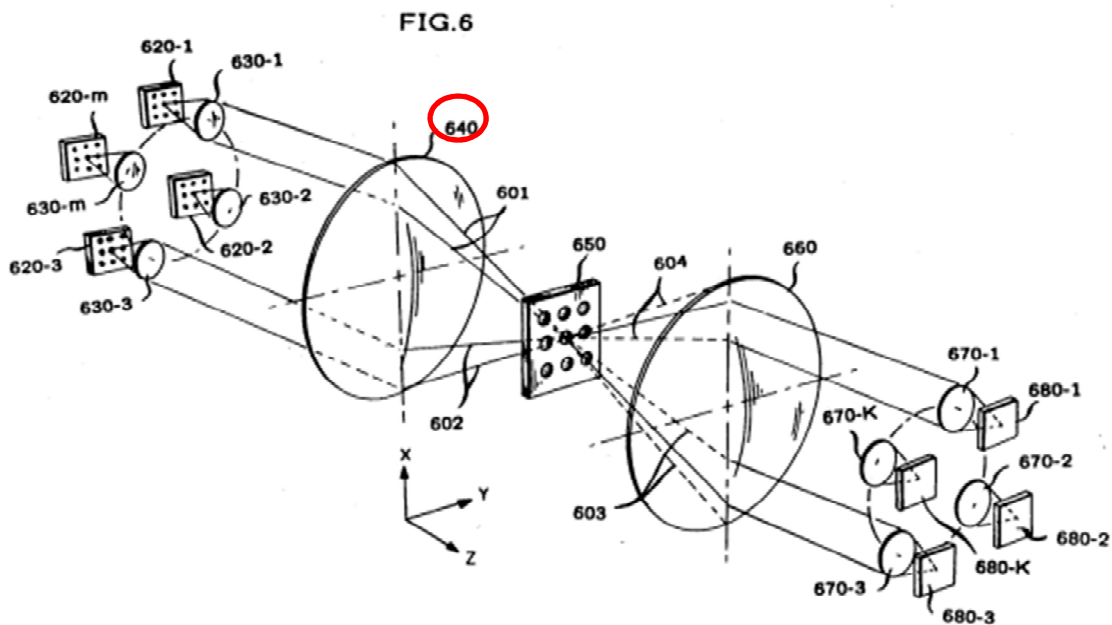
FIG. 6 that the collimated light from the input probe lenses 630-1 through 630-M will pass through a separate radial sector of the pupil lens 640.

271. Moreover, LaMarche teaches this radial arrangement for an arbitrary number of M input probe lenses 630-1 through 630-M. EX1005, FIG. 6, 2:13-18, 5:27-37, 5:49-53, 6:56-61. LaMarche further teaches that this radial (also referred to as non-collinear) arrangement of lenses results in improved coupling efficiency, reduced physical complexity, as well as having other advantages such as being able to achieve high-bandwidth connections. Cf. EX1005, 1:11-2:20 (Background of the Invention), 2:17-23 (Summary of the Invention). As can be seen by FIG. 6, the collimated light from each of input probe lenses 630-1 through 630-M will pass through a separate radial section of the pupil lens 640, owing to the radial arrangement of the input probe lenses 630-1 through 630-M. *See, e.g., See* EX1005, 5:23-53 (explaining symmetry of light detecting and light emitting devices, and that optical axis of each input probe lens is the same radial distance r away from the optical axis of the pupil lens).

272. Similarly to optical imaging element 220 of Lemoff, which has a focusing lens as noted above, the pupil lens 640 of LaMarche focuses the collimated light from the input probe lenses 630-1 through 630-M. The light is focused on a

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single spot when $N=1$, or when considering the center beam of the $N \times N$ array as shown in the figure. *See above*, ¶223. The pupil lens 640 also has a similar structure to that described in the '614 Patent's specification. Compare Lemoff FIG. 2 (imaging element 220) with '416 Patent, FIGS. 7 (focusing lens 250) and 10 (focusing lens 350), each of which is reproduced below with an annotation identifying the corresponding focusing lens:



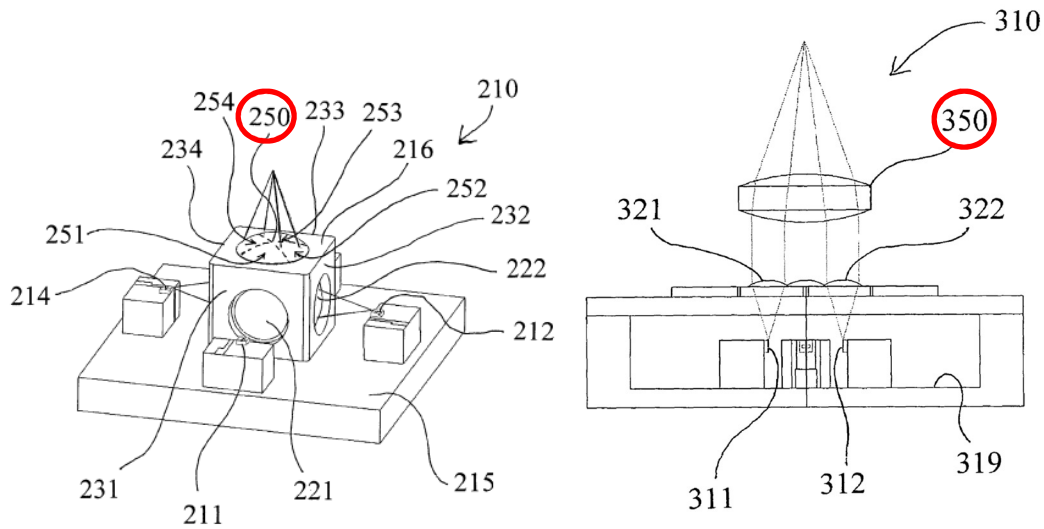


Fig. 7

Fig. 10

273. Thus, it is obvious in view of Lemoff alone that light from each of the radially arranged collimating lenses will pass through a separate radial sector of the focusing part of the optical imaging element 220. This is due to the radial arrangement of the collimating lenses. This fact is further confirmed by LaMarche, which shows a radial arrangement of input probe lenses 630-1 through 630-M (which collimate light), and shows visually in FIG. 6 that the collimated light from the input probe lenses 630-1 through 630-M will pass through a separate radial sector of the pupil lens 640. Moreover, a POSITA would have been motivated to modify Lemoff in view of LaMarche to have a radial arrangement of collimating lenses for

an arbitrarily sized lens array. *See* Section VIII(C)(i). For example, doing so may result in improved coupling efficiency, reduced physical complexity, as well as having other advantages such as being able to achieve high-bandwidth connections. *Cf.* EX1005, 1:11-2:20 (Background of the Invention), 2:17-23 (Summary of the Invention).

274. Accordingly, and for all of these reasons, in my opinion, Lemoff alone (Ground 3) and Lemoff and LaMarche (Ground 4) disclose, or would have rendered obvious, Claim Elements [1.5] and [1.6].

**v. Lemoff (Ground 3), and Lemoff and LaMarche (Ground 4),
disclose or render obvious Claim 2**

'416 Claim 2	U.S. Patent 6,870,195 to Lemoff et al. ("Lemoff") (EX1006) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
<i>The optical combiner of claim 1 wherein $n=4$ and wherein said four lasers and four collimating lenses are each formed in a two-dimensional, two by two array, wherein said focusing means is a single focusing lens, and wherein each radial sector is a pie-shaped quadrant.</i>	Lemoff (Ground 3) and Lemoff and LaMarche (Ground 4) disclose "<i>The optical combiner of claim 1 wherein $n=4$ and wherein said four lasers and four collimating lenses are each formed in a two-dimensional, two by two array, wherein said focusing means is a single focusing lens, and wherein each radial sector is a pie-shaped quadrant.</i>" See citations for claim 1 above. Lemoff discloses a variable number of emission apertures, which would result in a similarly variable number of collimating lenses. LaMarche also

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'416 Claim 2	U.S. Patent 6,870,195 to Lemoff et al. (“Lemoff”) (EX1006) and U.S. Patent 5,078,499 to LaMarche (“LaMarche”) (EX1005)
	discloses a variable number of light emitting devices and collimating lenses. In each case, these are arranged radially, and result in a two-by-two array when the variable number is four. <i>See, e.g.</i>, EX1006 (Lemoff): Title (“Array of discretely formed optical signal emitters for multi-channel communication”); FIG. 1A; 3:20-22 (“Signal-emitting area 125 is circular and emission apertures 120 are equally spaced just inside its circumference.”); 3:66-4:2 (“In various embodiments of the invention, various numbers of die may be used to generate optical signal components that form a single optical signal and couple to the same optical conduit.”). <i>See, e.g.</i>, EX1005 (LaMarche): FIG. 6; 5:27-37 (“Each of the M N×N arrays of light emitting devices, 620-1 through 620-M, is placed at the focal plane of input probe lenses, 630-1 through 630-M, respectively. Input probe lenses, 630-1 through 630-M, have a focal length of f_p. Thus, light that is emitted from a light emitting device is collimated by its respective input probe lens, wherein the resulting collimated beamlet propagates with propagation directions of an angle θ with respect to the optical sagittal plane and an

'416 Claim 2	U.S. Patent 6,870,195 to Lemoff et al. (“Lemoff”) (EX1006) and U.S. Patent 5,078,499 to LaMarche (“LaMarche”) (EX1005)
	angle α with respect to the optical tangential plane of its respective input probe lens.”).

275. In FIG. 1A of Lemoff, there are five emission apertures 120. However, Lemoff discloses that there can be various numbers of emission apertures 120, and it would have been obvious to a POSITA at the time of the invention to choose four emission apertures 120, and in doing so, to arrange them into a two-by-two array. As already noted, Lemoff teaches that “[s]ignal-emitting area 125 is circular and emission apertures 120 are equally spaced just inside its circumference.” EX1006, 3:20-22. It would have been clear to a POSTIA that equally spacing four emission apertures 120 in the manner taught by Lemoff would result in a two-by-two array. Lemoff also teaches that the arrangement of emission apertures 120 may be other shapes than circular: “In various embodiments of the invention, the die may be arranged such that the emission apertures are positioned in a circle, an oval, a polygon, or another shape.”). Lemoff also teaches that square or rectangular die may be used (e.g., EX1006, 7:39-44), in which case a two-by-two array of four die would be a natural (and obvious) implementation.

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276. Similarly, the arrangement of the collimating lenses in LaMarche results in a two-by-two array if there are four lenses being used. There are four lenses shown in the example of FIG. 6 of LaMarche, and LaMarche teaches a generic number of M lenses, and it would be obvious to a POSITA at the time of the invention to choose M=4.

277. It would have been obvious at the time of the invention for a POSITA to use four lenses in a two-by-two array. A wavelength-division-multiplexed (WDM) optical communication system generally combines two or more data-carrying beams of light, each of a different wavelength (e.g., color), to propagate through a common transmission medium (e.g., optical fiber). WDM systems grew dramatically in the 1990s, first in research & development (R&D) laboratories around the world and then as deployed commercial systems. A common number of wavelengths in both R&D and commercially deployed WDM systems throughout the 1990s was four. Indeed, WDM systems tended to grow beyond four wavelengths in multiples of the base number four, e.g., 8, 16, 32, 40, and 80 channels. For at least these reasons, four wavelengths (and therefore four lasers, and four collimating lenses) is an obvious implementation choice for a designer of a WDM system, and would have been obvious to a POSITA at the time of the invention.

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278. In each case, there are four equally shaped radial sectors, which are therefore pie-shaped quadrants. That is, because of the two-by-two array formation, the radial sectors will be equally shaped pie-shaped quadrants. This follows from the arrangement of the lasers and collimating lenses being arranged radially around the focusing lens, centered on the focal axis of focusing lens, such as shown in FIG. 1A and 2 of Lemoff, and FIG. 6 of LaMarche. There is also a single focusing lens, the focusing lens part of optical imaging element 220 of Lemoff, or the pupil lens 640 of LaMarche.

279. Accordingly, and for all of these reasons, in my opinion, Lemoff alone (Ground 3) and Lemoff and LaMarche (Ground 4) disclose, or would have rendered obvious, Claim 2.

**vi. Lemoff (Ground 3), and Lemoff and LaMarche (Ground 4),
disclose or render obvious Claim 6**

'416 Claim 6	U.S. Patent 6,870,195 to Lemoff et al. ("Lemoff") (EX1006) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
<i>The optical combiner of claim 1 wherein said optical combiner does not require the use of dielectric filters or waveguides.</i>	Lemoff (Ground 3) and Lemoff and LaMarche (Ground 4) disclose " <i>The optical combiner of claim 1 wherein said optical combiner does not require the use of dielectric filters or waveguides.</i> " See citations for claim 1 above.

'416 Claim 6	U.S. Patent 6,870,195 to Lemoff et al. (“Lemoff”) (EX1006) and U.S. Patent 5,078,499 to LaMarche (“LaMarche”) (EX1005)
	Lemoff discloses a simplified WDM communications system without using an optical multiplexer or other device external to the emitter, and discloses a device without dielectric filters or waveguides. <i>See, e.g.,</i> EX1006 (Lemoff): FIGS. 1A, 2 (lack of dielectric filters or waveguides); 1:52-56 (“The invention provides a multi-channel optical signal emitter for a wavelength division multiplexed (WDM) communication system that combines multiple signal components into a multi-channel optical signal without using an optical multiplexer or other device external to the emitter.”).

280. Lemoff discloses an optical combiner that does not have dielectric filters or waveguides, and hence which *does not require the use of dielectric filters or waveguides*. This is apparent from looking at the figures, as well as the corresponding description in the text. Additionally, Lemoff explains that unlike the complex designs in the prior art, it “provides a multi-channel optical signal emitter for a wavelength division multiplexed (WDM) communication system that combines multiple signal components into a multi-channel optical signal without

using an optical multiplexer or other device external to the emitter.” EX1006, FIGS. 1A, 2, 1:52-56; *cf.* EX1001, 2:21-26 (discussing providing a “compact and cost effective optical combiner”).

281. Accordingly, and for all of these reasons, in my opinion, Lemoff alone (Ground 3) and Lemoff and LaMarche (Ground 4) disclose, or would have rendered obvious, Claim 6.

vii. Lemoff (Ground 3), and Lemoff and LaMarche (Ground 4), disclose or render obvious Claim 7 (Claim Elements [7.0], [7.1], [7.2], [7.3], [7.4], [7.5], and [7.6])

'416 Claim Limitation	U.S. Patent 6,870,195 to Lemoff et al. (“Lemoff”) (EX1006) and U.S. Patent 5,078,499 to LaMarche (“LaMarche”) (EX1005)
[7.0] <i>An optical combiner</i>	See above for Claim Element [1.0].
[7.1] <i>usable in data communication systems for multiplexing the outputs of a plurality of lasers wherein each of said outputs has a different wavelength,</i>	See above for Claim Element [1.1]
[7.2] <i>for transmission into and through a stopped single optical fiber, comprising:</i>	See above for Claim Element [1.2]
[7.3] <i>an array of four lasers, formed in a two-</i>	See above for Claim Element [1.1], Claim 2

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'416 Claim Limitation	U.S. Patent 6,870,195 to Lemoff et al. ("Lemoff") (EX1006) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
<i>dimensional, two by two array, each of said lasers having an output beam with a different wavelength,</i>	
<i>[7.4] an array of four collimating lenses, said lenses being formed in a two-dimensional, two by two array and positioned to receive and collimate the output of said laser output beams, and</i>	See above for Claim Element [1.3], [1.4], Claim 2
<i>[7.5] focusing means for focusing said collimated output beams onto a single spot at said stopped single optical fiber,</i>	See above for Claim Element [1.5]
<i>[7.6] said focusing means having four separate quadrants on its surface, and each of said four collimated beams passes through a separate one of said quadrants of said focusing means whereby said output beams of said four lasers are coupled into said single fiber.</i>	See above for Claim Element [1.6], Claim [2]

282. As explained above at Section VII(B), claim 2 is narrower than (or possibly co-extensive with) claim 7. Therefore, the analysis above for claim 2 applies equally here to claim 9. That is, Lemoff alone, or Lemoff in view of LaMarche, discloses an optical combiner (the optical signal emitter 200 of Lemoff) with lasers (die 110 with emission apertures 120), collimating lenses (obvious to be part of optical imaging element 220, and also based on input probe lenses 320-1 through 320-M of LaMarche) to collimate light from the lasers, a focusing lens (optical imaging element 220, and also based on pupil lens 340 of LaMarche) to focus the collimated light onto a single stopped optical fiber (optical fiber 250). In particular, Lemoff teaches various numbers of die may be used, such as four, and that the die may be shaped such as in a rectangle or square, in which case it would naturally result in four die 110 with emission apertures 120 and four collimating lenses of optical imaging element 220, each in a two-by-two array.

283. Accordingly, and for all of these reasons, in my opinion, Lemoff alone (Ground 3) and Lemoff and LaMarche (Ground 4) disclose, or would have rendered obvious, Claim 7.

**viii. Lemoff (Ground 3), and Lemoff and LaMarche (Ground 4),
disclose or render obvious Claim 9**

'416 Claim 9	U.S. Patent 6,870,195 to Lemoff et al. ("Lemoff") (EX1006) and U.S. Patent 5,078,499 to LaMarche ("LaMarche") (EX1005)
<i>The optical combiner of claim 7 wherein said optical combiner does not require the use of dielectric filters or waveguides.</i>	See above for Claim 6, 7.

284. Claim 9 depends from claim 7, but other than the dependency from a different independent claim contains the same additional requirement as claim 6. Therefore, the analysis above for claim 6 applies equally here to claim 9.

285. Accordingly, and for all of these reasons, in my opinion, Lemoff alone (Ground 3) and Lemoff and LaMarche (Ground 4) disclose, or would have rendered obvious, Claim 9.

**E. Ground 5 – The Challenged Claims would have been obvious over
Bhandarkar**

286. Bhandarkar (EX1013) discloses or renders obvious every element of the Challenged Claims of the '416 Patent. *See* §VIII(A)(v); *see also* claim charts below. It is my opinion that the Challenged Claims would have been obvious over Bhandarkar.

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287. To the extent it is argued that Bhandarkar does not expressly disclose a limitation of the Challenged Claims, it would have been obvious over Bhandarkar's disclosure, to one of skill in the art at the time of the purported invention. *See* §§VI(A)-(D) (Technology Background); §VIII(A)(i) (Admitted Prior Art).

288. Note that the claim charts below cite to both Bhandarkar (the pre-grant publication) and U.S. Provisional Patent Application Ser. No. 60/506,795 entitled "GSE Laser Enabled WDM Mux," filed on Sep. 29, 2003 ("Bhandarkar Provisional Application," i.e., the provisional application that Bhandarkar claims priority to). In general, and as shown below, the Bhandarkar Provisional Application discloses the subject matter of the Bhandarkar pre-grant publication that I rely on here. Where I refer to specific paragraph numbers of the Bhandarkar pre-grant publication, I also am referring to the corresponding disclosure in the Bhandarkar Provisional Application, such as shown in the claim charts below. As I explained above, the Bhandarkar Provisional Application also provides support for the claims of the Bhandarkar pre-grant publication. *See* above, Section VIII(A)(v).

i. Bhandarkar (Ground 5) discloses or suggests Claim Elements [1.0], [1.1], and [1.2]

'416 Claim Limitation	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. (“Bhandarkar”) (EX1013)
[1.0] <i>An optical combiner</i>	To the extent this is a claim limitation, Bhandarkar (Ground 5) discloses “[a]n optical combiner.” The WDM multiplexer 500 of Bhandarkar is an optical combiner. It combines multiple wavelength inputs into a single optical fiber output. <i>See, e.g.,</i> EX1013 (Bhandarkar): FIG. 5; ¶[0043] (“The focusing lens 560 receives the light beam signals from all of the collimating lenses in the collimating lens array 540 and multiplexes them into a single light beam signal. Essentially, the focusing lens 560 focuses each of the light beam signals to a focal point 580 causing the light beam signals to be combined and multiplexed into a single light beam signal.”). <i>See, e.g.,</i> EX1015 (Bhandarkar Provisional Application): p. 9 (right figure, resembling FIG. 5 of Bhandarkar); p. 18 (“The WDM Mux proposed in this disclosure consists of an array of GSE lasers attached to a substrate, a matching array of collimating lenses, and a single focusing lens. The divergent laser beam emitted by each laser is collimated by the corresponding collimating lens. The multiple collimated beams are then focused by the single focusing lens into a single spot that is suitable for coupling into an optical fiber.”);

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'416 Claim Limitation	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. ("Bhandarkar") (EX1013)
	Claims, e.g., claims 1 and 17.
[1.1] <i>usable in data communication systems for multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength,</i>	To the extent this is a claim limitation, Bhandarkar (Ground 5) discloses an optical combiner "<i>usable in data communication systems for multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength.</i>" Bhandarkar expressly notes that it can be used for data communication (i.e., "<i>in data communication systems</i>"), and that it involves multiplexing multi-wavelength laser light sources. See, e.g., EX1013 (Bhandarkar): FIG. 5; ¶[0038] ("In one exemplary embodiment, the array of GSE lasers 520 is a 2x2 array in which four GSE lasers 520 are provided for generating light beam signals at four different wavelengths that are to be multiplexed together."); ¶[0042] ("In operation, the GSE lasers in the array of GSE lasers 520 emit light beam signals through the hermetic enclosure 530, which is transparent to the light beam signals. These light beam signals are captured by the collimating lenses of the collimating lens array 540. Since there is a one to one correspondence between GSE lasers and collimating lenses in the arrays 520 and 540, each collimating lens captures the light beam signal from its corresponding GSE laser."); ¶[0043] ("The focusing lens 560 receives the light beam signals from all of the collimating lenses in

'416 Claim Limitation	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. ("Bhandarkar") (EX1013)
	the collimating lens array 540 and multiplexes them into a single light beam signal."); ¶[0043] ("Thus, the WDM multiplexer 500 may be utilized to provide multimode 10 Gigabit Ethernet data communication using multiplexed light beam signals."). See, e.g., EX1015 (Bhandarkar Provisional Application): p. 9 (right figure, resembling FIG. 5 of Bhandarkar); p. 18 ("The WDM Mux proposed in this disclosure consists of an array of GSE lasers attached to a substrate, a matching array of collimating lenses, and a single focusing lens. The divergent laser beam emitted by each laser is collimated by the corresponding collimating lens. The multiple collimated beams are then focused by the single focusing lens into a single spot that is suitable for coupling into an optical fiber."); Claims, e.g., claims 1 and 17.
[1.2] <i>for transmission into and through a stopped single optical fiber, comprising:</i>	To the extent this is a claim limitation, Bhandarkar (Ground 5) discloses an optical combiner "<i>for transmission into and through a stopped single optical fiber.</i>" Bhandarkar expressly notes that the outputs of the light source are transmitted through a single optical fiber. See, e.g., EX1013 (Bhandarkar): ¶[0013] ("The WDM multiplexer includes a receptacle that houses the plurality of lasers, the

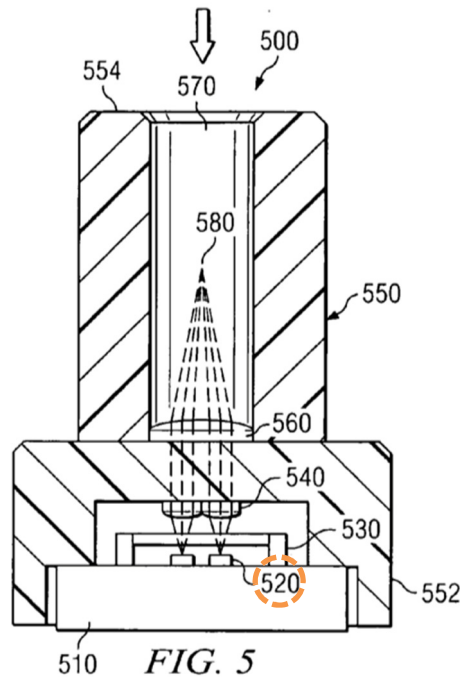
'416 Claim Limitation	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. ("Bhandarkar") (EX1013)
	plurality of collimating lenses and the focusing lens. The receptacle includes a ferrule sleeve for coupling the point of light to an optical fiber or fiber optic connector."); ¶[0043] ("This single light beam signal generated by the focusing lens 560 travels down the channel 570 so that it may pass to a fiber optic connector (not shown) for transmission through a fiber optic medium or the like."). <i>See, e.g.,</i> EX1015 (Bhandarkar Provisional Application): p. 9 (right figure, resembling FIG. 5 of Bhandarkar); p. 18 ("The WDM Mux proposed in this disclosure consists of an array of GSE lasers attached to a substrate, a matching array of collimating lenses, and a single focusing lens. The divergent laser beam emitted by each laser is collimated by the corresponding collimating lens. The multiple collimated beams are then focused by the single focusing lens into a single spot that is suitable for coupling into an optical fiber."); Claims, e.g., claims 1 and 17.

289. To the extent that the preamble is limiting, Bhandarkar discloses an optical combiner that has all of the properties noted in Claim Elements [1.0], [1.1], and [1.2].

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290. For instance, with respect to Claim Element [1.0], Bhandarkar is directed to an *optical combiner*. See, e.g., EX1013, FIG. 5, ¶¶[0013], [0038], [0042], [0043]; EX1015, pp. 9, 18, claims 1, 17.

291. Additionally, Bhandarkar discloses that its devices are *usable in data communication systems for multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength* (Claim Element [1.1]), and *for transmission into and through a stopped single optical fiber* (Claim Element [1.2]). With reference to FIG. 5, the optical device taught in Bhandarkar couples light from different lasers (each of the **GSE lasers 520**) having different wavelengths onto a single stopped optical fiber, via collimating lens array 540 that collimates the light and directs it to the single focusing lens 560 for converging the light onto the optical fiber (not shown, but would be inserted into channel 570 for receiving a fiber-optic connector):



E.g., EX1013 (“In one exemplary embodiment, the array of GSE lasers 520 is a 2×2 array in which four GSE lasers 520 are provided for generating light beam signals at four different wavelengths that are to be multiplexed together.”). Bhandarkar explains that this device can be used in data communication. *See, e.g.*, EX1013, ¶[0043]. Bhandarkar further explains that the device is a “WDM multiplexer” that causes the light from the lasers to be integrated into and transmitted through an optical fiber. *See, e.g.*, EX1013, ¶¶[0038]-[0043].

292. While Bhandarkar refers to an optical fiber, it does not explicitly use the term “stopped single optical fiber.” Even so, Bhandarkar teaches, or would have suggested, a stopped optical fiber, as that term would be understood by a POSITA.

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See Section VII(D)(ii). A “stopped” optical fiber is an optical fiber that is fixed. *See id.* It would have been readily apparent to a POSITA that the fiber of Bhandarkar is fixed in place, at least because it is fixed by the fiber optic connector which fits into the channel 570. *See* EX1013, FIG. 5 and ¶[0013] (“The WDM multiplexer includes a receptacle that houses the plurality of lasers, the plurality of collimating lenses and the focusing lens. The receptacle includes a ferrule sleeve for coupling the point of light to an optical fiber or fiber optic connector.”); ¶[0041] (“Also provided in the receptacle 550 is a single focusing lens 560. The single focusing lens is provided at a position within the receptacle 550 at one end of a channel 570 formed in the receptacle 550. At the opposite end of the channel 570, a fiber-optic connector (not shown), such as a SC connector, may be coupled to the WDM multiplexer 500.”); ¶[0043] (“This single light beam signal generated by the focusing lens 560 travels down the channel 570 so that it may pass to a fiber optic connector (not shown) for transmission through a fiber optic medium or the like.”). This is similar to the structure used in the ’416 Patent, which illustrates a “fiber stop or seat 60 formed in ferrule 60” described in the ’416 Patent. EX1001, 3:11-15.

293. Accordingly, and for all of these reasons, in my opinion, Bhandarkar (Ground 5) discloses, or would have suggested, Claim Elements [1.0], [1.1], and [1.2].

ii. Bhandarkar (Ground 5) discloses or suggests Claim Elements [1.3] and [1.4]

'416 Claim Limitation	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. ("Bhandarkar") (EX1013)
[1.3] <i>a plurality of n collimating lenses,</i>	Bhandarkar (Ground 5) discloses "<i>a plurality of n collimating lenses.</i>" The array of collimating lenses 540 are the plurality of collimating lenses. <i>See, e.g.,</i> EX1013 (Bhandarkar): FIG. 5; ¶[0039] ("Also provided is an array of collimating lenses 540 that are provided in receptacle 550."); ¶[0040] ("Returning to the discussion of the collimating lens array 540, in the depicted exemplary embodiment there is one collimating lens in the collimating lens array 540 for each GSE laser in the array of GSE lasers 520. Thus, in an exemplary embodiment, the collimating lens array 540 is a 2x2 array of collimating lenses that are positioned such that each lens in the collimating lens array 540 is aligned with a respective one of the GSE lasers in the 2x2 array of GSE lasers 520."); <i>See, e.g.,</i> EX1015 (Bhandarkar Provisional Application): p. 9 (right figure, resembling FIG. 5 of Bhandarkar);

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'416 Claim Limitation	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. ("Bhandarkar") (EX1013)
	p. 18 ("The WDM Mux proposed in this disclosure consists of an array of GSE lasers attached to a substrate, a matching array of collimating lenses, and a single focusing lens. The divergent laser beam emitted by each laser is collimated by the corresponding collimating lens. The multiple collimated beams are then focused by the single focusing lens into a single spot that is suitable for coupling into an optical fiber."); Claims, e.g., claims 1 and 17.
[1.4] <i>said lenses being spaced apart and positioned to receive and collimate the output of said n laser output beams, said n laser output beams have n different output wavelengths, and</i>	Bhandarkar (Ground 5) discloses <i>said lenses being spaced apart and positioned to receive and collimate the output of said n laser output beams, said n laser output beams have n different output wavelengths, and.</i> The collimating lenses 540 are in an array (and are placed at corresponding planar positions to GSE lasers 520. The collimating lenses 540 collimate the light from GSE lasers 520, where each GSE laser 520 may have a different wavelength. See, e.g., EX1013 (Bhandarkar): FIG. 5; ¶0038 ("In one exemplary embodiment, the array of GSE lasers 520 is a 2x2 array in which four GSE lasers 520 are provided for generating light beam signals at four different wavelengths that are to be multiplexed together."); ¶[0039] ("Also provided is an array of collimating lenses 540 that are provided in receptacle 550.");

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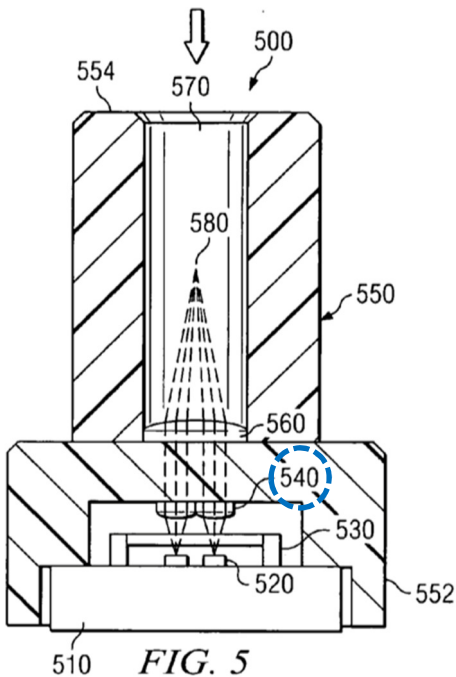
'416 Claim Limitation	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. ("Bhandarkar") (EX1013)
	¶[0040] ("Returning to the discussion of the collimating lens array 540, in the depicted exemplary embodiment there is one collimating lens in the collimating lens array 540 for each GSE laser in the array of GSE lasers 520. Thus, in an exemplary embodiment, the collimating lens array 540 is a 2x2 array of collimating lenses that are positioned such that each lens in the collimating lens array 540 is aligned with a respective one of the GSE lasers in the 2x2 array of GSE lasers 520."); ¶[0042] ("In operation, the GSE lasers in the array of GSE lasers 520 emit light beam signals through the hermetic enclosure 530, which is transparent to the light beam signals. These light beam signals are captured by the collimating lenses of the collimating lens array 540. Since there is a one to one correspondence between GSE lasers and collimating lenses in the arrays 520 and 540, each collimating lens captures the light beam signal from its corresponding GSE laser. As shown in FIG. 5, the collimating lenses adjust the direction of the light beam signals from being divergent, i.e. spreading, to a direction that is parallel with the axis of the lenses (the vertical straight lines illustrated in FIG. 5)."). <i>See, e.g.,</i> EX1015 (Bhandarkar Provisional Application): p. 9 (right figure, resembling FIG. 5 of Bhandarkar); p. 18 ("The WDM Mux proposed in this disclosure consists of an array of GSE lasers attached to a substrate, a matching array of collimating lenses,

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'416 Claim Limitation	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. (“Bhandarkar”) (EX1013)
	and a single focusing lens. The divergent laser beam emitted by each laser is collimated by the corresponding collimating lens . The multiple collimated beams are then focused by the single focusing lens into a single spot that is suitable for coupling into an optical fiber.”); Claims, e.g., claims 1 and 17.

294. Bhandarkar discloses an optical combiner that has the requirements of Claim Elements [1.3] and [1.4].

295. With respect to Claim Element [1.3], the array of collimating lenses 540 are a *plurality of n collimating lenses*:



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EX1013, FIG. 5 (annotations added).

296. And as required by Claim Element [1.4] and illustrated above, they are *spaced apart and positioned to receive and collimate the output of said n laser output beams*. The collimating lenses 540 are spaced apart because, as shown in FIG. 5, there are gaps (spaces) between the collimating lenses 540. They are positioned to receive and collimate the output of the laser output beams because the **array of collimating lenses 540** are placed at corresponding planar positions compared to the **GSE lasers 520**, and the **collimating lenses 540** receive and collimate **light** from the **GSE lasers 520**. Further, each of the **GSE lasers 520** emits light in a different wavelength. EX1013, FIG. 5, ¶¶[0038]-[0042].

297. Accordingly, and for all of these reasons, in my opinion, Bhandarkar (Ground 1) discloses, or would have suggested, Claim Elements [1.3] and [1.4].

iii. Bhandarkar (Ground 5) discloses or suggests Claim Elements [1.5] and [1.6]

'416 Claim Limitation	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. (“Bhandarkar”) (EX1013)
[1.5] <i>focusing means for focusing said n collimated output beams onto a single spot at said stopped single optical fiber,</i>	Bhandarkar (Ground 5) discloses “ <i>focusing means for focusing said n collimated output beams onto a single spot at said stopped single optical fiber.</i> ” The focusing lens 560 is the focusing means (corresponding to the focusing lens structure

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'416 Claim Limitation	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. ("Bhandarkar") (EX1013)
	described in the '416 Patent's specification). Focusing lens 560 focusses the light from the collimated output beams into a single optical fiber. <i>See, e.g.,</i> EX1013 (Bhandarkar): FIG. 5; ¶[0043] ("The focusing lens 560 receives the light beam signals from all of the collimating lenses in the collimating lens array 540 and multiplexes them into a single light beam signal. Essentially, the focusing lens 560 focuses each of the light beam signals to a focal point 580 causing the light beam signals to be combined and multiplexed into a single light beam signal. This single light beam signal generated by the focusing lens 560 travels down the channel 570 so that it may pass to a fiber optic connector (not shown) for transmission through a fiber optic medium or the like."). <i>See, e.g.,</i> EX1015 (Bhandarkar Provisional Application): p. 9 (right figure, resembling FIG. 5 of Bhandarkar); p. 18 ("The WDM Mux proposed in this disclosure consists of an array of GSE lasers attached to a substrate, a matching array of collimating lenses, and a single focusing lens. The divergent laser beam emitted by each laser is collimated by the corresponding collimating lens. The multiple collimated beams are then focused by the single focusing lens into a single spot that is suitable for coupling into an optical fiber."); Claims, e.g., claims 1 and 17.

'416 Claim Limitation	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. ("Bhandarkar") (EX1013)
[1.6] <i>said focusing means having n separate radial sectors on its surface, and each of said n collimated beams passes through a separate one of said n sectors of said focusing means whereby said n output beams having n different wavelengths are coupled into said single fiber.</i>	Bhandarkar (Ground 5) discloses “a plurality of n collimating lenses.” Bhandarkar discloses a two-by-two array of lasers and collimating lenses (FIG. 5). (This corresponds to the two-by-two array structures disclosed and claimed in the '416 Patent.) As a result of the two-by-two array of lasers and collimating lenses, the collimated beams pass through separate radial sectors on the surface of the focusing lens 560. See, e.g., EX1013 (Bhandarkar): FIG. 5; ¶[0038] (“In one exemplary embodiment, the array of GSE lasers 520 is a 2×2 array in which four GSE lasers 520 are provided for generating light beam signals at four different wavelengths that are to be multiplexed together.”); ¶[0040] (“Thus, in an exemplary embodiment, the collimating lens array 540 is a 2×2 array of collimating lenses that are positioned such that each lens in the collimating lens array 540 is aligned with a respective one of the GSE lasers in the 2×2 array of GSE lasers 520.”); ¶[0043] (“The focusing lens 560 receives the light beam signals from all of the collimating lenses in the collimating lens array 540 and multiplexes them into a single light beam signal. Essentially, the focusing lens 560 focuses each of the light beam signals to a focal point 580 causing the light beam signals to be combined and multiplexed into a single light beam signal. This single light beam signal

'416 Claim Limitation	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. ("Bhandarkar") (EX1013)
	generated by the focusing lens 560 travels down the channel 570 so that it may pass to a fiber optic connector (not shown) for transmission through a fiber optic medium or the like.”). <i>See, e.g.,</i> EX1015 (Bhandarkar Provisional Application): p. 9 (right figure, resembling FIG. 5 of Bhandarkar); p. 18 (“The WDM Mux proposed in this disclosure consists of an array of GSE lasers attached to a substrate, a matching array of collimating lenses, and a single focusing lens. The divergent laser beam emitted by each laser is collimated by the corresponding collimating lens. The multiple collimated beams are then focused by the single focusing lens into a single spot that is suitable for coupling into an optical fiber.”); Claims, e.g., claims 1 and 17.

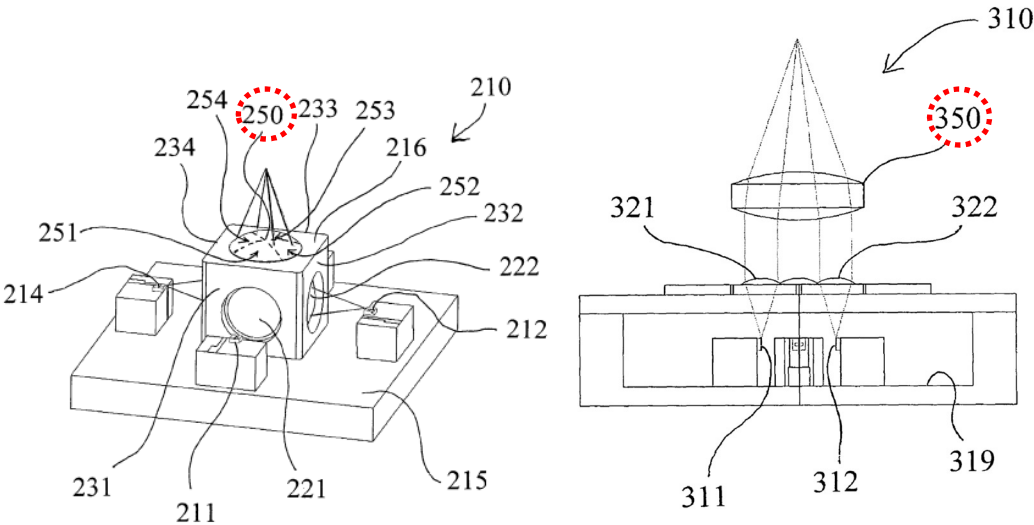
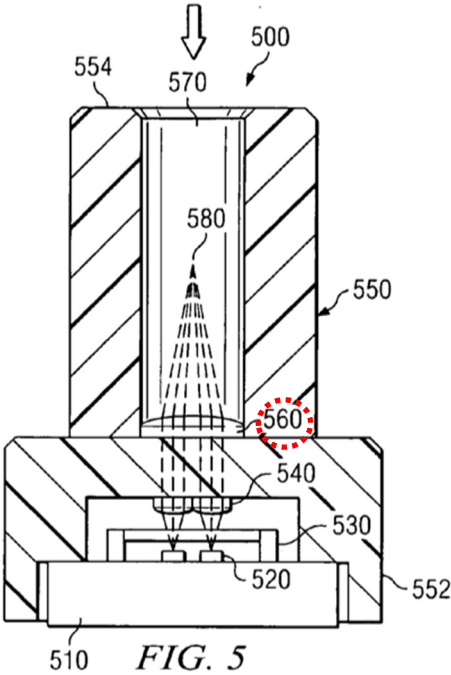
298. With respect to Claim Element [1.5], Bhandarkar discloses *focusing means for focusing said n collimated output beams onto a single spot at said stopped single optical fiber*. The structure corresponding to the focusing means in the '416 Patent is a focusing lens, and thus the focusing means refers to a focusing lens and equivalents thereof, as I explained above in Section VII(D)(iii)(2), and Bhandarkar discloses a focusing lens 560.

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299. The focusing lens 560 of Bhandarkar focuses light from the output of the collimating lens array 540 onto a single optical fiber and therefore is a focusing lens *for focusing said n collimated output beams onto a single spot at said stopped single optical fiber*. EX. 1013, FIG. 5, ¶¶[0038]-[0043]. Specifically, the focusing lens 560 focuses light onto a single spot, i.e., focusing point 580, at the optical fiber. EX1013, ¶[0043] (“Essentially, the focusing lens 560 focuses each of the light beam signals to a focal point 580 causing the light beam signals to be combined and multiplexed into a single light beam signal.”)

300. The structure of focusing lens 560 may also be compared to the corresponding structure disclosed in the '416 Patent. The structure of the focusing lens 560 (of Bhandarkar) is equivalent to, e.g., the structure of the focusing lens 250/350 (of the '416 Patent) shown in FIGS. 7-9 (focusing lens 250) and 10-11 (focusing lens 350) of the '416 Patent. Compare Bhandarkar FIG. 5 (focusing lens 560) with '416 Patent, FIGS. 7 (focusing lens 250) and 10 (focusing lens 350), each of which is reproduced below with an annotation identifying the corresponding focusing lens:

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I understand that Patent Owner has taken the position in the corresponding litigation that “*focusing means*” should not be interpreted under 35 U.S.C. § 112, ¶6. Even if the term is considered to have sufficient structure in the claims, that does not affect my analysis here. The disclosed structure of the “*focusing means*” is a focusing lens, and claim 2 shows that the “*focusing means*” must include at least a single focusing lens. *See* claim 2 (“said focusing means is a single focusing lens”). Because the structure I have identified in the prior art is a single focusing lens, it satisfies the “*focusing means*” claim element, regardless of whether it is interpreted as a means-plus-function term.

301. In particular, taking the example of Bhandarkar where there is a two-by-two array of GSE lasers 520 and a two-by-two array of collimating lenses 540, collimated light from the collimating lenses 540 passes through the focusing lens 560. In particular, collimated light from each of the collimating lenses 540 will pass through a separate radial sector on the surface of the focusing lens 560. This is because the two-by-two array of collimating lenses 540 results in radially arranged lenses that will each pass their respective collimated light to a separate radial portion (or sector) of the focusing lens 560. EX1013, FIG. 5, ¶¶[0038]-[0043].

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302. To the extent it is argued that Bhandarkar does not expressly disclose that “said focusing means ha[s] n separate radial sectors on its surface, and each of said n collimated beams passes through a separate one of said n sectors of said focusing means whereby said n output beams having n different wavelengths are coupled into said single fiber,” this would have been obvious to a POSITA at the time of the invention. As an initial matter, as I have explained, the separate radial sectors are achieved as a result of the arrangement of the lasers and collimating lenses radially with respect to a center focal axis of the focusing lens. See above, Section VII(A). Therefore, a POSITA would have understood Bhandarkar to teach this claim element. For example, the arrangement shown in FIG. 5 of Bhandarkar appears to show an optical combiner having four lasers (the four GSE lasers 520) and four collimating lenses (the four collimating lenses 540) that are radially arranged, in a two-by-two array, with respect to a center focal axis of the focusing lens (focusing lens 560).

303. In addition to a POSITA understanding that Bhandarkar discloses this arrangement, it also would have been obvious. Alignment of the collimating lenses around the center focal axis of the focusing lens was typical as of the time of the invention, it would have improved efficiency of the system by limiting signal losses,

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e.g., through an efficient low-angle (*i.e.*, relative to the fiber end-face normal) optical coupling into fiber (*i.e.*, high-angle coupling typically has higher coupling loss than low-angle coupling), and at any event would have been a known technique that would have improved the device. For example, a POSITA would have known that coupling is improved when the angle of light relative to the fiber normal from the focusing lens into the fiber end-face is small, *e.g.*, based on the numerical aperture. Furthermore, a POSITA would have known that if the alignment of the beams were not around the center focal axis of the focusing lens then the coupling efficiency could be decreased since the refractive angle of the outer beams relative to the fiber would be larger.

304. Accordingly, and for all of these reasons, in my opinion, Bhandarkar (Ground 5) discloses, or would have rendered obvious, Claim Elements [1.5] and [1.6].

iv. Bhandarkar (Ground 5) discloses or renders obvious Claim 2

'416 Claim 2	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. ("Bhandarkar") (EX1013)
<i>The optical combiner of claim 1 wherein $n=4$ and wherein said four lasers and four collimating lenses are</i>	Bhandarkar (Ground 5) discloses " <i>The optical combiner of claim 1 wherein $n=4$ and wherein said four lasers and four collimating lenses are each formed in a two-dimensional, two by two array,</i>

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'416 Claim 2	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. ("Bhandarkar") (EX1013)
<i>each formed in a two-dimensional, two by two array, wherein said focusing means is a single focusing lens, and wherein each radial sector is a pie-shaped quadrant.</i>	<i>wherein said focusing means is a single focusing lens, and wherein each radial sector is a pie-shaped quadrant."</i> See citations for claim 1 above. Bhandarkar discloses that both GSE lasers 520 and collimating lenses 540 may be a two-by-two array. Thus, there are four GSE lasers 520 (four lasers) and four collimating lenses 540 (four collimating lenses). <i>See, e.g.,</i> EX1013 (Bhandarkar): FIG. 5; ¶[0038] ("In one exemplary embodiment, the array of GSE lasers 520 is a 2x2 array in which four GSE lasers 520 are provided for generating light beam signals at four different wavelengths that are to be multiplexed together."); ¶[0039] ("Also provided is an array of collimating lenses 540 that are provided in receptacle 550."); ¶[0040] ("Returning to the discussion of the collimating lens array 540, in the depicted exemplary embodiment there is one collimating lens in the collimating lens array 540 for each GSE laser in the array of GSE lasers 520. Thus, in an exemplary embodiment, the collimating lens array 540 is a 2x2 array of collimating lenses that are positioned such that each lens in the collimating lens array 540 is aligned with a respective one of the GSE lasers in the 2x2 array of GSE lasers 520."); ¶[0042] ("As shown in FIG. 5, the collimating lenses adjust the direction of the light beam signals

'416 Claim 2	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. ("Bhandarkar") (EX1013)
	from being divergent, i.e. spreading, to a direction that is parallel with the axis of the lenses (the vertical straight lines illustrated in FIG. 5)." <i>See, e.g.,</i> EX1015 (Bhandarkar Provisional Application): p. 9 (right figure, resembling FIG. 5 of Bhandarkar); p. 18 ("The WDM Mux proposed in this disclosure consists of an array of GSE lasers attached to a substrate, a matching array of collimating lenses, and a single focusing lens. The divergent laser beam emitted by each laser is collimated by the corresponding collimating lens. The multiple collimated beams are then focused by the single focusing lens into a single spot that is suitable for coupling into an optical fiber."); Claims, e.g., claims 1 and 17.

305. Bhandarkar discloses all of the various aspects of claim 2.

306. First, Bhandarkar discloses that both GSE lasers 520 and collimating lenses 540 may be a two-by-two array, as shown for example in FIG. 5. Thus, in this embodiment from Bhandarkar, there are four GSE lasers 520 (four lasers) and four collimating lenses 540 (four collimating lenses) – i.e., "*wherein $n=4$ and wherein said four lasers and four collimating lenses are each formed in a two-dimensional, two by two array.*"

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307. Second, Bhandarkar uses focusing means that are *a single focusing lens*. See, e.g., EX1013, FIG. 5 (focusing lens 560). A single focusing lens 560 focusses the collimated light onto the optical fiber. EX1013, FIG. 5, ¶¶[0038]-[0043]; see also above, Section VIII(E)(i)-(iii) (addressing claim 1).

308. Third, the focusing lens 560 has four equally shaped radial sectors, which are therefore pie-shaped quadrants. That is, because of the two-by-two array formation, *each radial sector is a pie-shaped quadrant*. This follows from the arrangement of the GSE lasers 520 and collimating lenses 540 being arranged radially around the focusing lens 560, centered on the focal axis of focusing lens 560. This arrangement is shown in FIG. 5.

309. Moreover, it would be obvious to a POSITA when arranging a two-by-two array of GSE lasers 520 and collimating lenses 540 to make them radially arranged with respect to a center focal axis of the focusing lens (lens 560), as I explained in connection with Claim Element [1.6].

310. Accordingly, and for all of these reasons, in my opinion, Bhandarkar (Ground 5) discloses, or would have rendered obvious, Claim 2.

**v. Bhandarkar (Ground 5) discloses or renders obvious Claim
6**

'416 Claim 6	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. (“Bhandarkar”) (EX1013)
<i>The optical combiner of claim 1 wherein said optical combiner does not require the use of dielectric filters or waveguides.</i>	Bhandarkar (Ground 5) discloses “<i>The optical combiner of claim 1 wherein said optical combiner does not require the use of dielectric filters or waveguides.</i>” See citations for claim 1 above. Bhandarkar discloses reducing the number of component parts needed, and discloses a device without dielectric filters or waveguides. <i>See, e.g., EX1013 (Bhandarkar):</i> FIG. 5; ¶[0056] (“In addition, other components that are typically found in known WDM multiplexers are eliminated in the present invention, e.g., the filter array 130 and bounce cavity 140 in FIG. 1, which results in lower piece-part costs and assembly costs.”). <i>See, e.g., EX1015 (Bhandarkar Provisional Application):</i> p. 5 (“w/o filter”); p. 9 (right figure, resembling FIG. 5 of Bhandarkar); p. 11 (“Eliminates multiple bounce cavity ... Eliminates filter ... Simpler design....”).

311. Bhandarkar discloses an optical combiner that does not have dielectric filters or waveguides, and hence which *does not require the use of dielectric filters*

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or waveguides. This is apparent from looking at the figures, as well as the corresponding description in the text. Additionally, Bhandarkar explains that an “other components that are typically found in known WDM multiplexers are eliminated in the present invention, e.g., the filter array 130 and bounce cavity 140 in FIG. 1, which results in lower piece-part costs and assembly costs.” EX1013, ¶[0056]; cf. EX1001, 2:21-26 (discussing providing a “compact and cost effective optical combiner”).

312. Accordingly, and for all of these reasons, in my opinion, Bhandarkar (Ground 5) discloses, or would have rendered obvious, Claim 6.

vi. Bhandarkar (Ground 5) discloses or renders obvious Claim 7 (Claim Elements [7.0], [7.1], [7.2], [7.3], [7.4], [7.5], and [7.6])

'416 Claim Limitation	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. (“Bhandarkar”) (EX1013)
[7.0] <i>An optical combiner</i>	See above for Claim Element [1.0].
[7.1] <i>usable in data communication systems for multiplexing the outputs of a plurality of lasers wherein each of said outputs has a different wavelength,</i>	See above for Claim Element [1.1]
[7.2] <i>for transmission into and through a stopped</i>	See above for Claim Element [1.2]

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'416 Claim Limitation	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. ("Bhandarkar") (EX1013)
<i>single optical fiber, comprising:</i>	
<i>[7.3] an array of four lasers, formed in a two-dimensional, two by two array, each of said lasers having an output beam with a different wavelength,</i>	See above for Claim Element [1.1], Claim 2
<i>[7.4] an array of four collimating lenses, said lenses being formed in a two-dimensional, two by two array and positioned to receive and collimate the output of said laser output beams, and</i>	See above for Claim Element [1.3], [1.4], Claim 2
<i>[7.5] focusing means for focusing said collimated output beams onto a single spot at said stopped single optical fiber,</i>	See above for Claim Element [1.5]
<i>[7.6] said focusing means having four separate quadrants on its surface, and each of said four collimated beams passes through a separate one of said quadrants of said focusing means whereby said output beams of said</i>	See above for Claim Element [1.6], Claim [2]

'416 Claim Limitation	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. ("Bhandarkar") (EX1013)
<i>four lasers are coupled into said single fiber.</i>	

313. As explained above at Section VII(B), claim 2 is narrower than (or possibly co-extensive with) claim 7. Therefore, the analysis above for claim 2, which sets $n=4$ and requires two-by-two arrays of lasers and collimating lenses, applies equally here to claim 7, which also requires two-by-two arrays of lasers and collimating lenses. That is, Bhandarkar discloses an optical combiner (the WDM multiplexer of Bhandarkar) with lasers (GSE lasers 520), collimating lenses (collimating lenses 540) to collimate light from the lasers, a focusing lens (focusing lens 560) to focus the collimated light onto a single stopped optical fiber. In particular, the example of FIG. 5 of Bhandarkar shows four light emitting portions and four collimating lenses, each in a two-by-two array.

314. Accordingly, and for all of these reasons, in my opinion, Bhandarkar (Ground 5) discloses, or would have rendered obvious, Claim 7.

vii. Bhandarkar (Ground 5) discloses or renders obvious Claim 9

'416 Claim 9	U.S. Patent Publ. No. 2005/0069013 to Bhandarkar et al. ("Bhandarkar") (EX1013)
<i>The optical combiner of claim 7 wherein said optical combiner does not require the use of dielectric filters or waveguides.</i>	See above for Claim 6, 7.

315. Claim 9 depends from claim 7, but other than the dependency from a different independent claim contains the same additional requirement as claim 6. Therefore, the analysis above for claim 6 applies equally here to claim 9.

316. Accordingly, and for all of these reasons, in my opinion, Bhandarkar (Ground 5) discloses, or would have rendered obvious, Claim 9.

IX. SECONDARY CONSIDERATIONS

317. At this time, I am not aware of any objective evidence (or "secondary considerations") that would suggest the Challenged Claims are not obvious. For example, I am not aware of any evidence relating the purported invention to any commercial success, evidence of a long-felt need that was solved by the purported invention, evidence that others have copied the purported invention, evidence of failure of others facing the same state of the art to develop a satisfactory solution,

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evidence of professional approval or skepticism, or evidence that the purported invention achieved a surprising result. It is my opinion that the Challenged Claims would have been obvious to one of skill in the art.

318. I understand that if Patent Owner argues that objective evidence supports a finding of non-obviousness, I may be asked to review such evidence and formulate an opinion in response to Patent Owner's arguments. I reserve my right to do so.

X. CONCLUSION

319. The foregoing represents my opinion to date but as discussed above I reserve the right to supplement my opinion if, among other things, further evidence or information becomes available.

320. In signing this declaration, I understand that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross examination in the case and that cross examination will take place within the United States. If cross examination is required of me, I will appear for cross examination within the United States during the time allotted for cross examination.

321. I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine and/or imprisonment under §1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the patent which is under review in this proceeding.

Dated: July 28, 2023

Respectfully submitted,

Alan Willner

Alan E. Willner, PhD

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