UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

COMMSCOPE TECHNOLOGIES LLC
Petitioner

v.

BELDEN CANADA ULC
Patent Owner

U.S. Patent No. 11,740,423

EXPERT DECLARATION OF DR. STEPHEN RALPH

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I, Stephen E. Ralph, Ph.D., declare as follows.

I. Introduction

A. Engagement

1. I have been retained by CommScope Technologies LLC, ("CommScope") to provide expert opinions in connection with a petition for inter partes review before the United States Patent and Trademark Office. This declaration involves my expert opinions and expert knowledge related to U.S. Patent No. 11,740,423 ("the '423 Patent") and its field of endeavor.

2. I have been asked to provide my independent technical review, analysis, insights, and opinions regarding the '423 Patent and the references that form the basis for the grounds for invalidity set forth in the Petition for Inter Partes Review of the '423 Patent. The statements made herein are based on my own knowledge and opinions.

B. Qualifications

3. I am a professor of Electrical Engineering at the Georgia Institute of Technology. I received my Ph.D. (1988) in Electrical Engineering from Cornell University. I received my Bachelor degree (1980) in Electrical Engineering from Georgia Institute of Technology.

4. At Georgia Tech, I hold the Glen Robinson Chair in Electro-Optics and I am a Principal Research Scientist at the Georgia Tech Research Institute, the applied research unit of the Georgia Institute of Technology.

5. I was a Postdoctoral Member of the Technical Staff at AT&T Bell Laboratories and a Visiting Scientist at IBM T. J. Watson Research Laboratory. I was a founding member of Quellan, Inc., a startup focused on developing electronic signal processing and higher order modulation formats for fiber optic communication systems. Quellan was purchased by Intersil where the technologies are applied to a variety of high-speed links.

6. I am currently the Director of the Georgia Electronic Design Center at Georgia Tech. The GEDC is a cross-disciplinary Electronics and Photonics center of the Georgia Institute of Technology focused on the synergistic development of high-speed photonics, electronics, and signal processing. The center includes more than 12 active faculty, over 140 graduate students and an annual research expenditure of ~$8M. The GEDC is one of the world's largest university-based research centers of its kind.

7. I am the Director of a National Science Foundation (NSF) multi–University Center with lead site at Georgia Tech known as EPICA: Electronic and Photonic Integrated Circuits for Aerospace. The center is an NSF Industry University Collaborative Research Center (IUCRC) and is focused on developing

and testing integrated photonics and electronics for harsh environments. IUCRCs are unlike most NSF funding efforts in that they are industry driven. EPICA has more than 20 Industry members and affiliates.

8. I am actively involved as a reviewer, and committee member of various journals and conferences and have extensive experience with various international standards groups focused on electronic and photonic components and high-capacity fiber optic systems. I am a past Associate Editor for optoelectronic devices for the IEEE Journal Transactions on Electronic Devices and I am now the Treasurer of the IEEE Photonics Society (January 2023 through December 2025), and a Fellow of the OSA (formerly the Optical Society of America).

9. My research efforts currently focus on integrated photonics and electronics with application to high capacity communication systems including DWDM fiber networks and optical interconnects, particularly the intersection of electronics, photonics and signal processing; communication component and system design, optimization and simulations for photonic components including lasers, modulators and direct detect and coherent receivers; the integration, assembly and packaging of these components; and impairment identification and mitigation. Fiber systems efforts include; advanced modulation formats including PAM 4 and QAM, demodulation algorithms, equalization, AtoD and DtoAs and optical amplifiers. I am the founder and director of the Georgia Tech Terabit

Optical Networking Consortium: An industry-academia collaboration formed to investigate high-capacity optical systems.

10. I led a team that developed an open source, density-based topology optimization technique that robustly designs compact, broadband integrated photonic devices for different semiconductor process nodes. These chips have been fabricated on a number of commercial semiconductor foundries.

11. I have published more than 360 peer-reviewed papers in journals and conference proceedings and hold 17 patents in the fields of photonic devices, communications and signal processing. Georgia Tech has licensed multiple inventions to Industry.

12. I regularly teach undergraduate and graduate level classes on optical communication systems and components. I also regularly make presentations on optical communication technologies, including DWDM systems, modulation, optical transmission, impairment mitigation and signal processing.

13. Additional information concerning my background, qualifications, publications, conferences, honors, and awards are described in my Curriculum Vitae, a copy of which is attached with this declaration as Exhibit A.

14. I am being compensated for my time spent on this matter at my usual and customary rate of $575/hour, plus reasonable expenses. My rate is $650/hour

when travel is involved. My compensation is not related to the outcome of this action, and I have no financial interest in this case.

II. Materials Considered

15. My technical review, analysis, insights, and opinions are based on my experience and other qualifications discussed above, as well as my study of relevant materials.

16. I have reviewed and am familiar with the patent specification, claims, and prosecution history for each of the ‘423 patent, ‘422 patent, ’542 patent, and ‘107 patent. I have been asked to assume for the purpose of this analysis that the priority date of these patents is October 3, 2017, which is the date of Provisional Application No. 62/567,339.

17. I have reviewed and am familiar with each exhibit cited herein (see the chart at the end). I confirm that to the best of my knowledge the accompanying exhibits are true and accurate copies of what they purport to be, and that an expert in the field would reasonably rely on them to formulate opinions such as those set forth in this declaration.

III. Relevant Legal Principles

A. Person of Ordinary Skill in the Art

18. I have been informed that a person of ordinary skill in the art (“POSITA”) is a person who is presumed to have complete knowledge of the

relevant prior art and who would think along the lines of conventional wisdom in that art. The person of ordinary skill in the art has ordinary creativity and does not have extraordinary skill, e.g., is not an expert. I have been informed that factors to consider in determining the level of ordinary skill in the art include the educational level of workers in the field, the types of problems addressed in the art, prior-art solutions to such problems, how quickly innovations are made, and the complexity of the technology.

19. The ‘423 patent relates to fiber optic cassette systems. *See* EX1001 Title, Abstract, Field of the Invention, Background of the Invention. In view of the factors mentioned above and the discussion of the technical background herein, it is my opinion that a person of ordinary skill in the art of the ‘423 patent would have a B.S. degree or equivalent in mechanical or electrical engineering or similar fields, in addition to a minimum of two years of professional experience with or graduate studies involving design, development, and/or utilization of optical communication systems. I satisfied this level of ordinary skill in the art, including as Patent Owner’s alleged priority date of 2017.

20. Throughout my declaration, even if I discuss my analysis in the present tense, I am always making my determinations based on what a POSITA would have known at the time of the invention.

21. I am aware that during claim construction briefing, Patent Owner has produced the testimony of Dr. Charles Eldering in which opines that:

> In my view, a person of ordinary skill in the art would have had at least a B.S. degree or equivalent in mechanical or electrical engineering or similar fields, in addition to a minimum of two years of professional experience with design, development, and/or utilization of communication products.

I note that my articulation allows for relevant experience to have been gained through graduate studies whereas Dr. Eldering's articulation does not address whether the "professional experience" could have been gained through graduate studies. Nevertheless, to the extent there is any difference between these two articulations, none of my opinions herein would change if I applied the level of skill as articulated by Dr. Eldering. And I also satisfied Patent Owner's articulation of the level of ordinary skill in the art, including as Patent Owner's alleged priority date of 2017.

B. Claim Construction Standard

22. I have been instructed by counsel on the law regarding claim construction and patent claims, and understand that a patent may include two types of claims—independent claims and dependent claims. An independent claim stands alone and includes only the features it recites. A dependent claim can depend from an independent claim or another dependent claim. I understand that a dependent

claim includes all the features that it recites in addition to all the features recited in the claim from which it depends.

23. In an inter partes review proceeding such as this, I understand the claim of a patent shall be construed using the same claim construction standard that would be used to construe the claim in a civil action. I understand this includes construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent. Any prior claim construction determination concerning a term of the claim in a civil action, or a proceeding before the International Trade Commission, that is timely made of record in the inter partes review proceeding will be considered by the PTAB.

24. I understand an appropriate dictionary definition may provide evidence explaining the ordinary and customary meaning as would be understood by a person of ordinary skill in the art.

25. I understand that if there are specific statements in the specification that define the invention with respect to a term, those statements are strong evidence of a definition for the term.

C. Anticipation

26. In this declaration I have been instructed by counsel on the law regarding anticipation and obviousness. I understand that a claim is invalid and

unpatentable if it is anticipated or obvious. My opinions here relate to both anticipation and obviousness as detailed below.

27. I understand that anticipation of a claim requires that every element of a claim is expressly or inherently disclosed in a single prior art reference. I understand that an anticipating reference need not use the exact terms of the claims, but must describe the patented subject matter with sufficient clarity and detail to establish that the claimed subject matter existed in the prior art and that such existence would be recognized by persons of ordinary skill in the field of the purported invention. I also understand that an anticipating reference must enable one of ordinary skill in the art to reduce the purported invention to practice without undue experimentation.

D. Obviousness

28. I understand that a patent claim is also invalid if the claims would have been obvious to a POSITA at the time of the invention. I understand that the obviousness inquiry should not be done in hindsight but rather from the perspective of a POSITA as of the time of the invention.

29. I understand that to obtain a patent, the claims must have been, as of the time of the invention, nonobvious in view of the prior art. I understand that an obviousness analysis involves comparing a claim to the prior art to determine whether the claimed invention would have been obvious to a POSITA at the time

of the invention in view of the prior art and in light of the general knowledge in the art as a whole. I also understand that obviousness is ultimately a legal conclusion based on underlying facts of four general types, all of which must be considered:

(1) the scope and content of the prior art;

(2) the level of ordinary skill in the art;

(3) the differences between the claimed invention and the prior art;

and

(4) any objective indicia of non-obviousness.

30. I understand that a claim is obvious when the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious to a POSITA at the time of the invention.

31. I understand that certain objective indicia can be important evidence regarding whether a patent is obvious. Such indicia include: industry acceptance; commercial success of products covered by the patent claims; long-felt need for the invention; failed attempts by others to make the invention; copying of the invention by others in the field; unexpected results achieved by the invention as compared to the closest prior art; praise of the invention by the infringer or others in the field; taking of licenses under the patent by others; expressions of surprise by experts and those skilled in the art at making the invention; and the patentee

proceeded contrary to the accepted wisdom of the prior art. I understand that such evidence must have a nexus, or causal relationship to the elements of the claim. I am unaware of any such objective considerations having a nexus to the claims at issue in this proceeding.

32. I understand that obviousness can be established by combining multiple prior art references to meet each and every claim element, or by modifying a single prior art reference. I also understand that to support a combination of multiple prior art references or a modification of a single reference, there must be a rationale explaining why a skilled artisan would combine or modify the references in the manner claimed and how the proposed combination or modification meets each and every claim element. But I also understand that a proposed combination or modification of references can be susceptible to hindsight bias. When it appears hindsight bias is being used, I understand the modification or combination is not considered obvious.

33. I understand that exemplary rationales that may support a conclusion of obviousness include: combining or modifying prior art elements according to known methods to yield predictable results; simple substitutions of one known element for another to obtain predictable results; using a known technique to improve similar devices in the same way; applying a known technique to a known device ready for improvement to yield predicable results; choosing from a finite

number of identified, predicable solutions, with a reasonable expectation of success; 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 predicable to one of ordinary skill in the art; and some 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 prior art teachings to arrive at the claimed invention.

34. I understand that teaching away, e.g., discouragement from making the proposed modification, is strong evidence that the references are not combinable. I also understand that a disclosure of more than one alternative does not necessarily constitute a teaching away.

35. I understand that the combination does not need to result in the most desirable embodiment, but if the proposed combination does not have a reasonable expectation of success at the time of the invention, a POSITA would not have had an adequate teaching, suggestion, or motivation to combine the references.

36. I understand that the test for obviousness is not whether the features of a secondary reference may be bodily incorporated or physically combined into the structure of the primary reference, but whether the claimed invention is rendered obvious by the teachings of the references as a whole.

37. I understand that common sense and common knowledge have their proper place in the obviousness inquiry if explained with sufficient reasoning. I understand that resorting to common sense and common knowledge cannot be used as a wholesale substitute for reasoned analysis and evidentiary support.

IV. Technology Background

38. The technology in this petition is fiber optic cassette systems. These systems are deployed in data rooms where high-capacity fiber optic cables need to be distributed to many subscriber connections. The conventional elements are cassettes, trays, and a case. The "Sedor" prior art reference, discussed during prosecution, illustrates two conventional cassettes (30) on a tray (120):

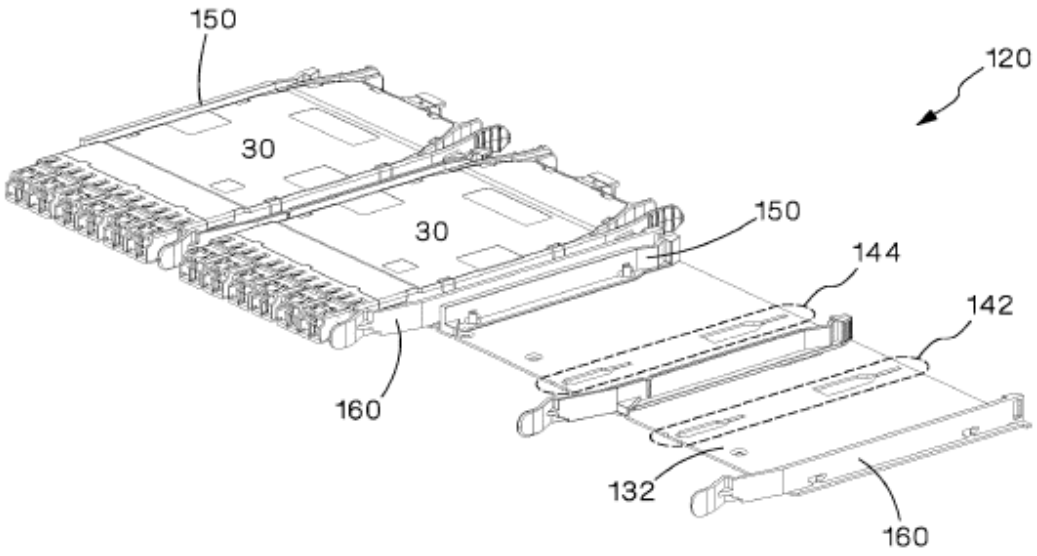


FIG.8

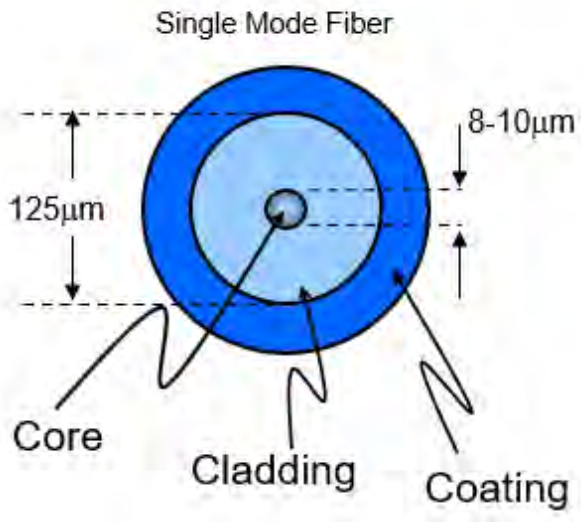
EX1005, Fig. 8. Each cassette has ports (called adapters) on the front and rear. Cassettes can have different types of adapters, typically, "LC" adapters on the front and "MPO" (multi-fiber push on) adapters on the rear.

39. LC adapters often take the form of a "quad" LC adapter with four receptacles to connect four individual LC connectorized fibers:

"Quad" LC adapter **LC connector on a cable**



"LC" connectors (Lucent Connector) are a standard connector for a single optical fiber. Connectorized fibers are often paired such that transmitted signals and received signals are managed together. The optical fiber, above, with the LC connector would have one "core" that light propagates down:



Optical fiber is comprised of a core and a cladding typically made of glass with the properties such that light is confined in the core. Various coatings are used to protect the fiber and prevent intrusion of water and other elements.

40. MPO adapters consists of two opposed multi-fiber connector receiving receptacles that enable the connection of two MPO connectorized fibers with high alignment:

MPO adapters



MPO connectors on a cable





MPO connectors (Multiple-Fiber Push-On) are a standard multi-fiber connector (e.g., 12 fibers) that enables the simultaneous connection of these multiple fibers. The optical fiber with the MPO connectors would contain many optical fibers like this:



Ribbon fiber optic cable is formed by first making individual separate fibers and then arranging them tightly together and bonding them into a single structure. Fibers are usually placed side by side to form a flat ribbon.

41. The fiber optic cassettes enable the operator to plug a high-capacity fiber optic cable with an MPO connector for multiple fibers (e.g., 12 fibers) into the rear MPO adapter and plug many single fiber optic cables with LC connectors into the LC adapters on the front. Fibers inside the cassette connect the front and rear ports. Thus, the high-capacity cable can serve multiple subscriber connections in the front. Other configurations of LC and MPO connectors on a cassette are feasible.

42. The trays of cassettes are stored in a protective case. Sedor illustrates a conventional case:

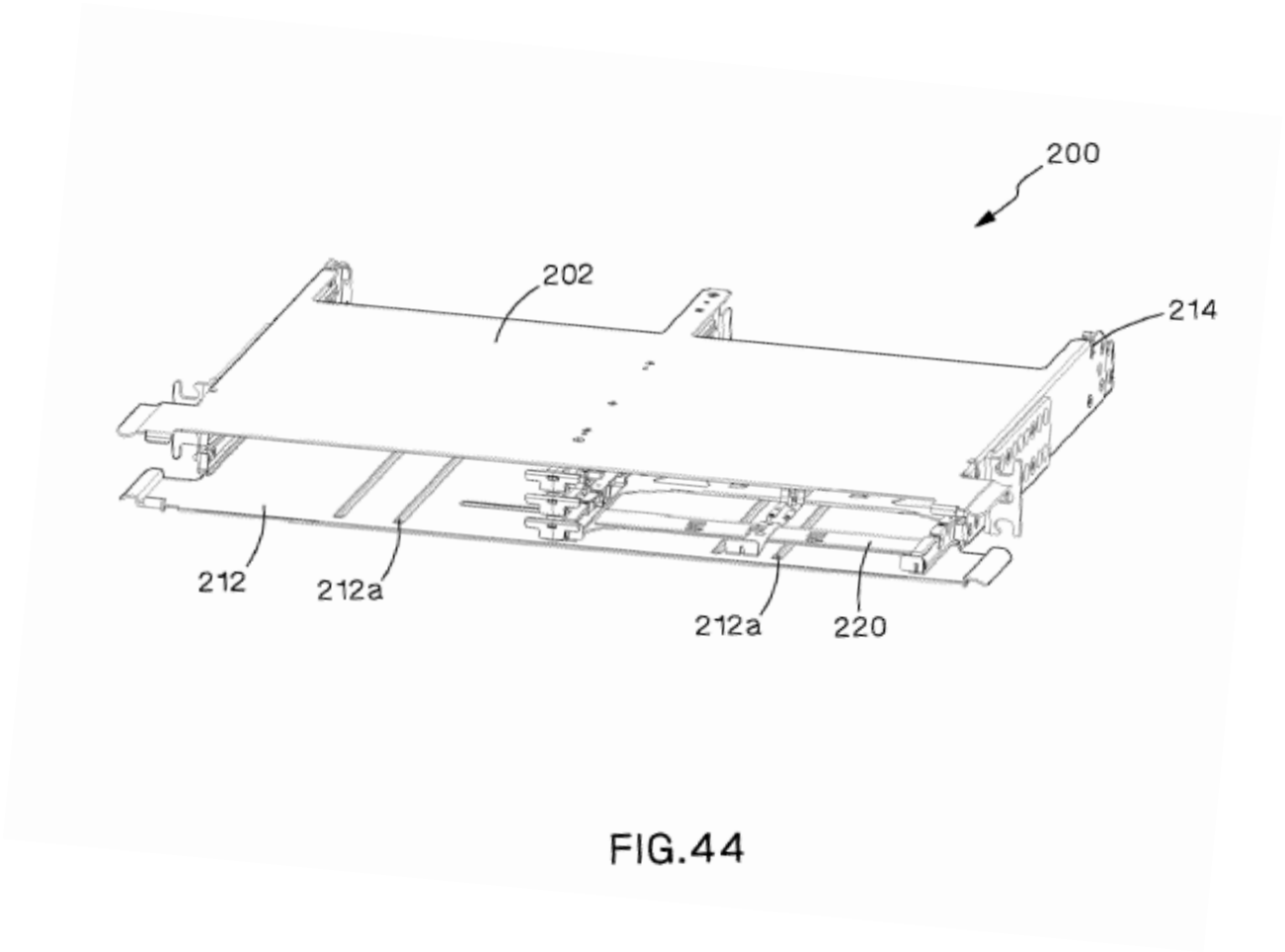


FIG.44

The trays slide in and out of the case to allow the operator to insert change or remove cassettes and plug in or remove fiber cables. The operator typically mounts the case in rack (using the side brackets) and multiple cases can be stacked vertically one on top of the other in the rack. Thus, a single rack may support thousands of connections.

V. Ground 1: The challenged claims are all anticipated by Fukui or obvious based on Fukui itself

43. The challenged claims are all anticipated by Fukui or obvious based on Fukui itself. The challenged claims are Claims 1-30.

A. Independent Claim 1

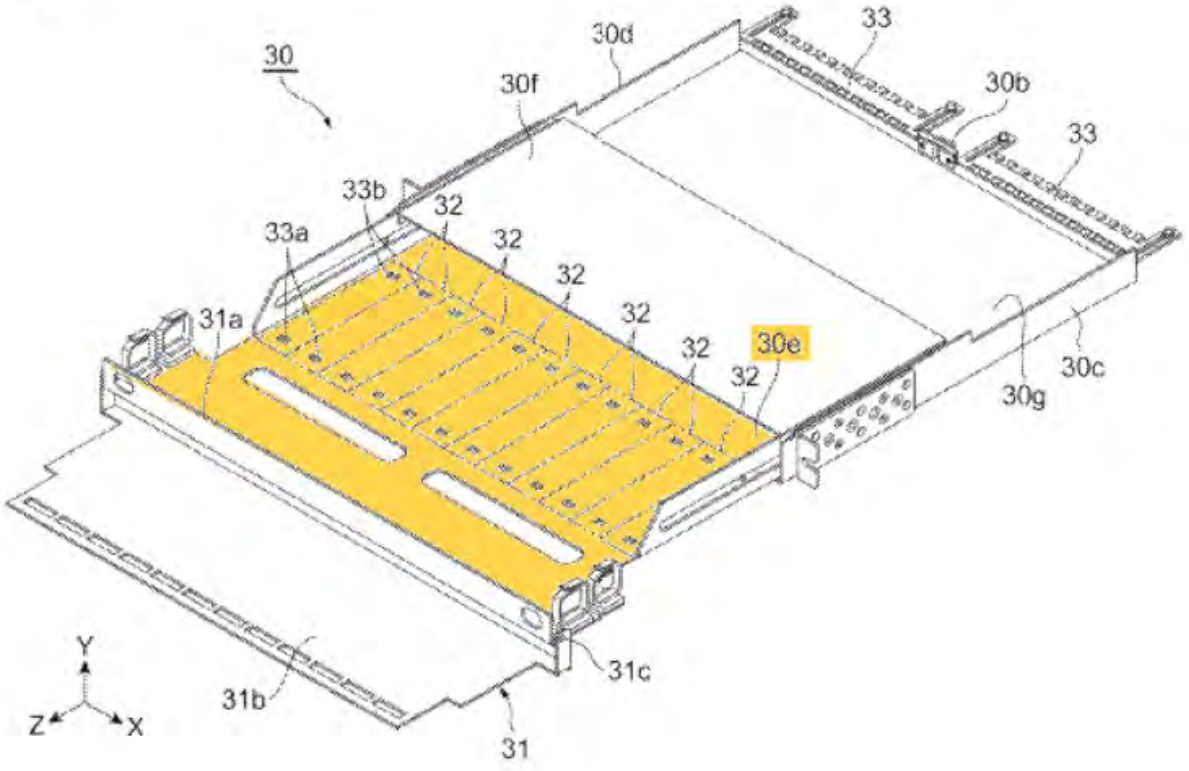
1. Preamble

44. The preamble of claim 1 recites: "A tray for providing a plurality of different modular fiber optic cassette configurations in a standard U-space fiber optic management system comprising

"A tray…"

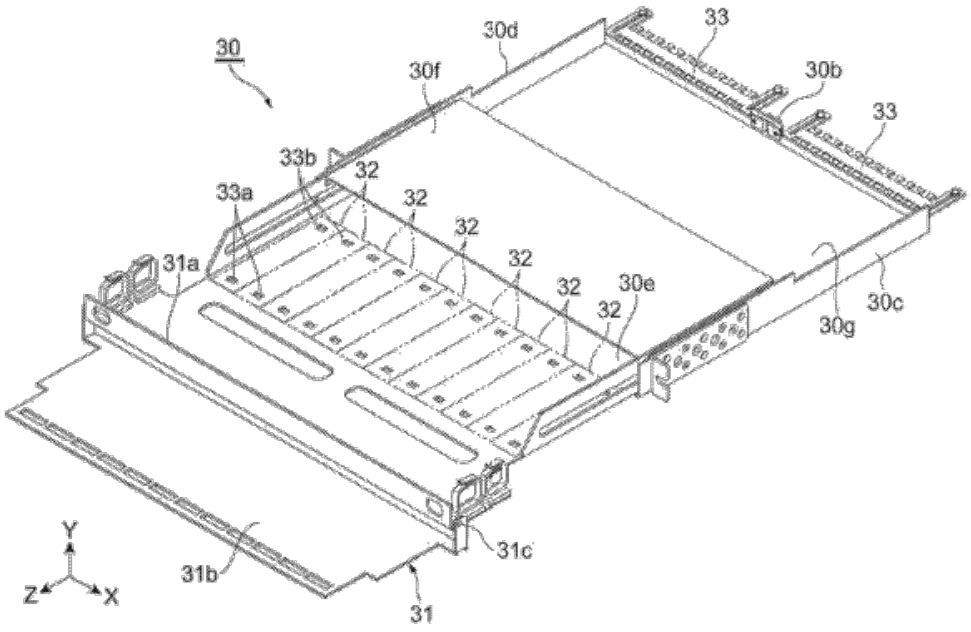
45. Fukui discloses the preamble. Fukui's tray is bottom panel 30e show below in orange:

Fig.9



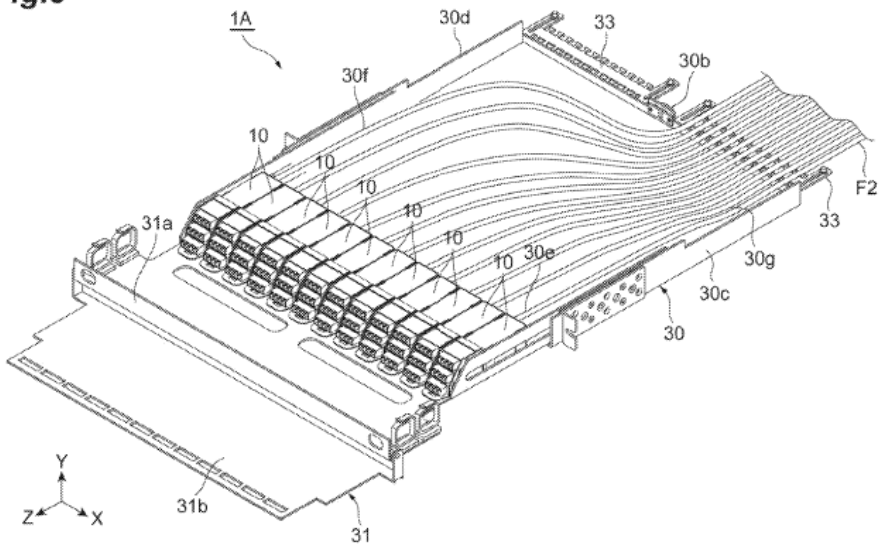
Like the tray in the challenged patent, Fukui's panel 30e is a flat panel upon which the Fukui's cassettes (e.g., modules 10, 20) are arranged. EX1004, 8:30-32 ("The plurality of conversion modules 10 are arranged on the bottom panel 30e inside the base member 30 along an X direction (first direction)."). Fukui's bottom panel has twelve areas (32) for arranging Fukui's modules. 8:45-51.

Fig.9



EX1004, Fig. 9. Figure 8 shows the modules (10) arranged on these areas:

Fig.8



EX1004, Fig. 8.

46. Fukui's modules (e.g., 10 and 20) are examples of "fiber optic cassettes" as recited in the preamble and claim. Figures 1 and 4 illustrate Fukui's module 10:

Fig.1

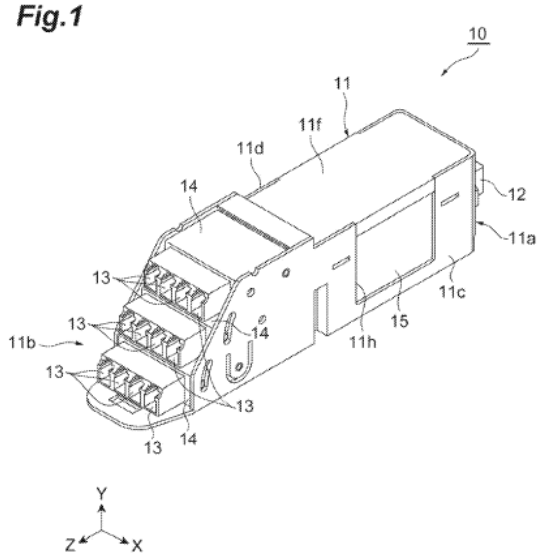
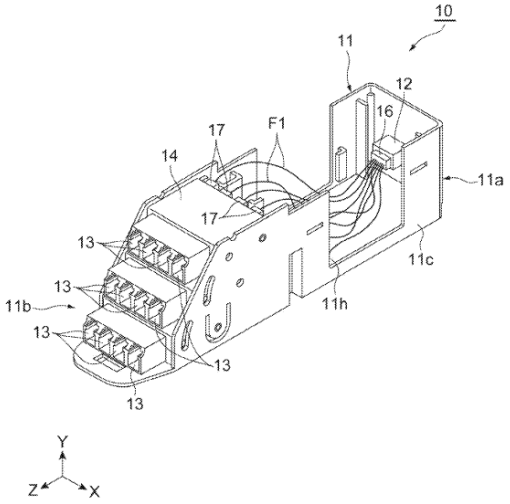


Fig.4



Like the cassettes in the challenged patents, Fukui's modules have LC adapters (13) on the front and an MPO[1] adapter (12) on the rear. EX1004, 5:12-42. Thus, the user of the system can plug a multi-fiber fiber optic cable into the rear and individual fiber cables into the front. Figure 8 shows a multi-core fiber optic cable (F2) going into the rear of each module:

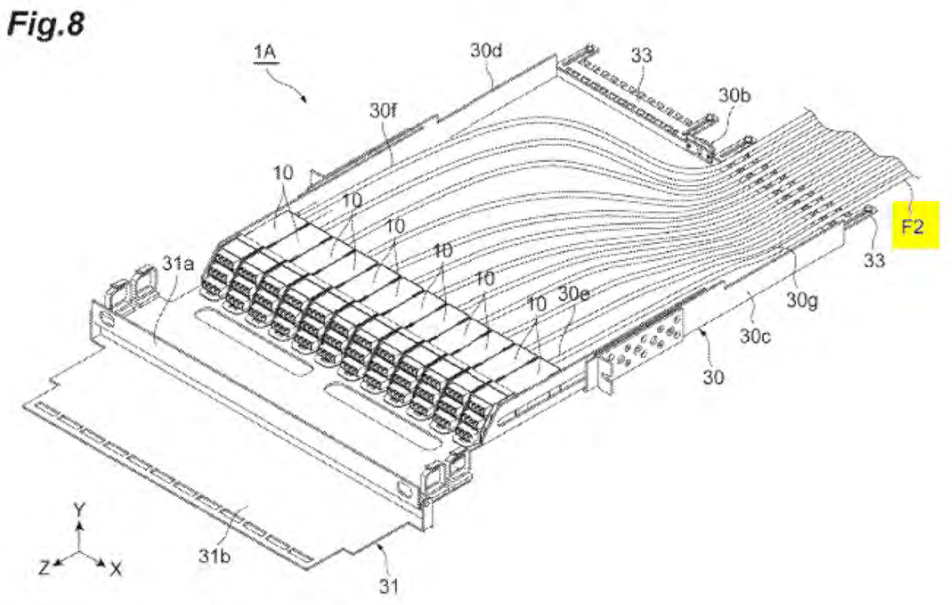
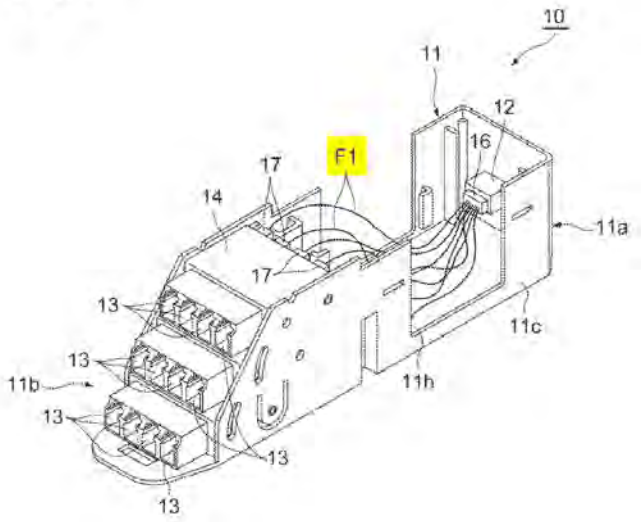


Figure 4 shows individual "optical fibers" (F1) going into the front of the module (where an LC connector would connect to the fiber):

[1] MPO refers to a **m**ulti-fiber **p**ush **o**n connector.

Fig.4

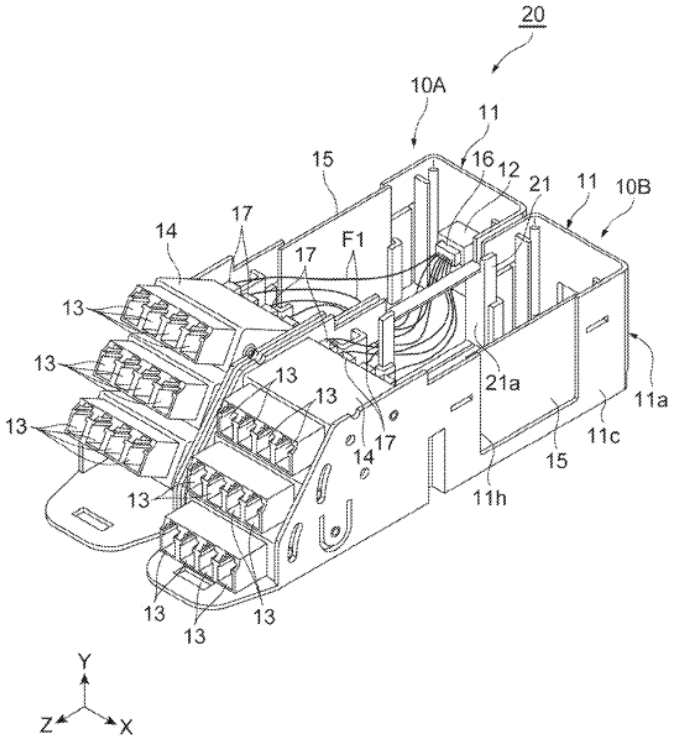


EX1004, 6:42-48.

47. Fukui's module 10 is a "conversion" module because it converts from multi-core connector in the rear (e.g., MPO connector) to single core connectors in the front (e.g., LC connectors). The "core" here refers to a fiber. A fiber optic cable can have either one fiber (core) or multiple fibers (cores). Here is an example of how the module is used. The user connects a large capacity fiber optic cable with 12 cores (fibers) to the back of the module by plugging the MPO connector on the end of the cable into the MPO adapter on the back of the module 10. Each of the twelve fibers is broken out inside the module and is connected to a separate LC adapter on the front of the module. The user can then connect twelve different smaller capacity fiber optic cables each with one core (fiber) to the front of the module by plugging the LC connectors on the end of the cable into the LC adapter on the front of the module.

48. Fukui discloses that the modules can have different sizes. For example, Fukui teaches that two modules 10 can be coupled together to form module 20 (i.e., a double size):

Fig.5



EX1004, Fig. 5, 7:23-67. Like module 10, module 20 has an MPO adapter (12) in the rear and LC adapters (13) in the front. *Id.* Module 20 accommodates double the cores/fibers, i.e., it accepts an MPO connector in the rear with 24 cores/fibers and accepts 24 LC connectors in the front. EX1004, 7:65-67 ("24 cores").

49. Fukui also discloses larger sizes of modules. Fukui broadly teaches there can be a "plurality of coupled unit modules," i.e., two or more modules 10 can be coupled together. EX1004, 8:2-3 ("plurality of coupled unit modules"),

7:18 ("a plurality thereof coupled to each other"). When more than two modules 10 are coupled together, larger sizes result. Fukui explains that one module 10 supports 12 cores and two coupled modules 20 support 24 cores. Fukui teaches you can continue this expansion further based on the "number of coupled unit modules" and gives the further examples of expanding to 36 and 48 cores:

> In other words, in this example, the number of cores of the multi-core optical connector 16 can be expanded to 24 cores. Further, the expansion can be easily made by the number of the coupled unit modules such as 36 cores and 48 cores. Additionally, a plurality of coupled unit modules can be dealt with as one body. For this reason, in the expansion, it is not necessary to prepare different shape unit modules, so long as the required number of the same shape unit modules are prepared.

EX1004, 7:65-8:6. "36 cores" is the result of coupling three of the 12 core modules together into one triple module (i.e., "the number of coupled unit modules" is three). "48 cores" is the result of coupling four of the 12 core modules together into one quadruple module (i.e., "the number of coupled unit modules" is four). Thus, Fukui teaches to have a single (12 core), a double (24 core), a triple (36 core), and a quadruple (48 core) size module.

"…for providing a plurality of different modular fiber optic cassette configurations …"

50. Fukui's tray is for providing a plurality of different modular fiber optic cassette configurations. Fukui provides for different numbers and

combinations of modules such as (1) "up to" twelve of the single modules 10, (2) "up to" six of the double modules 20, or (3) combinations of modules 10 and 20:

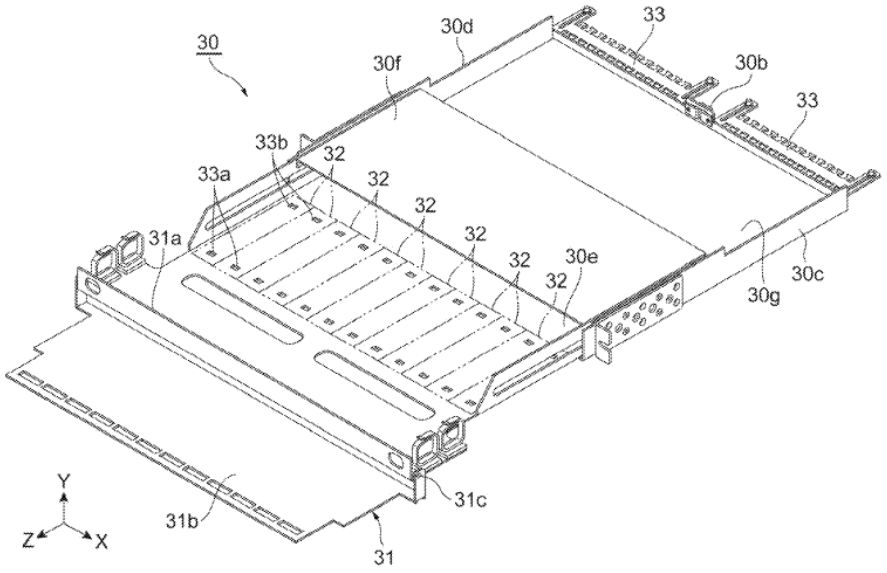
> For example, in the case of the conversion module 10, up to 1 tier×12 rows of the modules 10, that is, 144 single-core optical connector adapters 13 in total are housed in 1U size. Alternatively, in the case of the conversion module 20 coupling two unit modules, up to 1 tier×6 rows of the modules 20, that is, 144 single-core optical connector adapters 13 in total are housed. Of course, the conversion modules 10 and 20 may be present together in combination.

EX1004, 9:35-53. Fukui also allows for larger sizes of modules:

> Further, the expansion can be easily made by the number of the coupled unit modules such as 36 cores and 48 cores. Additionally, a plurality of coupled unit modules can be dealt with as one body. For this reason, in the expansion, it is not necessary to prepare different shape unit modules, so long as the required number of the same shape unit modules are prepared.

EX1004, 7:67-8:6. Fukui's trays (element 30e) has twelve areas (32) for placing the modules (e.g., 10 or 20):

Fig.9



EX1004, Fig. 9, 8:45-56. A POSITA understands that Fukui's larger sizes modules would simply occupy the number of areas (32) that correspond to the number of coupled modules (e.g., a larger 36 core module comprising three coupled unit modules 10 would occupy three areas 32, a larger 48 core modules comprising four coupled modules 10 would occupy four area 32, etc.)

"…in a standard U-space fiber optic management system"

51. Fukui's tray provides the configurations in in a standard U-space fiber optic management system/

52. Fukui expressly teaches that its disclosure applies to a "19-inch rack standardized by the Electronic Industries Alliance (IA) in 1U size." EX1004, 9:32-33. A "standardized…1U size" refers to a "a standard U-space" as recited in the preamble.

53. EIA standardized the rack size in the EIA-310 standard. 19 inch is the width. "U" or "RU" refers to the height:

4.2 Terms for Cabinets and Racks
"**n**"—"n" is equal to the number of modular units to be used in determining various dimensions. It is generally used with the value "U."

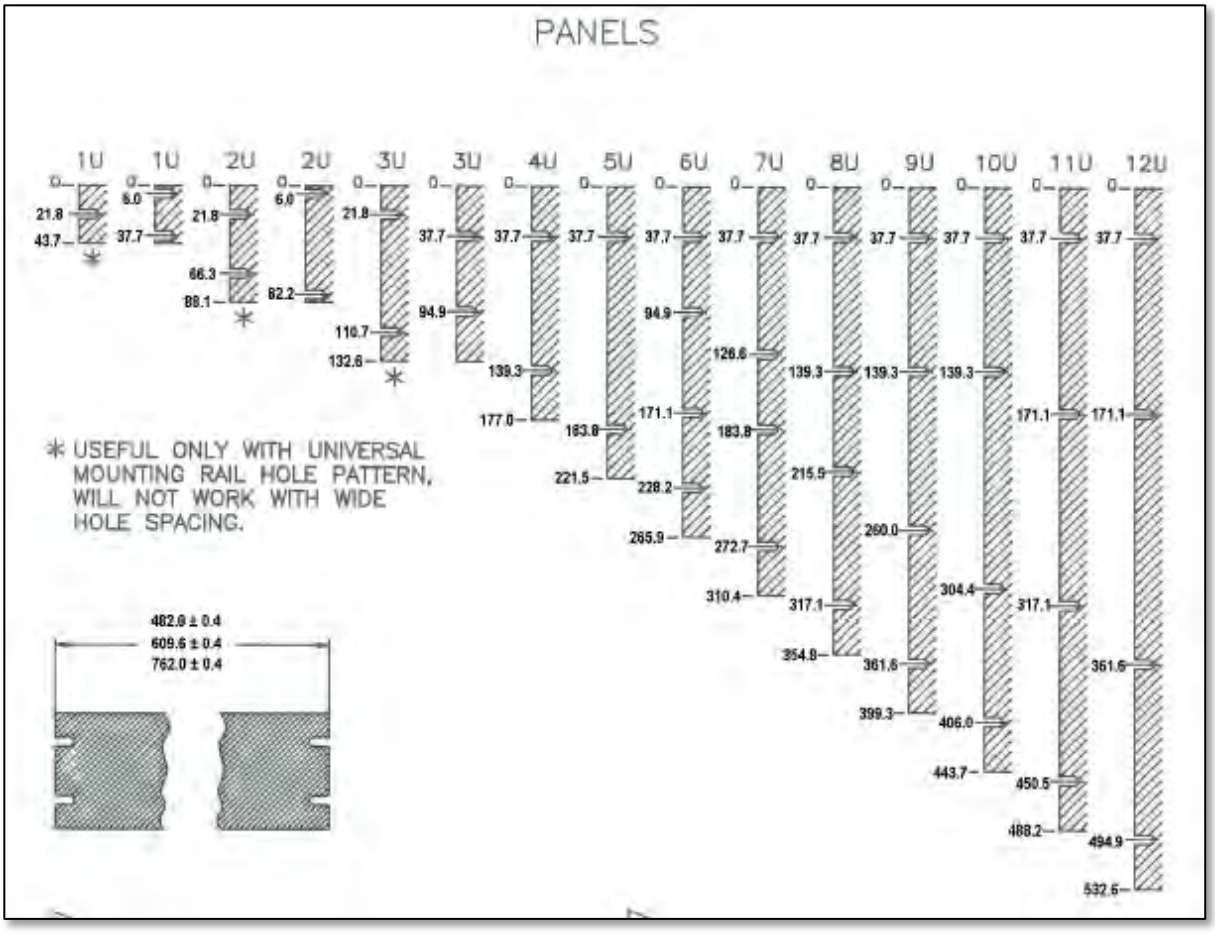
"**U**"—The modular unit "U" on which panel heights are based is equal to 44.45 millimeters.

4.3 Cabinets and Racks

4.3.1 Cabinet
A cabinet shall be standard when it conforms to the dimensional requirements shown in Figure 1 and Figure 3.

4.3.2 Rack
A rack shall be standard when it conforms to the dimensional requirements shown in Figure 2 and Figure 3.

EX1008 at 2. 1U is the base size (see left):



EX1008 at 5.

54. Fukui tray (bottom panel 30e) is part of a fiber optic management system. Fukui shows its fiber optic management system containing the tray in Figures 6-7, for example:

Fig.6

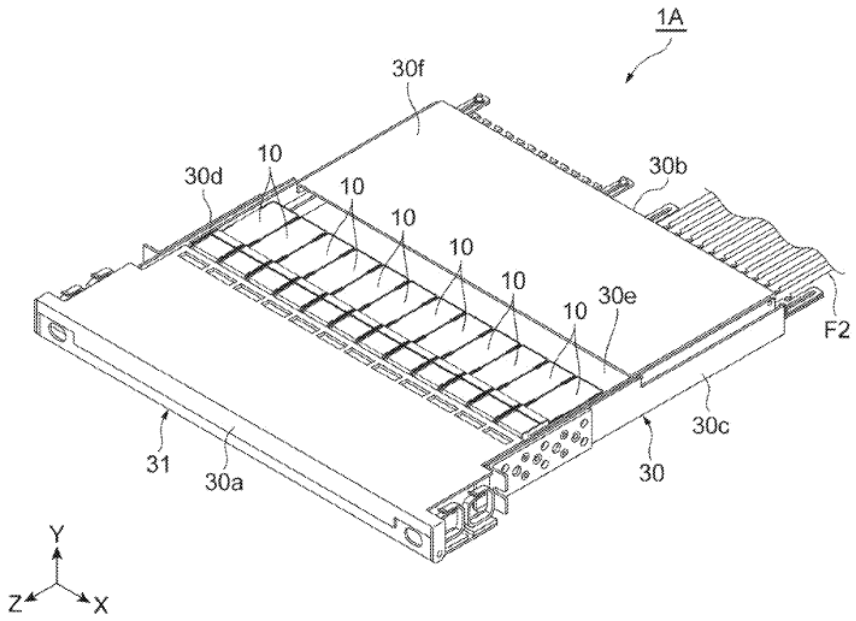
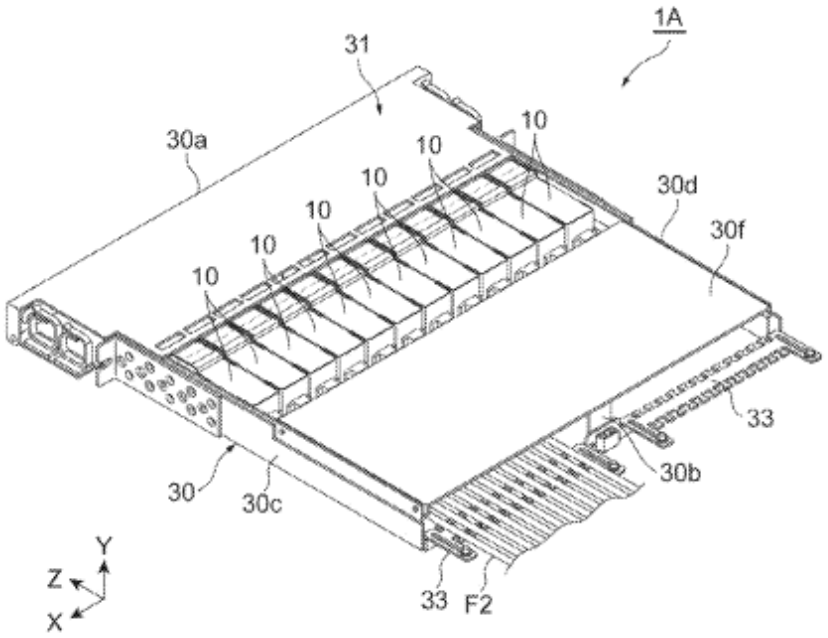


Fig.7

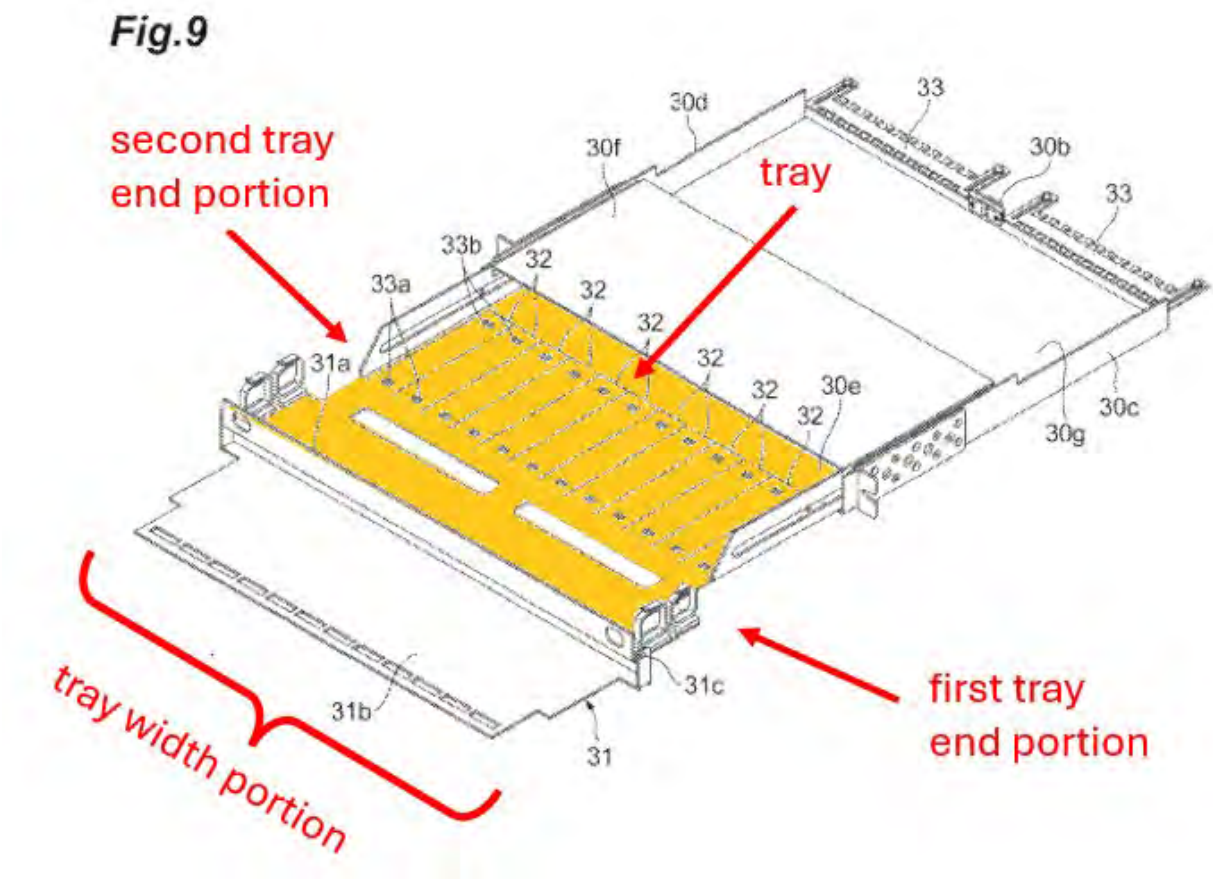


Fukui system (30) manages the connections between the cables (F2) in the rear and the fiber optic connectors that are plugged into the front of Fukui's modules. Fukui also manages supporting cables with "various" numbers of cores (e.g., 12, 24, 36, and 48) by coupling different numbers of unit modules 10 together to form larger modules to support the "various number" of cores as needed. EX1004, 3:27-28, 4:2-3, 4:42-43, 9:58-59, 10:4-6, 10:34-35.

2. Element 1A

55. Element 1A recites: "a tray having a first tray side end portion and a second tray side end portion defining a tray width portion that extends between the first tray side end portion and the second tray side end portion." Fukui discloses this element.

56. The analysis, above, for the preamble explains that Fukui's bottom panel (element 30e) is an example of the recited "tray." Figure 8 shows Fukui's tray (element 30e) has the claimed features. Here is an annotation showing this:



EX1004, Fig. 8, 8:30-32, 8:45-51. Figure 9 also shows Fukui's tray (element 30e) has the claimed features. See EX1004, Fig. 9.

3. Element 1B

57. Element 1B recites: "wherein the tray width portion fits within a standard U-space width dimension." Fukui discloses this.

58. I understand the parties stipulated to the following agreed construction in the litigation regarding the EIA standard:

Term	Stipulated construction
a standard U-space width dimension	a width dimension defined in the EIA/ECA-310-E standard

59. Fukui expressly refers to the "EIA" standard. Fukui teaches that its system (including the tray) is for a "19-inch rack standardized by the Electronic Industries Alliance (EIA) in 1U size." EX1004, 9:32-33. Fukui does not identify the standard by number but instead refers to the "19-inch rack" and the "1U" size standardized by the EIA.

60. A POSITA knows that the "19-inch rack" and 1U size standardized by the EIA as stated in Fukui refers to the EIA/ECA-310-E standard recited in the agreed construction because that is the standard that defines these features. The EIA/ECA-310-E standard defines standardized dimensions and features for three different widths of racks and panels:

4 Soft Metric Conversion of EIA-STD-310-C (Formerly Titled EIA-STD-310-C)
This section of EIA-310-E establishes those dimensions which are soft metric conversions of superseded EIA-310-C, and these dimensions are in millimeters. These dimensions are critical in ensuring compatibility between Cabinets or Racks and Panels, and the equipment or apparatus installed thereon. The figures contained in EIA-310-E shall not be construed to be standards for construction details.

4.1 Classification
EIA-310-C identified three cabinet or rack openings to accommodate each of three standard panel widths 482.6 mm, 609.6 mm and 762.0 mm. The preferred panel width is 482.6 mm.

EX1008, 10. The first size—482.6 mm—is 19 inches (as recited in Fukui). The second and third sizes—609.6 mm and 762.0 mm—are options for larger sizes (24 inches and 30 inches). The three widths are referred to as 19 inch, 24 inch and 30

inch racks. Version "E" of the standard was written to convert these dimensions from imperial inches into metric millimeters. EX1008, 9-10. The EIA/ECA-310-E standard further defines the "1U" size recited in Fukui. The EIA/ECA-310-E defines the generic terms "U" and numbers "n" of the U size:

4 Soft Metric Conversion of EIA-STD-310-C (Formerly Titled EIA-STD-310-C)
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"n"—"n" is equal to the number of modular units to be used in determining various dimensions. It is generally used with the value "U."

"U"—The modular unit "U" on which panel heights are based is equal to 44.45 millimeters.

4.3 Cabinets and Racks

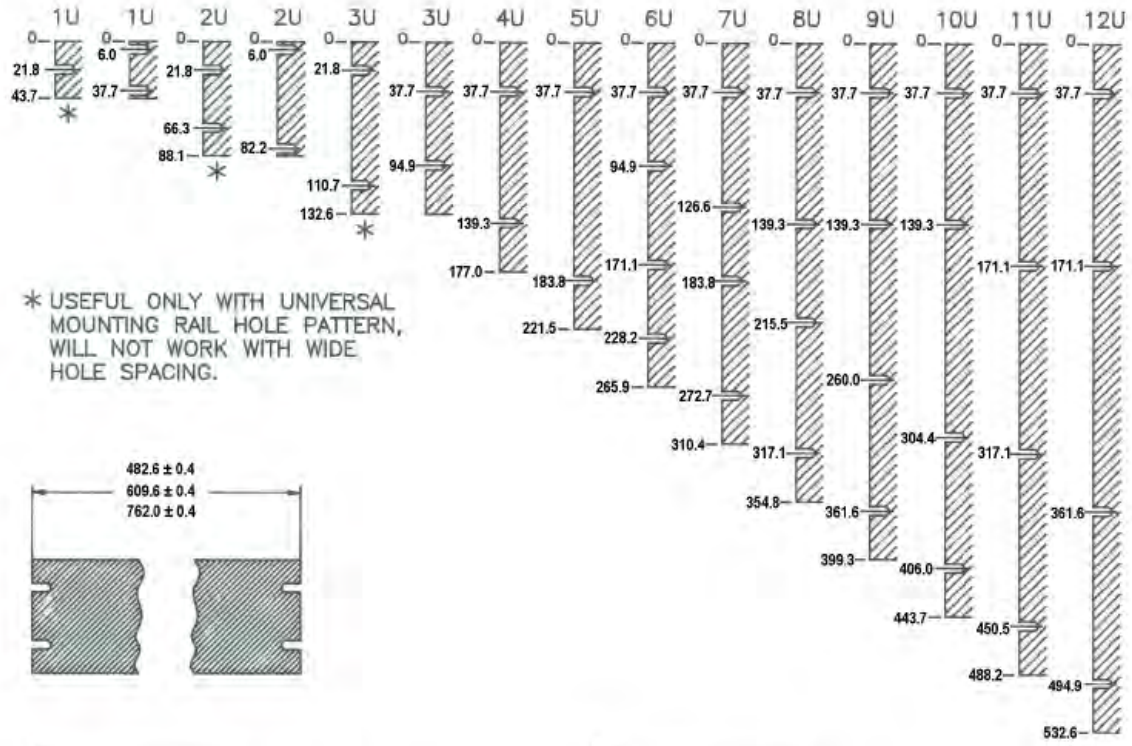
4.3.1 Cabinet
A cabinet shall be standard when it conforms to the dimensional requirements shown in Figure 1 and Figure 3.

4.3.2 Rack
A rack shall be standard when it conforms to the dimensional requirements shown in Figure 2 and Figure 3.

The standard then defines the different numbers, including 1U, 2U, 3U, etc..

EIA-310-E

PANELS



NOTES

1. PANEL THICKNESS AND NUMBER OF SLOTS MAY VARY WITH DESIGN REQUIREMENTS.
2. UNTOLERANCED DIMENSIONS TO BE ±0.4 AT MAX. MATERIAL CONDITION.
3. BOTH OPEN SLOTS AND CLOSED SLOTS AS SHOWN ABOVE ARE STANDARD.
4. PANEL HEIGHT = (n X U) − 0.8

61. Thus, a POSITA would understand that the width of Fukui's tray fits within a width dimension defined by EIA/ECA-310-E standard as recited in the

agreed construction. Because Fukui teaches that the system is for the rack size standardized by the EIA standard, the applicable components must comply with the EIA standard, including the width dimension for the tray. If the width of Fukui's tray did not comply, the system would not comply with the EIA standard. Fukui teaches the system does comply; therefore, the dimensions of the components comply with the EIA standard.

62. Specifically, a POSITA would understand the width of Fukui tray fits within the 450 mm width dimension defined in the EIA/ECA-310-E standard because that is the width dimension that corresponds to the rack opening for a 19-inch rack through which the tray can be inserted into the rack. The EIA/ECA-310-E standard defines the widths of the rack opening for each of the applicable rack sizes. EX1008, 12 (see Figure 3). 450 mm is the width of the rack opening for the 482.6 mm (19 inch) rack, 577 mm is the width of the rack opening for the 609.6 mm (24 inch) rack, and 730 mm is the width of the rack opening for the 762.0 mm (30 inch) rack. For a tray to fit within a width dimension from this standard, the tray must fit within one of these three width dimensions. As applied to Fukui, the width of Fukui's tray must fit within 450 mm to comply with the EIA standard for 19-inch racks, which Fukui expressly says it does comply with this. Thus, a POSITA would understand the width of Fukui tray fits within the 450 mm width defined in the EIA standard.

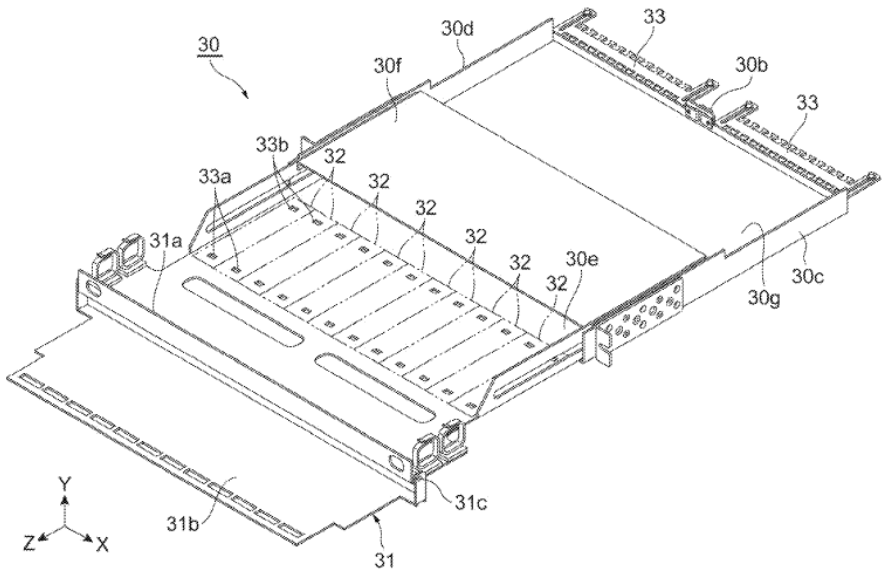
63. I note that Fukui's disclosure is the same as Patent Owner's preferred embodiment. The preferred embodiment for the '422 patent is for a "19″ rack," i.e., the tray fits within a 19 inch rack. EX1001, 7:60-61. Fukui, as quoted above, is also for a 19 inch rack.

4. Element 1C

64. Element 1C recites: "wherein the tray is configured to fit a plurality of different modular fiber optic cassette configurations in the tray width portion in a standard U-space fiber management system."

65. Fukui discloses this element. Fukui discloses tray is configured with twelve areas (32) for placing modules:

Fig.9



These twelve areas support a plurality of different modular fiber optic cassette configurations such as (1) "up to" twelve of the single modules 10, (2) "up to" six of the double modules 20, or (3) combinations of modules 10 and 20:

> For example, in the case of the conversion module 10, up to 1 tier×12 rows of the modules 10, that is, 144 single-core optical connector adapters 13 in total are housed in 1U size. Alternatively, in the case of the conversion module 20 coupling two unit modules, up to 1 tier×6 rows of the modules 20, that is, 144 single-core optical connector adapters 13 in total are housed. Of course, the conversion modules 10 and 20 may be present together in combination.

EX1004, 9:35-53. Figure 8 shows, for example, twelve modules 10 arranged in the areas 32, and Fukui's text explains that alternatively "a part or all" of the modules in the figures may modules 10A and 10B defining the larger module 20, including at least one of each module 10 and 20. EX1004, 8:17-24. A POSITA understands that Fukui's tray also support configurations with the larger sizes modules (e.g., the 36 core and 48 core unit modules). Fukui's larger modules are based on the "same" unit module 10; thus, Fukui's larger modules fit in the same areas 32. The larger sized modules simply occupy the number of areas (32) that correspond to the number of coupled modules (e.g., a larger 36 core module comprising three coupled unit modules 10 would occupy three areas 32, a larger 48 core modules comprising four coupled modules 10 would occupy four area 32, etc.). Fukui's larger modules comprise the same modules 10.

5. Element 1D

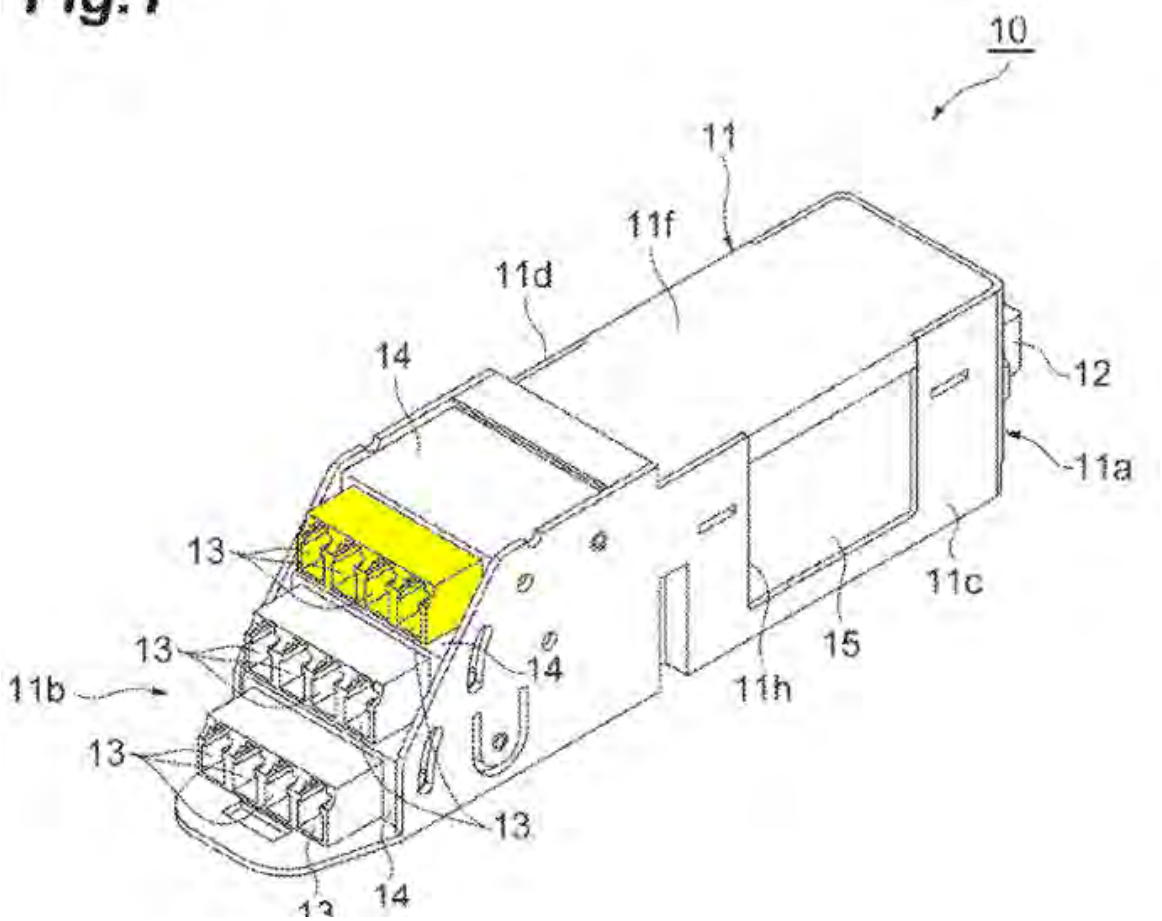
66. Element 1D recites: "wherein each of the plurality of different modular fiber optic cassette configurations include a modular fiber optic cassette that is configured to support a receptable module having a first module side end portion and a second module side end portion defining a module width portion that extends between the first tray side end portion and second tray side end portion." Fukui discloses this element.

67. Each of Fukui's configuration include a number of modules 10 (singly or coupled together). Module 10 is a modular fiber optic cassette. It is modular because it can be placed in any of the twelve areas and can be used to create larger modules by coupling the modules together. Module 10 is a fiber optic cassette. Like the cassettes in the challenged patents, Fukui's modules have LC adapters (13) on the front and an MPO[2] adapter (12) on the rear for fiber optic cables. EX1004, 5:12-42, Figs. 1-5. Like the cassettes in the challenged patents, Fukui's modules have flat bottom that can be arranged on Fukui's tray. EX1004, Figs. 1-5.

68. Module 10 (singly or coupled together). is configured to support a receptable module. Figure 1 show Fukui's module 10 is configured to support a quad LC receptacle module (yellow):

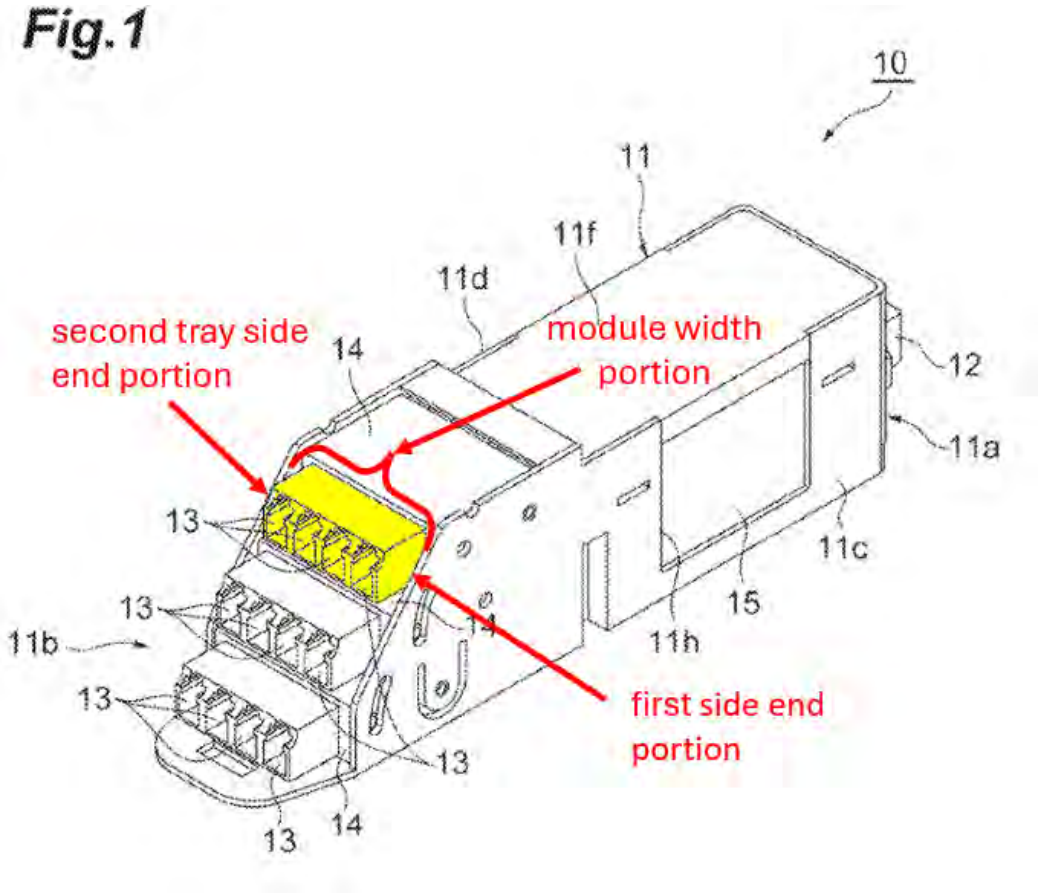
[2] MPO refers to a **m**ulti-fiber **p**ush **o**n connector.

Fig.1



EX1004, Figs. 4, 5:24-42. Numerals 13 are "single-core optical connectors adapters" for an "LC connector." EX1004, 5:24-27. Fukui teaches that the four adapters in each row are "made into one body," i.e., a quad LC adapter like PO's preferred embodiment. EX1004, 5:34-36. Fukui's "one body" (yellow) is the receptacle module. Fukui teaches that module 10 can "two or more" tiers. EX1004, 10:44-44. Figure 1 shows three tiers, i.e., three quad LC receptacle modules stacked on top of each other. Any of these three quad LC receptacle modules meets the claim.

69. Fukui receptacle module (the "one body" of four LC adapters) has the recited first module side end portion and a second module side end portion defining a module width portion that extends between the first tray side end portion and second tray side end portion:



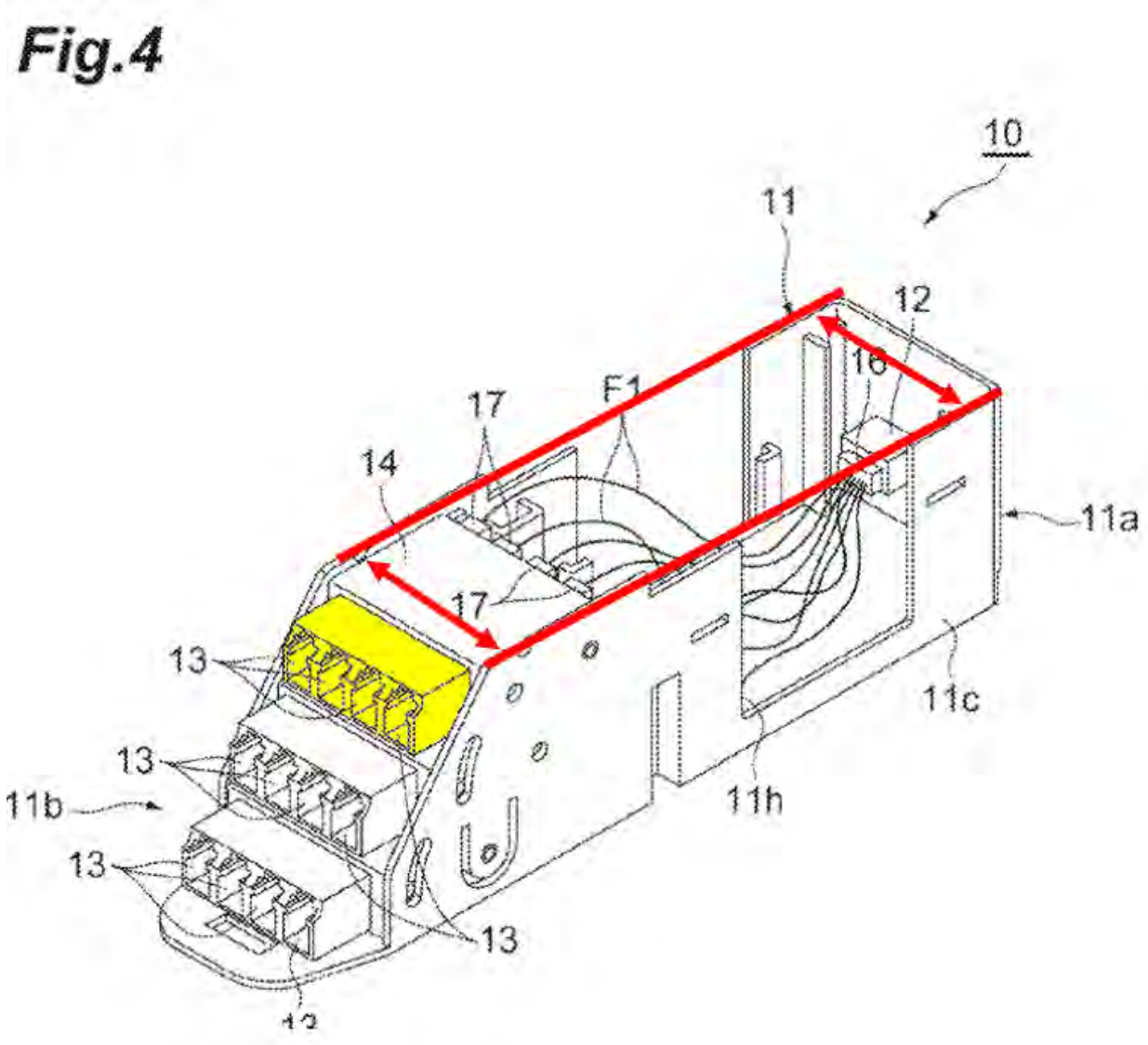
EX1004, Fig. 1.

70. INTENTIONALLY LEFT BLANK.

6. Element 1E

71. Element 1E recites: "wherein the module width portion is configured to fit in a standard one width (1 W) unit." Fukui discloses this.

72. The width of Fukui receptacle module (yellow) is configured to fit within one module 10 (red arrows), which is Fukui's one standard width unit:



73. The width of one module constitutes a one width (1 W) "unit." Module 10 is the "unit" for all of Fukui's modules. For example, Fukui's double module 20 comprises a first "unit" 10A and second "unit" 10B coupled together. EX1004, 7:26-27. Units 10A and 10B are the "same" as module 10. EX1004,

7:28-29, 8:3-6. Fukui explains that the modules can expand to larger sizes based on "the number" of coupled "unit modules." EX1004, 7:67-8:1. The width of module 10 is also the unit of width for tray, which has twelve evenly spaced areas for the modules 10:

Fig.9

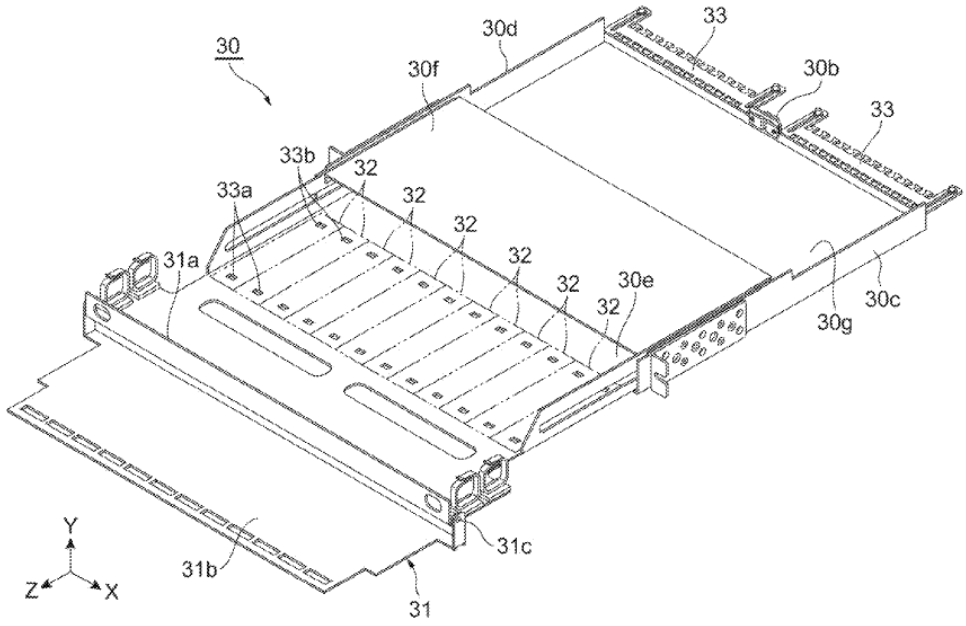
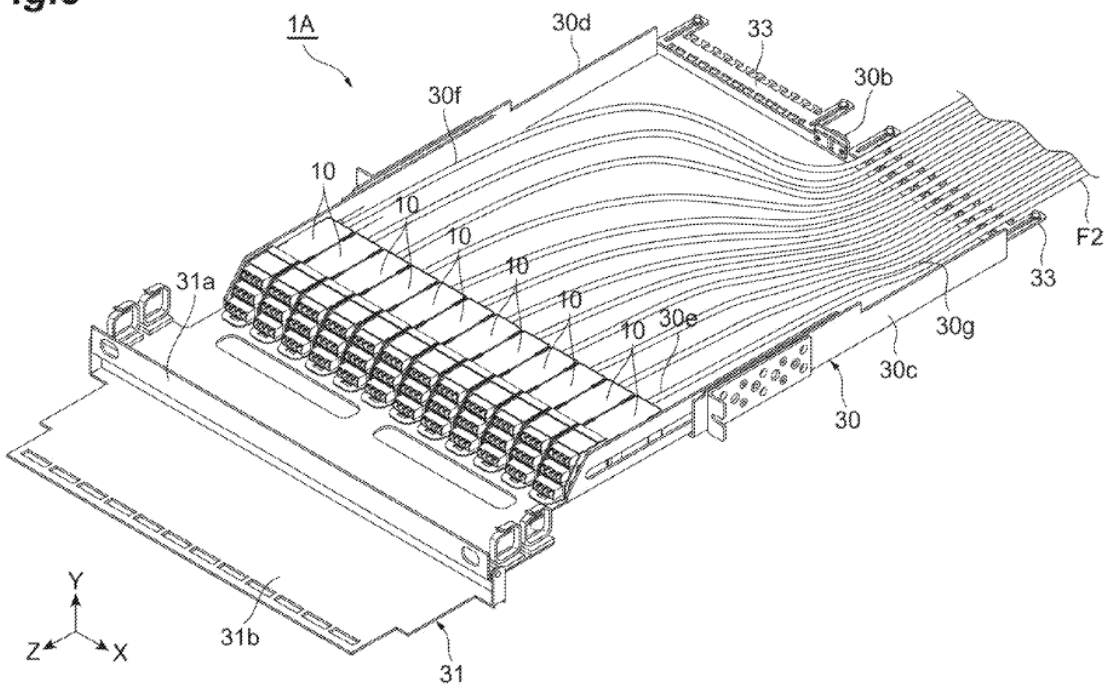


Fig.8



The width of Fukui's module 10 is a "standard" width unit because it is common for all of Fukui's modules and the tray and based on an actual width standardized in the industry. Figure 1, above, shows the width of Fukui's correspond to one LC quad adapter. The width of the LC quad adapter is standardized in the industry. See EX1009. For example, the International Electrotechnical Commission (IEC) published an international standard IEC 61754-20. Id. IEC 61754-20 specifies width dimensions for an LC quad adapter. For example, IEC 61754-20 specifies a width dimension of 25.6 mm – 25.9 mm:

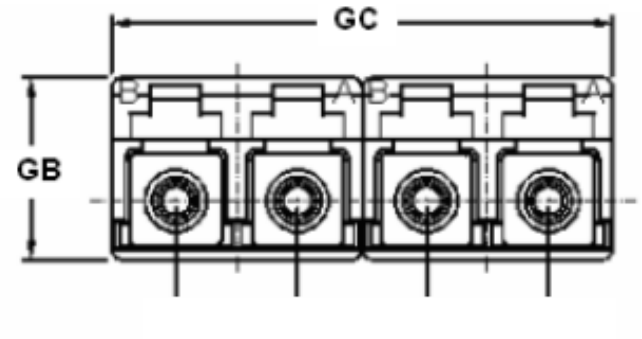


Table A.4 – Dimensions for quad rectangular flange adaptor

Ref.	Dimensions in millimeters		Remarks
	Min.	Max.	
GB	9,35	9,45	
GC	25,6	25,9	
GD	26,0	26,5	
GE	9,5	10,0	
GG	30,6	30,8	
GP	2,39	2,59	Holes optional

NOTE 1 Dimensions same as duplex rectangular flange adaptors (A.3) except as noted. Flange not shown.

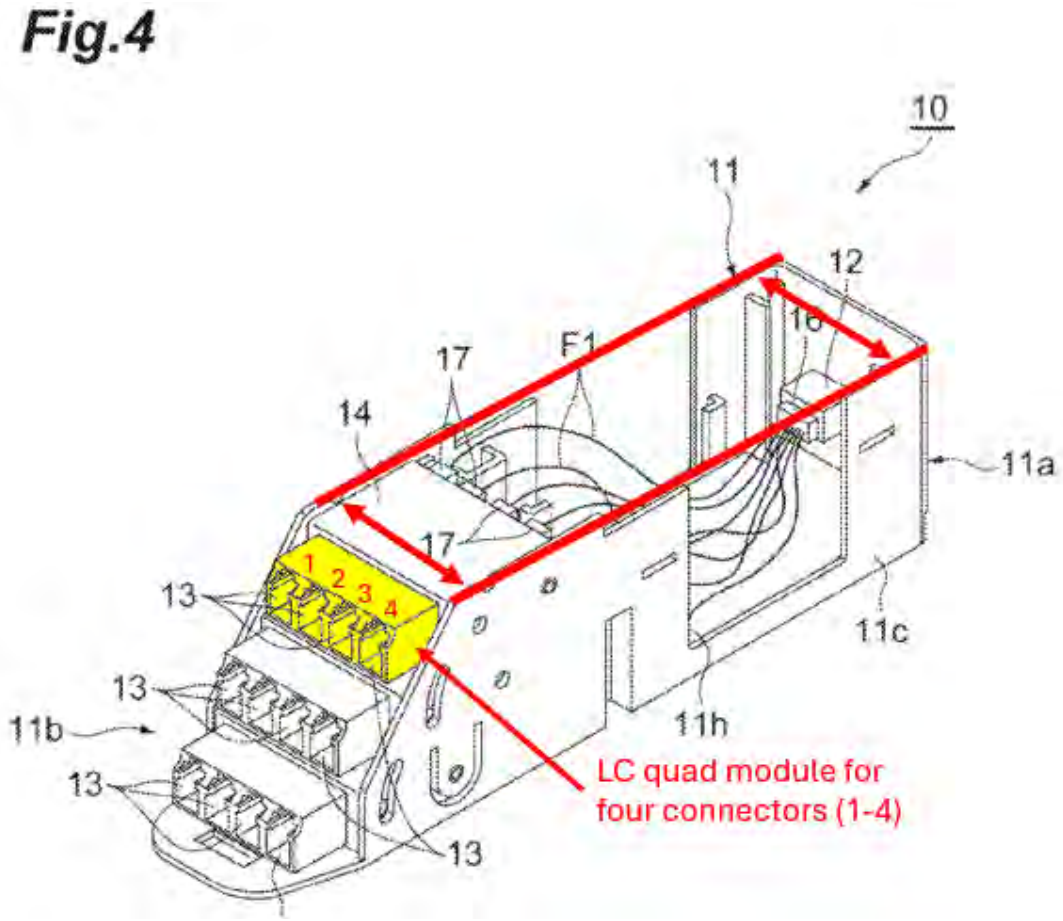
NOTE 2 Panel cutout: panel thickness should be between 1,0 and 1,5 mm.

EX1009 at 25. Thus, a POSITA would recognize that the width of Fukui module 10 is based on an actual width that is standardized in the industry (the width of an LC quad connector). Fukui modules, of course, includes walls around the LC quad adapter, which is standard in the industry.[3] Fukui, thus, closely conformed the width of its module to the actual standardized width of the LC quad adapter.

74. Fukui's disclosure meets both proposed constructions in the co-pending litigation.

[3] Fukui did not enlarge the standardized width to include further, separate functionality from the LC quad adapter.

75. *PO's construction*. PO proposes that a standard one width (1 W) unit is a unit of width that "accommodates a single receptacle module." EX1011, 8. PO also proposes that a specific example of this is a unit of width that accommodates a single "LC quad" module for four connectors. EX1011, 8. The width of Fukui's module 10 meets both PO's construction and the specific example in PO's construction. The width of module 10 accommodates a single receptacle module (yellow) that is LC quad module for four connectors:



Fukui explains that numerals 13 are adapters for LC connectors and the set of four adapters is made "made into one body", i.e., one receptacle module. 1004, 5:34-

36. If PO argues the height of Fukui's modules accommodates additional receptacles, that does not distinguish Fukui because the claim and PO's own construction states a limitation about the width, not the height. The specification also shows that the standard width unit is a *width* dimension, not a height dimension:

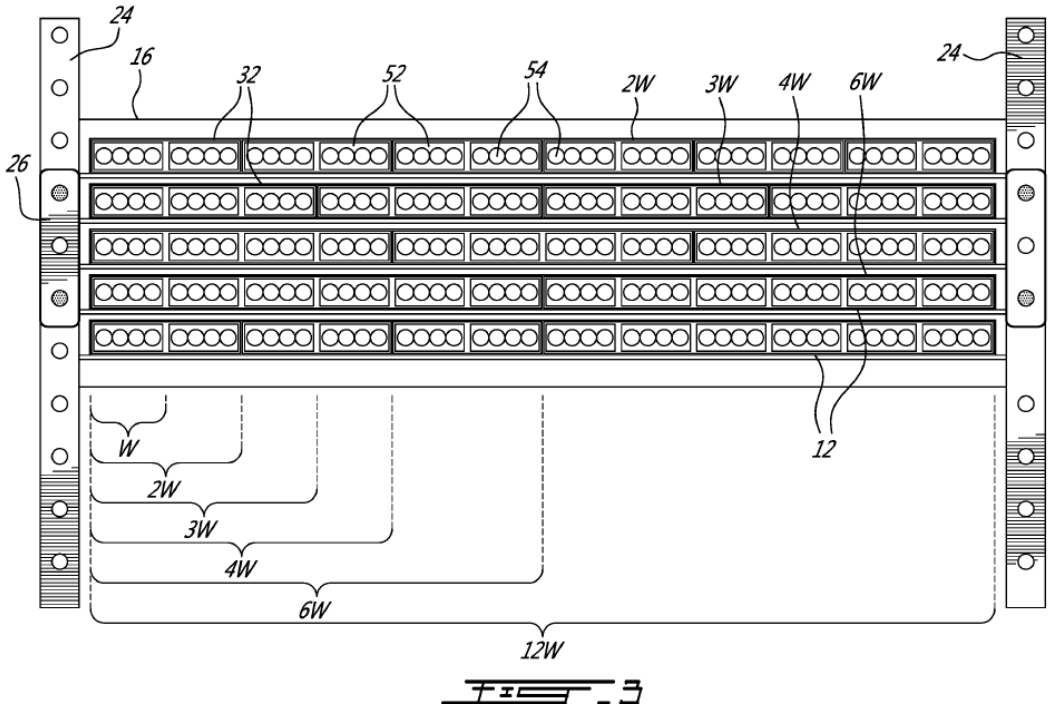


FIG. 3

EX1001 at Fig. 3.

76. *CommScope's construction*. The width of module 10 also conforms to an actual width that is standardized in the industry. The width of Fukui's corresponds to one LC quad adapter, and as explained above, the width of the LC quad adapter is an actual width that is standardized in the industry.

7. Element 1F

77. Element 1F recites: "wherein each of the modular fiber optic cassettes includes a first cassette side end portion and a second cassette side end portion defining a standard cassette width unit extending between the first cassette side end portion and the second cassette side end portion that comprises a standard two width (2 W) unit, a standard three width (3 W) unit, a standard four width (4 W) unit, or a standard a standard six width (6 W) unit relative to the standard one width (1 W) unit." Fukui discloses this.

78. Fukui discloses or renders obvious all of these sizes.

a standard two width (2 W) unit

79. Fukui's module 20 comprises a "first" and "second" module together, i.e., two modules 10. Comparing Figure 5 and 4 shows that Module 20 comprises two standard width units relative to the standard one width unit module 10. Module 10 supports 12 cores. By coupling two modules together, Fukui explains the module can be expanded to support 24 cores. EX1004, 7:65-67

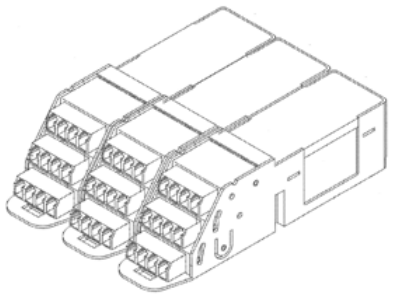
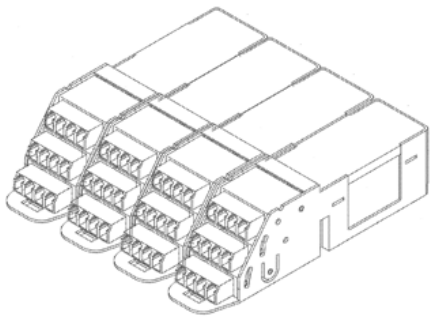
a standard three width (3 W) unit and a standard four width (4 W) unit

80. After disclosing to expand to 24 cores by coupling two modules, Fukui teaches to expand further to support larger sizes "such as" 36 cores and 48 cores according to "the number of coupled unit modules." EX1004, 7:67-8:3.

81. The "number" of coupled unit module to support 36 cores is three, i.e., a triple module that comprises three standard width units. A POSITA knows this because each unit module supports 12 cores; thus, supporting 36 cores requires 3 x 12 cores = 36 cores. Fukui discloses to treat the plurality of coupled units as "one body," i.e., one cassette. EX1004, 8:2-3. Thus, Fukui's 36 core unit is three width (3W) unit relative to Fukui's one width (1W) unit 10.

82. The "number" of coupled unit modules to support 48 cores is four, i.e., a quadruple module that comprises four standard width units. A POSITA knows this because each unit module supports 12 cores; thus, supporting 48 cores requires 4 x 12 cores = 48 cores. Fukui discloses to treat the plurality of coupled units as "one body," i.e., one cassette. EX1004, 8:2-3. Thus, Fukui's 48 core unit is four width (4W) unit relative to Fukui's one width (1W) unit 10.

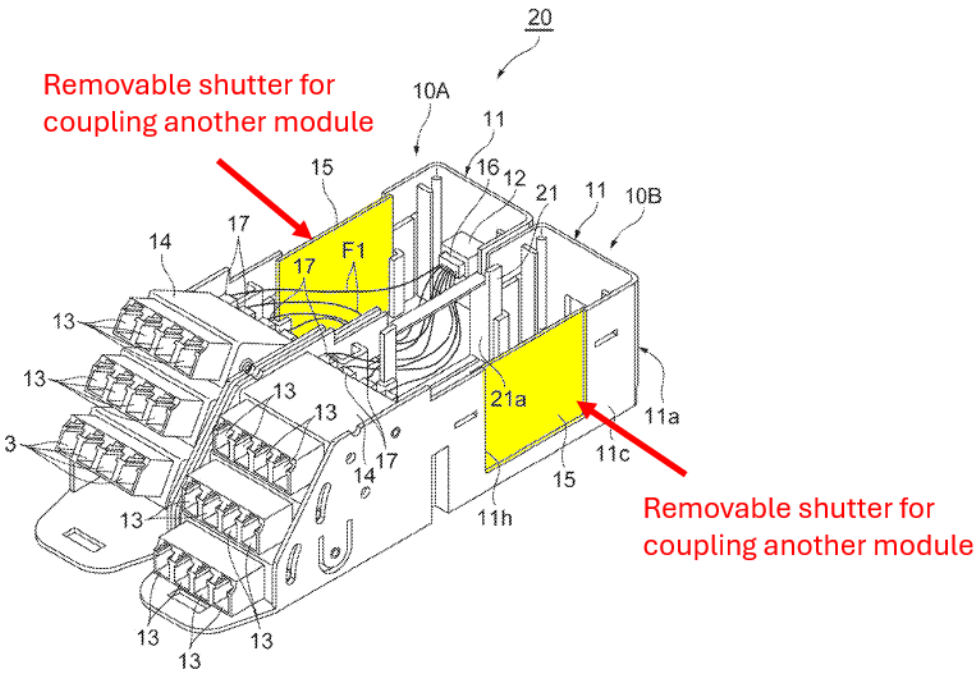
83. A POSA understands that Fukui's 36 core and 48 core unit modules look like this:

Triple (36 core) module	**Quadruple (48 core) module**
	

As shown, the 36 core and 48 core modules are three and four standard with units compared to the standard one width module 10.

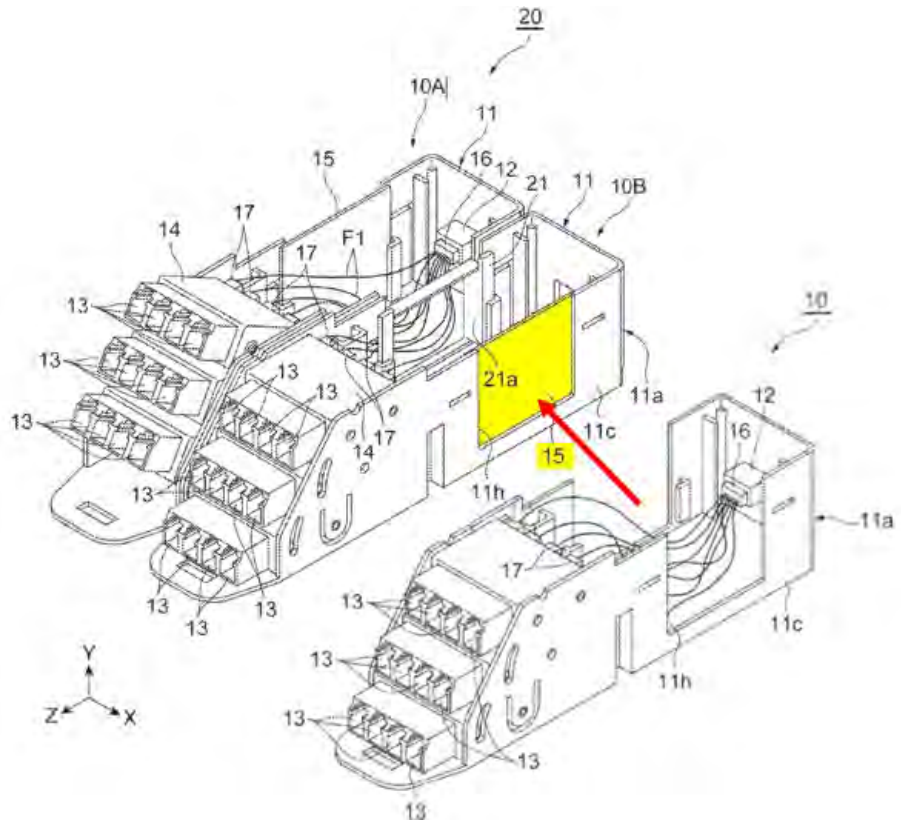
84. Figure 5 of Fukui shows the removable shutter to expand the two coupled unit modules (20) supporting 24 cores to the larger three coupled unit modules supporting 36 cores and larger four coupled units modules support 48 cores:

Fig.5



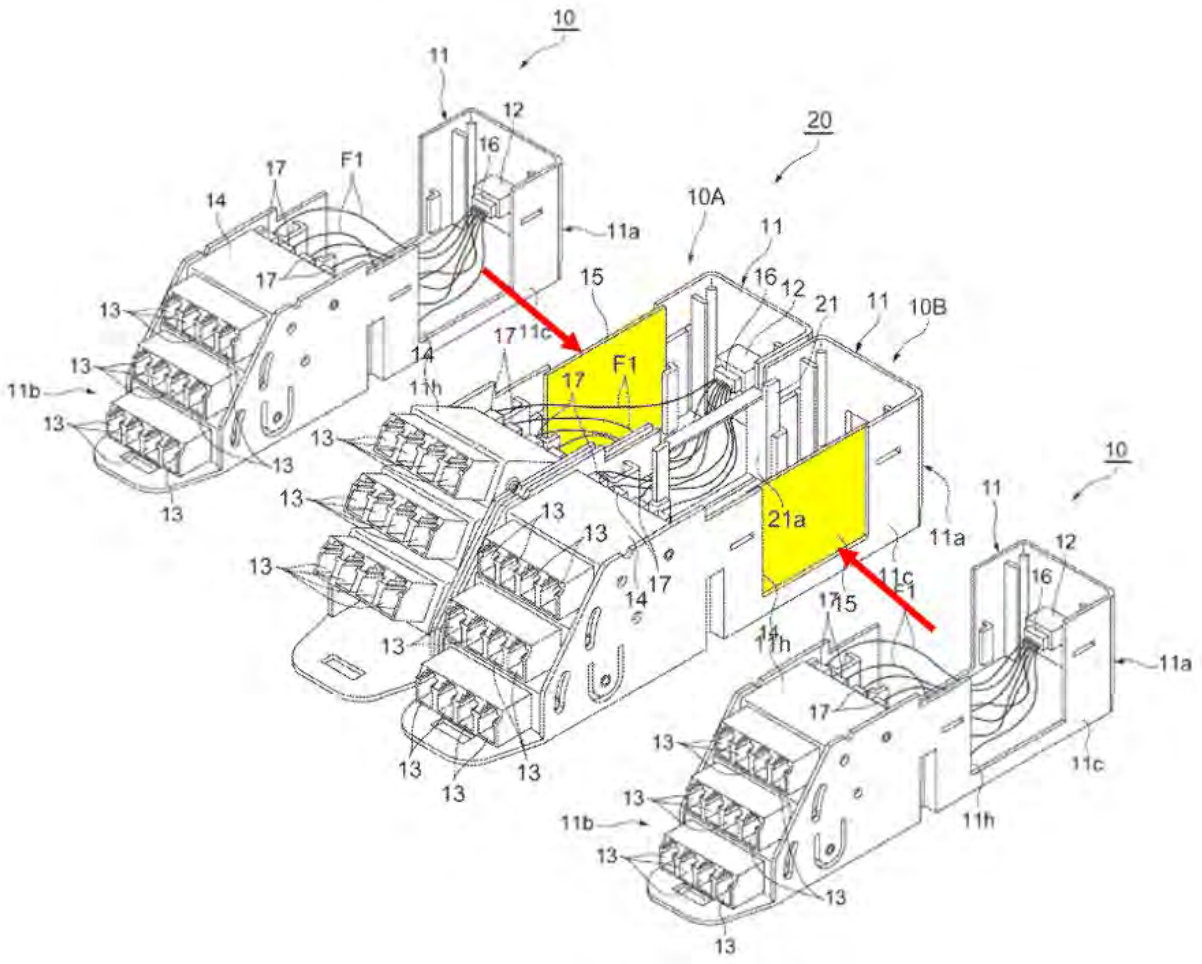
The two coupled modules include additional removeable shutters (15) on each side to couple either one more unit and form a triple module supporting 36 cores or coupled two more units to form a quadruple module supporting 48 cores.

85. Here is a visual of coupling a third unit module:



To couple the third unit module, one of removable shutters (15) would be removed and a second coupling member (21) would be inserted in the opening created by removing the shutter.

86. Here is a visual of coupling a third and fourth unit module:



To couple the third and fourth unit module, both of removable shutters (15) would be removed and coupling members (21) would be inserted in both of the opening created by removing the shutters.

“standard six width (6 W) unit”

87. Fukui lists expanding to 36 and 48 cores as “such as” examples, which indicates Fukui’s disclosure covers other examples too. EX1004, 8:1-6. Fukui broadly teaches that any “plurality of coupled unit modules” can be treated together so long as “the required number of the same shape unit modules are

prepared," which includes preparing six coupled unit module. When the "plurality" of coupled unit modules is six, the result is a six module that comprises six unit modules, i.e., six standard width units.

88. If Fukui disclosure to couple six unit modules is not sufficiently express, a POSITA would it obvious based on Fukui itself. Fukui itself discloses a "plurality" of coupled unit modules, which includes six coupled unit modules. EX1004, 8:2-3. Fukui itself teaches to support a "number" of coupled of unit modules, which also includes six coupled unit modules. EX1004, 7:67-8:6.

89. A POSITA would be motivated to coupled six unit modules to support 72 cores (which requires 6 x 12 core unit modules 10). EX1032, 4:35-38. Fukui broadly teaches to support the "various" number of cores, which includes 72 cores. EX1004, 3:27-28, 4:2-3, 4:42-43, 9:58-59, 10:4-6, 10:34-35. It was known in the art for cables to have 72 cores. EX1032, 4:35-38. The industry standards also provided for MPO connectors (as would be plugged into the MPO adapter at the back of Fukui's modules) to have 72 cores. There are industry standards for MPO connectors. For example, the Telecommunications Industry Association (TIA) published TIA-604-5-E (Nov. 2005) entitled "Fiber Optic Connector Intermateability Standard- Type MPO." The standard provides for a MPO connector plug for "72" fibers:

Table 1 – Number of Fiber Rows Options

Fiber rows option	Number of fiber rows	Maximum number of fibers per plug
$m = 1$	1	12
$m = 2$	2	24
$m = 3$	3	36
$m = 4$	4	48
$m = 5$	5	60
$m = 6$	6	72

For context, the number of fibers in the plug to equals m × n:

TIA-604-5-E

3.2.4 Number of fibers per row options

The five values defined for the number of fibers in a single row are specified in Table 2. The number of fibers in the plug is equal to the number of fiber rows (m) times the number of fibers per row (n), or $m \times n$. The fiber configurations are shown in Figures 3.2.3a through 3.2.3f.

The standard defines these values for “m” and “n”:

Table 1 – Number of Fiber Rows Options

Fiber rows option	Number of fiber rows	Maximum number of fibers per plug
$m = 1$	1	12
$m = 2$	2	24
$m = 3$	3	36
$m = 4$	4	48
$m = 5$	5	60
$m = 6$	6	72

Table 2 – Number of Fibers per Row Options

Fibers per row option	Number of fibers per row
$n = 4$	4
$n = 6$	6
$n = 8$	8
$n = 10$	10
$n = 12$	12

"72" is the case where m=6 (meaning there are six rows of fibers in the connector) and n=12 (meaning there are 12 fibers in each of the six rows) such that m x n is 6 x 12 = 72 fibers.

90. A POSITA would also be motivated to couple six unit modules to reduce the installation work. Consider the example where the worker needs to connect three cables each with 24 cores to customers. The worker could install a separate module for each cable, i.e. three 24 cores modules. Alternatively, the user could install one six unit module. The six unit module could handle all three cables with 24 cores because the six unit module has 72 cores and 3 x 24 cores = 72 cores. The worker could reduce three step installations (install three 24 core unit modules for three 24 core cables) to one step (install one 72 core unit module for all the cables at once). Because each coupled unit module 10 has a space for rear connector, multiple cables can be plugged into the coupled unit modules. Fukui is specifically concerned with "reducing the work" by combing functionality. EX1004, 9:18-29.

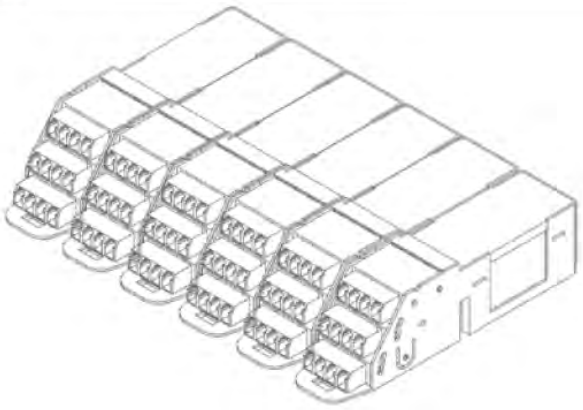
91. A POSITA would also recognize that grouping six modules together into one unit is advantageous any time the cables for the six modules need to be treated together (e.g., because they serve the same set of customers or same type of service). Grouping the modules together reduces the chance of error during installation (e.g., connecting a cable to the wrong set of modules).

92. A POSITA would have also recognized that coupling six unit modules is one of a finite number of predicable solution. Fukui lists expanding to 36 and 48 cores as "such as" examples, which indicates Fukui's disclosure covers other examples too. EX1004, 8:1-6. There are only a finite number of additional examples. The next examples are 60 cores (five unit modules) and 72 cores (six unit modules). Thus, six unit modules is one of only two choices for the next examples (five or six unit modules).

93. A POSITA would have a reasonable expectation of success because Fukui already discloses the functionality to couple six unit modules. The coupled units each have detachable shutter on the other side for further expansion. Fukui's already teaches expanding to 48 cores (four coupled unit modules). EX1004, 8:2. When four unit modules are coupled, the outer coupled units each would also an additional detachable shutter on the outer side to add two more coupled unit for a total of six coupled units.

94. Here is a demonstrative showing the six coupled unit modules:

Six (72 cores) module

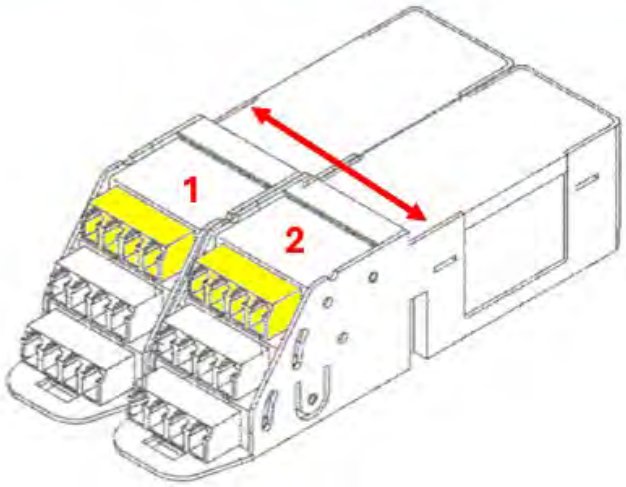


As shown, the six coupled unit modules are six with units compared to the standard one width module 10.

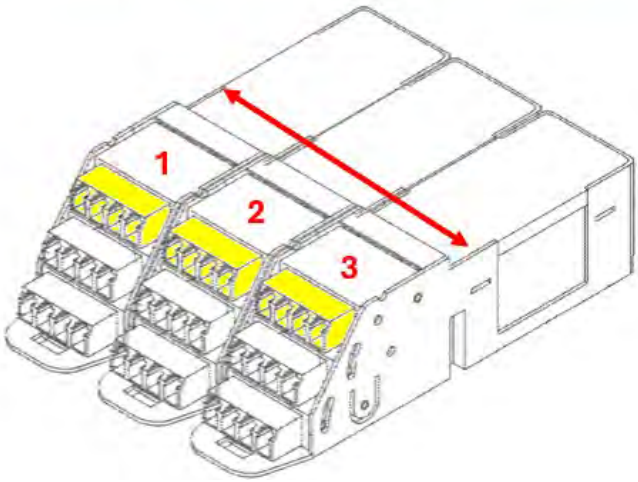
95. Fukui's teachings to couple different numbers of unit modules together to form larger modules meets both parties' proposed construction in the co-pending litigation.

96. *Patent Owner's construction*. The width of each larger module that results from coupling two, three, four, and six unit modules together does accommodate two, three, four, and six receptacle modules, respectively, as proposed by Patent Owner.

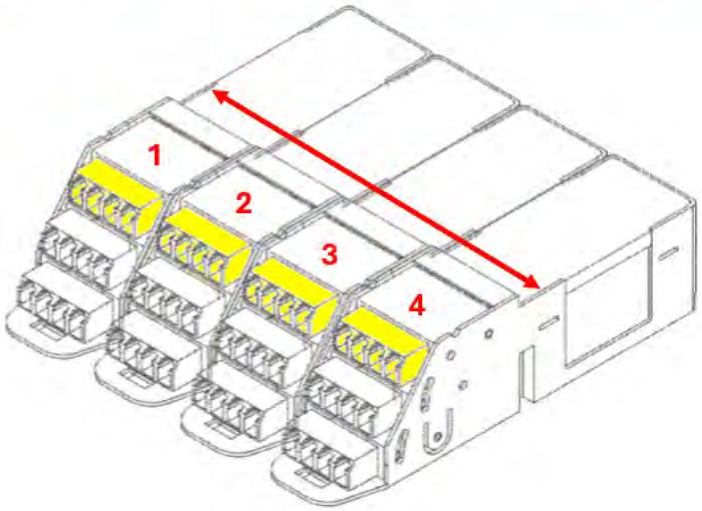
The width of Fukui's two coupled unit accommodates two receptacle modules



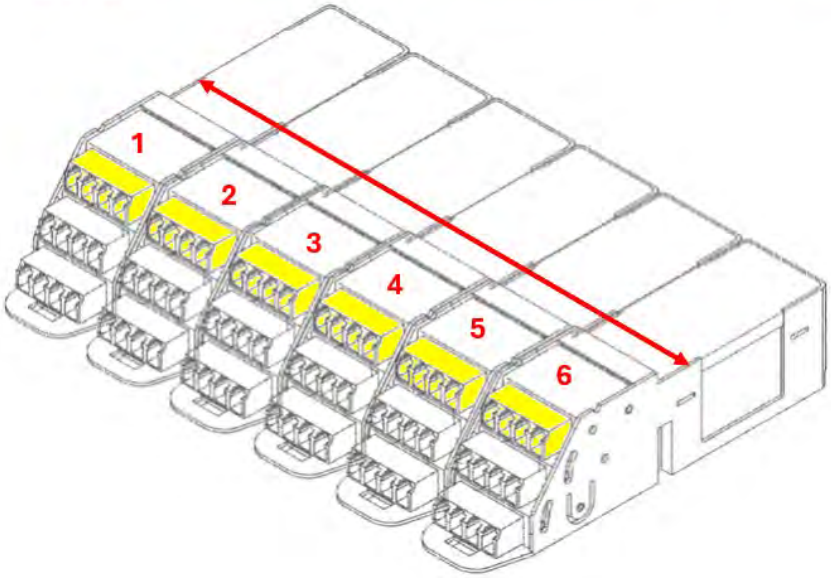
The width of Fukui's three coupled unit accommodates three receptacle modules



The width of Fukui's four coupled unit accommodates four receptacle modules

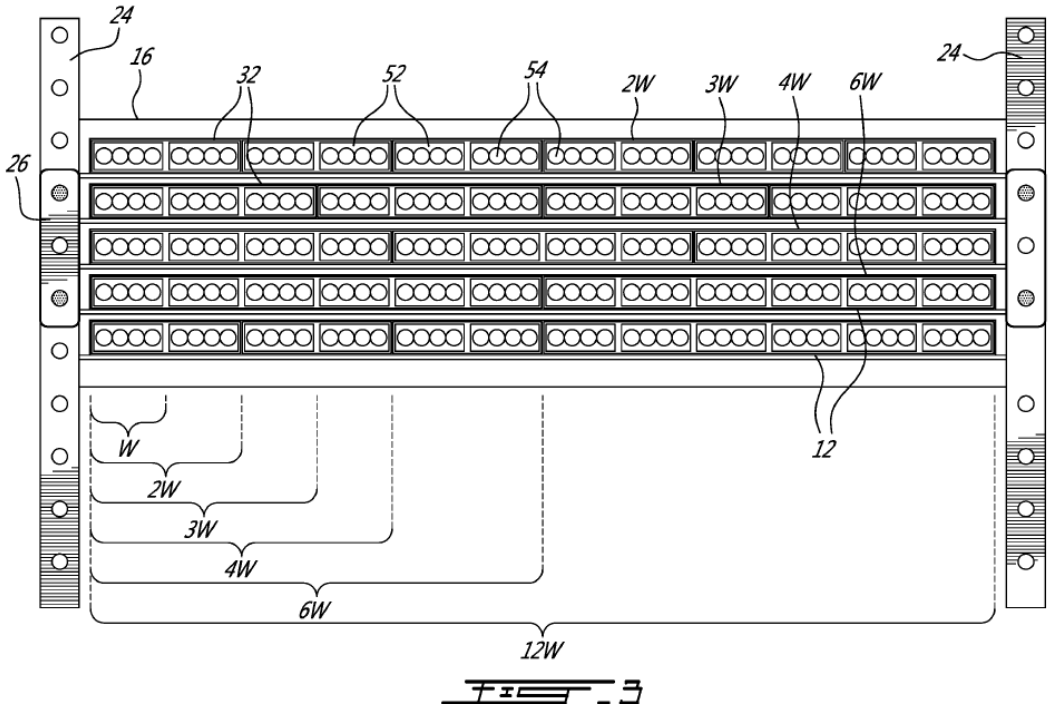


The width of Fukui's six coupled unit accommodates six receptacle modules



97. If PO argues the height of Fukui's modules accommodates additional receptacles, that does not distinguish Fukui because the claim and PO's own construction states a limitation about the width, not the height. The specification

also shows that the standard width unit is a *width* dimension, not a height dimension:



EX1001 at Fig. 3.

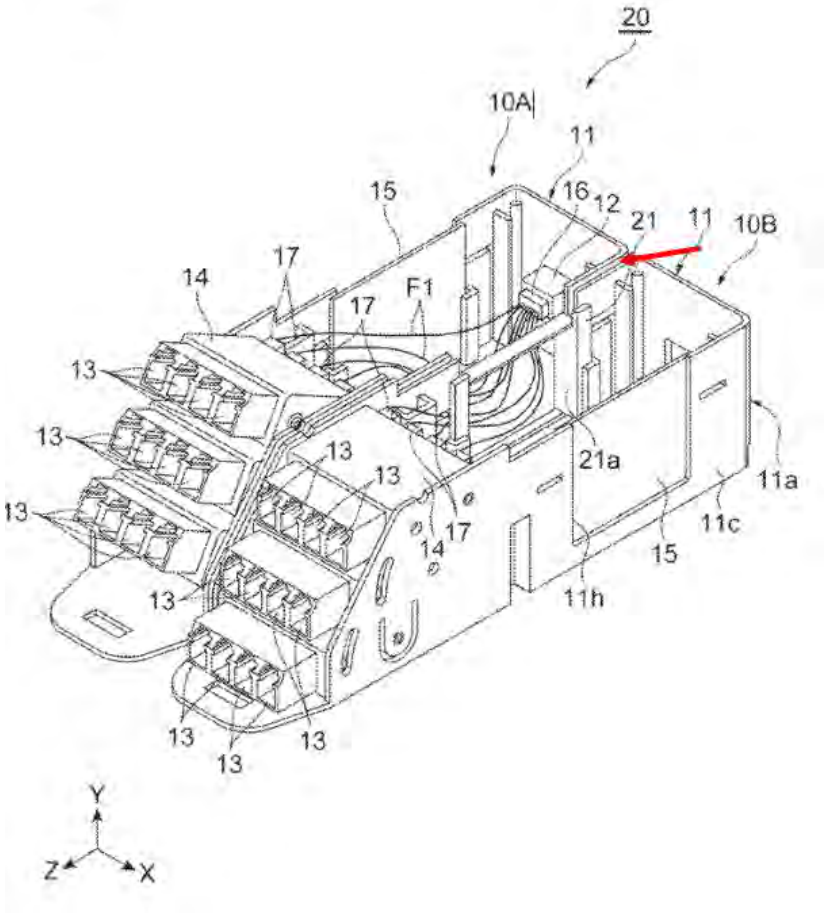
98. *CommScope's construction*. The width of each larger module that results from coupling two, three, four, and six unit modules together equals two, three, four, and six times the standard width units because, as shown above, each larger module comprises exactly that number of coupled unit modules. Fukui's modules do not include any additional amount such as a rail. Fukui's system has no rails. See, e.g., EX1004, Figs. 4-9. For the same reason, Fukui's modules are all "evenly divisible" by the width of module 10. The width of the two coupled unit modules 10 / the width of module 10 (i.e., Fukui's standard with unit) = 2.

The width of the three coupled unit modules 10 / the width of module 10 (i.e., Fukui's standard with unit) = 3. The width of the four coupled unit modules 10 / the width of module 10 (i.e., Fukui's standard with unit) = 4. The width of the six coupled unit modules 10 / the width of module 10 (i.e., Fukui's standard with unit) = 6. You can state the same point with equations:

The width of two coupled unit modules (W_2) divided by the standard width unit	$\frac{W_2}{S} = \frac{2 * S}{S} = 2$
The width of three coupled unit modules (W_3) divided by the standard width unit	$\frac{W_3}{S} = \frac{3 * S}{S} = 3$
The width of four coupled unit modules (W_4) divided by the standard width unit	$\frac{W_4}{S} = \frac{4 * S}{S} = 4$
The width of six coupled unit modules (W_6) divided by the standard width unit	$\frac{W_6}{S} = \frac{6 * S}{S} = 6$

99. Even if Patent Owner argues the width of Fukui's coupled modules includes some additional width or is not exactly evenly divisible, a POSITA would still find the claims invalid as obvious. Patent Owner might argue that Figure 5 shows a tiny space between modules 10A and 10B:

Fig.5

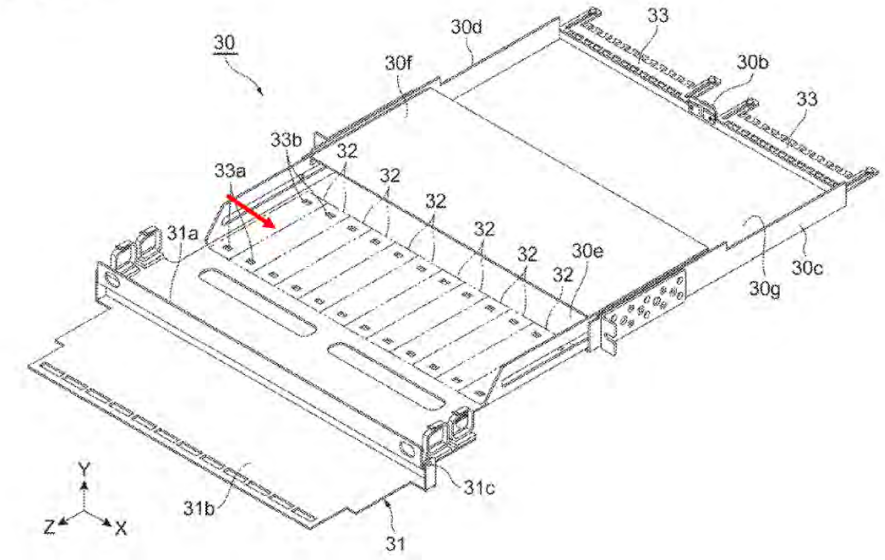


Note that the apparent space is tiny—approximately the width of a wall. I would disagree with such an argument for two reasons.

100. First, a POSITA understands there is no space between the modules after reading Fukui's full disclosure. The text accompanying Figure 5 clarifies that the modules are "fixed to each other" (i.e., touching to each other), not spaced apart. EX1004, 10:14, 4:9. Fukui also explains that the modules in Figure 5 have the "same" shape as modules 10 and Fukui never describes modules 10 as spaced apart. EX1004, 7:28, 8:5-6, 8:19-20.

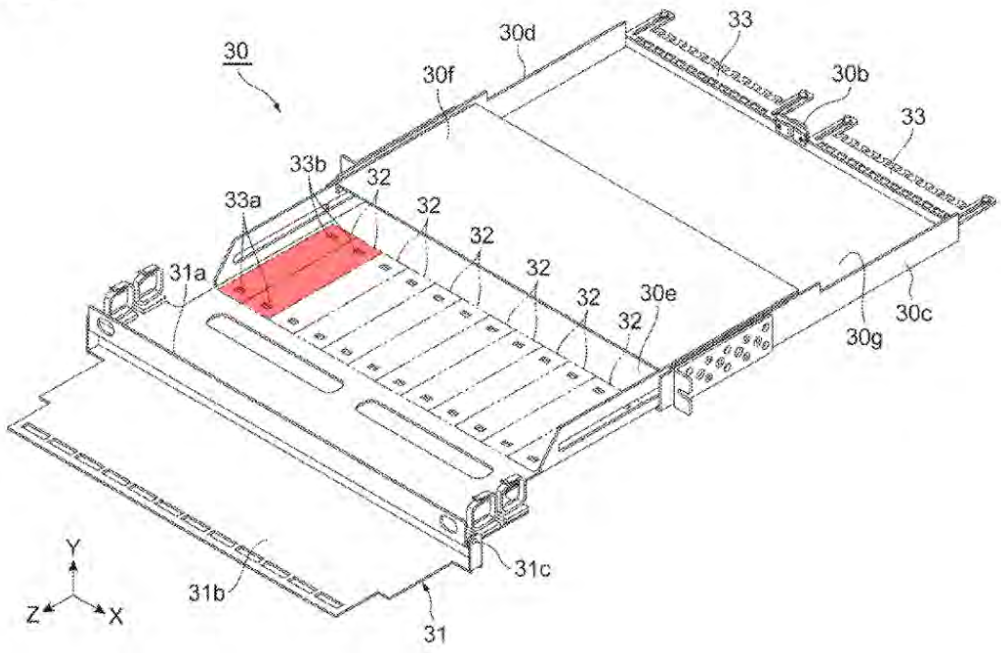
101. Fukui's other figures also show there is no room to space apart the modules. Figure 9, below, shows the areas for placing the modules touch with no room to space apart the modules:

Fig.9

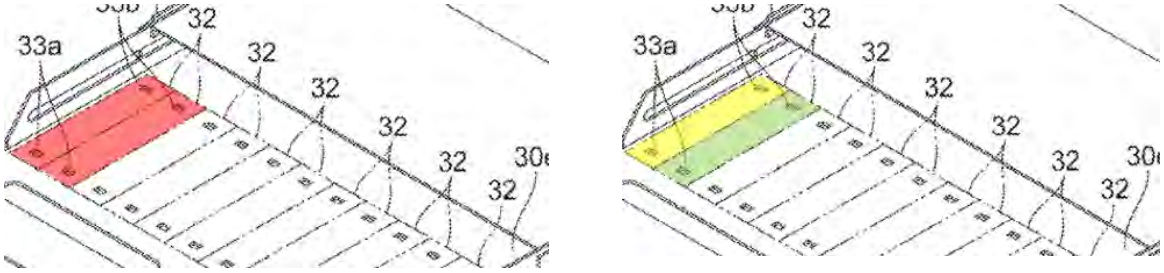


There are no separate lines between the adjacent areas. If modules 10A and 10B were separated by a space, you would expect to see a space between adjacent areas. Figure 9 does not show that. It shows a single line between the areas, not two separate lines with a space between. Here is an annotation showing an area for placing the combined module 20:

Fig.9



EX1004, Fig. 9. Note that there is no space between the areas. The area for placing one module 20 (red) is the same as the area for placing two modules 10 (yellow, green):



There is no additional area for module 20.

102. Furthermore, Fukui teaches that modules 10A and 10B are the "same" as modules 10. Thus, if there was a gap between modules 10A and 10B, you

would expect the figures to also show spacing between adjacent modules 10. None of the figures shows spacing between adjacent modules 10. Consider Figures 6-8:

Fig.8

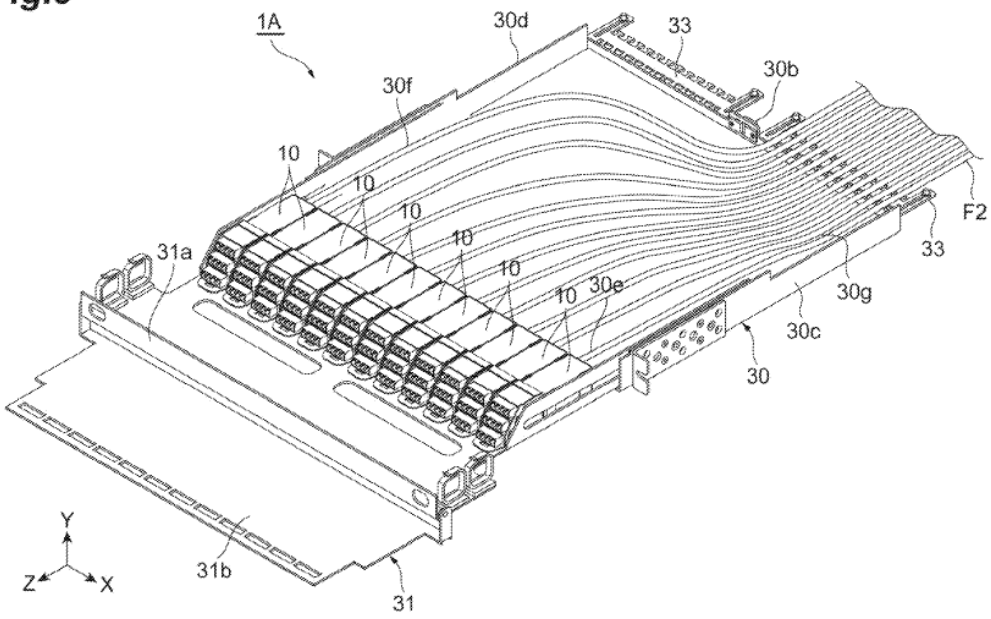


Fig.6

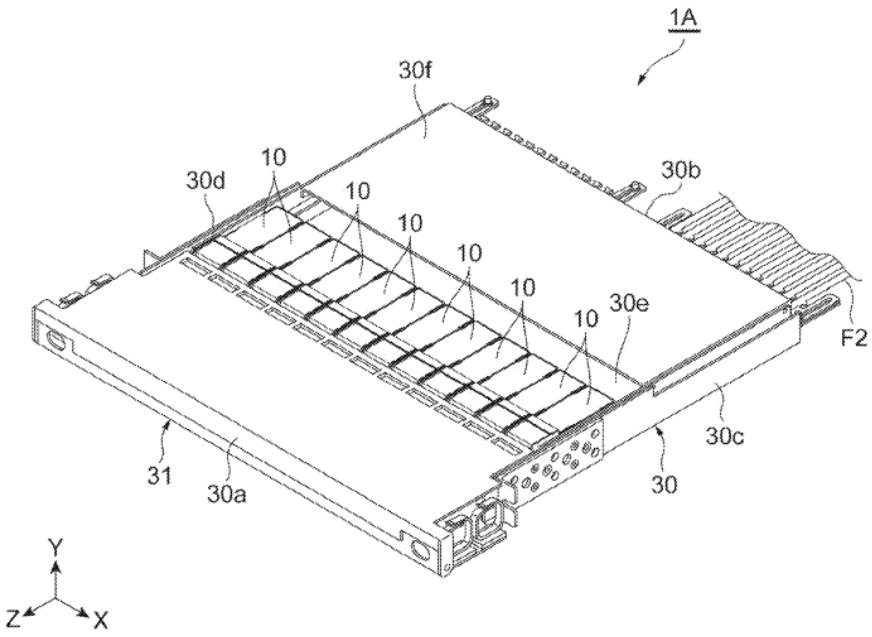
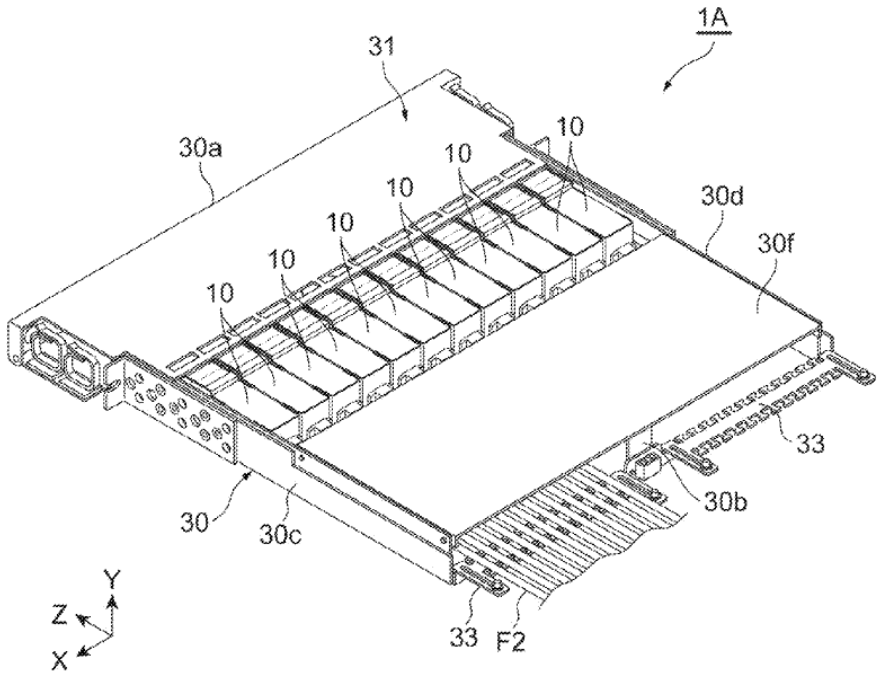


Fig.7



EX1004, Figs. 6-8. Figures 6-8 also show the sides of adjacent modules come together to a single black line with no space between.

103. Thus, considering Figure 5 with the description of Figure 5 and the other figures, a POSITA would not conclude Fukui teaches adding a space between modules. Fukui never mentions such a space or assigns its any relevance. A POSITA also understands it would not make sense to add a space between modules because it would interfere with the modules being coupled together. The coupling member performs the function of a clip. For a clip to be functional the two items held together must be in contact (touch) so as to resist the force of the clip and maintain a tight coupling.

104. Even if there is a tiny space between modules, that does not make the claims patentable. A POSITA would have found it obvious to couple the modules without any such tiny space.

105. This is, at most, an insignificant modification to Fukui. Any such gap is already so small it is not even visible in the other figures. Fukui never discusses much less assigns any significance to there being a tiny gap between modules. A POSITA could easily make this modification (to the extent any modification is even needed) by omitting the tiny space and having modules touch.

106. Furthermore, this is an obvious implementation of Fukui's existing teaching. As discussed above, Fukui shows that the areas (32) for adjacent modules touch with no space between. Fukui also already teaches that the unit modules are "fixed to each other." EX1004, 10:13-14. It is at least an obvious implementation of this teaching is to have the modules touch with no additional width or space between them.

107. A POSITA would have been motivated to have no extra spaces between Fukui's modules for several reasons. First, a POSITA would have been motivated to remove any such space because it would make it easier to align the cassettes during installation. To install Fukui's modules, the hooks on the modules must be aligned with the holes on the trays. This is complicated by several factors. (1) The user cannot clearly see the hooks or the holes during installation. The user

cannot clearly see the hooks because they are on the bottom of the modules, and the user cannot clearly see the holes because the modules cover them up when placed above the areas for installation. (2) The user must align multiple hooks and holes. For example, the user must align four hooks and holes when installing module 20 because each of the two coupled modules 10 itself has two hooks for two holes. (3) The holes are relatively small. With this background, any space between coupled modules would make it more difficult to install the modules. This space could result in the modules being misaligned, i.e., being placed slightly to one side in the areas 32, which would misalign the hooks and holes. With the tiny space eliminated, the user installing the modules could use the adjacent module to help precisely guide and place the next modules by sliding that next modules along the side of the adjacent modules which would naturally align the modules with holes. Aligning a module with the adjacent modules would naturally align the modules with its own areas without need for further adjustment.

108. Second, a POSITA would have been motivated to remove any such gap to make the modules more rigid. The prior art recognizes that having no clearance (i.e., gap) between interconnected cassettes (e.g., coupled modules) creates a rigid assembly. EX1026 at 3:4-9 ("… interconnect patch cassettes in such a way that the housings of two adjacent patch cassettes are contiguous, meaning they extend adjacent to each other without significant or even no clearance. Thus, a

rigid assembly is achieved.”). This is advantageous for several reasons. If there is a gap between the modules, that means the modules are only fixed together in the middle along the coupling member, not along the other portions of the sides. As a result, the modules would be susceptible to flexing/bending inward along the other portion of the sides. For example, if pressure is put on the side of the modules during installation (e.g., because the installer is holding the module from the sides), the sides of the cassette might flex inward which would (a) put stress on the coupling member in the middle (and potentially lead to the coupling member breaking) and (b) make alignment more difficult because the flexing would slightly change the lateral alignment of the hooks on the bottom. This concern would be multiplied as the number of coupled units increases, e.g., for Fukui’s 36-core (triple) module or 48-core (quadruple module). By contrast, omitting any such gap would address these issues because the walls would then contact each other along the whole side, which would prevent flexing inward.

109. Relatedly, a POSITA would have been motivated to remove any such gap so that the coupled modules could be more easily handled as one unit. Fukui recognizes to treat the coupled units as “one body.” EX1004, 8:2-6. If there is a gap between the modules, it is more difficult to treat the coupled units as one body because the individual modules might independently flex/move as discussed above. By contrast, omitting any such gap would make it easier to treat the

coupled units as body during installation because the individual modules would not independently move because their walls would press on each other.

110. Third, a POSITA would have been motivated to remove any tiny gap between the modules to prevent material (e.g., dust) from getting into the gap or entering the modules through the gap and interfering with coupling the modules or the fiber inside the modules. Fukui explains that fibers from modules 10A "pass through" module 10B through the opening. If there is a gap between the modules 10A and 10B, then the fiber would be at least partially exposed as they through the opening susceptible to accidental damages (e.g., if anything got into the gap). A POSITA would be particularly motivated to protect the fibers passing through the gaps because the fibers are exposed. Normally, fibers are protected inside a cable (which has a plastic covering). But, here, the fibers are not inside a cable and there is no apparent plastic covering. And, especially when the fibers are outside a cable, they are susceptible to damage from excessive bending. The point where the fibers pass through the gaps is one of the points of maximum bending stress because the fibers have to change direction and move laterally into the other module.

111. Lastly, the primary goal of fiber cassette systems is to maximize the so-called "front panel density" i.e., maximize the number of LC connections

possible within a given amount of front panel space. Thus, there is an inherent motivation to minimize any non-functional space such as a gap.

112. ***Reasonable expectation of success***. A POSITA would have a reasonable expectation of success in removing a tiny (if any) space between the coupled modules. Fukui does not teach a tiny gap (if any) between the coupled modules has any function. The modification does not require adding any functionality. It only requires omitting a tiny gap (if any). All of Fukui's other functionality in the coupled units, including the coupling member and openings in the modules for routing fibers between the coupled modules could remain the same. Eliminating a tiny, non-functional space is well within the level of ordinary skill. A POSITA could omit the tiny (if any) space by simply making each module 10 slightly bigger.

113. Further, it was already known in the art to have adjacent modules touch. See, e.g., EX1026 at 3:4-9 ("… interconnect patch cassettes in such a way that the housings of two adjacent patch cassettes are contiguous, meaning they extend adjacent to each other without significant or even no clearance. Thus, a rigid assembly is achieved."), Figs. 5 (showing the coupled modules touch), EX1010 at Figs. 3-4 (showing the coupled modules touch). Further, a POSITA could easily achieve this modification by simply having the width of the modules 10 match the width of the existing areas (32) on the existing tray. Figure 9 shows

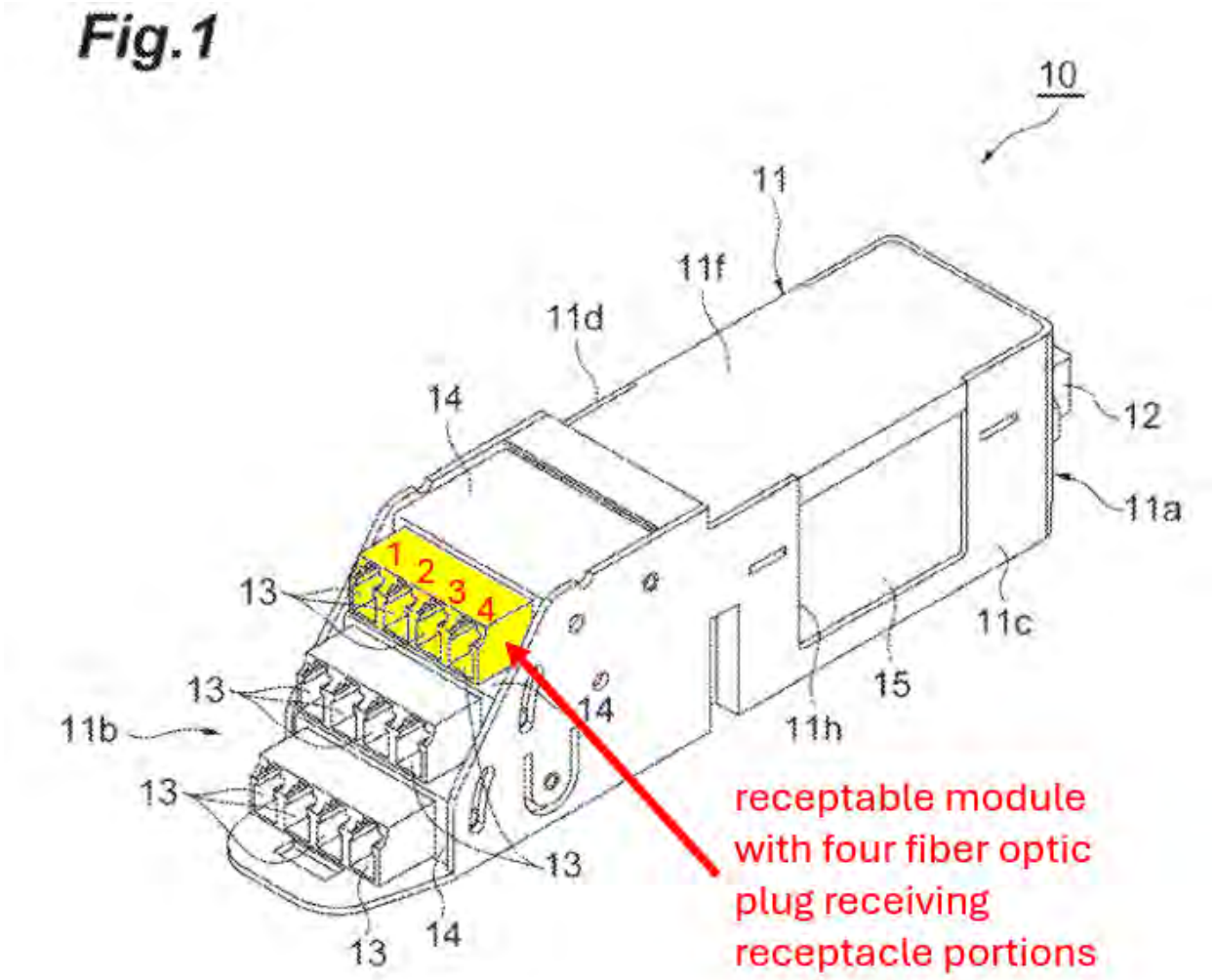
adjacent areas (32) touch. Thus, when the width of the modules matches the width of the areas, each adjacent module would also touch. Adjacent modules 10 would touch each other, and equally the modules 10A and 10B inside modules 20 would touch each other because they are the "same" as module 10.

114. ***Predictable result***. A POSITA would also consider this a predicable variation of Fukui's existing design. Fukui already shows any gap between the modules is so insignificant it does not appear in Figures 6-8. Further, Fukui already contemplates having the sides of the modules touch via the coupling member. Thus, a POSITA would consider it predictable variation for the rest of the sides to touch with no space between.

8. Element 1G

115. Element 1G recites: "wherein the receptable module is configured to fit at least four fiber optic plug receiving receptacle portions in a standard one width (1 W) unit." Fukui discloses this element.

116. Figure 5, for example, shows the receptable module (yellow) with the recited four fiber optic plug receiving receptacle:



Fukui's receptable module (yellow) is the "one body" of "four" optical connector adapters (13) for LC connectors. The "four" optical connector adapters (13) are "at least four fiber optic plug receiving receptacle portions" as recited in the claim. They receive LC plugs (also called connectors).

9. Element 1H

117. Element 1H relates back to Element 1C. Here are the two elements:

[1C] wherein *the tray is configured to fit* **a plurality of different modular fiber optic cassette configurations** in the tray width portion in a standard U-space fiber management system;

[1H] wherein **<u>the</u> plurality of different modular fiber optic cassette configurations** comprise:

a first modular fiber optic cassette configuration that includes…

a second modular fiber optic cassette configuration that includes…

a third modular fiber optic cassette configuration that includes…

a fourth modular fiber optic cassette configuration that includes…

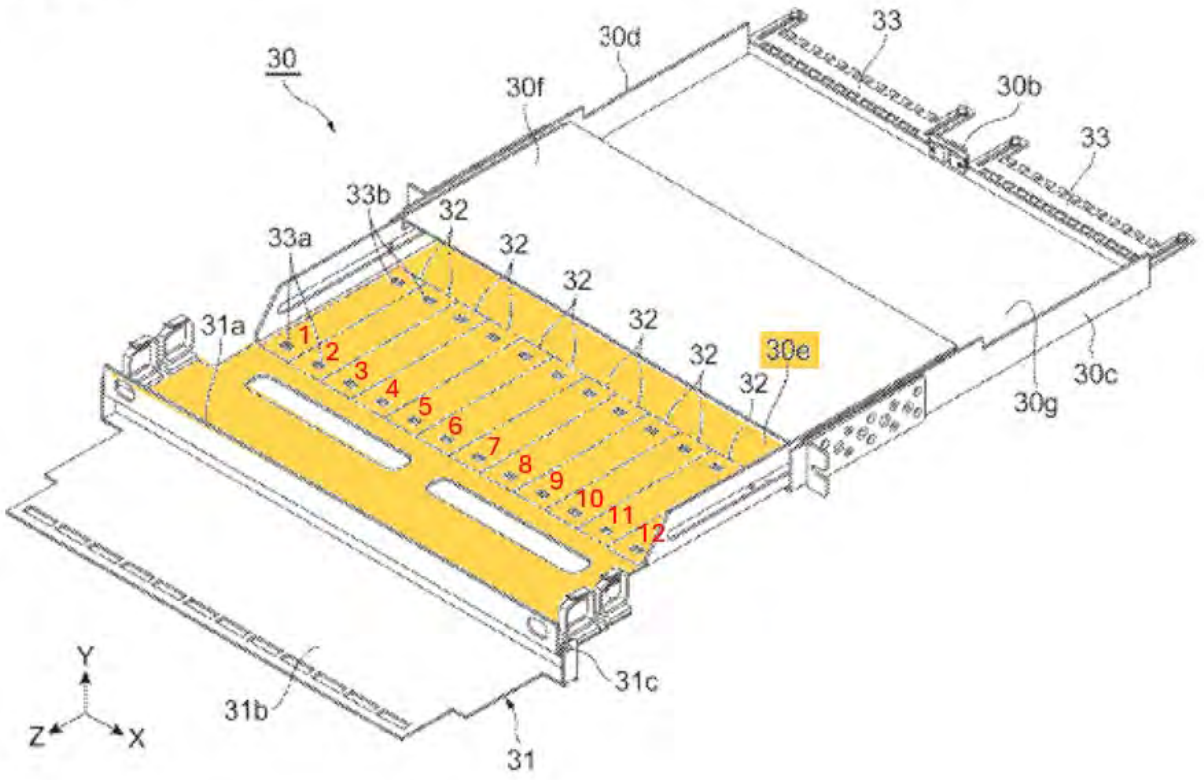
a fifth modular fiber optic cassette configuration that includes…

Element 1H further defines the recited "a plurality of different modular fiber optic cassette configurations" that the tray must be "configured to fit" in Element 1C. Thus, reading these elements together, the tray must be "configured to fit" the five configurations recited in Element 1H.

118. Fukui's tray is configured to fit the five recited configurations. Each of the five configurations requires twelve standard width units ("W") to fit. The first configuration is "six" 2W cassettes; 6 x 2W = 12W. The second configuration is "four" 3W cassettes; 4 x 3W = 12W. The third configuration is "three" 4W cassettes; 3 x 4W = 12W. The fourth configuration is "two" 6W cassettes; 2 x 6W = 12W. The fifth configuration is "three" 2W cassettes and "one" 6W cassettes; 3 x 2W + 1 x 6W = 12W.

119. Fukui's tray is configured fit twelve standard width units ("W"):

Fig.9



There are twelve areas (32) and each area accommodates one module, i.e., one standard width per area for a total twelve standard width units. Because each of Fukui's modules size is simply a "number" of coupled modules that all have the "same" shape, any of Fukui's module size can fit in the areas. Each module size simply occupies the number of areas that equals the "number" of coupled modules, i.e., Fuki's double modules occupies two area, Fukui's triple module occupies three areas, etc. As a result, Fukui's twelve areas fit the five recited configurations.

120. Here are annotation showing Fukui's tray is configured to fit each of the five configurations:

Fig.8

First configuration: six 2W cassettes

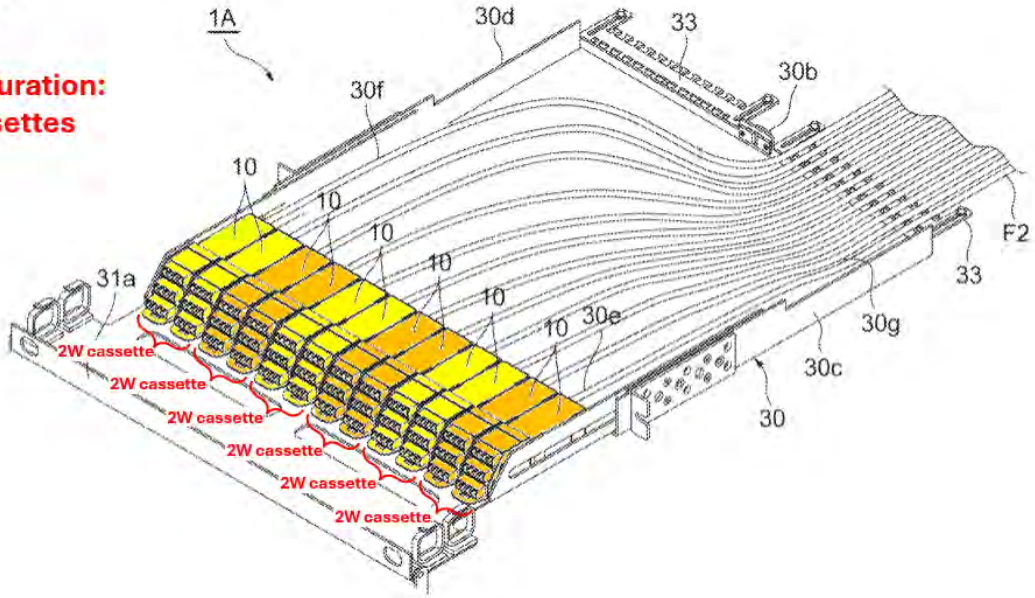


Fig.8

Second configuration: four 3W cassettes

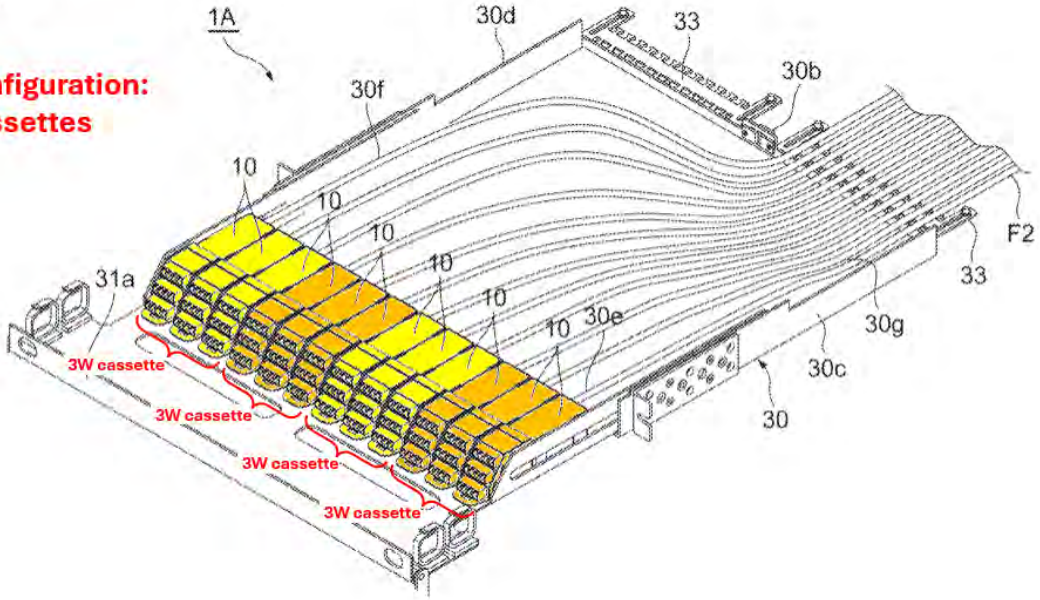


Fig.8

Third configuration: three 4W cassettes

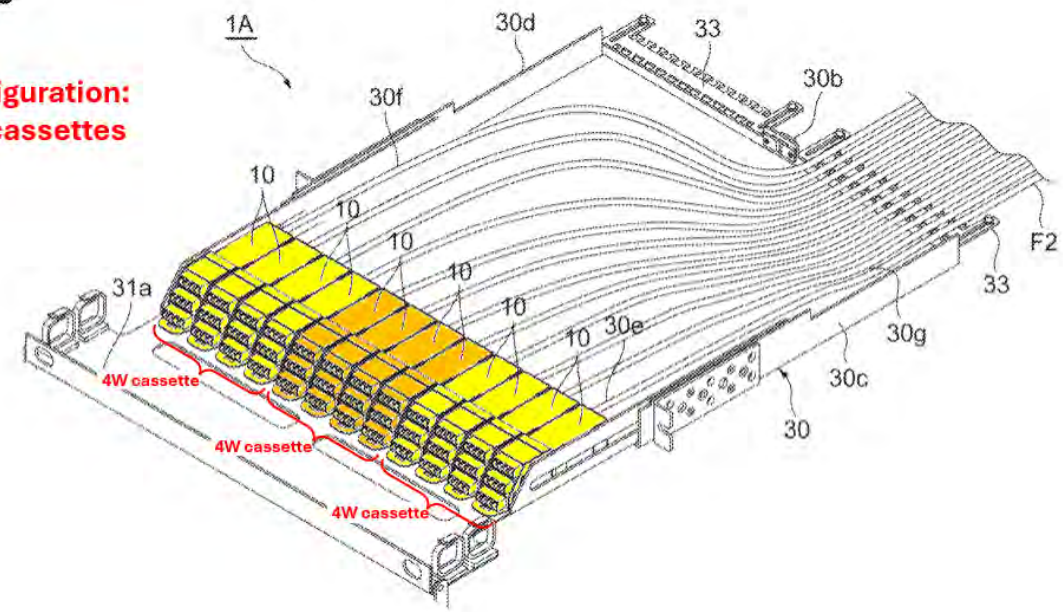
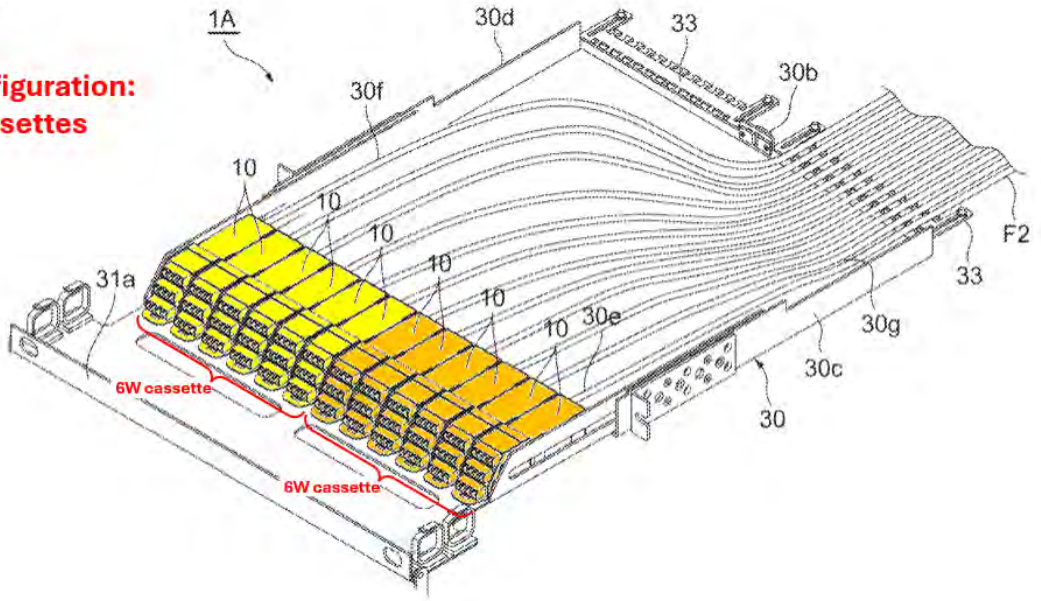
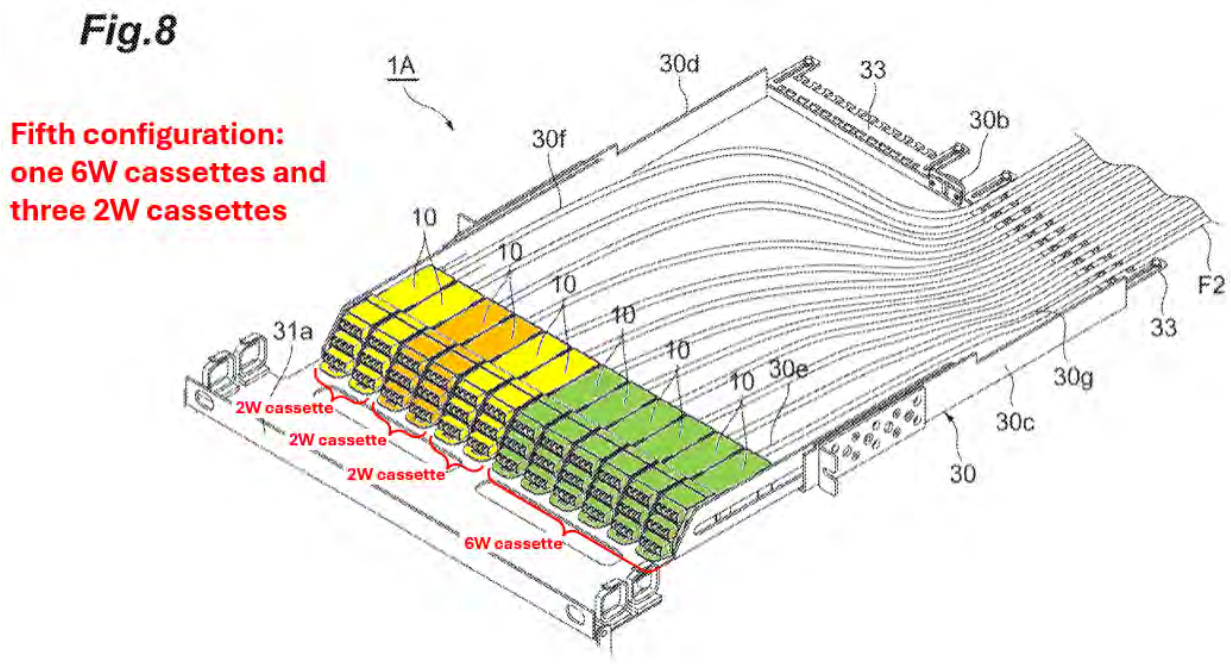


Fig.8

Fourth configuration: two 6W cassettes





EX1004, Fig. 8.

121. Fukui's disclosure is very similar to Patent Owner's preferred embodiment. In Patent Owner's preferred embodiment, specification explains that the tray is configured to fit the different sizes of cassettes because the apertures to connect the cassettes conform to the standard width unit, i.e., the apertures are spaced apart by one standard width unit. EX1001, 9:5-9. Figure 1 shows the tray has twelve of these apertures each spaced apart by on standard width unit, which allows the tray to fit the different combinations of twelve standard width units. Fukui has the same features as just discussed.

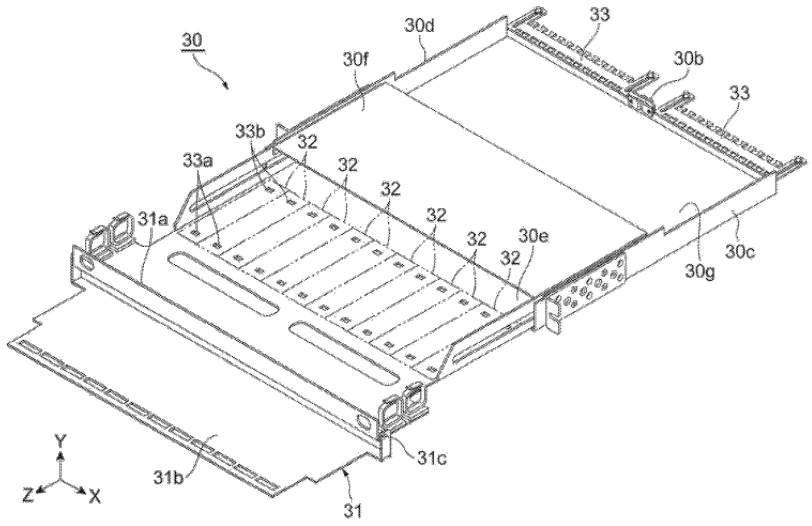
122. This element also requires that tray be configured to fit the cassettes in the five configurations *"side by side"* in a *"row"* such that a cassette side end portion of each modular cassette *"adjacently faces"* a cassette side end portion of

another cassettes. The annotation above shows this is true for all the five configurations as applied to Fukui.

"arranged side by side of each other in a row along the tray"

123. Figure 9 shows that Fukui's areas (32) for placing the modules are arranged side by side in a row along the tray:

Fig.9

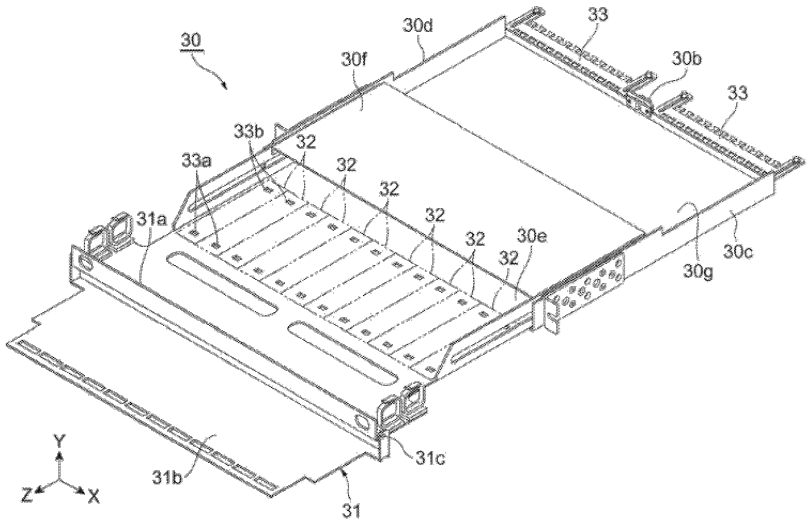


EX1004, Fig. 9. Fukui explains: "The plurality of areas 32 are provided to be arranged along the X direction." EX1004, 8:47-48. The "X" direction is the side-by-side direction. EX1004, Fig. 9. Fukui explains later that the modules placed in those areas are "laterally aligned." Because all the configurations uses these same areas for placing the modules, Fukui's tray is configured such that modules in all of the five configurations are arranged side by side in a row.

“adjacently faces”

124. Figure 8 also shows that Fukui’s areas (32) for placing the modules are adjacent and the sides of adjacent areas face each other with no intervening structure such as a rail.

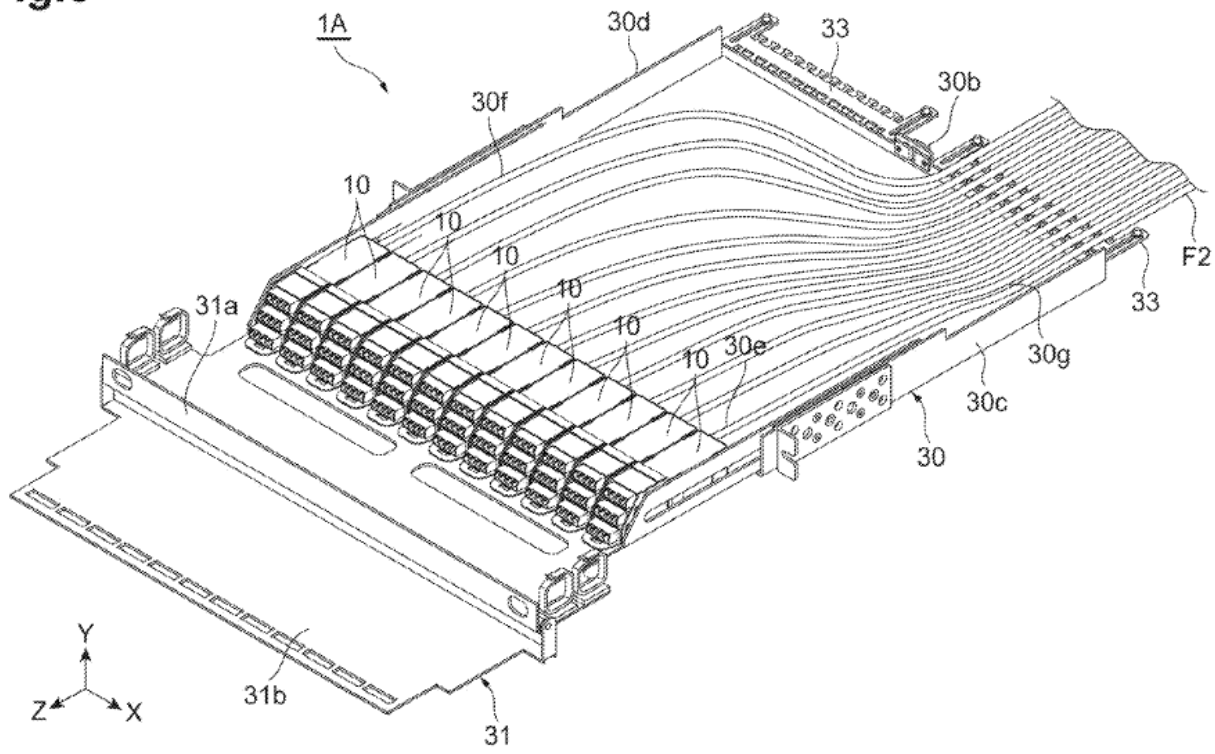
Fig.9



EX1004, Fig. 9. Fukui explains: “The plurality of multi-core/single-core conversion modules may be respectively placed on the plurality of areas along the first direction in such a way that adjacent lateral walls of the plurality of multi-core/single-core conversion modules are faced with each other.” EX1004, 4:34-38. Because each and every areas (32) is adjacent and facing the area next to it and all the modules size comprises the same unit module 10 for placing in those areas, in all the configurations, each module will be adjacent and facing the module in the area next to it.

125. Figures 8, which shows modules placed in the area, confirm that the modules are all arranged side by side in a row such that the entire outer side of the modules of each module is both adjacent and facing the module next to it:

Fig.8



EX1004, Fig. 8; see also Figs 6-7.

126. If Belden argues that Fukui does not expressly recite populating the tray with the five configurations, that does not distinguish Fukui. The plain language of the claim only requires the tray be "configured to fit" the configurations. The claim does not require the additional step of populating the tray with each of the configurations.

127. Even if the claim had required the additional step of populating the tray with each of the configurations, that would not distinguish Fukui. A POSITA would have found it obvious to perform the small additional step of populating Fukui's tray with each of the five configurations. This small additional step is simply a predictable implementation of Fuki's existing teachings and does not require any modification to Fukui. Fukui already discloses to fully populate the tray. EX1004, Fig. 8, 9:36-37. The claimed first, second, third, and fourth recited configuration are simply predictable variations of Fukui's existing teaching to fully populate the tray as applied to Fukui's different sizes. For example, the first configuration of "six" 2W cassettes is simply populating Fukui's tray with Fukui's already disclosed two unit module (20) for 24 cores. Fukui existing tray already fits exactly six two unit modules (see annotation above). The same reasoning applies to Fukui's second, third, and fourth configurations.[4] The fifth configuration simply recites a combination of two modules sizes. Fukui already

[4] The second configuration of "four" 3W cassettes is simply populating Fukui's tray with Fukui's already disclosed three unit module for 36 cores. Fukui existing tray already fits exactly four three unit modules (see annotation above). The third configuration of "three" 4W cassettes is simply populating Fukui's tray with Fukui's already disclosed four unit module for 48 cores. Fukui existing tray already fits exactly three four unit modules (see annotation above). The fourth configuration of "two" 6W cassettes is simply populating Fukui's tray with six unit module for 72 cores (see annotation above). Fukui existing tray already fits exactly two six unit modules (see annotation above). Element 1E already explains that Fukui discloses or renders obvious a 6W cassettes (i.e., coupling six unit modules).

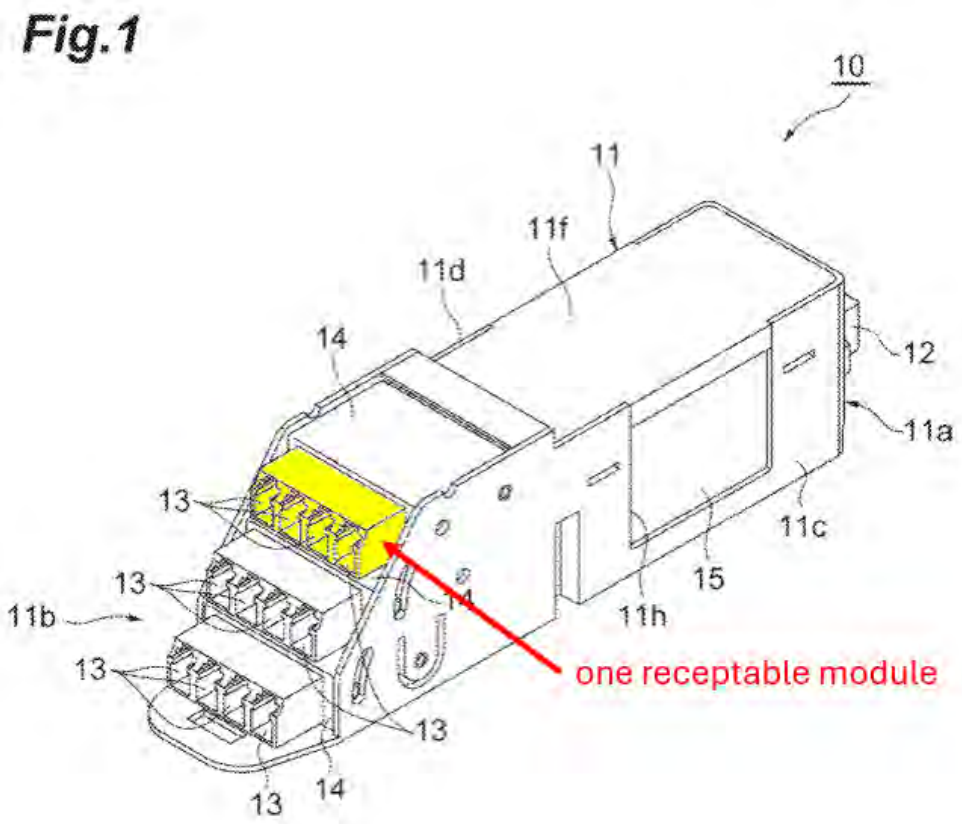
teaches that its module size may be present in "combination." EX1004, 9:43-45, 8:19-23. A predictable example of modules being present in "combination" is a combination of two unit modules and a six unit module. A POSITA would have been motivated to perform the small additional step of actually configuring Fukui's tray with each of the five configurations to fully and efficiently use Fukui's system for the different combinations of input cables. Fukui already teaches to support input cables with "various" number of cores. EX1004, 3:27-28, 4:2-3, 4:42-43, 8:1-2, 9:58-59, 10:4-6, 10:34-35. Consider the example where there are six input cables with 24 cores. A POSITA would be motivated to configure Fukui's tray to support these cables. An obvious implementation is to configure Fukui's tray with the six two unit modules that each support 24 cores to match the six cables with 24 cores. This obvious implementation of Fukui's system is an example of actually configuring the tray with six 2W cassettes per the first configuration. The same reasoning applies to the other claimed configurations.

10. Element 1I

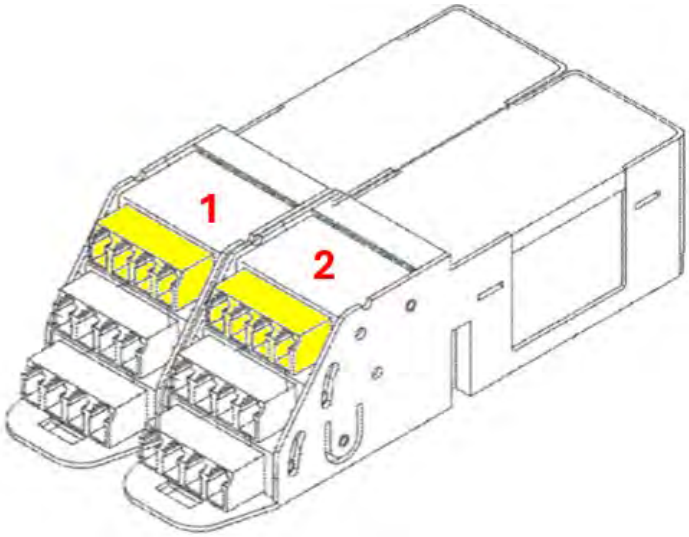
128. Element 1I recites: "wherein each modular two standard width (2 W) cassette is configured to fit two receptacle modules; wherein each modular three standard width (3 W) cassette is configured to fit three receptacle modules; wherein each modular four standard width (4 W) cassette is configured to fit four

receptacle modules; wherein each modular six standard width (6 W) cassette is configured to fit six receptacle modules."

129. Fukui discloses this. Each size of Fukui's modules is a "number" of unit modules coupled together as discussed above. EX1004, 7:67-8:6. Each unit module, by itself, has three tiers that are each configured to fit one receptacle modules:



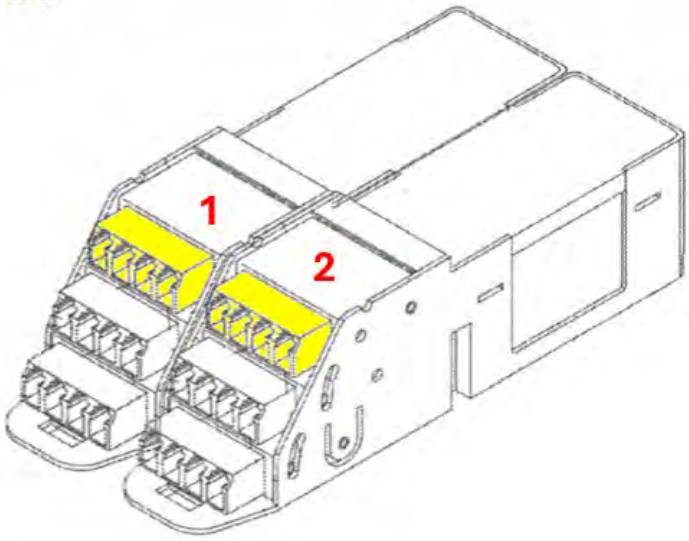
When two moules 10 are coupled together, the result has the same three tiers that are each now configured to fit two receptacle modules:



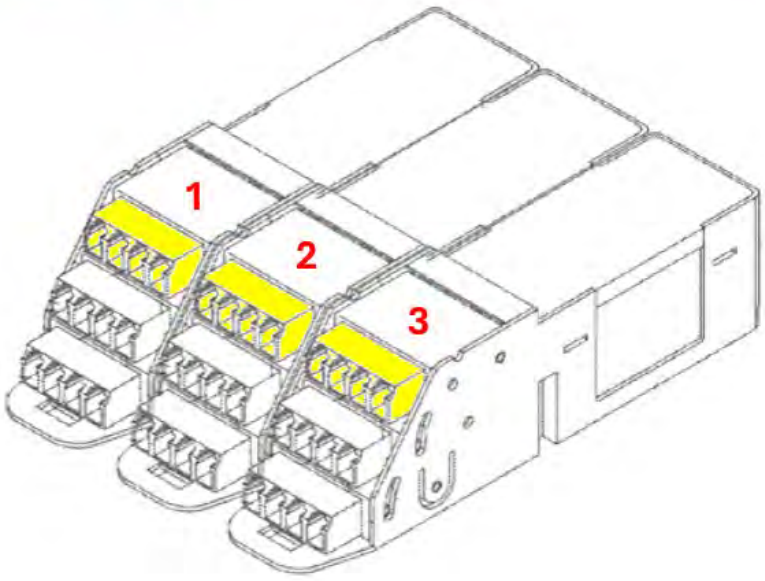
See also Figs. 5. Each additional coupled module increases each of the tiers by one more receptacle more. Thus, when three, four, or six modules are coupled together, each tier is now configured to fit three, four, or six receptable modules, respectively.

130. Here is an annotation for each of the sizes recited in the claim:

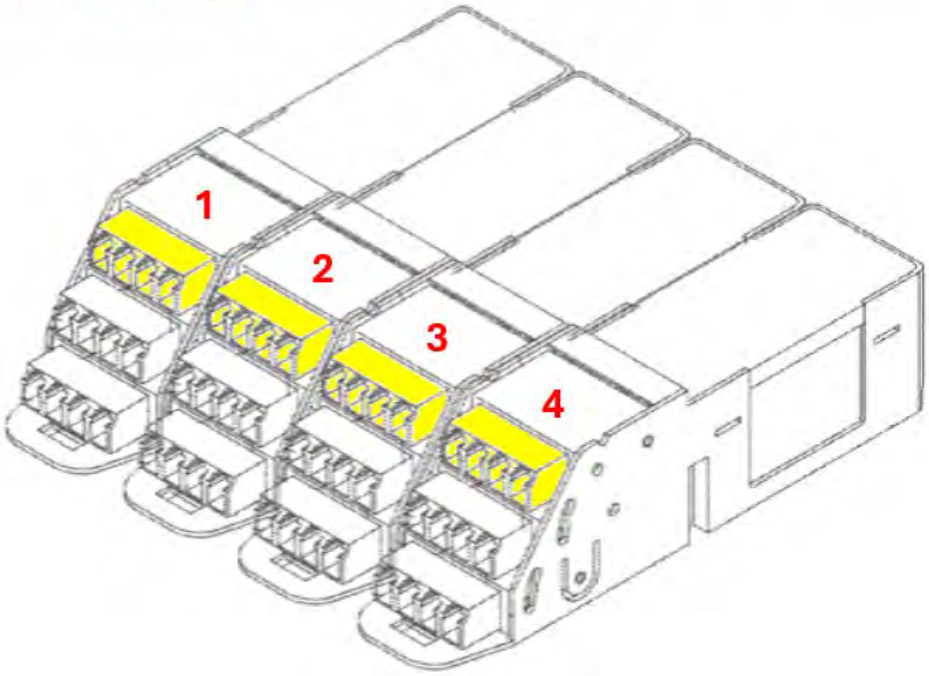
A modular two standard width (2W) cassette configured to fit two receptacle modules

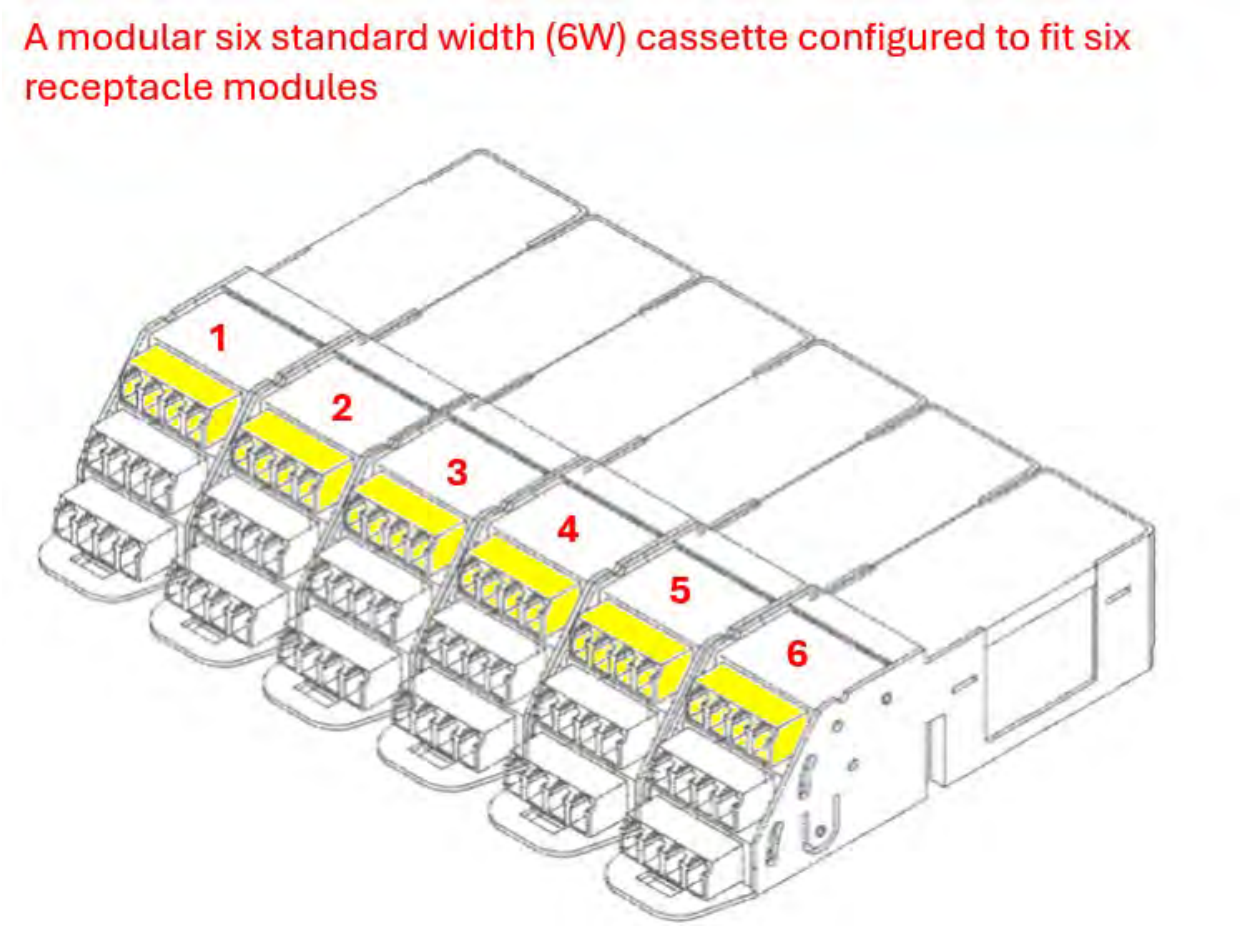


A modular three standard width (3W) cassette configured to fit three receptacle modules



A modular four standard width (4W) cassette configured to fit four receptacle modules

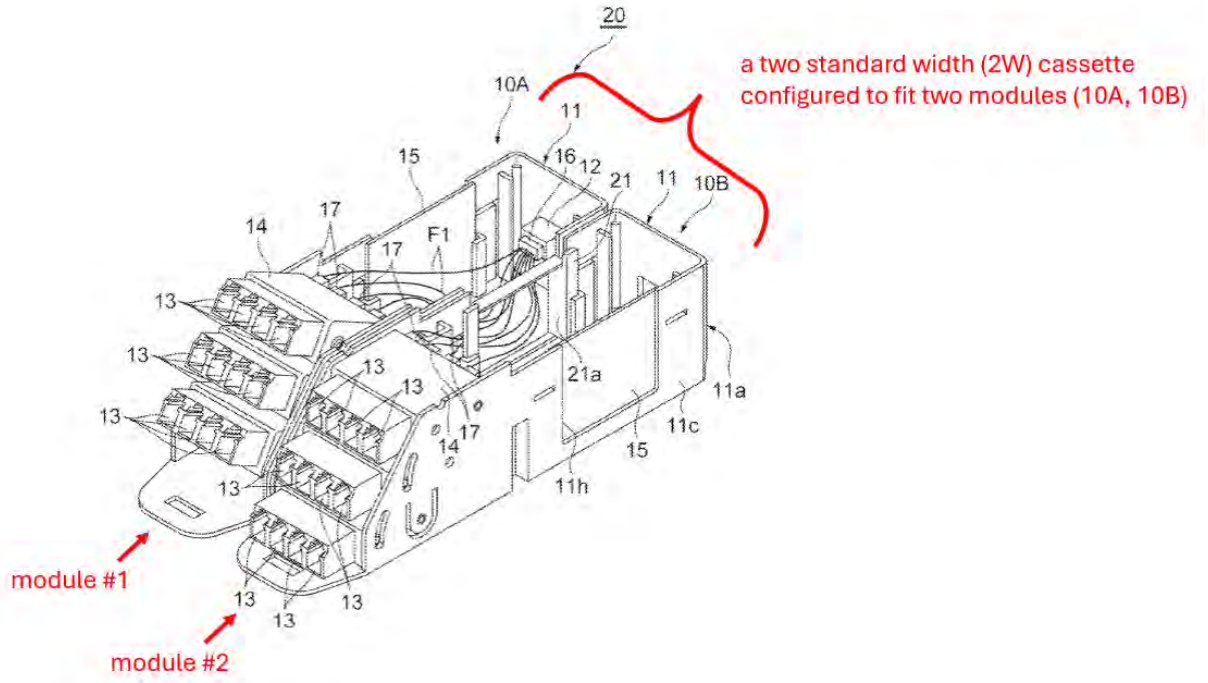




131. If Patent Owner argues Fukui's modules have additional tiers that support additional receptacle modules, that does not distinguish Fukui. Claim 1 is a "comprising" claim. I understand that means the prior art can add additional structure, i.e., additional tiers in Fukui. Furthermore, the claim does not say the recited cassettes is configured to fit "only" the recited number of modules or any similar language. Patent Owner has not proposed any construction in the co-pending litigation that this limitation requires the cassettes fit "only" recited number of modules or any similar language. EX1011 (proposing no such construction). Therefore, the claim is open ended and cannot be distinguished

based on additional elements such as additional tiers. Furthermore, the additional tiers in Fukui are arranged in the height dimension. There is no limitation on the height dimension of the cassette other than that the tray when configured with cassettes fits in a U space, which is true in Fukui. EX1004, 9:33 ("1U size"). The claim does restrict the width dimension of the cassette, and Fukui's modules do fit the recited two, three, four, and six receptacle modules in the width dimension.

132. Even if claim 1 were interpreted to have an "only" limitation for the modules (e.g., the 2W cassettes must be configured to fit "only" two receptacle modules), that would not distinguish Fukui. Fukui has two different examples of the modules. The "one body" of four receptacles 13 is one example of a module, which is discussed above. The one body is inserted into the larger "module" 10. By Fukui's express terms, the larger module 10 is also a "module." The larger module 10 also houses the receptacle 13. Thus, the larger module 10 qualifies as a second example of a receptacle module as recited in the claim. When the claim is compared to this second example of a receptacle module, each of Fukui's cassette sizes do fit "only" two, three, four, and six of the larger modules 10. Figure 5, for example, shows the Fukui's double fits "only" two modules 10 numbered 10A and 10B:



The same applies to Fukui's 3W, 4W, and 6W sizes that comprises three, four, and six modules 10, respectively.

133. To be clear, I am not taking inconsistent positions on the meaning of "receptacle modules." My point is that Fukui has two examples of "receptacle modules." A POSITA recognizes there can be multiple examples because one module can fit inside another module.

134. Fukui's second example of a receptacle module also meets the earlier limitations for the receptacle module recited in Elements 1D, 1E, and 1G:

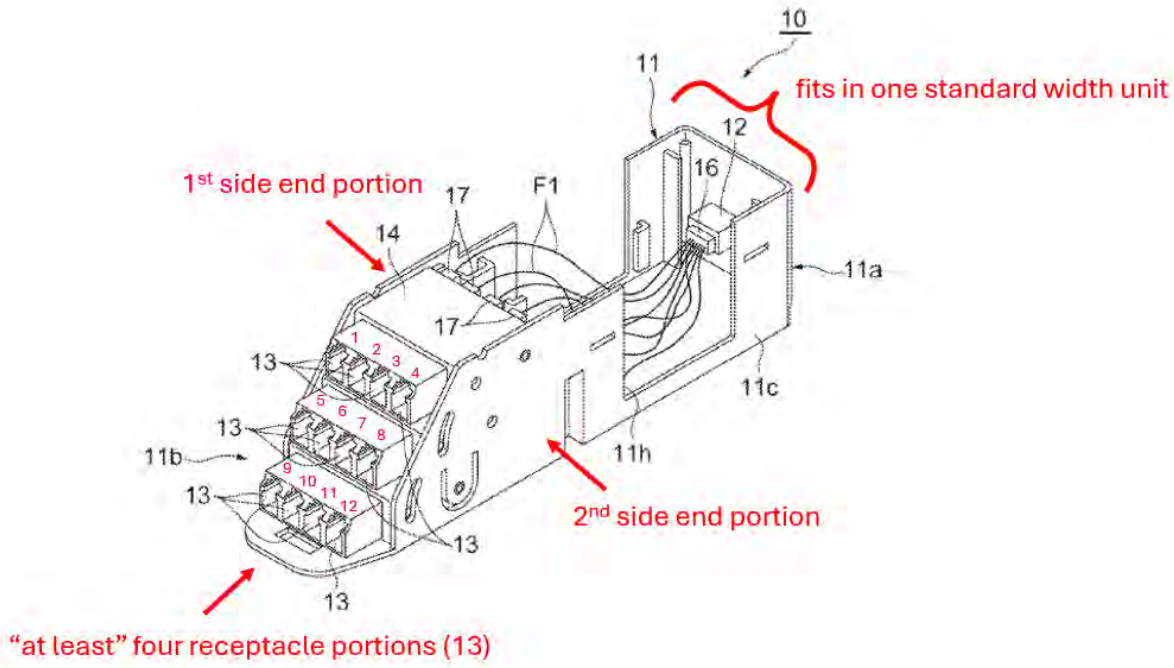
Element 1D wherein each of the plurality of different modular fiber optic cassette configurations include a modular fiber optic cassette that is configured to support a receptable module having a first module side end portion and a second module side end portion defining a module

width portion that extends between the first tray side end portion and second tray side end portion;

Element 1E wherein the module width portion is configured to fit in a standard one width (1 W) unit;

Element 1G wherein the receptable module is configured to fit at least four fiber optic plug receiving receptacle portions in a standard one width (1 W) unit;

Figure 1 shows that each of Fukui's modules 10 have two sides as recited in Element 1D. Fukui's standard width unit, as discussed above, is the width of module 10. Thus, by definition, the width of module 10 fits in a standard one standard width unit as recited in Element 1E. Figure 1 also shows each of Fukui's modules is configured to fit "at least" four receptacle portions in the standard one with unit. Here is annotation showing this module 10 meets these earlier limitations:



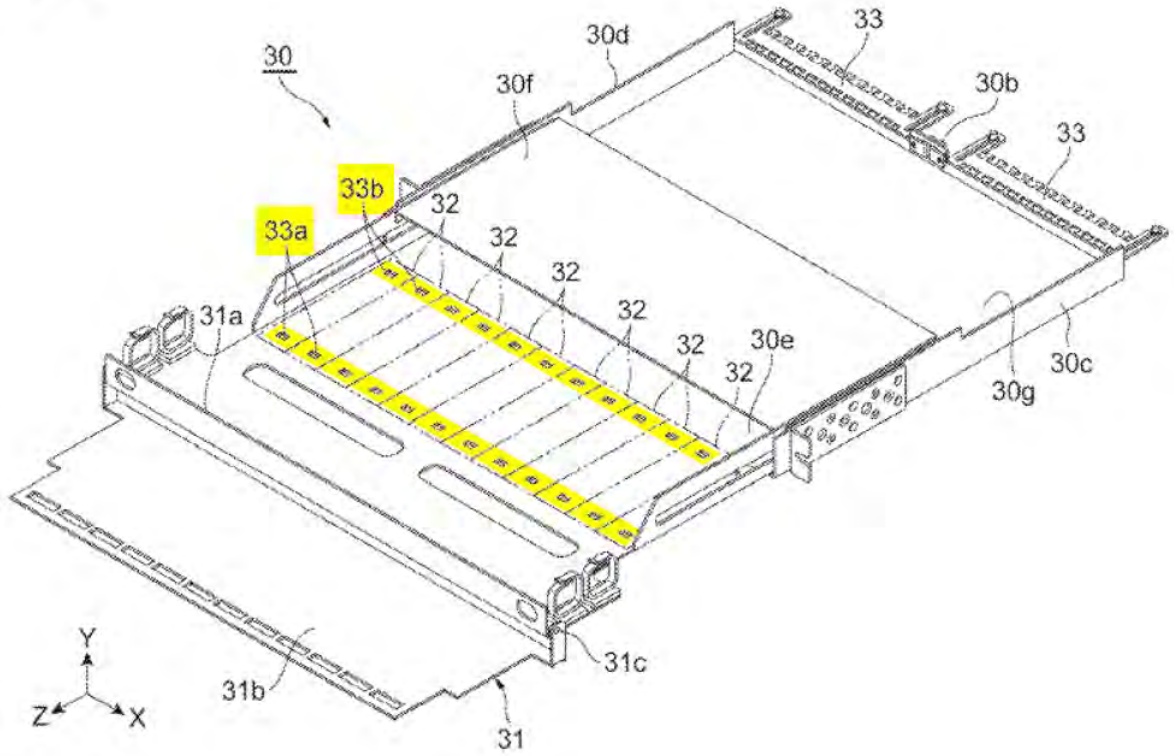
135. I note that this limitation is not even in the other independent claims (claims 9 and 17); thus, Fukui also cannot be distinguished from those claims for that additional reason.

11. Element 1J

136. Element 1J recites: "wherein the tray is configured to be removably secured to each modular fiber optic cassette when the tray fits the plurality of different modular fiber optic cassette configurations within the tray width portion in the standard U-space fiber management system." Fukui discloses this element,

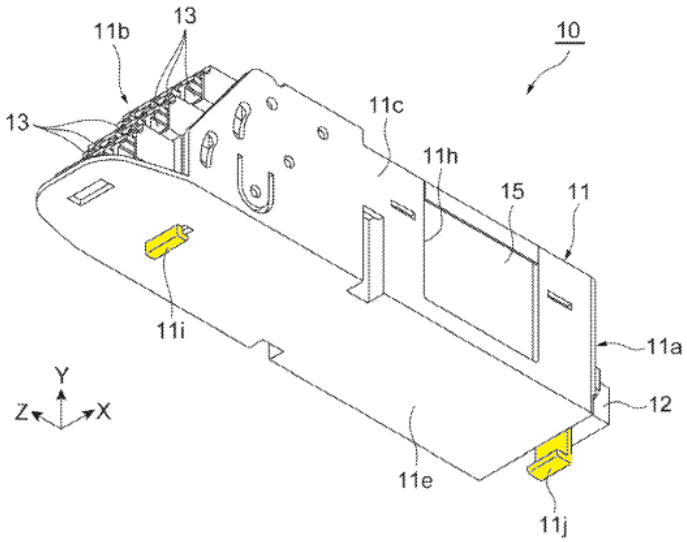
137. Fukui's tray has a plurality of areas (32) with holes (33a, 33b) for removably securing Fukui's modules:

Fig.9



Fukui's module 10 has hooks (11i, 11j) on the bottom to "engage" the holes:

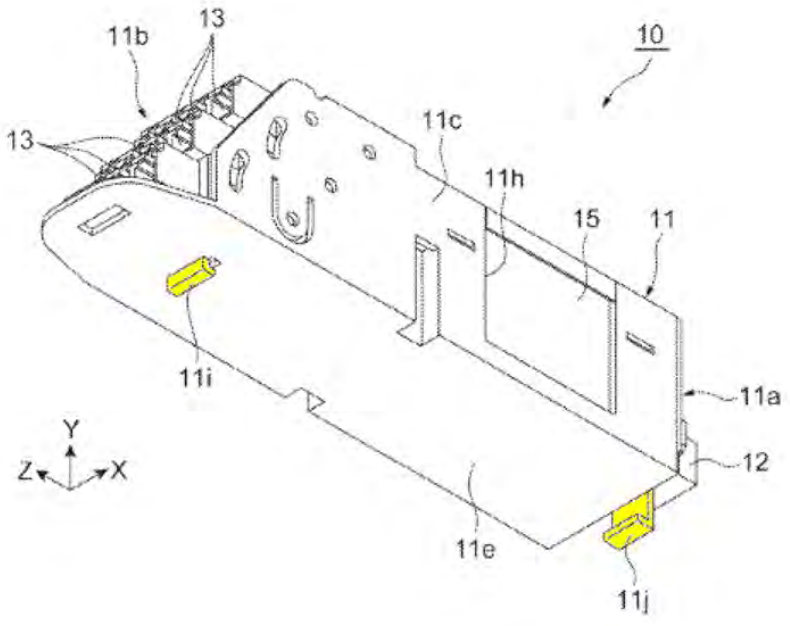
Fig.2



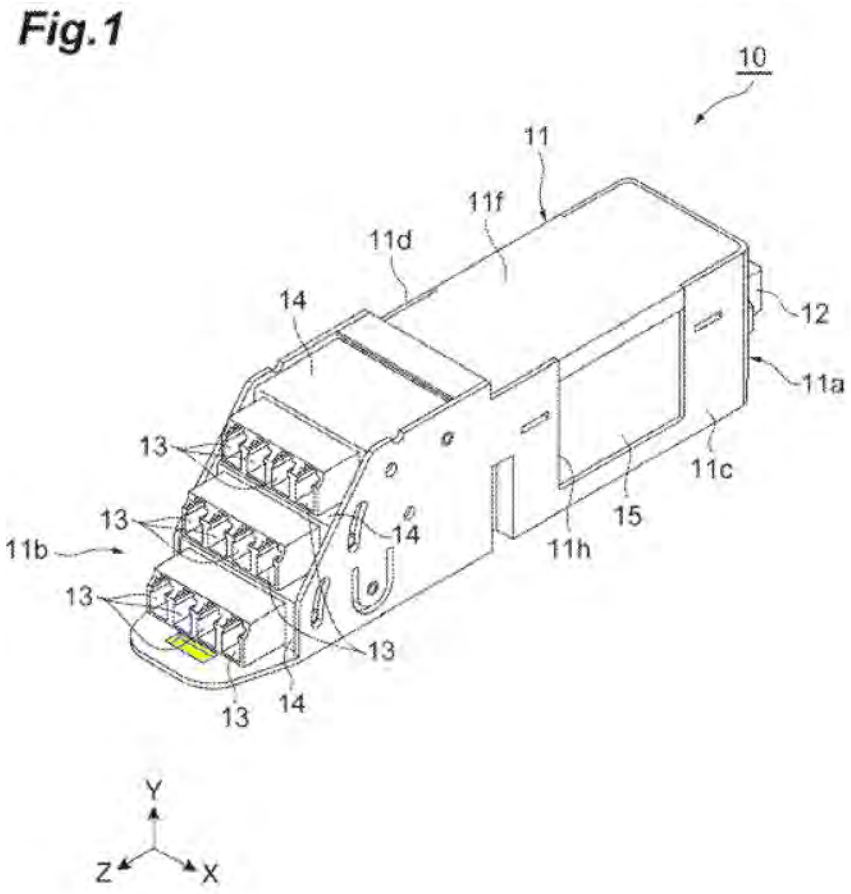
EX1004, Fig. 2, 8:52-56. Because all of Fukui's modules comprises either an individual module 10 or multiple modules 10 coupled together, all of Fukui modules have this same feature. EX1004, 7:27-29, 8:3-6, Figs. 4-5. Fukui expressly teaches the modules can be "easily removed" and "exchanged" (i.e., one removed and another secured). EX1004, 9:18-29, 9:66-10:1, 10:33-35, 3:8-11.

138. A POSITA would recognize that module can be removed by, for example, pushing back the hooks and lifting the module up. Here is an example of how Fukui's modules would be removed. The shorter and longer hook face opposite directions. The front hook (11i) faces the rear and the rear hook (11j) faces the front:

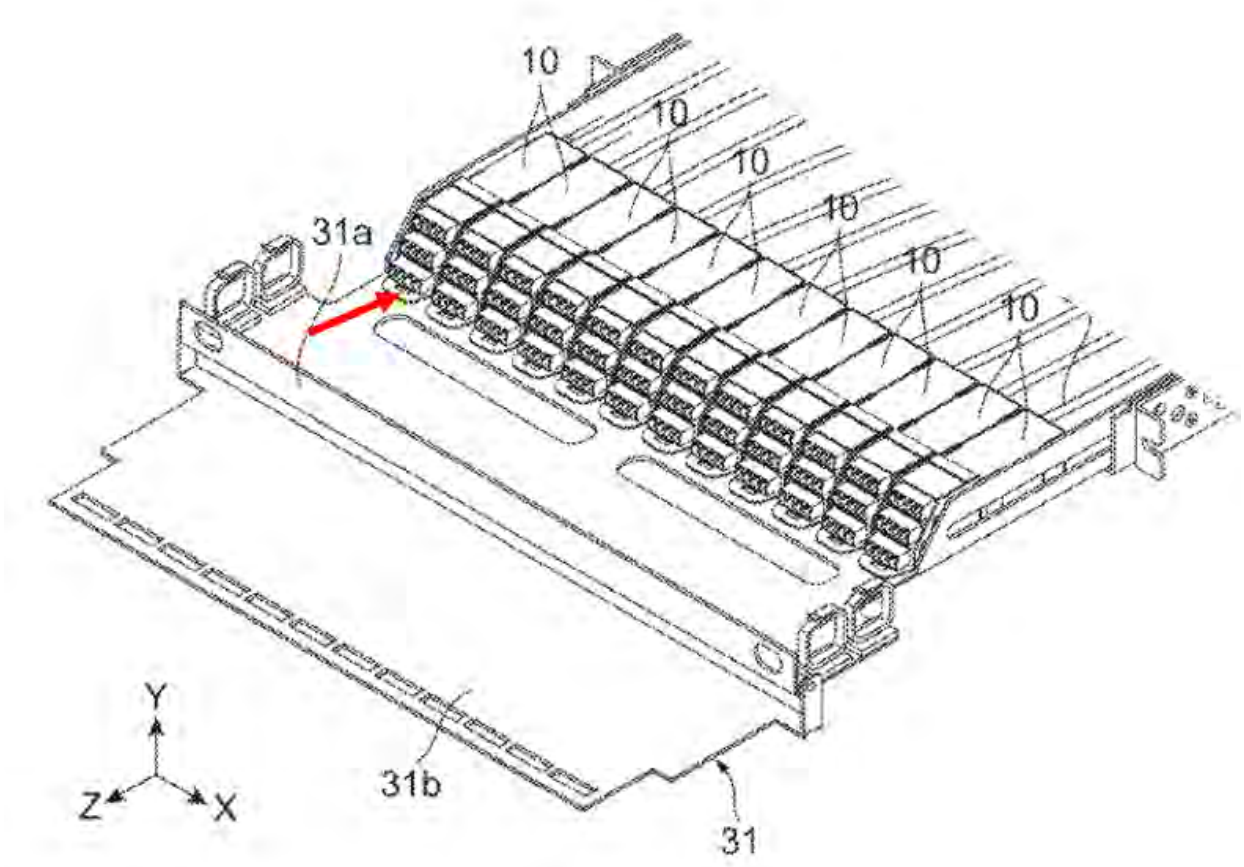
Fig.2



Because the front hook faces rear, the module must be pulled forward to disengage the hook from the front hole. This puts pressure on the rear hook, which flexes backward to accommodate the module being pulled forward. After the front hook is disengaged, the user can lift the module up and backward to disengage the whole module. Fukui's modules have a finger-sized indent at the front that can be used to pull the module forward (using a finger or tool):



EX1004, Figure 1. After installation, the finger-sized indent (yellow) is accessible if the module needs to be removed:

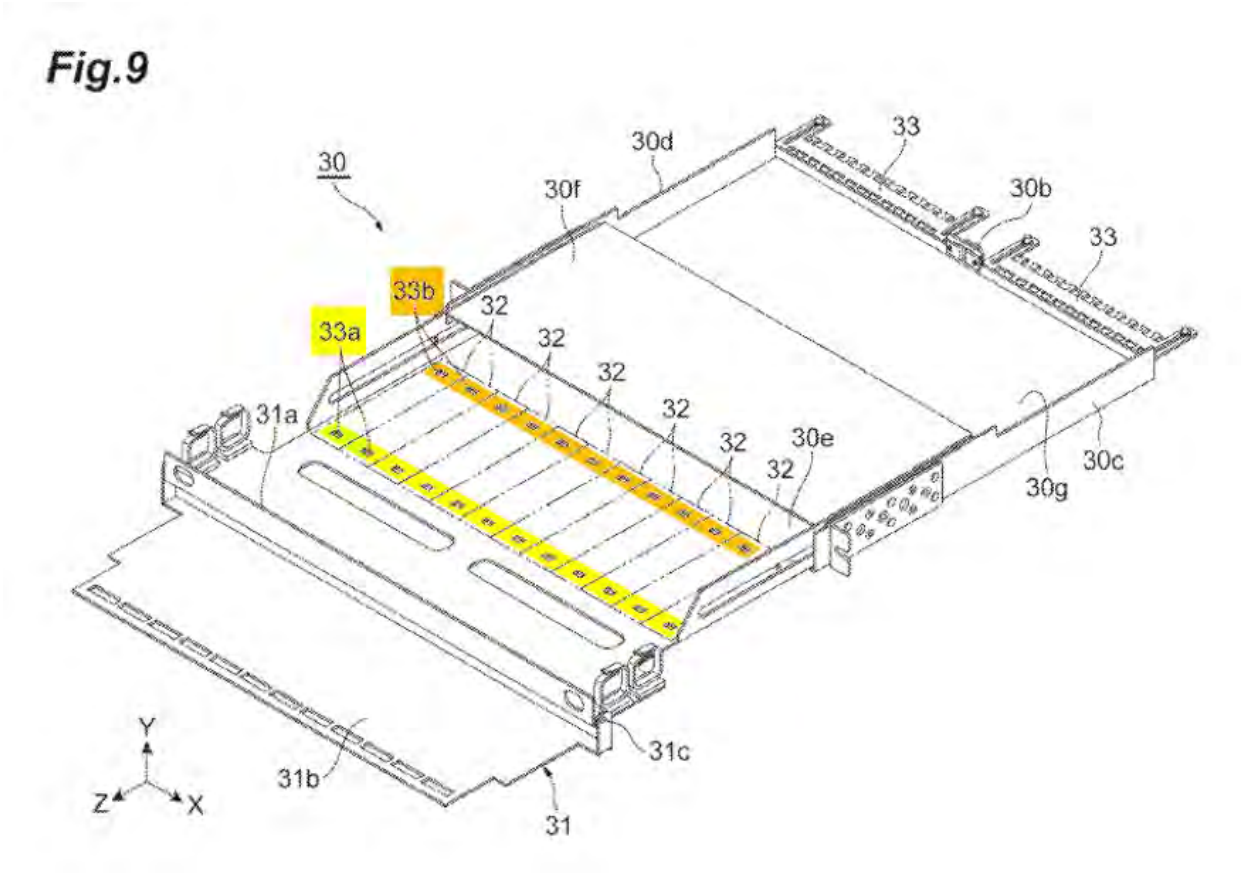


EX1004, Fig. 8 (cropped). The user can use the finger-sized indent to pull the module forward (using a finger or tool) and disengage the front hook and then lift the module up and backward to disengage the whole module

12. Element 1K

139. Element 1K recites: "wherein the tray includes a plurality of cassette engaging portions that are configured to conform to the standard one width (1 W) so as to support the modular two standard width (2 W) cassette, the modular three standard width (3 W) cassette, the modular four standard width (4 W) cassette, and the modular six standard width (6 W) cassette." Fukui discloses this.

140. Fukui's tray includes a plurality of holes (33a, 33b) arranged in two roles:

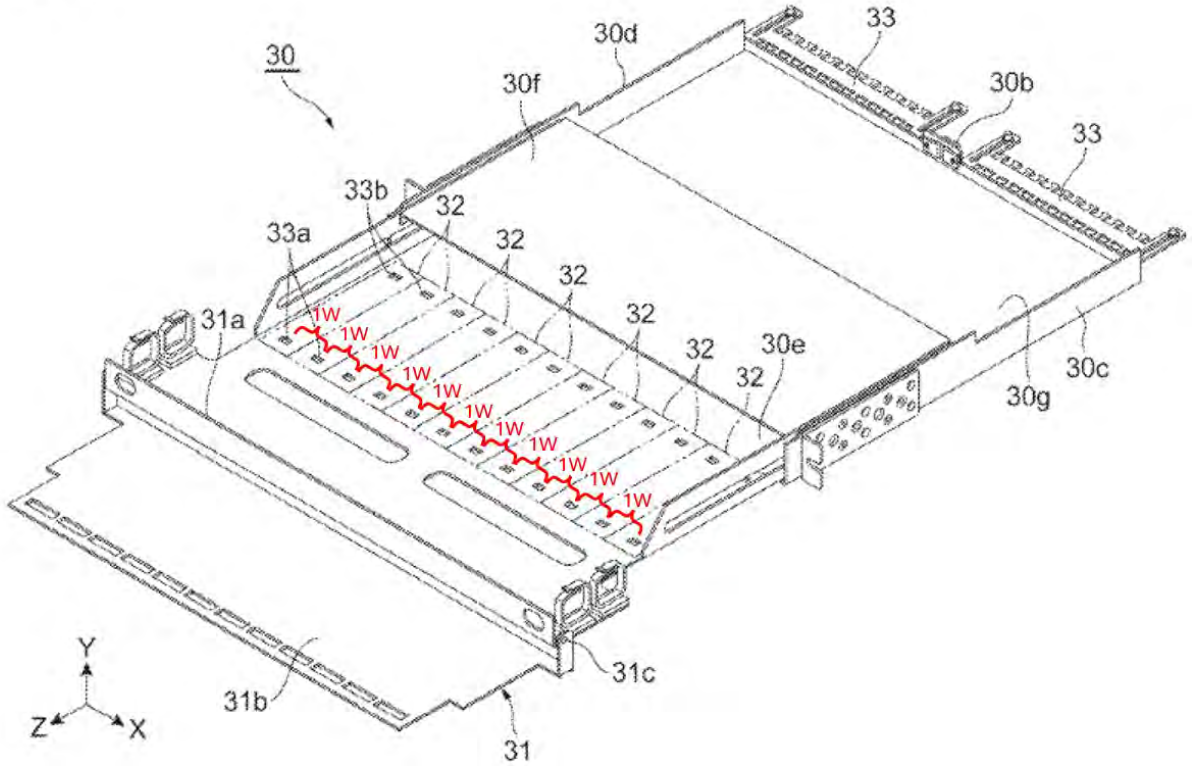


Fukui's holes are *"a plurality of cassette engaging portions."* Fukui's two rows of holes engage the corresponding two hooks on the bottom of each module. EX1004, 8:52-55 ("Two holes 33a and 33b are provided to each of these areas 32, and two hooks 11i and 11j (see FIG . 2) protruding from the bottom face of the housing 11 of each conversion module 10 *engage* with these holes 33a and 33b such that conversion module 10 is easily fixed to the base member 30."), Fig. 2.

141. Fukui's holes "*conform to the standard one width*." Each set of holes supports one module 10, i.e., one standard width unit. EX1004, 8:52-55, Figs. 8-9.

Each set of holes is one area 32 for one module 10. *Id.* Furthermore, Fukui's holes are spaced apart at a pitch of one standard width. Fukui's tray supports 12 single modules, i.e., 12 standard one width units. EX1004, Fig. 8, 9:36-37 ("12…modules 10"). Figure 8 shows that the holes for each of these standard one width units are evenly spaced apart, i.e., each hole is spaced apart at a pitch of one standard width:

Fig.9



Each row of holes has 12 evenly spaced holes to match the 12 evenly spaced standard one width units, i.e., 12 holes spaced apart at a pitch of one standard width.

142. Fukui's disclosure is very similar to Patent Owner's preferred embodiment. In Patent Owner's preferred embodiment, the cassette engaging portions include twelve slots (38):

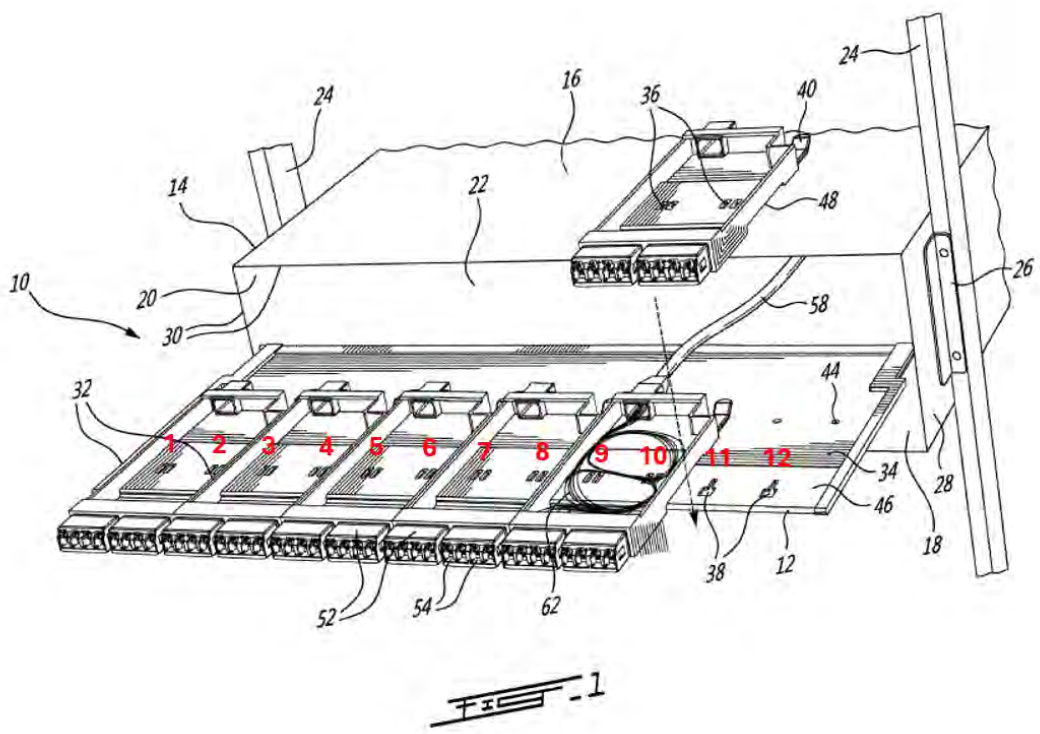


FIG. 1

EX1001, Fig. 1. Patent Owner's preferred cassette engaging portions conform to the standard one width unit because they are evenly spaced apart at a pitch of one standard width unit. Fukui, as just discussed, discloses these same features. Fukui's cassette engaging portions include twelve holes that are evenly spaced apart at a pitch of one standard width unit.

143. Fukui's cassette engaging portions (the holes) can also "support" two, three, four, and six standard width unit cassettes. The different size cassettes are simply a number of the same modules 10 that already engage with the holes

coupled together. EX1004, 8:3-6 ("the required number of the same shape unit modules are prepared"), 7:27-28 ("unit modules…are the same as that of the conversion module 10"). The different size cassettes simply engage with the corresponding number of holes like this:

Fig.9

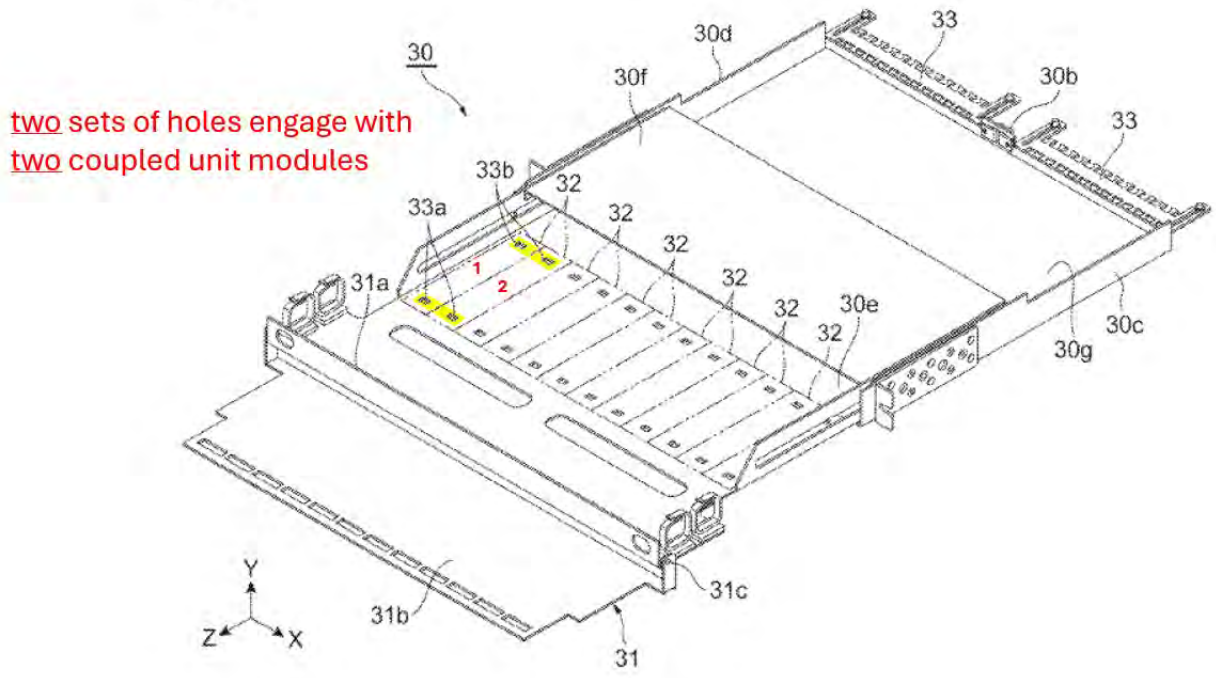


Fig.9

three sets of holes engage with three coupled unit modules

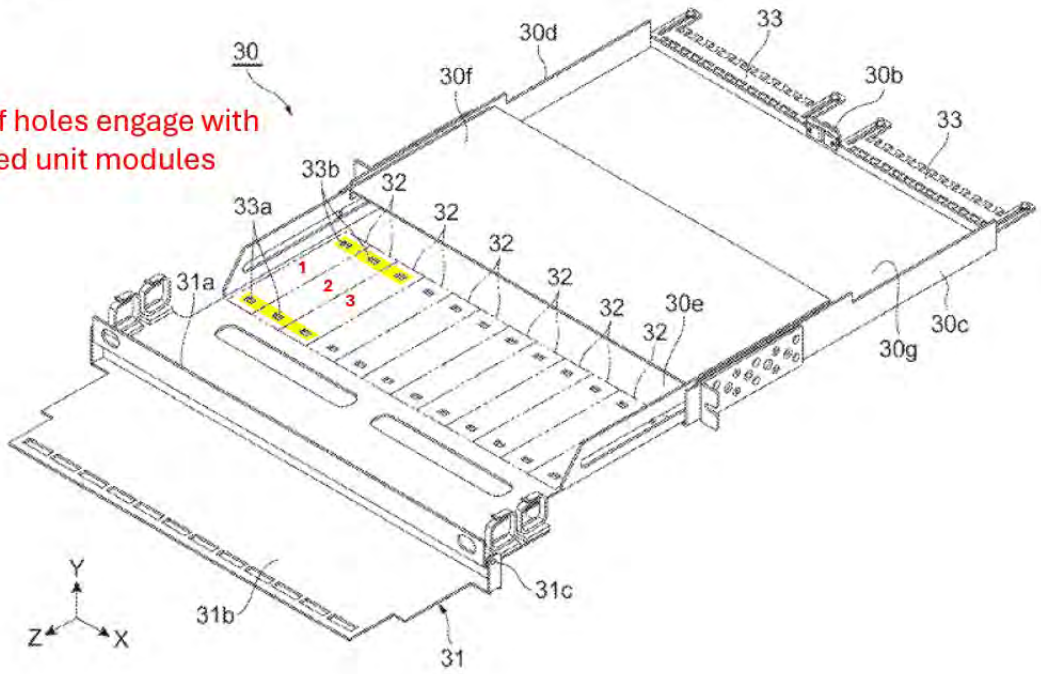


Fig.9

four sets of holes engage with four coupled unit modules

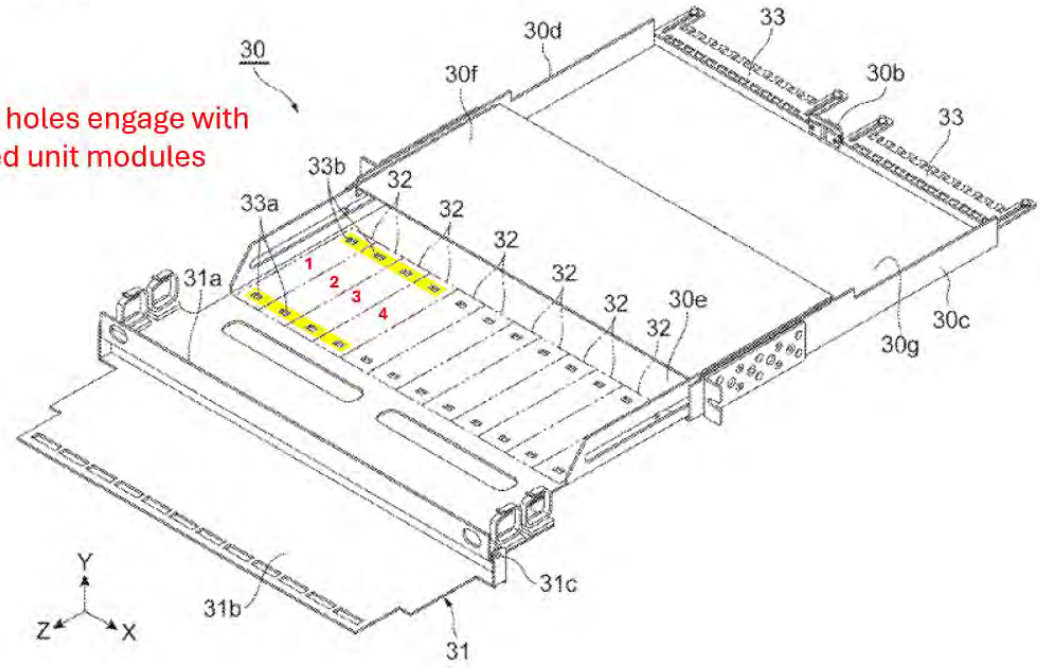
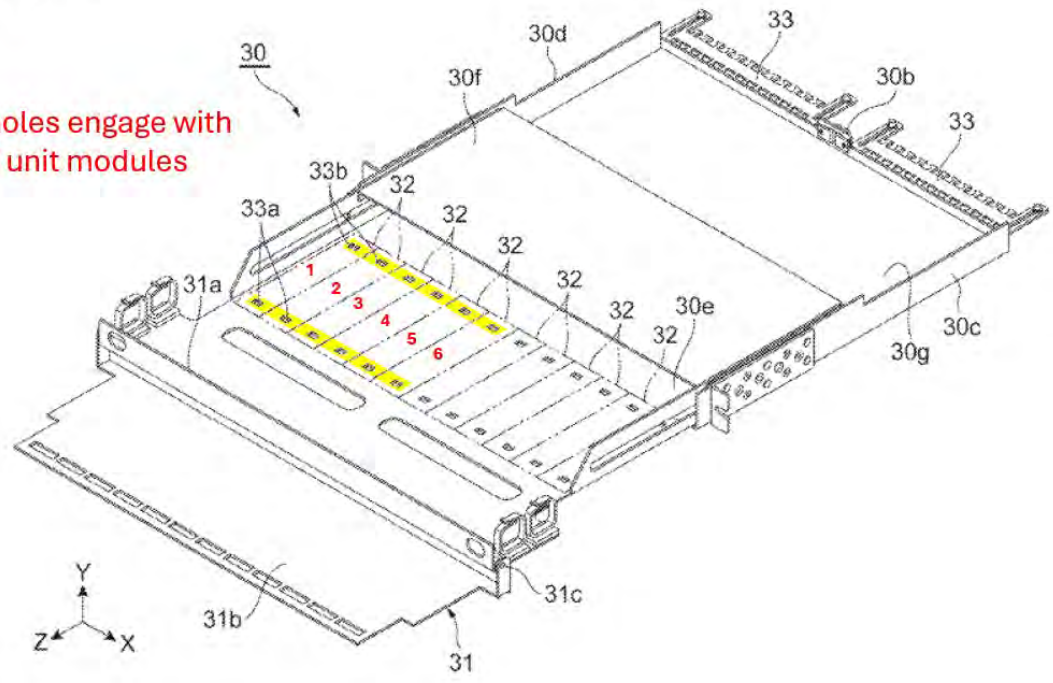


Fig.9

six sets of holes engage with
six coupled unit modules



B. Independent Claim 9

144. In nearly all respects, independent claim 9 recites substantially the same limitations as Claim 1 or is broader than claim 1. As shown in the comparison of claim 1 and claim 9 below, Claim 9 eliminates several limitations from claim 1. For example, Claim 9 does not include equivalent language for claim elements 1A and 1I, and portions of Element 1D. With one notable exception (Element 9B addressed below), Claim 9 does not add any substantial limitation that is not already disclosed or rendered obvious by Fukui for the reasons already given under Claim 1.

Comparison of Claim 1 to Claim 9 of the '423 Patent[5]	
(Preamble) 1. A tray for providing a plurality of different modular fiber optic cassette configurations in a standard U-space fiber optic management system comprising:	(Preamble) 9. A tray for providing a plurality of different modular fiber optic cassette configurations in a standard U-space fiber optic management system comprising:
(Element 1A) a tray having a first tray side end portion and a second tray side end portion defining a tray width portion that extends between the first tray side end portion and the second tray side end portion;	
(Element 1B) wherein the tray width portion fits within a standard U-space width dimension;	(Element 9A) a tray configured to fit in a standard U-space and
(Element 1C) wherein the tray is configured to fit a plurality of different modular fiber optic cassette configurations in the tray width portion in a standard U-space fiber management system;	support a plurality of different modular fiber optic cassette configurations in the standard U-space;
(Element 1D) wherein each of the plurality of different modular fiber optic cassette configurations include a modular fiber optic cassette that is configured to support a receptable module having a first	(Element 9B) wherein each of the plurality of different modular fiber optic cassette configurations includes a plurality of different sizes of modular fiber optic cassettes;

[5] Note that although not included in the claims as originally published in the '423 patent, a certificate of correction inserted a "W" after the numeral 2 at several places in claim 9 (and later claims), which I indicate here using brackets.

module side end portion and a second module side end portion defining a module width portion that extends between the first tray side end portion and second tray side end portion;	
(Element 1E) wherein the module width portion is configured to fit in a standard one width (1 W) unit;	(Element 9C) wherein each of the plurality of different sizes of modular fiber optic cassettes is configured to support a fiber optic receptable module that is configured to fit in a standard one width (1 W) unit;
(Element 1F) wherein each of the modular fiber optic cassettes includes a first cassette side end portion and a second cassette side end portion defining a standard cassette width unit extending between the first cassette side end portion and the second cassette side end portion that comprises a standard two width (2 W) unit, a standard three width (3 W) unit, a standard four width (4 W) unit, or a standard a standard six width (6 W) unit relative to the standard one width (1 W) unit;	(Element 9D) wherein the plurality of different sizes of modular fiber optic cassettes include a 2[W] cassette size that is configured to fit a standard two width (2 W) unit relative to the standard one width (1 W) unit, a 3 W cassette size that is configured to fit a standard three width (3 W) unit relative to the standard one width (1 W) unit, a 4 W cassette size that is configured to fit a standard four width (4 W) unit relative to the standard one width (1 W) unit, and a 6 W cassette size that is configured to fit a standard six width (6 W) unit relative to the standard one width (1 W) unit;
(Element 1G) wherein the receptable module is configured to fit at least four fiber optic plug receiving receptacle portions in a standard one width (1 W) unit;	

(Element 1H)	(Element 9E)
wherein the plurality of different modular fiber optic cassette configurations comprise:	wherein the plurality of different modular fiber optic cassette configurations comprise:
a first modular fiber optic cassette configuration that includes six modular two standard width unit (2 W) cassettes that are each arranged side by side of each other along the tray such that a cassette side end portion of each modular two standard width (2 W) cassette adjacently faces a cassette side end portion of at least one other modular two standard width (2 W) cassette;	a first modular fiber optic cassette configuration that includes six modular 2[W] standard width unit size cassettes that are each arranged side by side of each other along the tray such that a cassette side end portion of each modular 2[W] standard width unit size cassette adjacently faces a cassette side end portion of at least one other modular 2[W] standard width size cassette;
a second modular fiber optic cassette configuration that includes four modular three standard width unit (3 W) cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of each modular three standard width (3 W) cassette adjacently faces a cassette side end portion of at least one other modular three standard width (3 W) cassette;	a second modular fiber optic cassette configuration that includes four modular 3 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of each modular 3 W standard width size cassette adjacently faces a cassette side end portion of at least one other modular 3 W standard width size cassette;
a third modular fiber optic cassette configuration that includes three modular four standard width unit (4 W) cassettes that are each arranged side by side of each other in a row along the tray such that a	a third modular fiber optic cassette configuration that includes three modular 4 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side

cassette side end portion of each modular four standard width (4 W) cassette adjacently faces a cassette side end portion of at least one other modular four standard width (4 W) cassette;	end portion of each modular 4 W standard width size cassette adjacently faces a cassette side end portion of at least one other modular 4 W standard width size cassette;
a fourth modular fiber optic cassette configuration that includes two modular six standard width unit (6 W) cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of one of the two modular six standard width (6 W) cassettes adjacently faces a cassette side end portion of the other modular six standard width (6 W) cassette; and	a fourth modular fiber optic cassette configuration that includes two modular 6 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of one of the two modular 6 W standard width size cassettes adjacently faces a cassette side end portion of the other modular 6 W standard width size cassette; and
a fifth modular fiber optic cassette configuration that includes three modular two standard width unit (2 W) cassettes, which are each arranged side by side of each other in a row along the tray such that a cassette side end portion of one of the three modular two standard width (2 W) cassettes adjacently faces a cassette side end portion of one of the other modular two standard width (2 W) cassette, and one modular six standard width unit (6 W) cassette that is arranged side by side in a row along the tray with one of the three modular two standard width unit (2 W) cassettes, such that a	a fifth modular fiber optic cassette configuration that includes three modular 2[W] standard width unit size cassettes, which are each arranged side by side of each other in a row along the tray such that a cassette side end portion of one of the three modular 2[W] standard width size cassettes adjacently faces a cassette side end portion of one of the other modular 2[W] standard width size cassette, and one modular 6 W standard width unit size cassette that is arranged side by side in a row along the tray with one of the three modular 2[W] standard width unit size cassettes, such that a cassette side

cassette side end portion of the one modular six standard width unit (6 W) cassette adjacently faces a cassette side end portion of one of the other three modular two standard width unit (2 W) cassettes; (Element 1I) wherein each modular two standard width (2 W) cassette is configured to fit two receptacle modules; wherein each modular three standard width (3 W) cassette is configured to fit three receptacle modules; wherein each modular four standard width (4 W) cassette is configured to fit four receptacle modules; wherein each modular six standard width (6 W) cassette is configured to fit six receptacle modules; (Element 1J) wherein the tray is configured to be removably secured to each modular fiber optic cassette when the tray fits the plurality of different modular fiber optic cassette configurations within the tray width portion in the standard U-space fiber management system; and	end portion of the one modular 6 W standard width unit size cassette adjacently faces a cassette side end portion of one of the other three modular 2[W] standard width unit size cassettes; (Element 9F) wherein the tray is configured to be removably secured to each modular fiber optic cassette when the tray fits the plurality of different modular fiber optic cassette configurations within a tray width portion in the standard U-space fiber management system; and

(Element 1K)	(Element 9G)
wherein the tray includes a plurality of cassette engaging portions that are configured to conform to the standard one width (1 W) so as to support the modular two standard width (2 W) cassette, the modular three standard width (3 W) cassette, the modular four standard width (4 W) cassette, and the modular six standard width (6 W) cassette.	wherein the tray includes a plurality of cassette engaging portions that are configured to conform to the standard one width (1 W) so as to support the modular 2[W] standard width unit size cassette, the modular 3 W standard width unit size cassette, the modular 4 W standard width unit size cassette, and the modular 6 W standard width unit size cassette.

1. Element 9B

"wherein each of the plurality of different modular fiber optic cassette configurations includes a plurality of different sizes of modular fiber optic cassettes"

145. The parties dispute the meaning of Element 9B. Ultimately, resolving the dispute is not necessary because Fukui discloses or renders obvious this limitation under either party's construction. Here are the two party's claim construction positions as presented in the district court action:

Claim Term	Patent Owner's Construction	Petitioner's Construction
"wherein each of the plurality of different modular fiber optic cassette configurations includes a plurality of different sizes of modular fiber optic cassettes" '423 Patent (Claim 9)	"Each of the plurality of different modular fiber optic cassette configurations includes a plurality of different sizes of modular fiber optic cassettes, such as the fifth modular fiber optic cassette configuration, which includes three modular 2 W standard width size cassettes and one modular 6 W standard width size cassettes"	"This requires each of the first, second, third, fourth, and fifth modular fiber optic cassette configurations includes a plurality of different sizes of modular fiber optic cassettes."

EX1011, Ex. A, p. 24.

146. Patent Owner has taken the position that satisfying Element 9E is one way to satisfy Element 9B. That is, if the tray supports the first through fifth configurations, which includes the fifth configuration in which there are three cassettes having the 2W cassette size and one cassette having the 6W cassette size, then that is sufficient to satisfy claim element 9B. In other words, configurations one, two, three, and four do not need to include multiple different sizes of cassettes. If this is the case, then Fukui discloses or renders obvious Claim Element 9B for the same reasons given in the analysis of Claim Elements 1H and 1F which already address why each of the first through fifth configurations for Fukui.

147. The correct interpretation of Element 9B, however, is not satisfied merely by satisfying the fifth cassette configuration of Element 9E. Element 9B requires that "**each** of the plurality" of cassette configurations includes different sizes of cassettes. It is not satisfied by a single configuration, but must be met by "each" configuration in the plurality of configurations. Element 9E enumerates five different configurations that must be in the plurality. To satisfy Element 9B, each of the five configurations described in Element 9E, must also satisfy Element 9B. "Each of" means every one of two or more things.

148. To meet both 9B and 9E, the tray must be sized to support more than a total of 12W in cassette widths. For example, it would need to be wide enough to fit a total of 15W in cassette widths. With a wider tray that can support more than 12W of cassette width, both Elements 9B and 9E can be satisfied by one tray. The cassettes called for in each of the first, second, third, and fourth configurations could be supported on the tray in addition to at least one more cassette of a different width to satisfy Element 9B. For example, a tray that was wide enough to support a total of 15W of cassette widths would meet both claim limitations. Populating the 15W wide tray with six 2W cassettes and one 3W cassette would occupy the entire tray and would be a configuration that satisfies both the "first" configuration of 9E as well as the requirement of 9B (two different cassette sizes). Likewise, populating a 15W wide tray with four 3W cassettes and one 2W cassette

would occupy fourteen out of the fifteen available spaces in the tray and would satisfy both 9B and the "second" configuration of Element 9E. The same analysis applies to the third and fourth configurations.

149. There is nothing in claim 9 that limits the tray to fit **only** 12W in cassette widths. Claim 9 does require that the tray "fit in a standard U-space." As explained in the analysis of claim Element 1B, the standard that defines the dimensions of a U-space provides that there are three standard panel widths which are: 19 inches, 24 inches, or 30 inches (482.6 mm, 609.6 mm, 762.0 mm respectively).

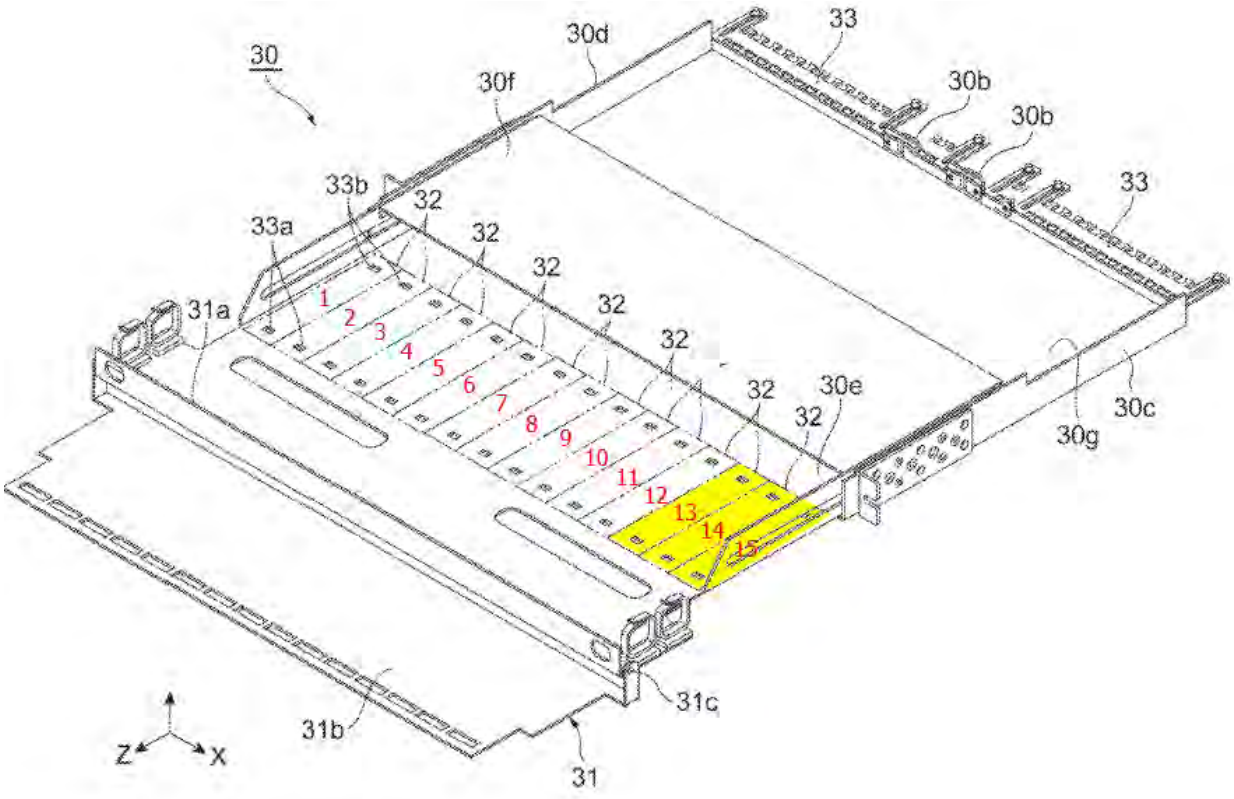
4.1 Classification
EIA-310-C identified three cabinet or rack openings to accommodate each of three standard panel widths 482.6 mm, 609.6 mm and 762.0 mm. The preferred panel width is 482.6 mm.

EX1008 at p. 2. Note that 482.6 mm equals 19 inches; 609.6 mm equals 24 inches; and 762.0 mm equals 30 inches. The three widths are sometimes referred to as 19 inch, 24 inch and 30 inch racks (Version E of the standard was written to convert these dimension from imperial inches into metric millimeters). EX1008 p. 1 ("EA-310-E Section 4 is the soft metric conversion of superseded EIA-310-C to conform with U.S. Public Law 100-418."). The "U" space defined in the standard refers to the amount of vertical space for any of the three standard panel widths.

150. Although Fukui discloses its tray fits within a standard 19 inch rack, it would have been equally obvious to one of ordinary skill in the art that the same system could be modified for use in either of the two the larger standard sizes (24

inch or 30 inch panels) to accommodate more cassettes on one tray. A POSITA would recognize that if 12W of cassette width could fit in Fukui's tray for a 19 inch panel, then scaling proportionally (which is a conservative estimate because all of the additional space could be used for expanding the capacity of the tray) a tray for a 24 inch panel could fit at least 15W of cassette width. Likewise, scaling proportionally, a 30 inch panel could fit at least 18W of cassette width.

151. The figures below illustrate that a tray that fits within a standard 24 inch U-space system be configured to fit 15 width units include space for an additional 3W in cassette width:



152. Claim 9, also suggests that the tray contemplated by the claims could have more than 12W of total cassette capacity. Claim 16 recites:

> 16. The tray of claim 9, wherein the tray has first tray end portion, a second tray end portion spaced away from the first tray end portion so as to define a tray width extending between the first tray end portion and the second tray end portion, and wherein the tray width is configured to support **at least twelve** standard one width (1 W) units side by side along the tray.

By reciting "at least twelve" units side by side along the tray, the patentee expressly allowed for the claims to read on trays that support **more than** twelve width units.

153. A POSITA would be motivated to use a larger standard panel and tray width for customers who already have existing racks in these larger sizes and to make most efficient use of valuable and limited available rack space. A POSITA would have a reasonable expectation of success because no new functionality would be required, merely adding additional width to support 15W rather than merely 12W in total cassette width.

2. Other differences between Claim 9 and Claim 1

154. For completeness I note that claim 9 recites that the tray is configured to "support" a plurality of cassette configurations where claim 1 recited that the tray is configured to "fit" a plurality of cassette configurations. Fukui's tray both supports and fits the cassettes. The bottom wall of Fukui's tray supports each cassette configuration mounted to the tray.

155. I also note that claim 9 refers to "a standard U-space" where claim 1 referred to a "standard U-space width." To the extent there is any difference between these two phrases, both are disclosed based on Fukui's disclosures of a "standardized…1U size." EX1004, 9:33-34; *see also* EX1004, 9:35-37 ("For example, in the case of the conversion module 10, up to 1 tier×12 rows of the modules 10, that is, 144 single-core optical connector adapters 13 in total are housed in 1U size.")

156. Each of the other limitations in Claim 9 are disclosed or rendered obvious by Fukui alone for the reasons given for corresponding language in the discussion of Claim 1 as set forth in the table below:

Preamble of Claim 9:	See Preamble of Claim 1.
Element 9A:	See Preamble of Claim 1, Element 1B, and Element 1C.
Element 9C:	See Element 1E, 1D.
Element 9D:	See Element 1F.
Element 9E:	See Element 1H.
Element 9F:	See Element 1J.
Element 9G:	See Element 1K.

C. Independent Claim 17

157. As shown in the comparison of claims 9 and 17 below, independent claim 17 tracks almost verbatim the language of claim 9, except it is broader in the

following respects. Claim 17 eliminates Element 9F and eliminates the requirement for the "fifth" cassette configuration of 9E. Also, Claim 17 does not include the "each of" language that appears in Element 9B discussed above. Claim 17, therefore, is broader than Claim 9 and is, in fact, the broadest claim of the '423 patent.

Comparison of Claim 9 to Claim 17 of the '423 Patent[6,7]	
(Preamble) 9. A tray for providing a plurality of different modular fiber optic cassette configurations in a standard U-space fiber optic management system comprising:	(Preamble) 17. A tray for providing a plurality of different modular fiber optic cassette configurations in a fiber optic management system comprising:
(Element 9A) a tray configured to fit in a standard U-space and support a plurality of different modular fiber optic cassette configurations in the standard U-space;	(Element 17A) a tray member configured to support a plurality of different modular fiber optic cassette configurations in a standard U-space width;
(Element 9B) wherein each of the plurality of different modular fiber optic cassette configurations includes a plurality of different sizes of modular fiber optic cassettes;	(Element 17B) wherein the plurality of different modular fiber optic cassette configurations include different sizes of modular fiber optic cassettes;

[6] Note that although not included in the claims as originally published in the '423 patent, a certificate of correction inserted a "W" after the numeral 2 at several places in claim 17 (and later claims), which I indicate here using brackets.
[7] The designations in red are added for ease of reference.

(Element 9C) wherein each of the plurality of different sizes of modular fiber optic cassettes is configured to support a fiber optic receptable module that is configured to fit in a standard one width (1 W) unit;	(Element 17C) wherein each of the different sizes of modular fiber optic cassettes is configured to support a fiber optic receptable module that is configured to fit in a standard one width (1 W) unit;
(Element 9D) wherein the plurality of different sizes of modular fiber optic cassettes include a 2[W] cassette size that is configured to fit a standard two width (2 W) unit relative to the standard one width (1 W) unit, a 3 W cassette size that is configured to fit a standard three width (3 W) unit relative to the standard one width (1 W) unit, a 4 W cassette size that is configured to fit a standard four width (4 W) unit relative to the standard one width (1 W) unit, and a 6 W cassette size that is configured to fit a standard six width (6 W) unit relative to the standard one width (1 W) unit;	(Element 17D) wherein the plurality of different sizes of modular fiber optic cassettes include a 2[W] cassette size that is configured to fit a standard two width (2 W) unit relative to the standard one width (1 W) unit, a 3 W cassette size that is configured to fit a standard three width (3 W) unit relative to the standard one width (1 W) unit, a 4 W cassette size that is configured to fit a standard four width (4 W) unit relative to the standard one width (1 W) unit, and a 6 W cassette size that is configured to fit a standard six width (6 W) unit relative to the standard one width (1 W) unit;
(Element 9E) wherein the plurality of different modular fiber optic cassette configurations comprise: a first modular fiber optic cassette configuration that includes six modular 2[W] standard width unit size cassettes that are each arranged side by side of each other along the tray such that a cassette side end portion of each modular 2[W]	(Element 17E) wherein the plurality of different modular fiber optic cassette configurations comprise: a first modular fiber optic cassette configuration that includes six modular 2[W] standard width unit size cassettes that are each arranged side by side of each other along the tray member such that a cassette side end portion of each modular 2[W]

standard width unit size cassette adjacently faces a cassette side end portion of at least one other modular 2[W] standard width size cassette;	standard width unit size cassette adjacently faces a cassette side end portion of at least one other modular 2[W] standard width size cassette;
a second modular fiber optic cassette configuration that includes four modular 3 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of each modular 3 W standard width size cassette adjacently faces a cassette side end portion of at least one other modular 3 W standard width size cassette;	a second modular fiber optic cassette configuration that includes four modular 3 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray member such that a cassette side end portion of each modular 3 W standard width size cassette adjacently faces a cassette side end portion of at least one other modular 3 W standard width size cassette;
a third modular fiber optic cassette configuration that includes three modular 4 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of each modular 4 W standard width size cassette adjacently faces a cassette side end portion of at least one other modular 4 W standard width size cassette;	a third modular fiber optic cassette configuration that includes three modular 4 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray member such that a cassette side end portion of each modular 4 W standard width size cassette adjacently faces a cassette side end portion of at least one other modular 4 W standard width size cassette; and
a fourth modular fiber optic cassette configuration that includes two modular 6 W standard width unit size cassettes	a fourth modular fiber optic cassette configuration that includes two modular 6 W standard width unit size cassettes

that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of one of the two modular 6 W standard width size cassettes adjacently faces a cassette side end portion of the other modular 6 W standard width size cassette; and a fifth modular fiber optic cassette configuration that includes three modular 2[W] standard width unit size cassettes, which are each arranged side by side of each other in a row along the tray such that a cassette side end portion of one of the three modular 2[W] standard width size cassettes adjacently faces a cassette side end portion of one of the other modular 2[W] standard width size cassette, and one modular 6 W standard width unit size cassette that is arranged side by side in a row along the tray with one of the three modular 2[W] standard width unit size cassettes, such that a cassette side end portion of the one modular 6 W standard width unit size cassette adjacently faces a cassette side end portion of one of the other three modular 2[W] standard width unit size cassettes; (Element 9F) wherein the tray is configured to be removably secured to each	that are each arranged side by side of each other in a row along the tray member such that a cassette side end portion of one of the two modular 6 W standard width size cassettes adjacently faces a cassette side end portion of the other modular 6 W standard width size cassette; and

modular fiber optic cassette when the tray fits the plurality of different modular fiber optic cassette configurations within a tray width portion in the standard U-space fiber management system; and	
(Element 9G) wherein the tray includes a plurality of cassette engaging portions that are configured to conform to the standard one width (1 W) so as to support the modular 2[W] standard width unit size cassette, the modular 3 W standard width unit size cassette, the modular 4 W standard width unit size cassette, and the modular 6 W standard width unit size cassette.	(Element 17F) wherein the tray member is configured to conform to the standard one width (1 W) so as to support the modular 2[W] standard width unit size cassette, the modular 3 W standard width unit size cassette, the modular 4 W standard width unit size cassette, and the modular 6 W standard width unit size cassette.

158. Fukui alone discloses or renders obvious Claim 17 for the same reasons given above for the corresponding claim elements in Claims 9 and 1. See the chart below which identifies claim elements discussed for claims 1 and 9 that correspond to the language in each Element of claim 17. Claim 17 is therefore invalid as being disclosed or obvious for the same reasons given as provided above for the corresponding language in Claims 1 and 9.

Element of Claim 17	Corresponding Claim Language and Analysis
Preamble of Claim 17:	See Preamble of Claims 9 and 1.

Element 17A:	See Element 9A, Preamble of Claim 1, Element 1B, and Element 1C.
Element 17B:	See Element 17E, and the discussion below.
Element 17C:	See Element 9C, 1E, 1D.
Element 17D:	See Elements 9D, 1F.
Element 17E:	See Elements 9E, 1H.
Element 17F:	See Elements 9F, 1J.
Element 17G:	See Element 9G, 1K.

159. I note that Claim 17 recites a "tray member" instead of simply a "tray." Fukui's bottom panel (element 30e) is an example of both a tray and a "tray member." There is no material difference between these two terms for the purpose of applying Fukui.

160. Element 17B does not recite that "each of" the plurality of cassette configurations must include different sizes of cassettes. Instead, it merely recites that "the plurality" of cassette configurations includes different sizes of cassettes. Here, unlike claim Element 9B/9E, satisfying the four configurations recited in Element 17E will satisfy Element 17B because taken collectively, not individually, the four configurations recited do include multiple different sizes of cassettes. Therefore, Element 17B is satisfied for the same reasons that Element 17E (and 9E, and 1H) is satisfied.

161. Element 17F is also broader than Element 9F. Element 17F generically says the "the tray member" is configured to conform to the standard one width. Element 9F more specifically says the "cassette engaging portions" of the tray are configured to conform to the standard one width (1 W). Because Fukui teaches the more specific example in Element 9F, Fukui also disclose the more generic claim language in Element 17F. Said another way, a tray with cassette engaging portions that are configured to conform to the standard one width (1 W) as disclosed in Fukui is an example of a tray member that is configured to conform to the standard one width.

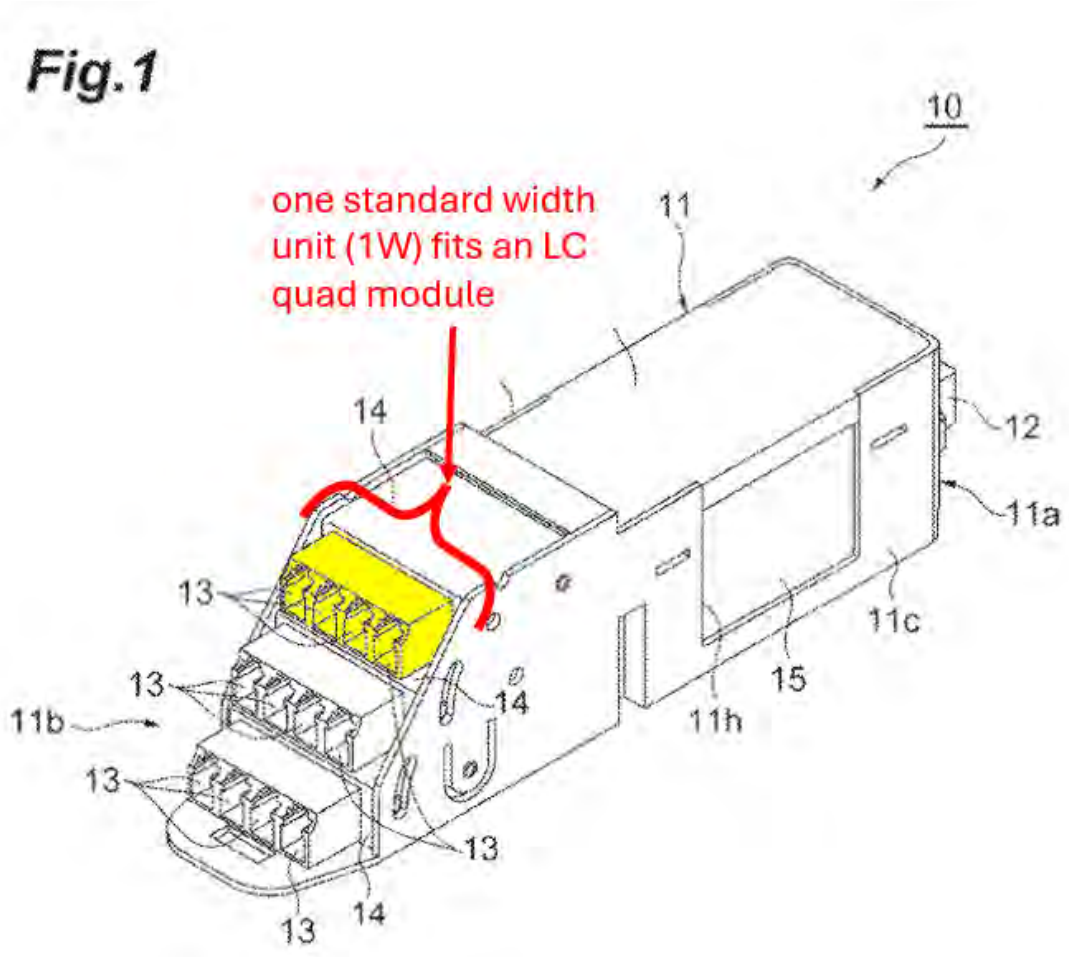
D. Dependent Claims 2, 10, 18

162. These claims add the limitation: "wherein the standard one width (1 W) unit is based on a standard SC Duplex width unit that is configured to fit a plurality of different type of LC, SC, and MPO connectors."

163. PO's specification further explains this limitation. PO's specification explains: "In a particular embodiment the pitch/width W is based on a LC Quad (SC Duplex) technology footprint"). EX1001, 8:58-59. The parenthetical recognizes that a width based on an LC quad technology footprint is also based on the SC Duplex technology footprint. That is PO's preferred embodiment. This is because the LC quad technology is specifically designed to fit in the SC Duplex technology footprint. The LC connector was specifically designed to fit in ½ the

size of an SC connectors. Thus, the footprint of four (quad) LC connectors is based on the footprint of two (dual) SC connectors (4 * ½ = 2).

164. Like PO's preferred embodiment, Fukui's standard one width unit is based on the LC quad technology footprint and thus, as recognized by the parenthetical in PO's specification, is also based on the SC duplex technology footprint. Fukui's standard one width unit is the width of one unit module 10. *See* Element 1E. Figure 1 shows that the width of Fukui's one unit module fits a LC quad module:

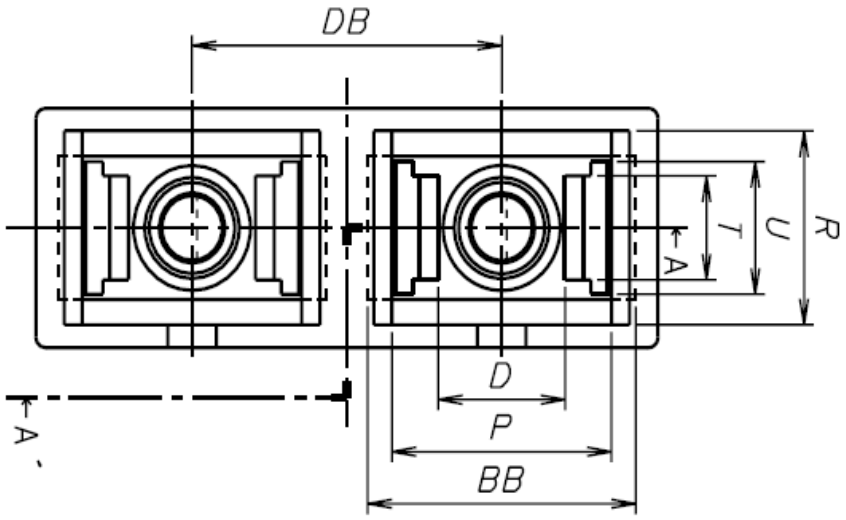


As already explained, the quad LC footprint is itself based on the SC duplex footprint; thus, Fukui's standard width unit also corresponds to the SC duplex footprint.

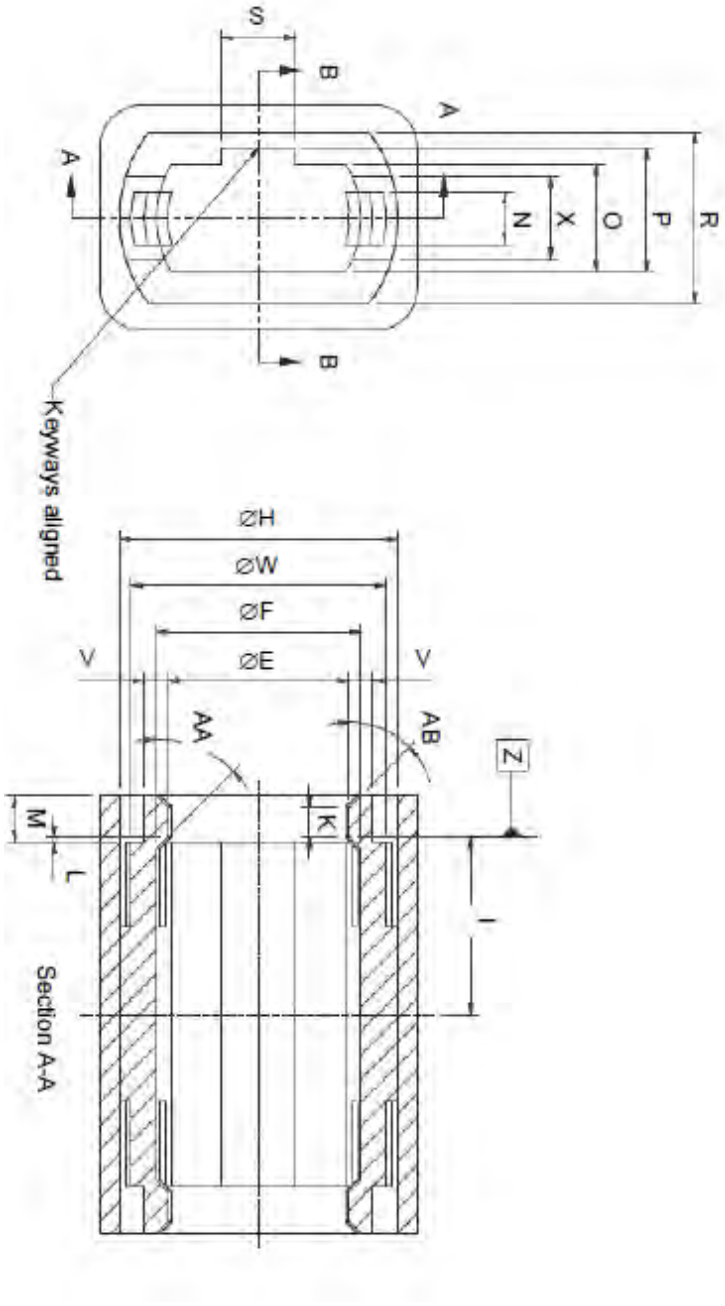
165. Said another way, Patent Owner cannot deny that Fukui's standard width unit is at least indirectly based on the standard SC duplex width unit because Patent Owner's own specification recognized that a standard width based on an LC quad technology footprint is also based on the SC Duplex technology footprint.

166. The final part of the limitation in these claims merely recognizes a property of the standard SC Duplex width unit, which Fukui is based upon as already explained. The claims recite "a standard SC Duplex width unit that is configured to fit a plurality of different type of LC, SC, and MPO connectors." First, by definition, an SC "duplex" width unit is configured to fit a plurality of SC connectors because the "duplex" refers to two SC connectors. Second, an SC duplex width unit is also configured to fit a plurality of LC connectors because, as explained by PO's specification, the SC technology footprint is the same as the LC quad footprint, i.e., four LC connectors fit in the same footprint as the two SC connectors. Third, an SC duplex width unit is configured to fit a plurality of MPO connectors because the width of an MPO connector was standardized such that it corresponds to the width of an SC connector. To explain this more, recall that

Fukui's standard width unit fits an LC quad receptacle module that is 25.6 mm – 25.9 mm per IEC 61754-20 for LC connectors. That same width does fit two SC connectors and two MPO connectors per the standards for SC and MPO connectors. SC connectors. Per IEC 61754-4 for SC connectors, the SC duplex adapter footprint is standardized as follows:



If you add DB and BB to get the inner width, the result is 23.65 – 23.95 mm, which fits within the 25.6 mm – 25.9 mm width dimension discussed above for Fukui's quad LC adapter modules. MPO connectors. Per IEC 61754-7-1 for MPO connectors, the MPO adapter footprint is standardized as follows



The “H” dimension is 12.6 mm. 12.6 x 2 for two MPO adapters for two MPO connectors is 25.2 mm, which fits within the 25.6 mm – 25.9 mm width dimension discussed above for Fukui’s quad LC adapter modules.

E. Dependent Claims 3, 11, 19

167. These claims similarly specify that the plurality of cassette engaging portions of the tray are *"spaced apart from one another so as to conform to the standard one width (1 W)"* and *"support"* the modular two standard width (2 W) cassette, the modular three standard width (3 W) cassette, the modular four standard width (4 W) cassette, and the modular six standard width (6 W) cassette. Fukui discloses this for the same reason discussed for Element 1K above. Element K also explains that the cassette engaging portions are arranged in a "*row*" (as required by claim 19).

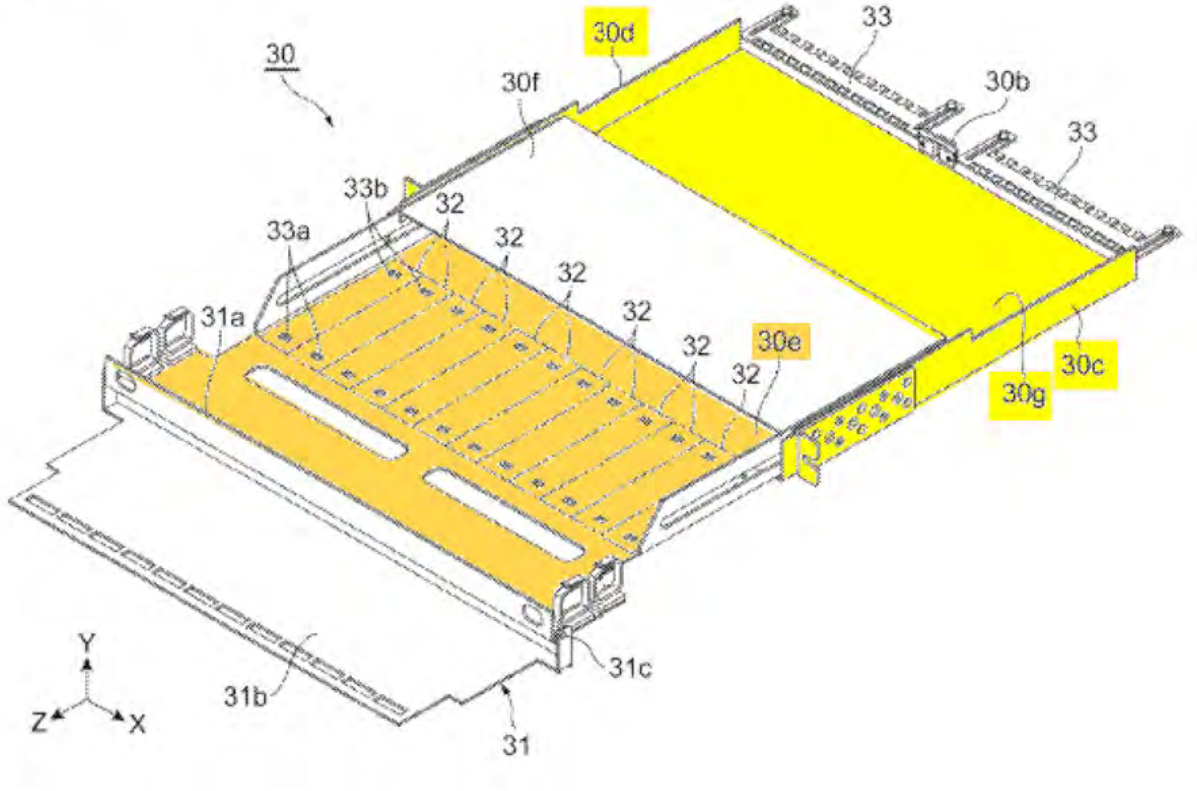
F. Dependent Claims 4, 12, 22

168. These claims add the limitations that the tray / tray member is configured to be "slidingly received in at least [a] portion of a [tray / tray member] receiving space of a case of a fiber optic management system." Fukui discloses this.

169. As discussed in the independent claims, above, Fukui's bottom panel (element 30e) is the recited *"tray"* and *"tray member."*

170. Fukui's bottom panel is configured to be "slidingly received" in at least a portion of receiving space of a case of a fiber optic management system. Figure 9 shows Fukui's bottom panel (orange) slid out from Fukui's case (yellow):

Fig.9

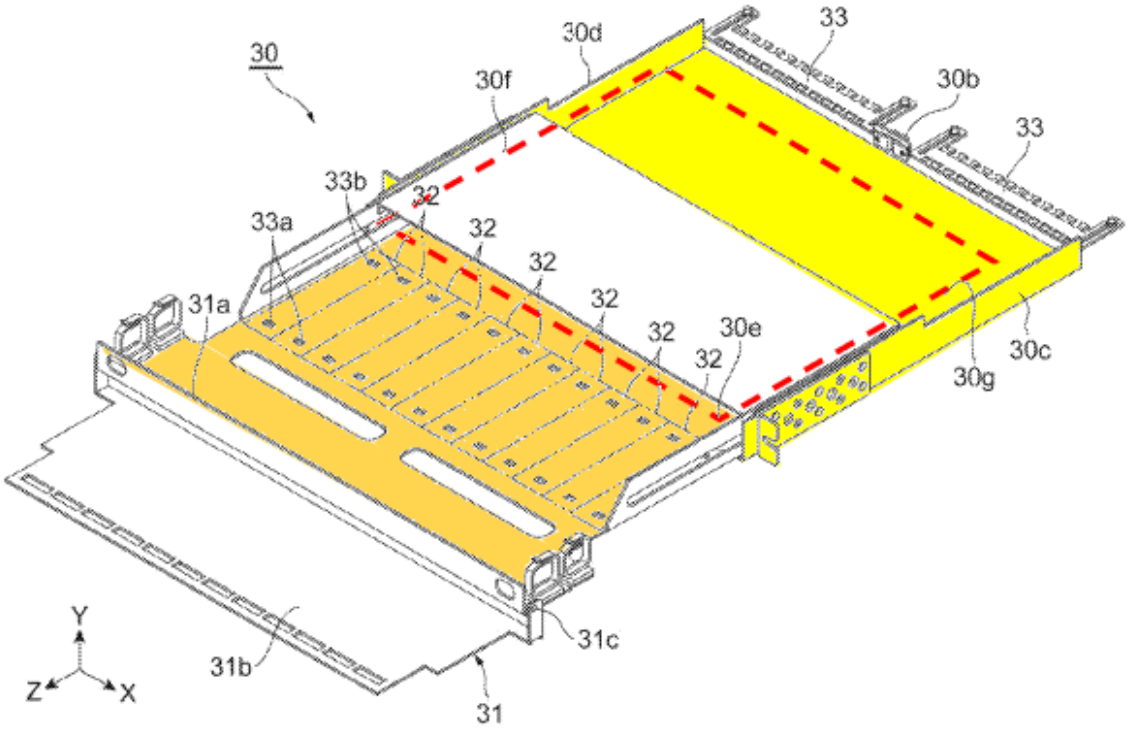


Fukui explains that the yellow structure—bottom panel 30g and lateral faces 30c and 30d—are formed into "one body." EX1004, 8:58-60. This "one body" define Fukui's case. The bottom wall of Fukui's case is partially obscured because the bottom of Fukui's tray (30e) overlaps and covers up the bottom wall. Figure 7 further shows

171. Fukui case defines a *tray receiving space."* The dashed red lines below show the approximates tray receiving space of Fukui's case. Figure 6 shows

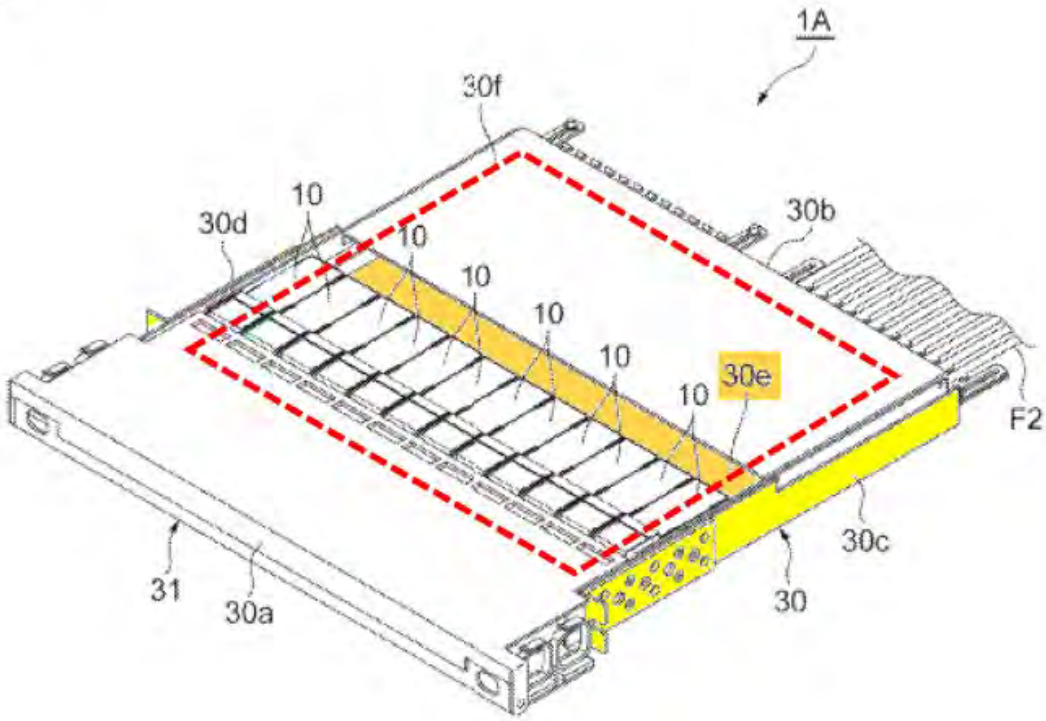
the tray slid out of that space:

Fig.9



172. Fukui's tray is configured to be "*slidingly received in at least a portion of a tray receiving space*." Figure 6 shows Fukui's tray slid back into the tray receiving space:

Fig.6



Fukui's case (yellow) is "hollow" and the tray can be slid back into the hollow space that defines a tray receiving space. EX1004, 8:26.

173. Fukui's tray (30e) is "slidable" in the "Z direction." EX1004, 8:57-62 ("attached to be slidable to these bottom panel 30g and lateral faces 30c and 30d in the Z direction"). [8] The Z direction correspond to sliding in and out of Fukui's housing:

[8] Fukui also claims this feature. Fukui, claim 16.

Fig.6

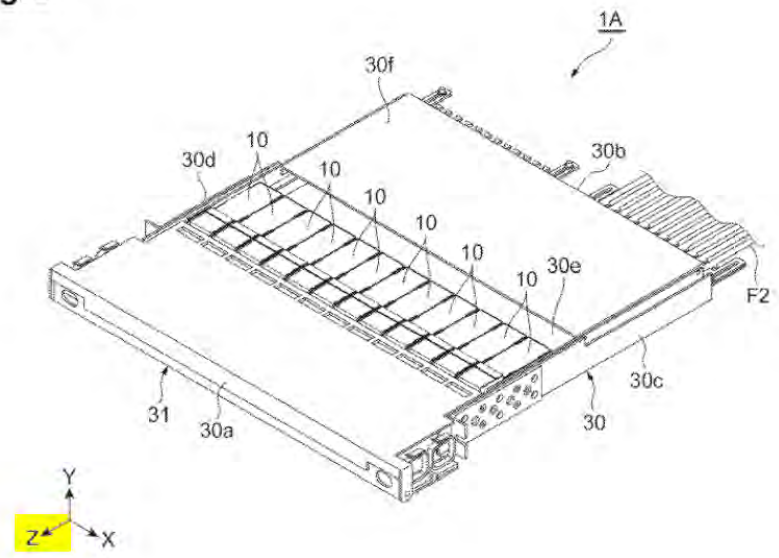
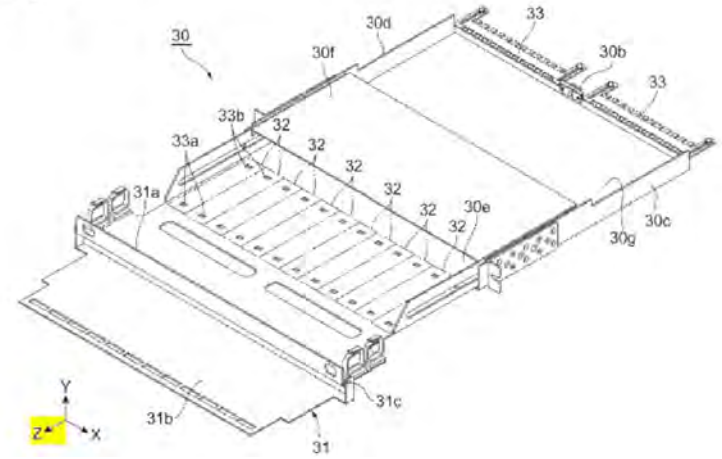
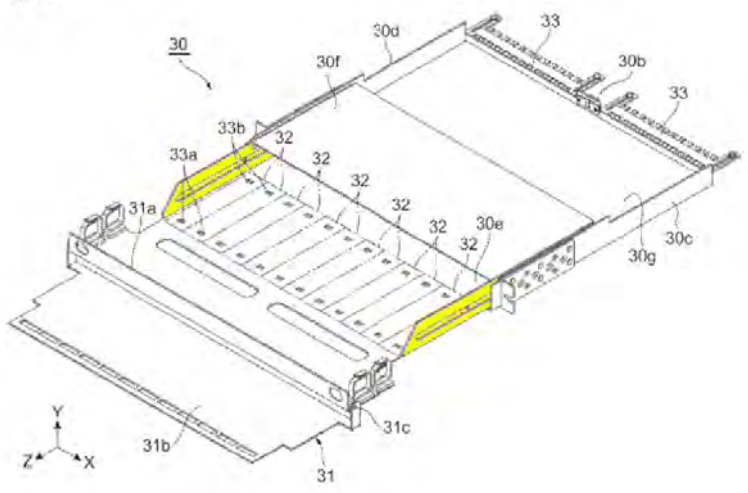


Fig.9



EX1004, Figs. 6, 9. Figure 9 also shows Fukui's tray has attached side walls with a groove for sliding in and out of Fukui's case:

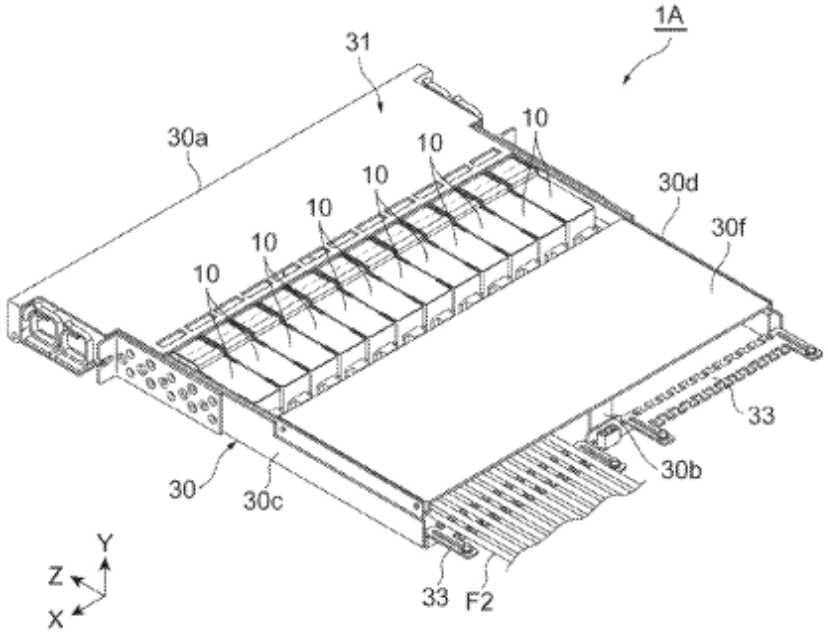
Fig.9



174. Lastly, Fukui's case is part of a "*fiber optic management system.*"

Fukui shows its cases receives fiber optic cables (F2) in the rear:

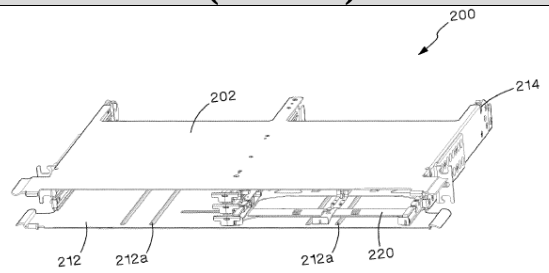
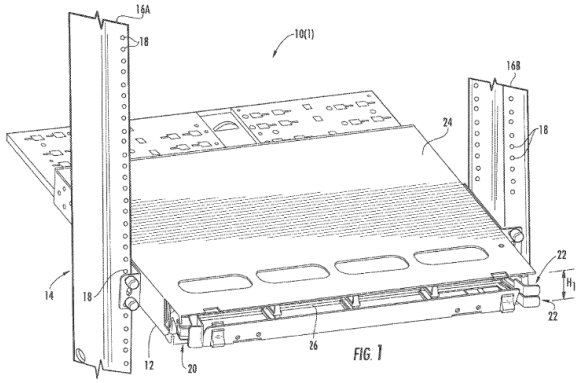
Fig.7



Fukui system (30) manages the connections between the cables (F2) in the rear and the fiber optic connectors that are plugged into the front of Fukui's modules. Fukui also manages supporting cables with "various" numbers of cores (e.g., 12, 24, 36, and 48) by coupling different numbers of unit modules 10 together to form larger modules to support the "various number" of cores as needed. EX1004, 3:27-28, 4:2-3, 4:42-43, 9:58-59, 10:4-6, 10:34-35.

175. If Patent Owner argues the term "case" requires a top wall, a POSITA would find this element obvious because it was common knowledge that a case could have a top wall.

176. The prior art cited on the face of PO's patent shows it was common for the housing with a top wall and includes five examples:

U.S. Patent No. 10,215,944 (EX1005)	**U.S. Patent No. 9,008,485 (EX1018)**
 FIG.44 EX1005, Fig. 44, 7:32-35.	 FIG. 1 EX1018, Fig. 1, 3:67.
U.S. Patent No. 9,075,216 (EX1019)	**U.S. Patent Pub. No. 2016/0062050 (EX1020)**

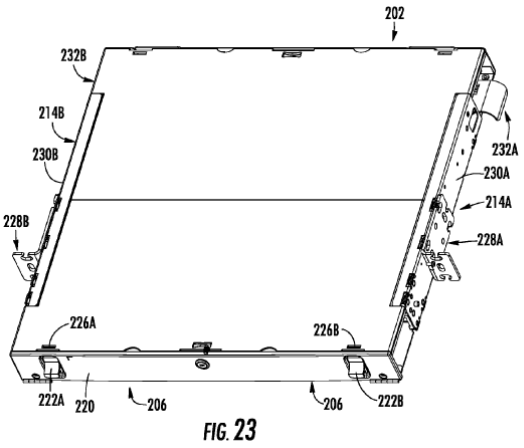


FIG. 23

EX1019, Fig. 23, 16:15-29, Figs. 24-27, 17:13-15.

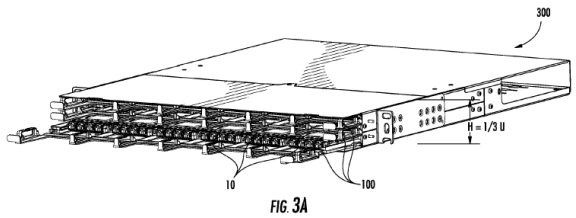
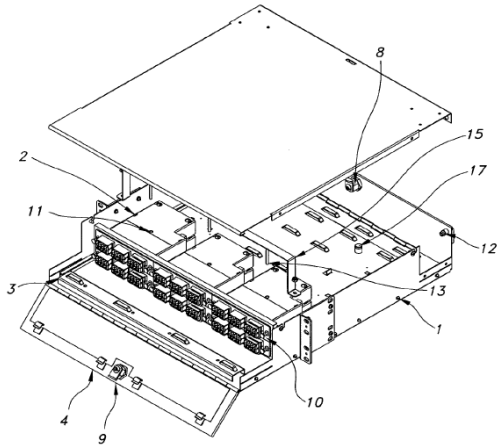


FIG. 3A

EX1020, Fig. 3A-3C, 10D-10E, ¶0052, ¶0061.

U.S. Patent No. 7,509,015 (EX1017)



EX1017, Fig. 1-4, 4:12-15

177. The publicly available product literature in the industry also shows that the manufacturers of modular fiber optic cassettes systems at the time of PO's '423 patent (Leviton, Corning, Panduit) each advertised that the case had a top wall. Here is example from Leviton showing the housing had a top wall:



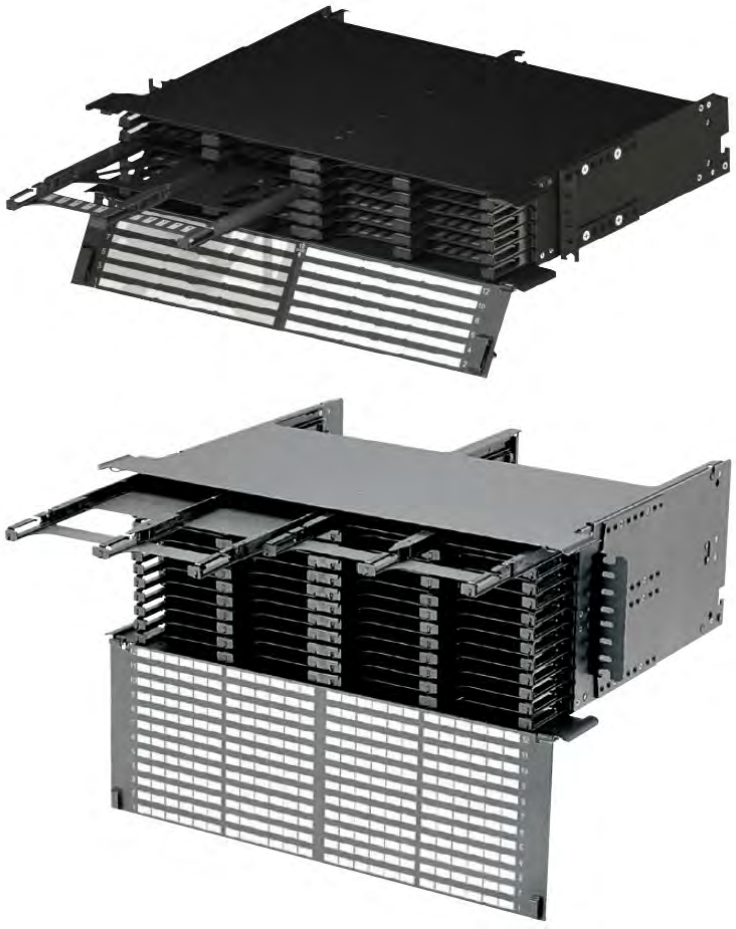
EX1022 at 4. Here are examples from Corning showing the housing had a top wall:





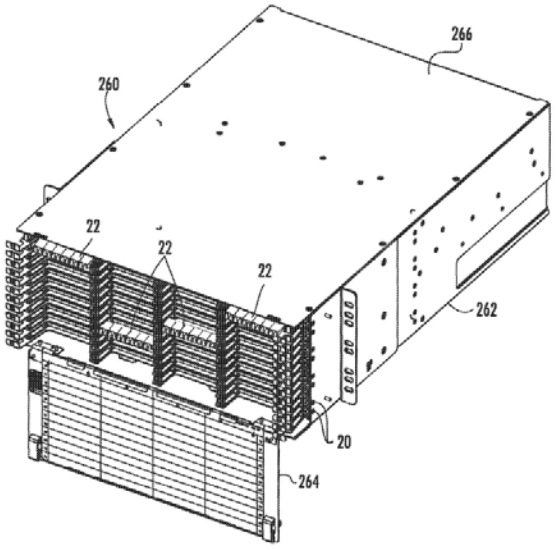


EX1023 at 4. Here is example from Panduit showing the housing had a top wall and:



EX1024 at 10.

178. Fukui's itself in the "Background" cites W02010/148325 that illustrates a housing with a top wall:



EX1004, 1:21 (citing W02010/148325); EX1025 (W02010/148325**)**, Fig. 25, ¶0087 ("A cover 266 is attached").

179. It is especially appropriate to consider the common knowledge the feature at issue (a top wall) is indisputably simple. A top wall is merely an ordinary, flat piece of metal.

180. Fukui itself discloses a partial top panel (30f) attached to the side walls of the tray bottom and a lid (32) attached to the front of the tray that flips up to partially cover the top:

Fig.9

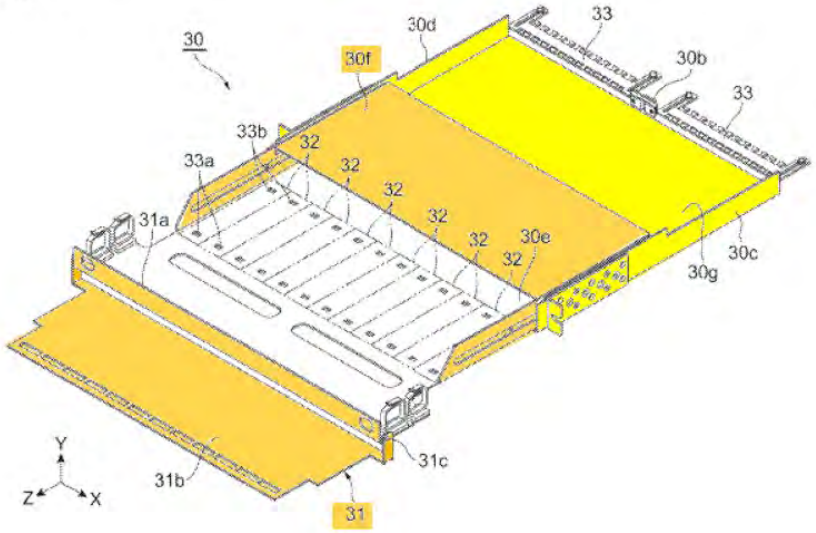
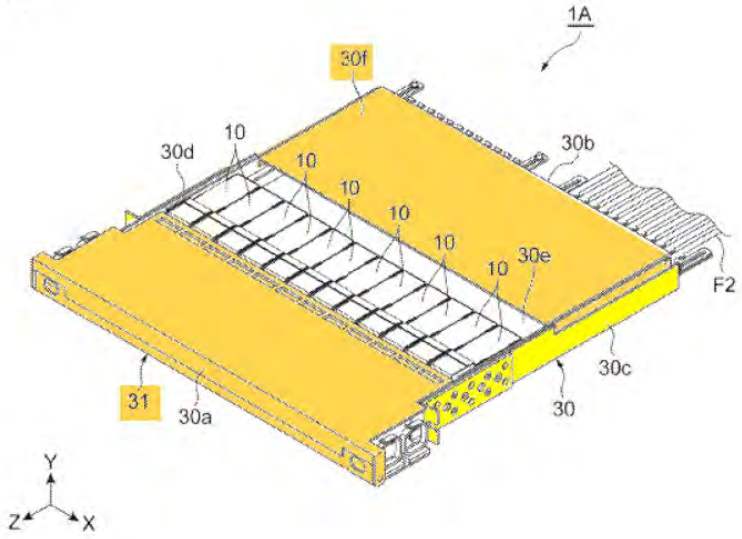


Fig.6



EX1004, Figs. 6, 9, 8:34-42, 8:29-3. Fukui's modules, however, are not full protected from the top because there is a gap (white) where there is no top.

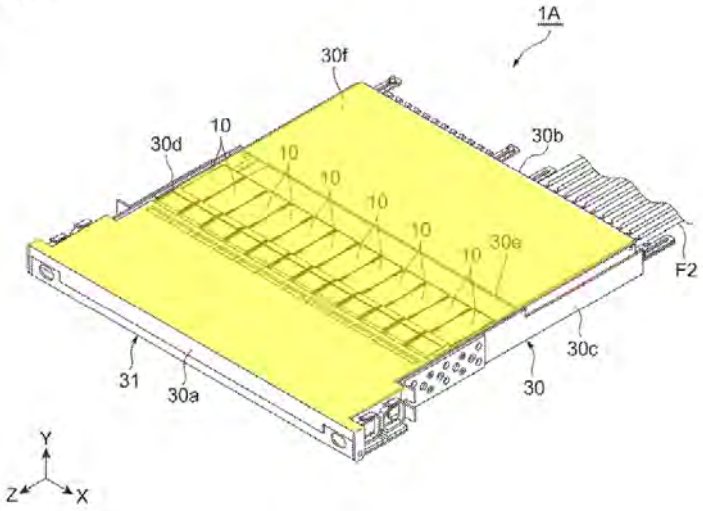
181. A POSITA would have been motivated to add a top wall to Fukui's housing (yellow) to better protect Fukui's system. Fukui's current design leaves a gap in the top. Environmental elements (e.g., dust, water, etc.) can enter through

this gap. Components, tools, and other materials could also be accidentally dropped into this gap. The modules and cables also could be accidentally bumped through this gap. Fiber optic components are sensitive and even minor movement, damage, or obstruction (e.g., dust) can impeded the proper propagation of light. Adding a top wall would predicably better protect the system because that is the very purpose of a top wall.

182. A POSITA would also recognize that modifying Fukui's case to have a top wall merely calls for a simple substitution of one known element for another, i.e., a case with a top for a case without a top. A top wall is an ordinary piece of metal that can be added with screws. Nothing in PO's disclosure describes a top wall as inventive. Likewise, Fukui does not teach there is anything critical about its existing case other than that it fits in a 19-inch rack. EX1004, 9:30-35.

183. A POSITA would also recognize that modifying Fukui's case to have a top wall is a predictable variation of Fukui's existing disclosure. Fukui's existing top panel (30f) could simply be attached to the Fukui's side walls (30c and 30d) instead of Fukui's tray and extended to the front:

Fig.6



184. A POSITA would also recognize that adding a top wall to the case simplifies Fukui's design. ¶¶80-82. Fukui's current design requires two partial top panels (30f and 31) attached to the tray that only achieve partial protection. EX1004, Figs. 6, 9, 8:34-42, 8:29-30. Fukui's current design also requires two steps to access the modules (flip up Fukui's lid and slide the tray out):

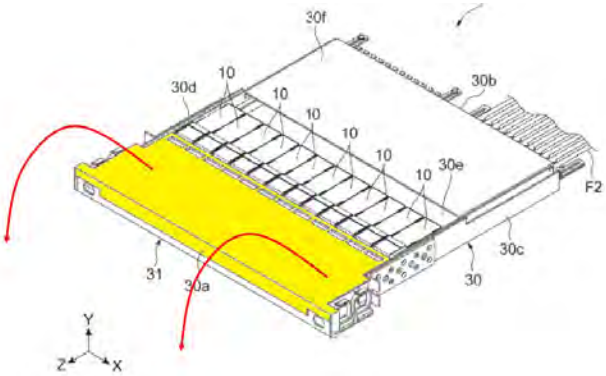
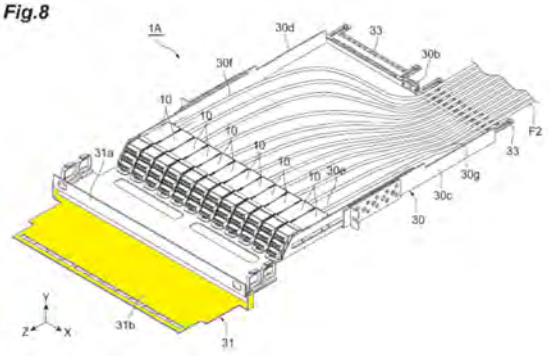


Fig.8

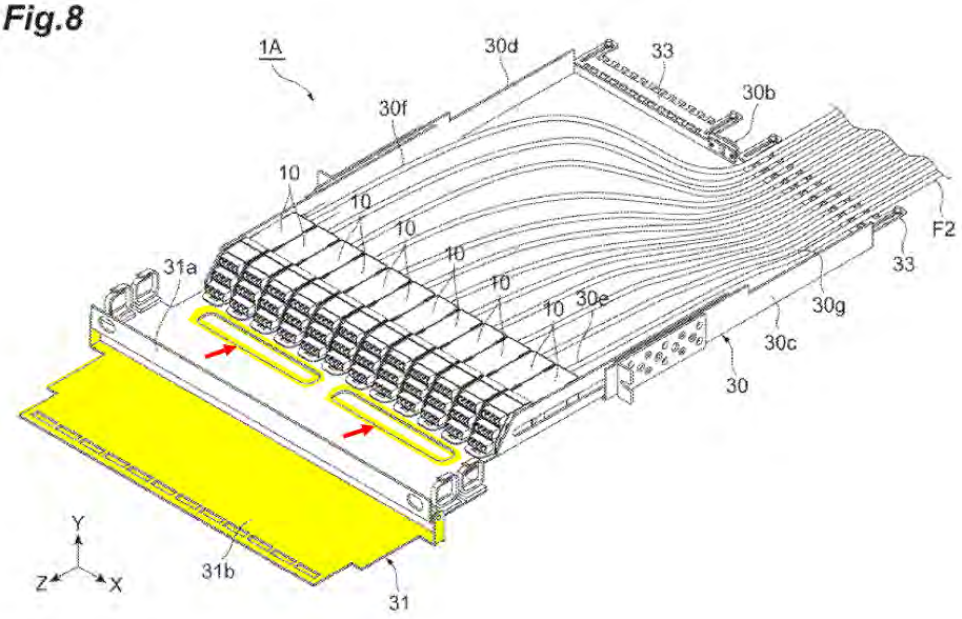


The pivoting lid also hangs down in front of the tray, which makes it more difficult for a technician who is standing in front. A POSITA could simply Fukui's design to one complete top panel attached to the case. This would simplify access to one

step (slide the tray out) and eliminate the problem of the pivoting partial top handing down in front.

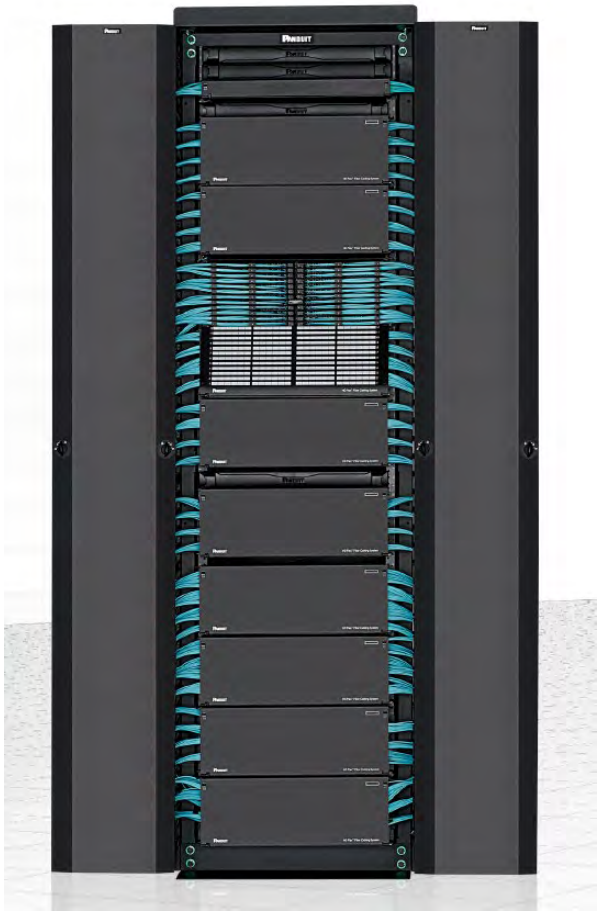
185. Replacing the pivoting lid with a conventional top wall would improve access for a second reason. The pivoting front lid hangs down in front when it opened:

Fig.8



Thus, the lid makes it more difficult for the technician to reach his hand into the tray and grab a connector between his thumb and forefinger from both above and below via the windows in the tray. In addition, the technician standing in front must stand farther back and reach farther in to access the modules. Eliminating the lid in favor of a conventional top wall would avoid these issues.

186. Fukui's pivoting lid is also cumbersome and potentially interferes with other units in the rack. Multiple units are stacked one on top of the other in a rack:



Fukui's system would require either (a) extra clearance above each case (to leave room for the front lid to flip up) or (b) extra clearance in front of the rack (to leave room for the tray to be pulled out far enough for the front lid to lip forward outside the case). Both are undesirable. Choice (a) would reduce the number of units that could be populated in a rack. Choice (b) would require the rack to be spaced apart farther from other nearby racks, units, or walls. Telecommunication racks are often

installed in an equipment room. It is desirable to have efficient designs to allow for more equipment and racks to be placed in the room (for example, multiple rows of racks).

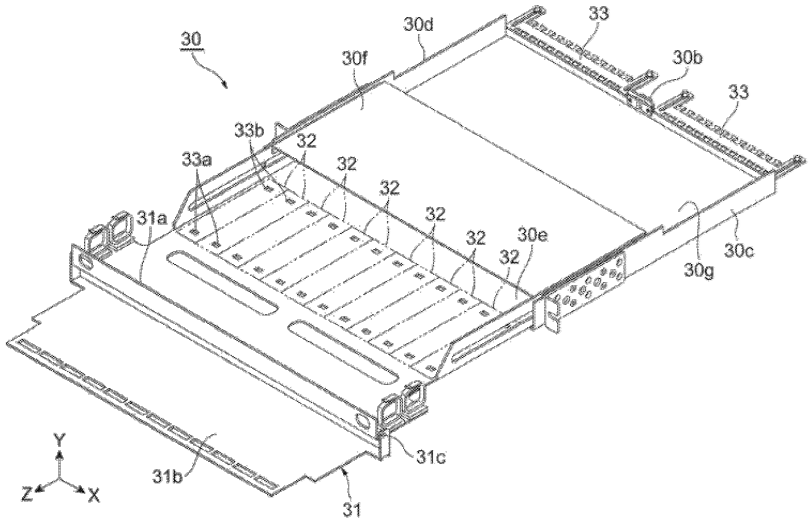
187. ***Reasonable expectation of success***. Adding a top wall merely requires screws and a piece of metal. A top wall is merely an ordinary, flat piece of metal that can be added with screws. Fukui's existing top panel (30f) could simply be attached to the Fukui's side walls (30c and 30d) instead of Fukui's tray and extended to the front as shown above. Fukui does not teach there is anything special or critical about its existing case other than that it fit in a 19-inch rack; thus, there is no teaching away.

G. Dependent Claims 5, 13, 23

188. These claims add the limitation: "wherein each of the modular fiber optic cassettes includes a cassette side end portion that is directly adjacent to a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations." This limitation requires a side end portion of each cassette be *"directly adjacent"* the side end portion of another cassette. Fukui discloses this.

189. Fukui modules are all placed in areas 32 shown in Figure 9 below. Figure 9 shows that Fukui's areas (32) for placing the modules are directly adjacent with no intervening structure:

Fig.9



190. Figure 6-8 show that the outer side edges of the modules are directly adjacent when they are placed in these areas:

Fig.8

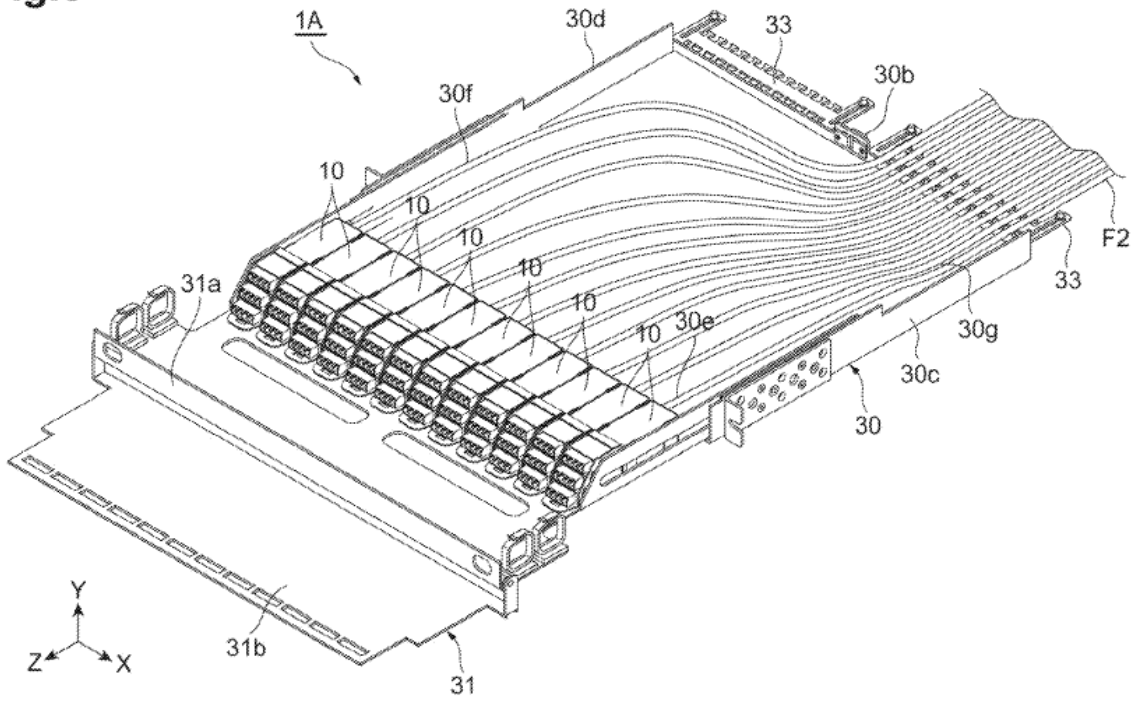

1A
30d
33
30b
30f
10
31a
F2
30e
30g
30c
30
31b
31
Y
Z
X

Fig.6

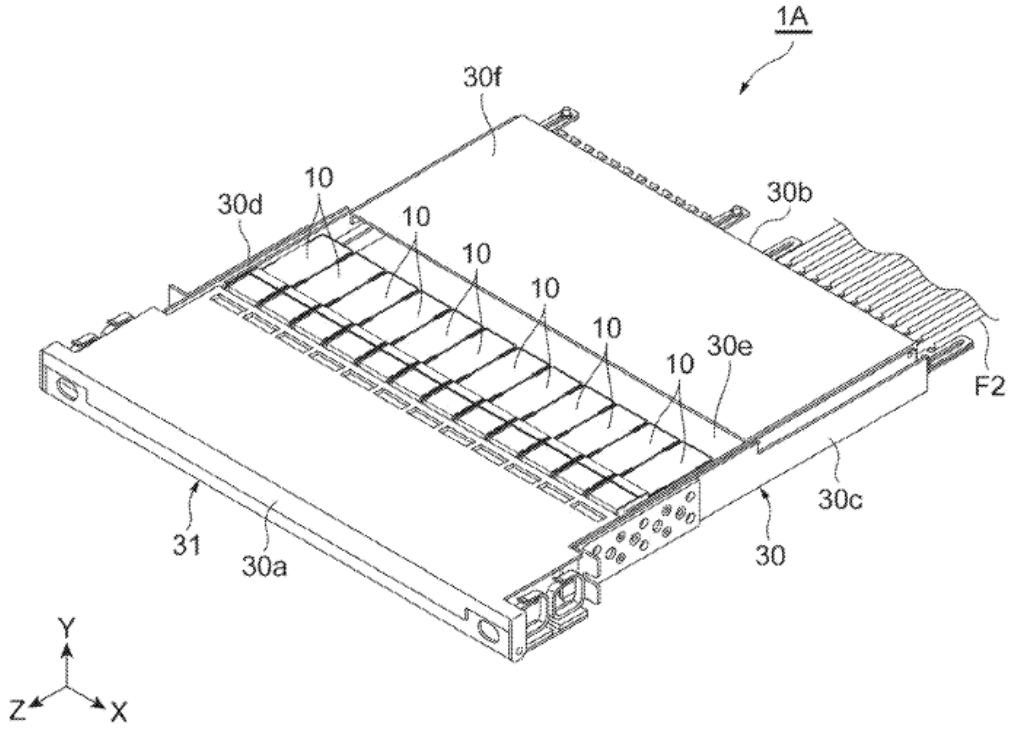
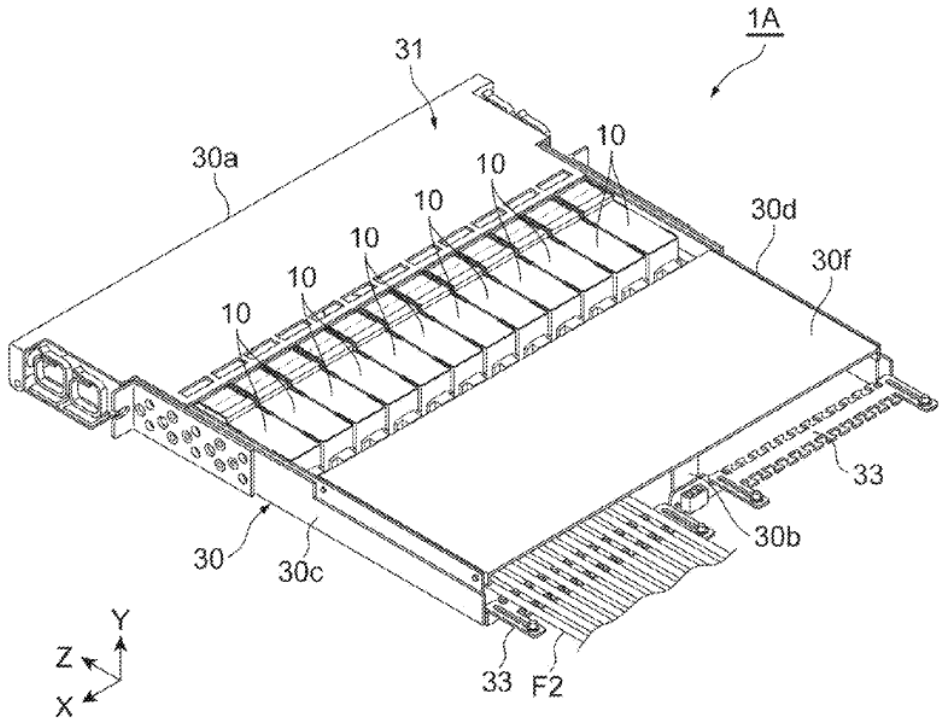

1A
30f
30d
10
30b
30e
F2
30c
31
30a
30
Y
Z
X

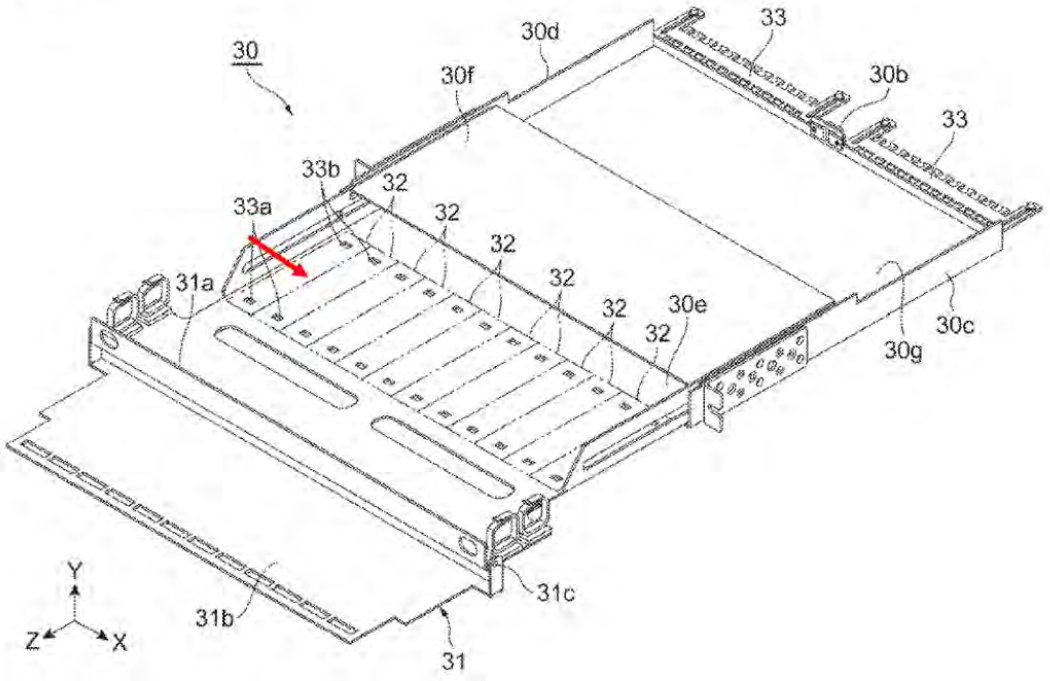
Fig.7



EX1004, Figs. 6-8, 4:36-37 ("adjacent lateral walls"). Because all the areas (32) are directly adjacent with no intervening structure and all the modules size comprises the same unit module 10 for placing in those areas, in all the configurations, the modules in adjacent areas will be directly adjacent to each other and there side end portions will be directly adjacent for the same reason.

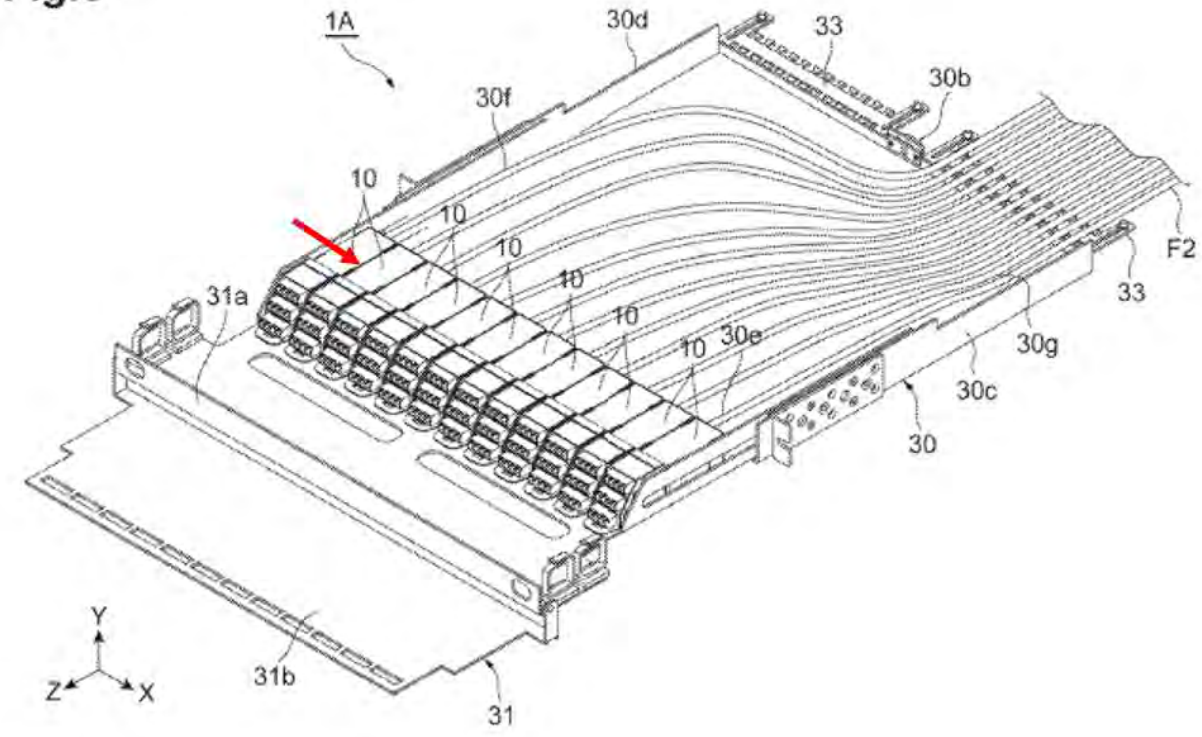
191. Fukui meets the proposed constructions of "directly adjacent" from both parties. Fukui's disclosure meets the requirement of *"almost touching or touching"* recited in both constructions. Figure 9 shows the areas (32) for placing the modules so that they touch each other:

Fig.9



Figures 8 show the modules touch when installed those areas 32:

Fig.8



EX1004, Fig. 6. The sides of adjacent modules come together to a single black line with no gaps showing the modules touch. There are no rails to prevent the modules from touching.

192. Figure 9, above, also shows that areas (32) for placing Fukui's modules have no intervening structure between the modules such as rails. Fukui's modules attach directly to the tray bottom (via holes 32), which entirely avoids the issue of intervening structure to the sides such as rails. EX1004, 8:45-56.

H. Dependent Claims 6, 14, 24

193. These claims add the limitation: "wherein each of the modular fiber optic cassettes includes a cassette side end portion that is adjacent to a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations." This limitation requires a side end portion of each cassette be "*adjacent*" the side end portion of another cassette.

194. Fukui discloses claims 6, 14, 24 for the same reasons just discussed for claims 5, 13, and 23.

I. Dependent Claims 7, 15, 25

195. These claims add the limitation: "wherein each of the modular fiber optic cassettes includes a cassette side end portion that touches a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic

cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations." This limitation requires a side end portion of each cassette be "*touches*" the side end portion of another cassette. Fukui discloses this.

196. Each of Fukui's modules comprises either an individual module 10 or multiple modules 10 coupled together. Figure 6-8 shows Fukui's modules 10 arranged on Fukui's tray. Figure 6-8 show that the modules 10 touch the adjacent modules:

Fig.8

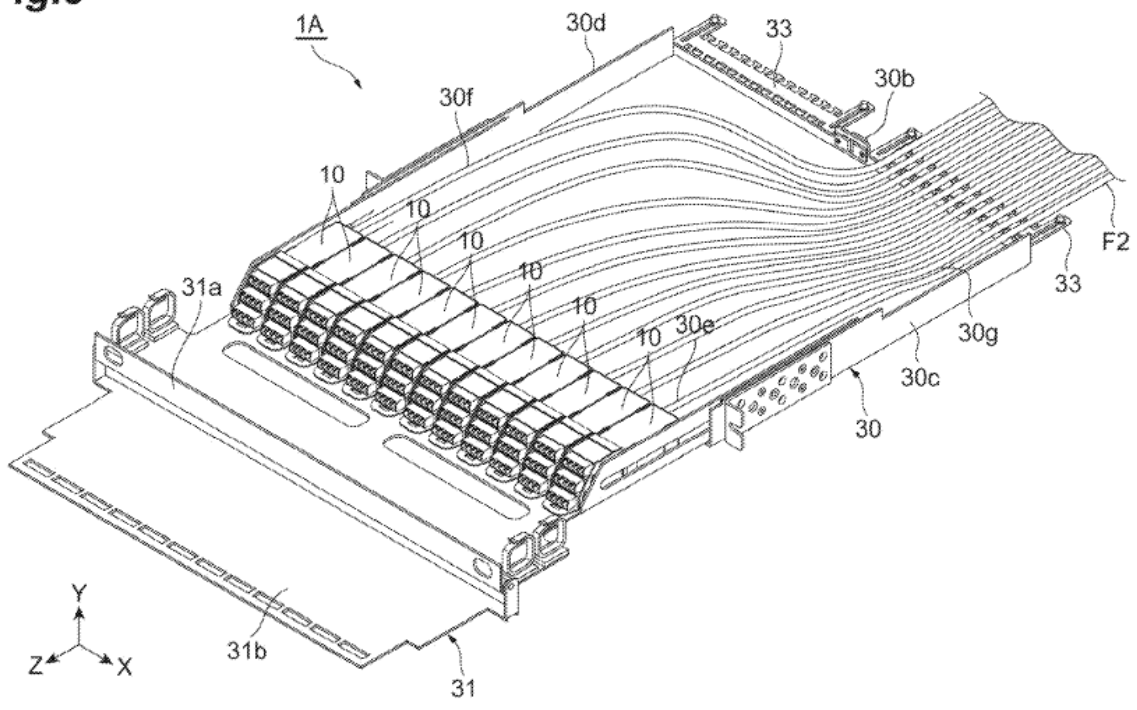


Fig.6

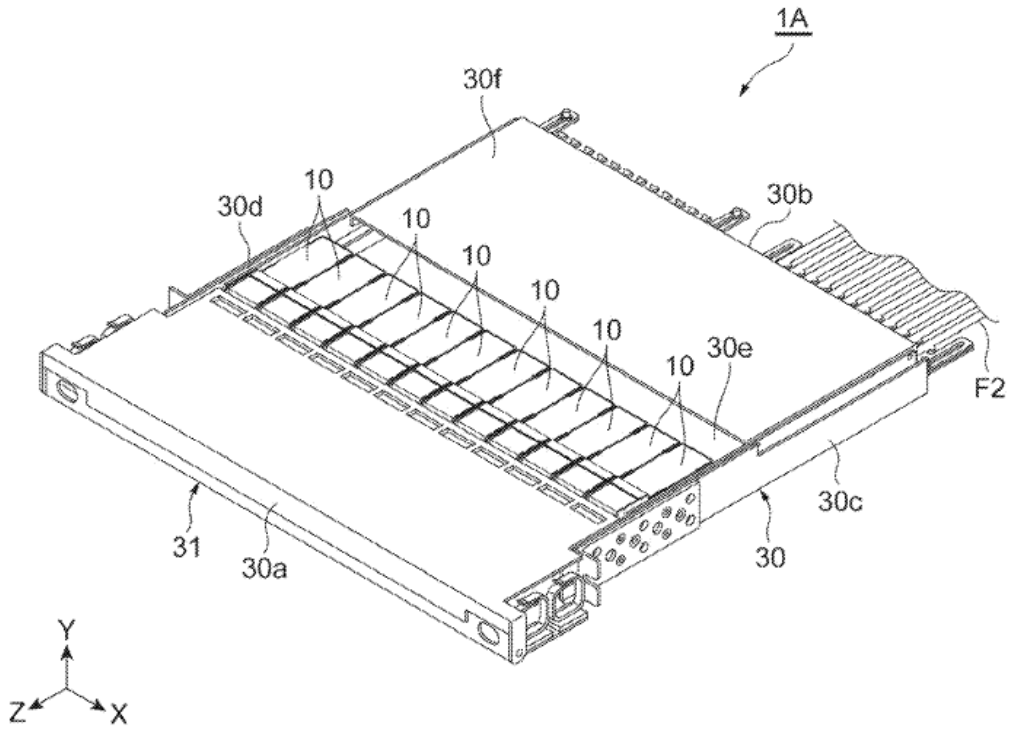
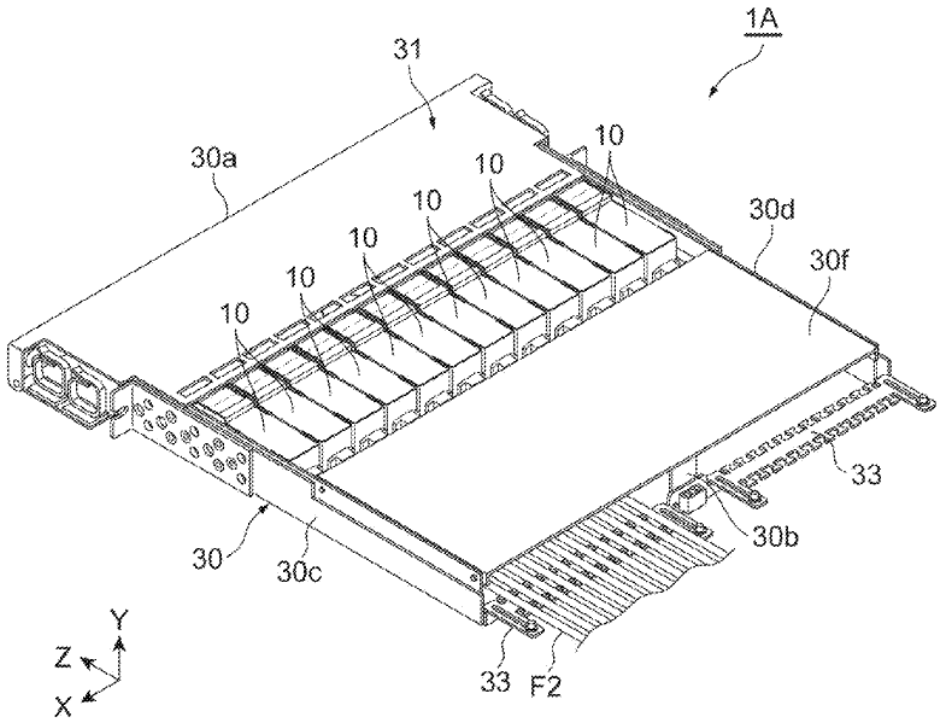


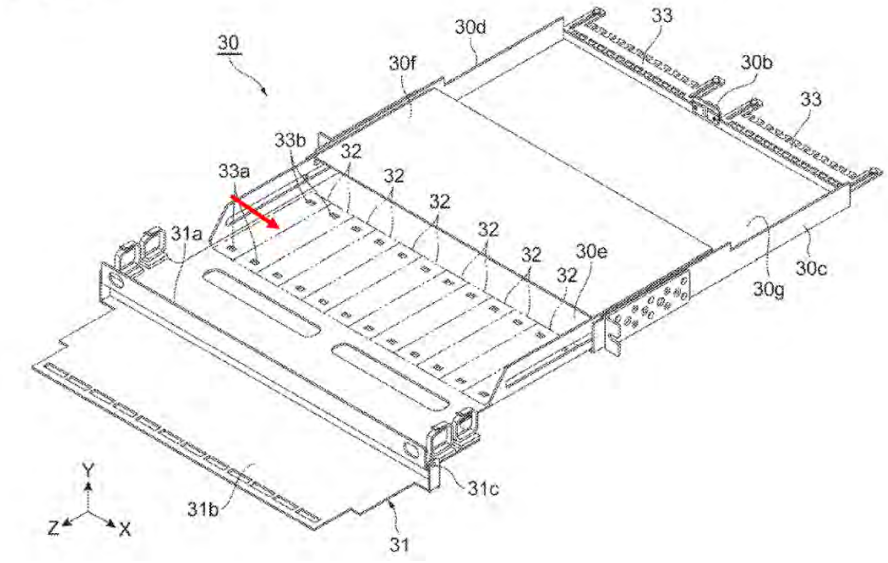
Fig.7



EX1004, Figs. 6-8. As shown above, the sides of adjacent modules come together to a single black line with no gaps showing the modules touch. There are no rails to prevent the modules from touching.

197. Fukui's Figure 9 is also informative. Figure 9 shows the areas (32) for placing the modules touch each other. EX1004, 8:45-47, Fig. 9. There are no separate lines between the adjacent areas. There is a single line for both areas:

Fig.9



EX1004, Fig. 9. Again, there are no rails to prevent the modules from touching.

198. To be clear, although the above figures show modules 10, the same proximity applies to other sizes of modules because the other sizes would also use the same areas (32) and the larger sizes are multiples of the smaller modules size 10 and built from the smaller module 10. For example, module 20 is simply two modules 10 fixed together. EX1004, 7:25-29. Fukui expressly teaches that any of the modules 10 in Figure 6-8 can be the modules 10A and 10B of the larger module 20. EX1004, 8:19-24.

199. Here is an annotation showing the proximity of two coupled modules 10 (orange) to three coupled unit modules (green):

Fig.8

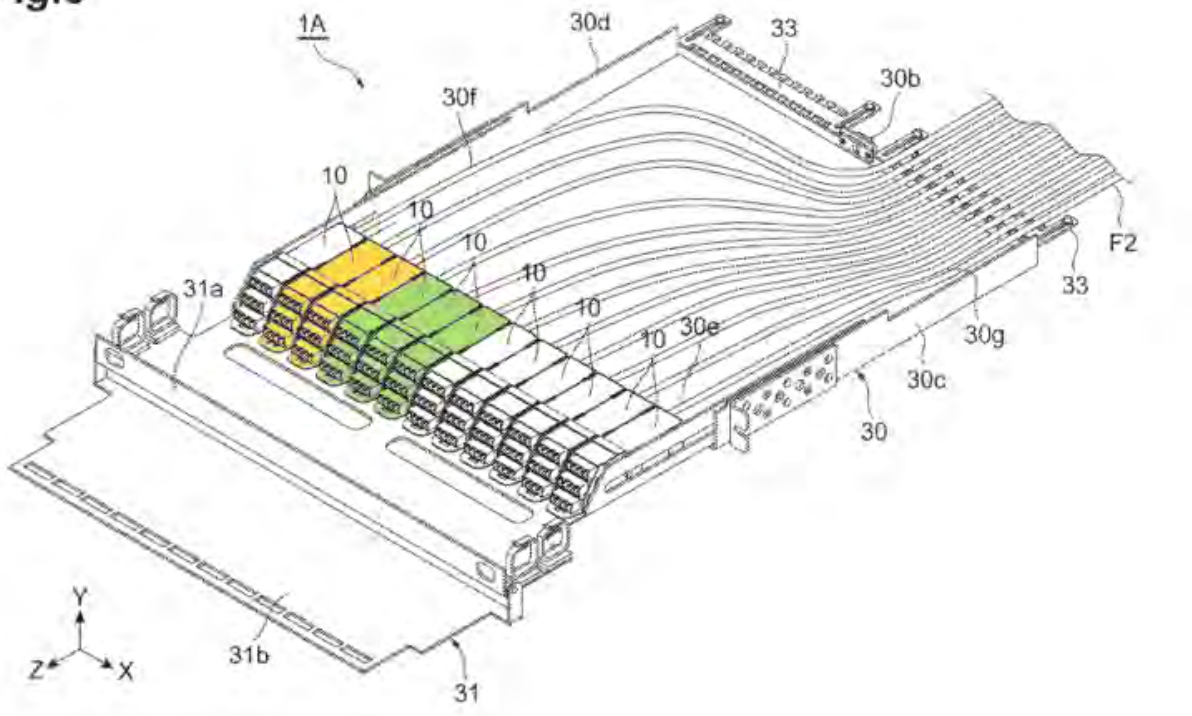
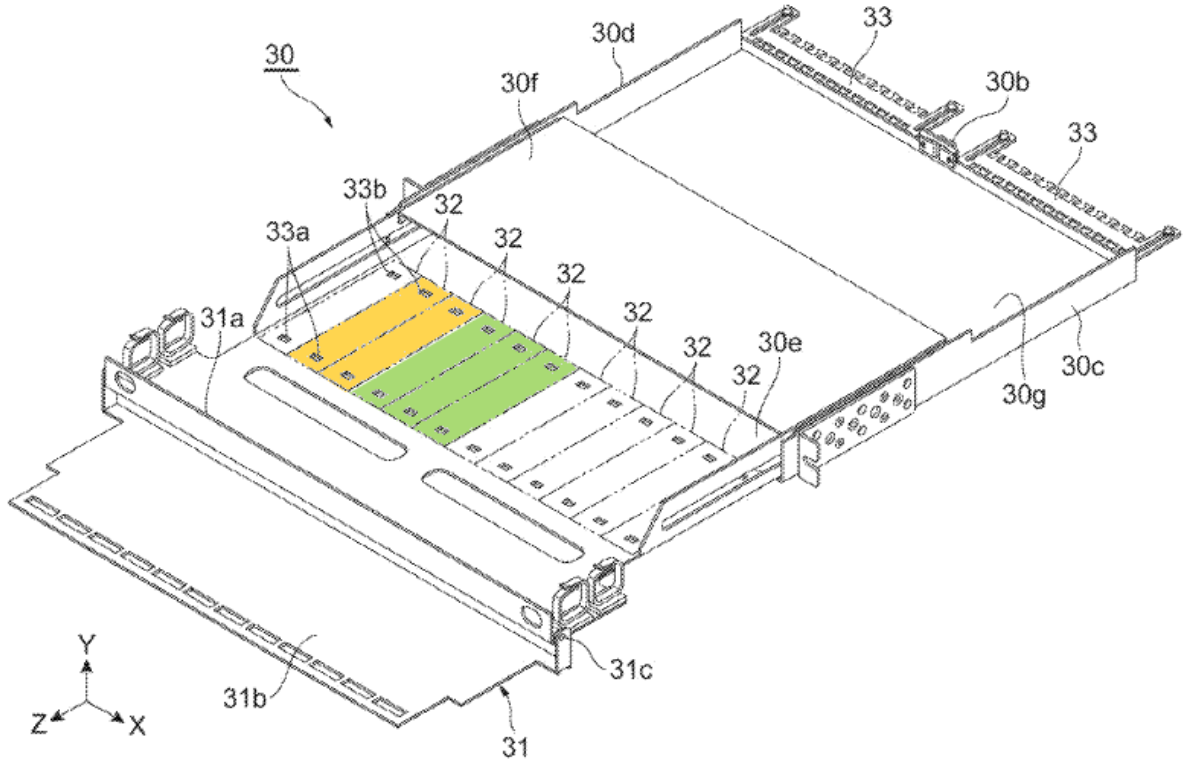

1A
30d
33
30b
30f
10
10
10
10
10
10
31a
30e
F2
33
30g
30c
30
Y
Z
X
31b
31

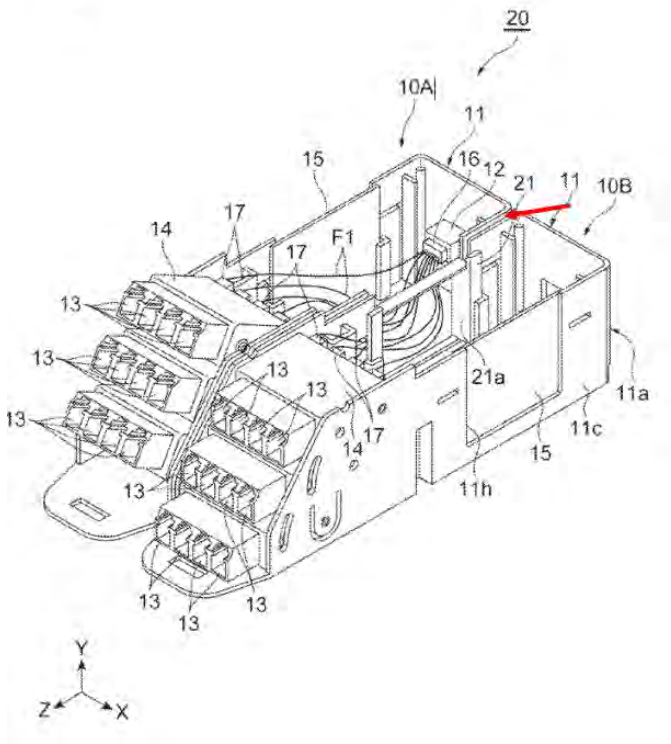
Fig.9



See EX1004, Figs. 8-9. The double module touches the triple module.

200. PO may, based on Figure 5, argue the coupled modules include a space between the coupled modules 10A and 10B:

Fig.5



The text accompanying Figure 5, however, clarifies that the modules are "fixed to each other" (i.e., touching to each other), not spaced apart. EX1004, 10:14, 4:9. Fukui also explains that the modules in Figure 5 have the "same" shape as modules 10 and Fukui never describes modules 10 as spaced apart. EX1004, 7:28, 8:5-6, 8:19-20. Furthermore, Fukui's other figures show there is no room to space apart the modules. Figure 9, above, shows the areas for placing the modules touch with no room to space apart the modules, and Figures 6-8 show the sides of adjacent modules come together to a single black line with no space between. Thus, considering Figure 5 with the description of Figure 5 and the other figures, a POSITA would not conclude Fukui teaches adding a space between modules.

Fukui never mentions such a space or assigns its any relevance. A POSITA also understands it would not make sense to add a space between modules because it would interfere with the modules being coupled together. The coupling member performs the function of a clip. For a clip to be functional the two items held together must be in contact (touch) so as to resist the force of the clip and maintain a tight coupling.

201. Even if there was a tiny space between the modules, a POSITA would certainly find it obvious to omit such a tiny space and have the modules touch. Fukui never describes any need to space apart the modules and any space between the modules is so insignificant it does not appear in Figures 6-9. A POSITA would consider this obvious and predictable implementation of Fukui's existing teachings showing the areas (32) for placing the modules touch.

202. This is, at most, an insignificant modification to Fukui. Any such gap is already so small it is not even visible in the other figures. Fukui never discusses much less assigns any significance to there being a tiny gap between modules 10A and 10B. A POSITA could easily make this modification (to the extent any modification is even needed) by simply making the modules slightly larger to eliminate any alleged tiny space.

203. Furthermore, this is an obvious implementation of Fukui's existing teaching. As discussed above, Fukui shows that the areas (32) for adjacent

modules touch with no space between. Fukui also already teaches that modules 10A and 10B are "fixed to each other." EX1004, 10:13-14. It is at least an obvious implementation of this teaching is to have the modules touch with no additional width or space between them.

204. ***Motivation***. A POSITA would have been motivated to remove the gap for at least three reasons.

205. First, a POSITA would have been motivated to remove any such tiny space because it would make it easier to align the cassettes during installation. To install Fukui's modules, the hooks on the modules must be aligned with the holes on the trays. This is complicated by several factors. (1) The user cannot clearly see the hooks or the holes during installation. The user cannot clearly see the hooks because they are on the bottom of the modules, and the user cannot clearly see the holes because the modules cover them up when placed above the areas for installation. (2) The user must align multiple hooks and holes. For example, the user must align four hooks and holes when installing module 20 because each of the two coupled modules 10 itself has two hooks for two holes. (3) The holes are relatively small. With this background, any space between coupled modules would make it more difficult to install the modules. This space could result in the modules being misaligned, i.e., being placed slightly to one side in the areas 32, which would misalign the hooks and holes. With the space eliminated, the user

installing the modules could use the adjacent module to help precisely guide and place the next modules by sliding that next modules along the side of the adjacent modules which would naturally algin the modules with holes. Aligning a module with the adjacent modules would naturally align the modules with its own areas without need for further adjustment.

206. Second, a POSITA would have been motivated to remove any such gap to make the modules more rigid. The prior art recognizes that having no clearance (i.e., gap) between interconnected cassettes (e.g., coupled modules) creates a rigid assembly. EX1026 at 3:4-9 ("… interconnect patch cassettes in such a way that the housings of two adjacent patch cassettes are contiguous, meaning they extend adjacent to each other without significant or even no clearance. Thus, a rigid assembly is achieved."). This is advantageous for several reasons. If there is a gap between the modules, that means the modules are only fixed together in the middle along the coupling member, not along the other portions of the sides. As a result, the modules would be susceptible to flexing/bending inward along the other portion of the sides. For example, if pressure is put on the side of the modules during installation (e.g., because the installer is holding the module from the sides), the sides of the cassette might flex inward which would (a) put stress on the coupling member in the middle (and potentially lead to the coupling member breaking) and (b) make alignment more difficult because the flexing would slightly

change the lateral alignment of the hooks on the bottom. This concern would be multiplied as the number of coupled units increases, e.g., for Fukui's 36-core (triple) module or 48-core (quadruple module). By contrast, omitting any such gap would address these issues because the walls would then contact each other along the whole side, which would prevent flexing inward.

207. Relatedly, a POSITA would have been motivated to remove any such gap so that the coupled modules could be more easily handled as one unit. Fukui recognizes to treat the coupled units as "one body." EX1004, 8:2-6. If there is a gap between the modules, it is more difficult to treat the coupled units as one body because the individual modules might independently flex/move as discussed above. By contrast, omitting any such gap would make it easier to treat the coupled units as body during installation because the individual modules would not independently move because their walls would press on each other.

208. Third, a POSITA would have been motivated to remove any tiny gap between the modules to prevent material (e.g., dust) from getting into the gap or entering the modules through the gap and interfering with coupling the modules or the fiber inside the modules. Fukui explains that fibers from modules 10A "pass through" module 10B through the opening. If there is a gap between the modules 10A and 10B, then the fiber would be at least partially exposed as they through the opening susceptible to accidental damages (e.g., if anything got into the gap). A

POSITA would be particularly motivated to protect the fibers passing through the gaps because the fibers are exposed. Normally, fibers are protected inside a cable (which has a plastic covering). But, here, the fibers are not inside a cable and there is no apparent plastic covering. And, especially when the fibers are outside a cable, they are susceptible to damage from excessive bending. The point where the fibers pass through the gaps is one of the points of maximum bending stress because the fibers have to change direction and move laterally into the other module.

209. Lastly, the primary goal of fiber cassette systems is to maximize the so-called "front panel density" i.e., maximize the number of LC connections possible within a given amount of front panel space. Thus, there is an inherent motivation to minimize any non-functional space such as a gap.

210. ***Reasonable expectation of success***. A POSITA would have a reasonable expectation of success in removing a tiny (if any) space between the coupled modules. Fukui does not teach a tiny space (if any) between the coupled modules has any function. The modification does not require adding any functionality. It only requires omitting a tiny space (if any). All of Fukui's other functionality in the coupled units, including the coupling member and openings in the modules for routing fibers between the coupled modules could remain the same. Eliminating a tiny, non-functional space is well within the level of ordinary

skill. A POSITA could omit the tiny (if any) space by simply making each module 10 slightly bigger.

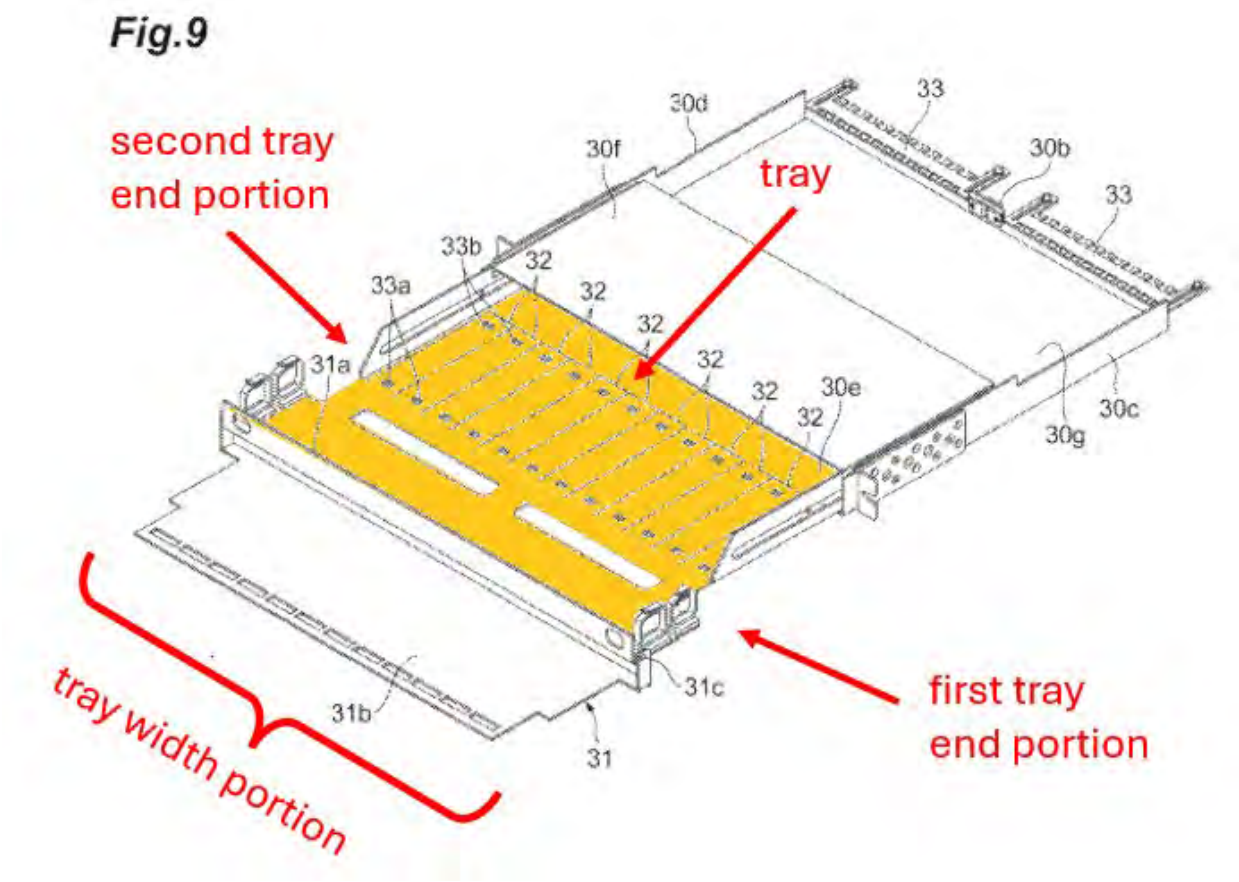
211. Further, it was already known in the art to have adjacent modules touch. See, e.g., EX1026 at 3:4-9 ("… interconnect patch cassettes in such a way that the housings of two adjacent patch cassettes are contiguous, meaning they extend adjacent to each other without significant or even no clearance. Thus, a rigid assembly is achieved."), Figs. 5 (showing the coupled modules touch), EX1010 at Figs. 3-4 (showing the coupled modules touch). Further, a POSITA could easily achieve this modification by simply having the width of the modules 10 match the width of the existing areas (32) on the existing tray. Figure 9 shows adjacent areas (32) touch. Thus, when the width of the modules matches the width of the areas, each adjacent module would also touch. Adjacent modules 10 would touch each other, and equally the unit modules comprising the larger coupled modules would touch each other because they are the "same" as module 10.

212. ***Predictable result***. A POSITA would also consider this a predicable variation of Fukui's existing design. Fukui already shows any gap between the modules is so insignificant it does not appear in Figures 6-8. Further, Fukui already contemplates having the sides of the modules touch via the coupling member. Thus, a POSITA would consider it predictable variation for the rest of the sides to touch with no space between.

J. Dependent Claims 8, 16, 26, 27

213. These claims similarly recites that the width of tray / tray member is configured to fit or support *"at least twelve standard one width (1 W) units"* side by side along the tray / tray member. Claims, 8, 16, and 27 also similarly recites that the width of tray / tray member extends between a "first" and "second" end portion that are spaced apart from each other.

214. As discussed in the independent claims, above, Fukui's bottom panel (element 30e) is the recited *"tray"* and *"tray member."* Figure 8 shows that Fukui's bottom panel has a first and second portion that are spaced apart and defines a tray width extending between them:



215. Figure 8-9 further shows the width of Fukui's tray is configured with twelve side by side areas (32) for receiving twelve side by side module units, i.e., twelve standard width units where each standard width unit is one module 10:

Fig.9

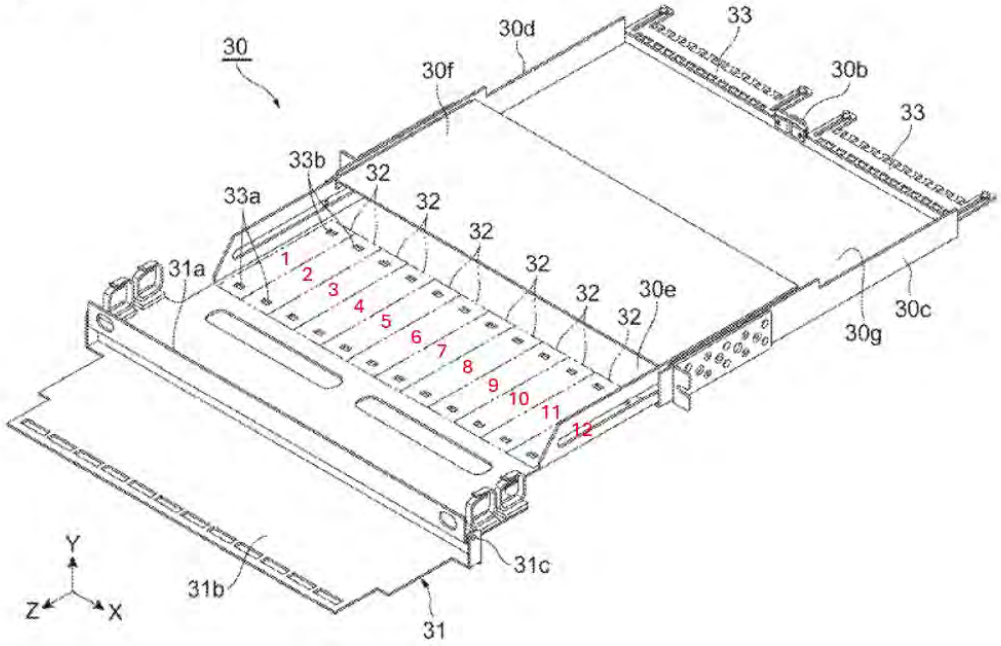
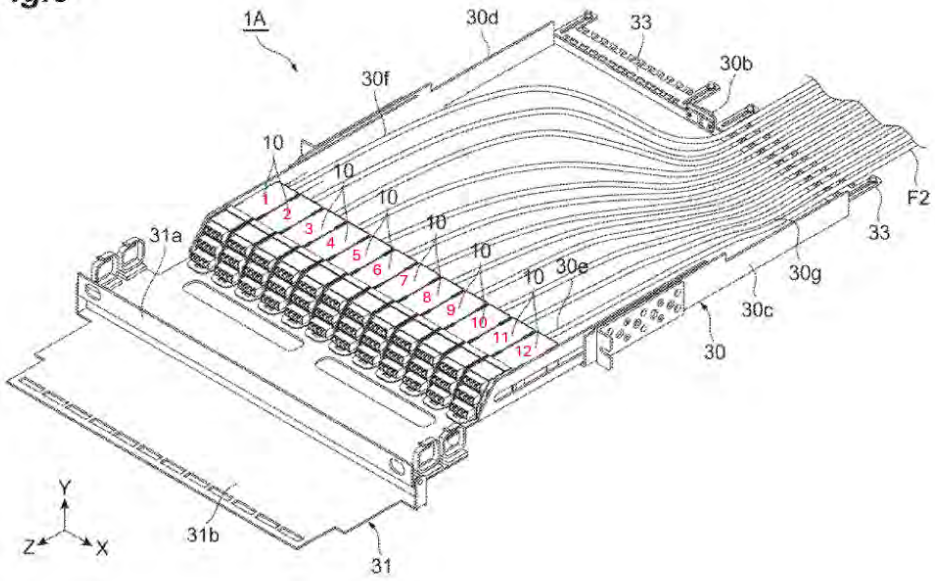


Fig.8



EX1004, Fig. 8. The figures also show the twelve side by side areas (32) are arranged in a row.

216. Fukui's text confirms that Fukui's tray accommodates any combination of the unit modules adding up to 12 (e.g., 12 x 1 unit modules 10 or 6 x 2 unit modules 20):

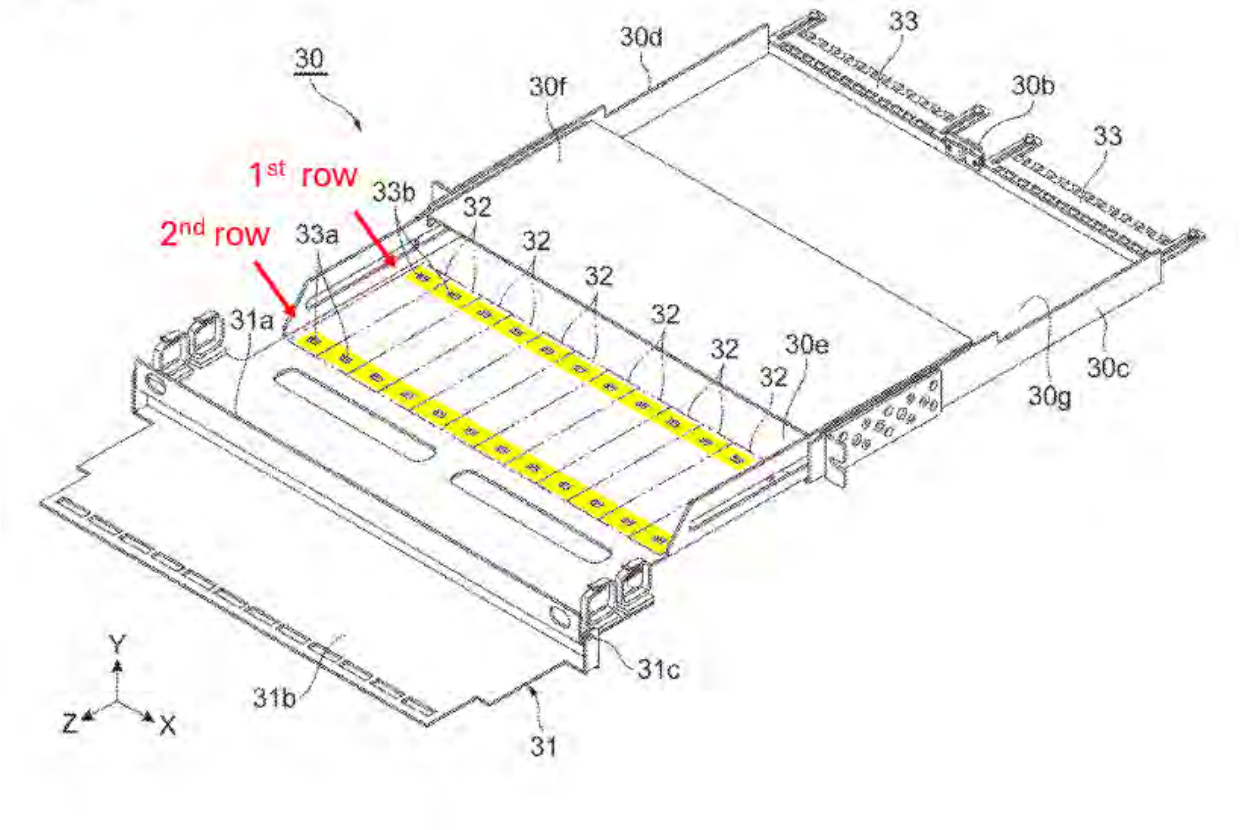
> For example, in the case of the conversion module 10, up to 1 tier×12 rows of the modules 10, that is, 144 single-core optical connector adapters 13 in total are housed in 1U size. Alternatively, in the case of the conversion module 20 coupling two unit modules, up to 1 tier×6 rows of the modules 20, that is, 144 single-core optical connector adapters 13 in total are housed. Of course, the conversion modules 10 and 20 may be present together in combination.

EX1004, 9:35-53.

K. Dependent Claim 20

217. Claim 20 recites: "20. The tray member of claim 19, wherein the row of cassette engaging portions comprises a first row of cassette engaging portions, and the tray includes a second row of cassette engaging portions that is spaced away from the first row of cassette engaging portions." Fukui discloses this. Figure 8 shows the two rows:

Fig.9



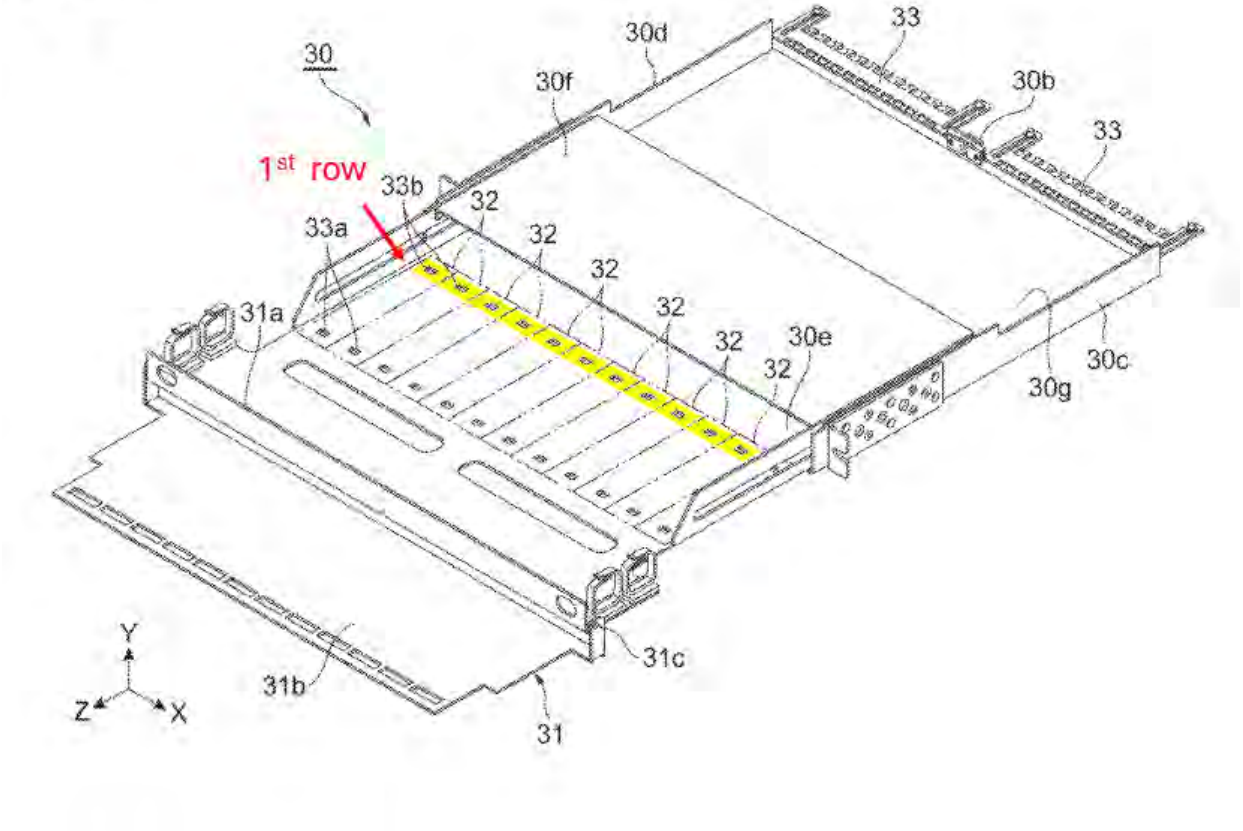
EX1004, Fig. 9, 8:52-55.

L. Dependent Claim 21

218. Claim 21 recites: "21. The tray member of claim 20, wherein the first row of cassette engaging portion comprises a first row of slot portions that are each configured to engage a tab portion of each modular cassette." Fukui discloses this.

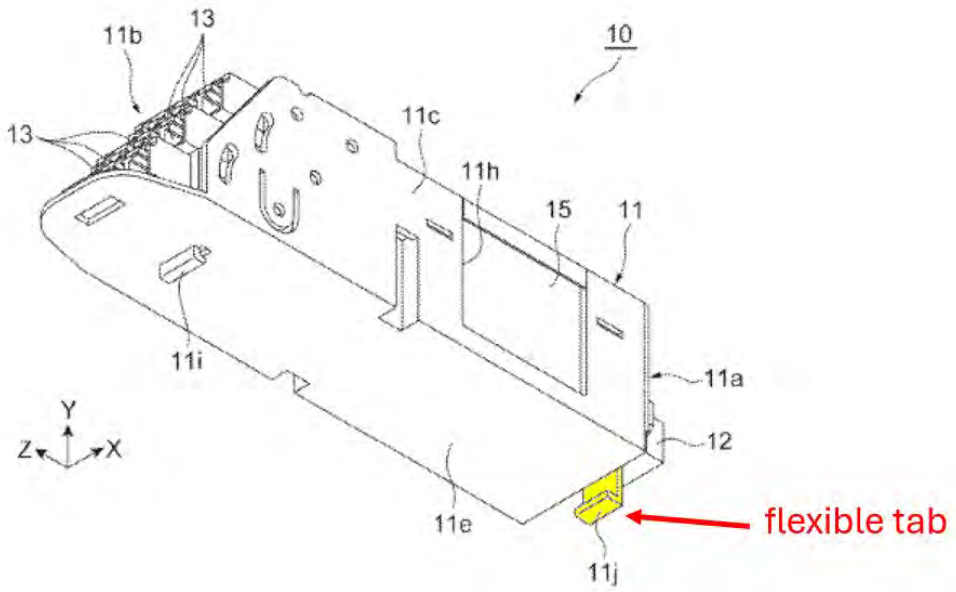
219. The first row of Fukui's cassette engaging portions comprises rectangular holes that each define a "slot:

Fig.9



Fukui's rectangular holes engage matching tabs on the bottom of Fukui's modules:

Fig.2



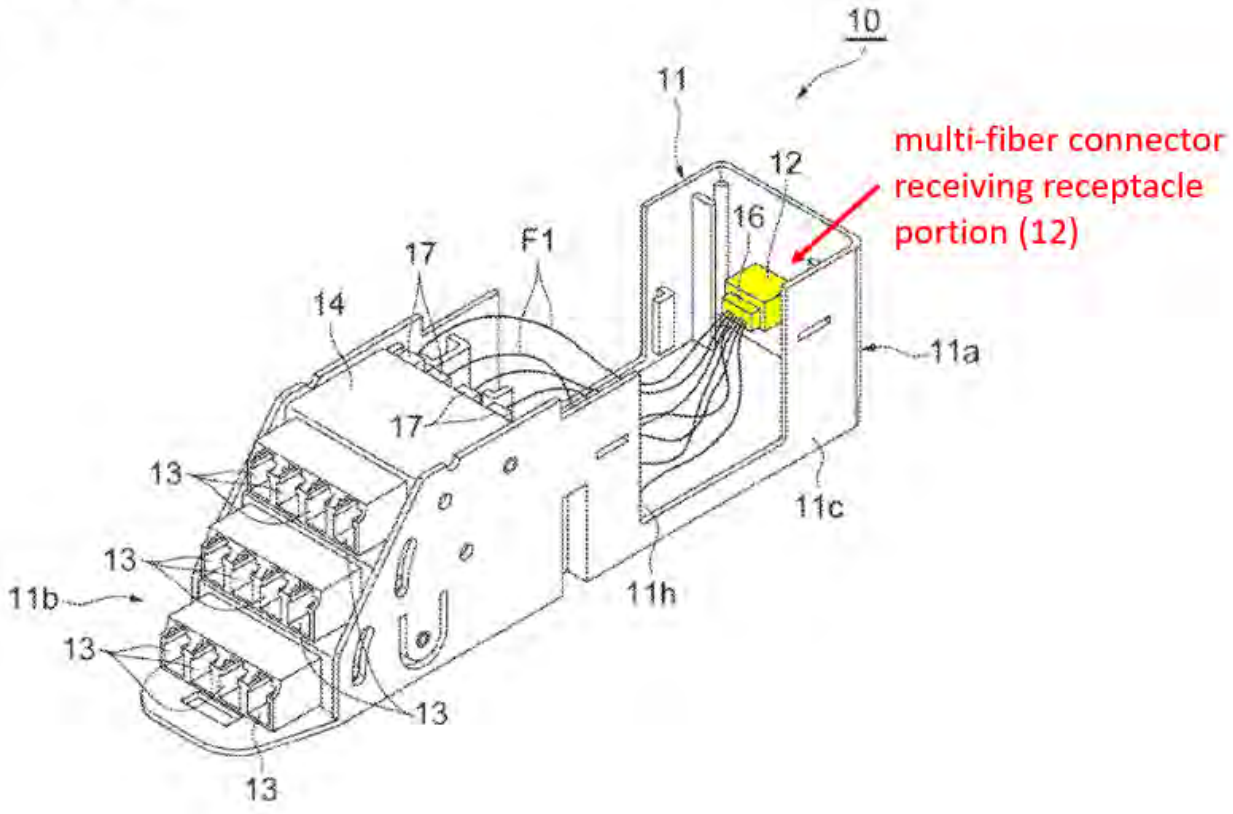
EX1004, Fig. 2, 8:52-56. The tab goes through the holes and engages with the underside of the tray.

M. Dependent Claim 28

220. Claim 28 recites: "28. The tray member of claim 17, wherein each of the modular fiber optic cassettes comprises a multi-fiber connector receiving receptacle portion arranged on a rear portion thereof." Fukui discloses this.

221. Each of Fukui's unit modules 10 comprises a multi-fiber connector (12) receiving receptacle portion arranged on a rear portion thereof:

Fig.4



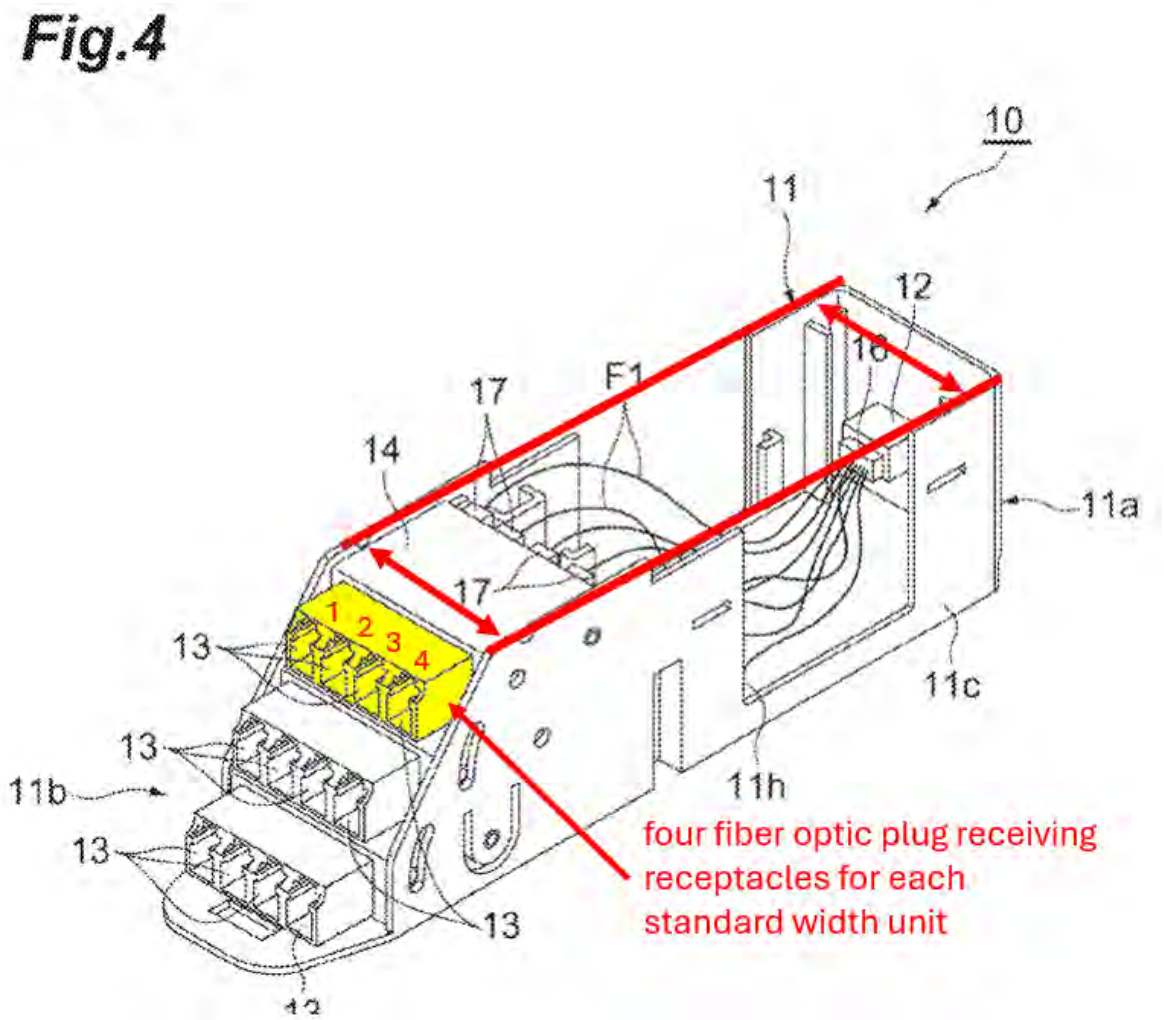
EX1004, Figs. 4-5, 6:35-48, 6:64-7:13, 7:34-65. Element 12 is a "multi-core optical connector adapter…for connecting a multi-core optical connector (e.g., an MPO connector). EX1004, 5:13-14. Because all of Fukui's modules are either an individual module 10 or multiple modules 10 coupled together, all of Fukui modules have this same feature. EX1004, 7:27-29, 8:3-6, Figs. 4-5.

N. Dependent Claim 29

222. Claim 29 recites: "29. The tray member of claim 17, wherein each of the modules fiber optic cassettes comprises four fiber optic plug receiving

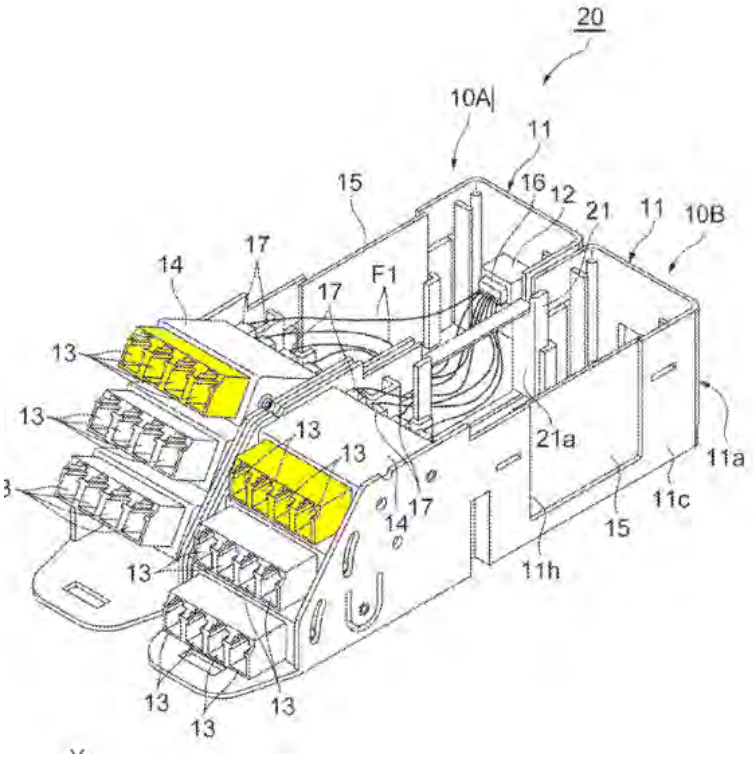
receptacle portions configured to be arranged side by side in a row along a front portion thereof for each standard width (1 W) unit." Fukui discloses this.

223. Fukui's one unit modules 10 comprises four fiber optic plug receiving receptacles (13) arranged side by side in a row along a front thereof, i.e., four fiber optic plug receiving receptacles for the one standard width unit:



Fukui explains: "four single-core optical connector adapters 13 per one tier are arranged across three tiers." EX1004, 5:31-33. Any of these three tiers meets the claims.

224. When a number of the one unit modules are coupled to form the larger modules, the larger modules comprise four fiber optic plug for each for each one unit module, i.e., for each standard width (1 W) unit. Figure 5 is exemplary. It shows that when two unit modules are coupled to form the larger two unit module 20, the larger module has four fiber optic plug for each for each one unit module:

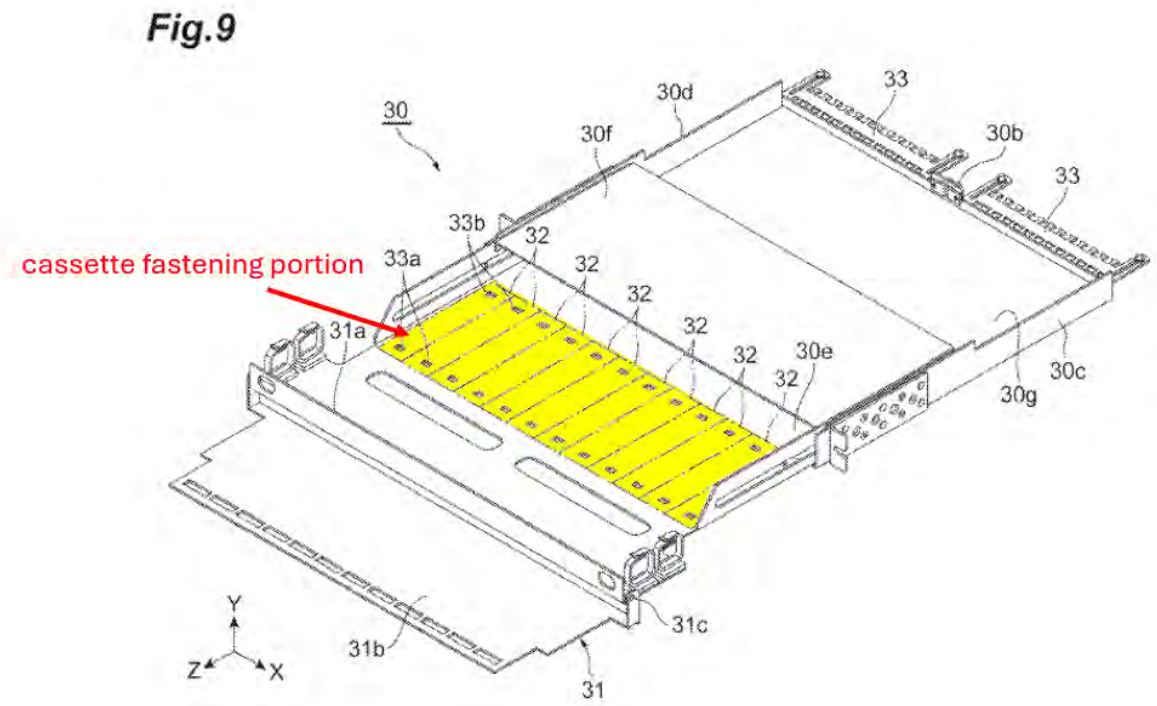


EX1004, Fig. 5, 7:27-29. Module 20 is two standard width units with four receptacles (13) for each of those two standard width units. The result simply scales up when three, four, or six unit modules are coupled together.

O. Dependent Claim 30

225. Claim 30 recites: "30. The tray member of claim 17, wherein the tray member comprises a cassette fastening portion that is configured to removably secure the tray member to each modular fiber optic cassette." Fukui discloses this.

226. Figure 9 shows Fukui's cassette fastening portion:



EX1004, Fig. 9. Fukui's cassette fastening portion is configured to removably secure the tray to each module via holes (33a, 33b) in each area (32) that engage with hooks (11i, 11j) on the bottom of the modules placed in the areas. EX1004, 8:45-56. Figure 8 shows Fukui's modules removably secure in these areas. EX1004, Fig. 8. Fukui expressly teaches the modules can be "easily removed" and

"exchanged" (i.e., one removed and another secured). EX1004, 9:18-29, 9:66-10:1, 10:33-35, 3:8-11.

VI. Ground 2: The challenged claims are also all obvious based on Fukui plus Sauter

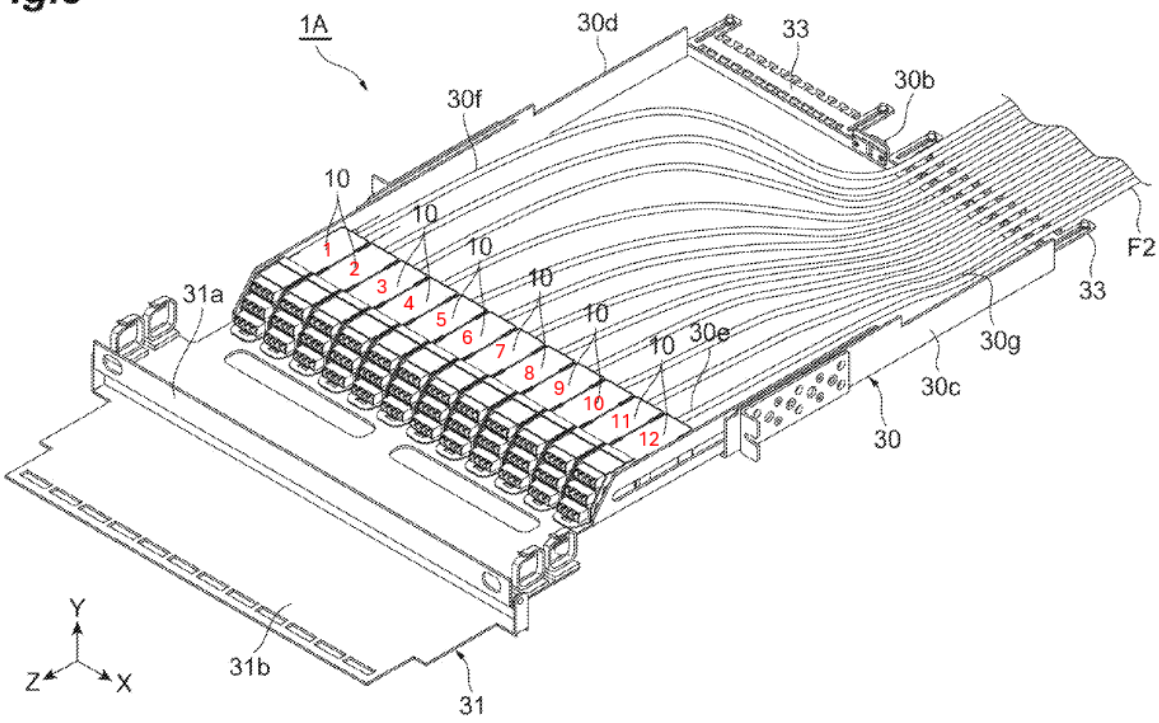
227. The challenged claims are also all obvious based on Fukui plus Sauter. Ground 2 addresses three points.

228. First, if Patent Owner disputes that Fukui itself discloses or renders obvious the recited five configurations (see Elements 1H, 9E, 17E) or argues for a narrow interpretation that requires the tray not only be configured to fit the five combinations but actually installed with the five combinations, Sauter provides further disclosure.

229. Sauter broadly teaches that "any combination of single-gang and multi-gang cassettes can be installed on a given tray 1510, subject to space limitations of the tray." EX1006, 9:60-62. A POSITA reading Fukui in view of Sauter would recognize that Fukui's one module unit 10 is a type of single "gang" cassette. EX1004, Fig 1. A POSITA reading Fukui in view of Sauter would also recognize that any multiple of Fukui's one unit module is a type of multi-gang" cassette, including two, three, four, and six coupled unit modules that are all multiples of one module. EX1004, 9:66-10:10. Applying Sauter's broad teaching to install "any combination" of multi-gang cassettes "subject to space limitations of

the tray," a POSITA would find the five recited configuration obvious. The space limitation of Fukui's tray is 12 unit modules, i.e., 12 standard width units:

Fig.8



230. EX1004, Fig. 8, 9:35-43 ("1 tierx12 rows of the modules 10"). As explained in Element 1H, the recited five configurations all fit within this space constraints because they are all total 12 standard width units. Thus, a POSITA would find it obvious to install all these combination in view of Sauter's broad teaching.

231. ***Motivations***. A POSITA would have been motivated to perform the small additional step of actually configuring Fukui's tray with each of the five configurations to fully and efficiently use Fukui's system for the different

combinations of input cables. Fukui already teaches to support input cables with "various" number of cores. EX1004, 3:27-28, 4:2-3, 4:42-43, 8:1-2, 9:58-59, 10:4-6, 10:34-35. Consider the example where there are six input cables with 24 cores. A POSITA would be motivated to configure Fukui's tray to support these cables. An obvious implementation is to configure Fukui's tray with the six two unit modules that each support 24 cores to match the six cables with 24 cores. This obvious implementation of Fukui's system is an example of actually configuring the tray with six 2W cassettes per the first configuration. The same reasoning applies to the other claimed configurations.

232. ***Reasonable expectation of success***. A POSITA would have a reasonable expectation of success because no changes to Fukui's tray are needed. As shown in Element 1H, Fukui's tray already is configured to fit all five recited configurations. The proposed combination is covered by using Fukui's existing space on the tray. The first, second, third, and fourth recited configuration are simply predictable variations of Fukui's existing teaching to fully populate the tray as applied to Fukui's different sizes. See EX1004, Fig. 6-8. For example, the first configuration of "six" 2W cassettes is simply populating Fukui's tray with Fukui's already disclosed two unit module (20) for 24 cores. Fukui existing tray already fits exactly six two unit modules (see annotation above). The same reasoning

applies to Fukui's second, third, and fourth configurations.[9] The fifth configuration simply recites a combination of two modules sizes. Fukui already teaches that its module size may be present in "combination." EX1004, 9:43-45, 8:19-23. A predictable example of modules being present in "combination" is a combination of two unit modules and a six unit module.

233. Second, if Patent Owner argues Fukui is distinguishable because of the height of Fukui's moules, a POSITA would find it obvious that Fukui's modules could be scaled down in the height dimension. Fukui itself already teaches that the height of Fukui's can be scaled down in the height dimension from three tiers of adapter modules to two tiers of adapter modules. EX1004, 10:39-44 ("For example, the above embodiment shows the example in which the single-core optical connector adapters are arranged on three tiers, but the single-core optical connector adapters can be arranged on the various numbers of two or more tiers."). Fukui itself also already recognizes that it was known to have the height of the

[9] The second configuration of "four" 3W cassettes is simply populating Fukui's tray with Fukui's already disclosed three unit module for 36 cores. Fukui existing tray already fits exactly four three unit modules (see annotation above). The third configuration of "three" 4W cassettes is simply populating Fukui's tray with Fukui's already disclosed four unit module for 48 cores. Fukui existing tray already fits exactly three four unit modules (see annotation above). The fourth configuration of "two" 6W cassettes is simply populating Fukui's tray with six unit module for 72 cores (see annotation above). Fukui existing tray already fits exactly two six unit modules (see annotation above). Element 1E already explains that Fukui discloses or renders obvious a 6W cassettes (i.e., coupling six unit modules).

modules be "one tier." EX1004, 9:16. Although Fukui itself does not implement the variation where the height of the module is one tier, a POSITA would certainly find it obvious that height of Fukui's modules could be scaled down from two tiers to one tier just like Fukui teaches the height can be scaled down from three tiers two tiers.

234. Sauter discloses an example where the height of the modules is scaled down to one tier. Figure 9 shows an exemplary module with one tier of quad LC connectors in the height dimension:

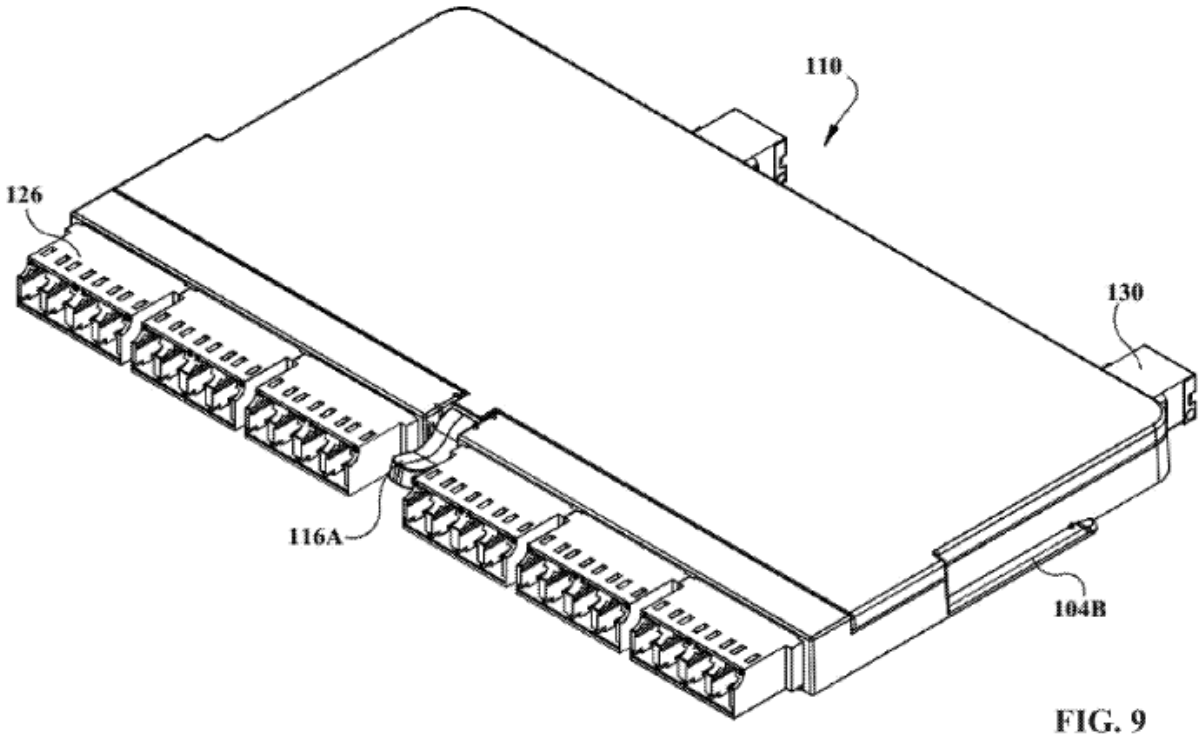


FIG. 9

EX1006, Fig. 9. Figure 9 shows an exemplary module with one tier of quad LC connectors in the height dimension:

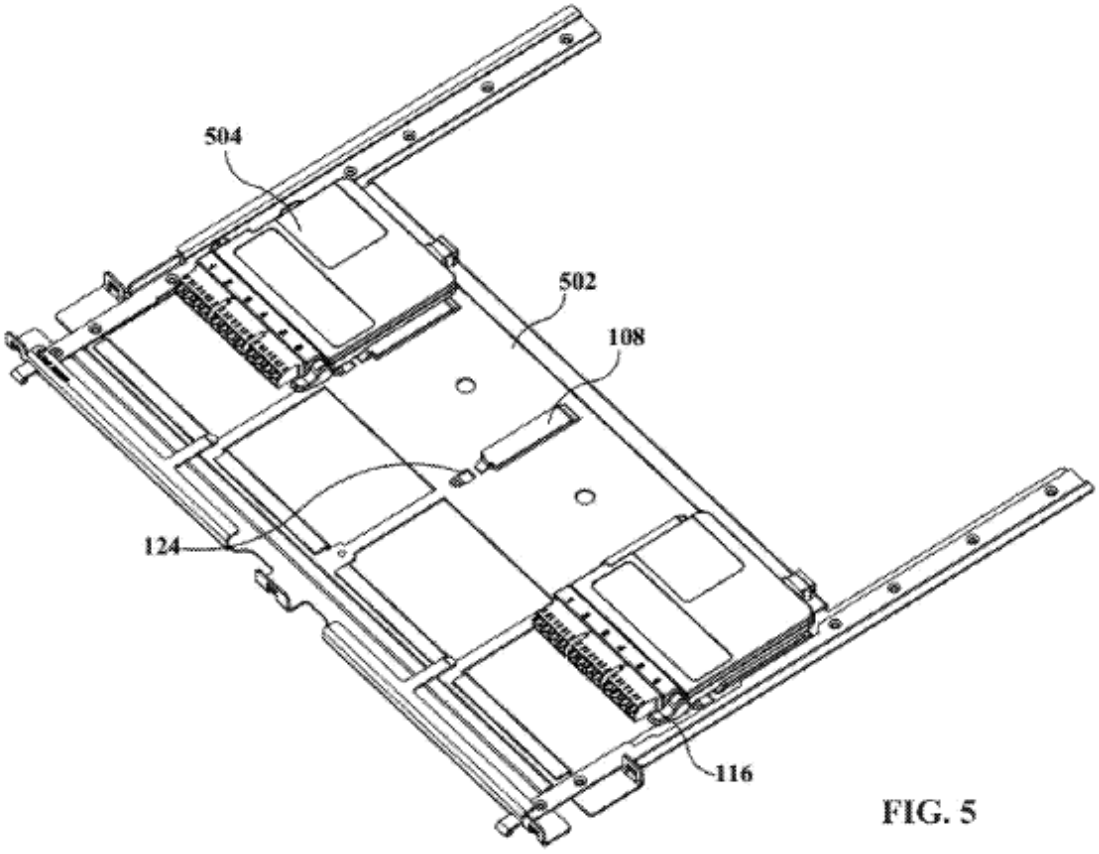


FIG. 5

EX1006, Fig. 5.

235. A POSITA reading Fukui in view of Sauter would find it obvious that height of Fukui's modules could be scaled down to one tier. As mentioned above, Fukui itself already teaches the height of Fukui's modules could be scaled down from three tiers to two tiers.

236. ***Motivation***. A POSITA would have been motivated to scale the height of Fukui's modules down to one tier to support deployments where there is not sufficient space to accommodate more than one tier. Fukui explains that its three

tier design fits within a 1U space of a rack. EX1004, 9:30 ("rack…1U size"), 9:38 ("1U size"). "1U" space refers to a height of 44.45 millimeters:

> **4.2 Terms for Cabinets and Racks**
> **"n"—**"n" is equal to the number of modular units to be used in determining various dimensions. It is generally used with the value "U."
>
> **"U"**—The modular unit "U" on which panel heights are based is equal to 44.45 millimeters.

EX1008, 10. But, a POSITA would recognize that there is not always 1U of space available in a rack. A rack may be already populated by other equipment that only leaves a smaller amount of remaining space such as ½ U or ⅓ U. In either of these situations, there is not sufficient space to accommodate more than one tier. Fukui's three-tier design requires 1U, and Fukui's two-tier design would proportionally require ⅔ U—both of which are too big to fit when there is only a smaller amount of remaining space such as ½ U or ⅓ U. But simply scaling Fukui's design to one tier would fit because one tier would only proportionally require ⅓ U space. Background art confirms that a single tier of modules occupies ⅓ U space:

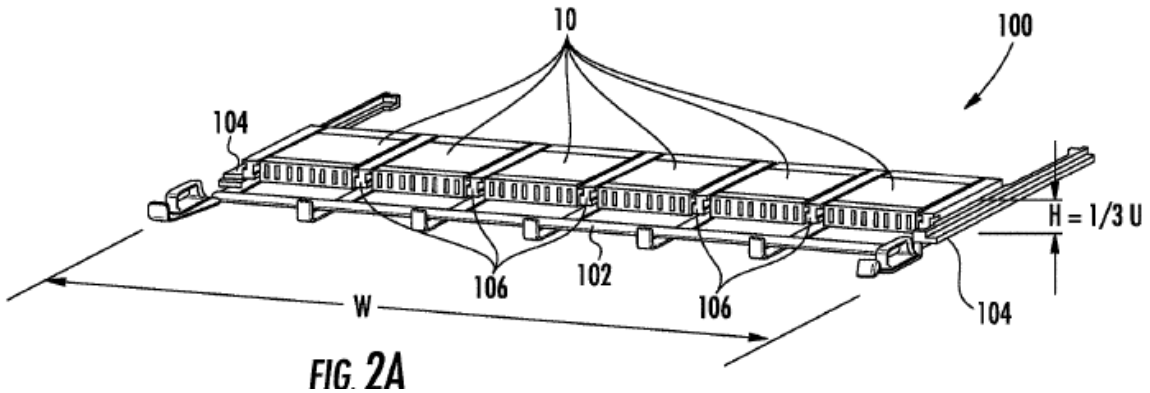


FIG. 2A

EX1030, Fig. 2A, ¶0060 ("⅓ U-Space for the individual trays 100"). Thus, by scaling Fukui's design to one tier, Fukui's system could take advantage of smaller U spaces and provide a solution for deployments with only a small amount of remaining space such as ½ U or ⅓ U.

237. A POSITA is motivated to use the available space in the rack. It is not always possible to build another rack due to physical space constraints in the rack room; thus, a POSITA would be motivated to conform the height of Fukui's system to the available space.

238. A POSITA would also know that only a fractional amount of space may be left in rack. This can happen for several reasons. Installers may space apart the mounting locations of components, e.g., by one universal spacing location which leaves only a fractional amount of U space at the end. Installers may not start from the bottommost or topmost mounting locations, which again can leave only a fractional amount of U space at the end. Installers may also need to accommodate other equipment that only occupies a fractional amount of U space, which again leaves a fractional amount of U space at the end. See, e.g., EX1044 ¶0013, Figs. 2C (describing other equipment occupying "1 and ⅔ U height" that would leave ⅓ U left over). Fukui itself contemplates a fractional U space. Fukui, as mentioned above, contemplates reducing its three tier design for 1U space to a two tier design which would scale to 2/3 U.

239. Fukui does not discourage reducing the height of Fukui's modules from three tiers to one tier in the instance where less than 1U of space is available. Although Fukui does disclose certain benefits of having three tiers instead of one tier, that discussion relates to the instance where 1U of space is available. Fukui never discusses much less discourages reducing the height of Fukui's modules from three tiers to one tier in the alternative instance where less than 1U of space is available. Fukui's discussion of the benefits of three tiers is inapplicable to that alternative instance because it is impossible to fit three tiers in that alternative instance.

240. ***Reasonable expectation of success***. A POSITA would have a reasonable expectation of success for two reasons. First, this modification only requires scaling Fukui's existing components, not adding any new functionality. A POSITA knows how to scale the size of components. Second, Fukui itself recognizes the height of the module could be only one tier. EX1004, 9:16. Although Fukui did not specifically implement that example, the fact that Fukui recognized the example confirms the example can be implemented. A POSITA also knows how to scale the size of Fukui's housing for the modules.

241. This modification would not result in any loss in front panel density. Fukui's existing design accommodates three tiers in a 1U space. Fukui's modified design accommodates one tier in a 1/3 U space. By basic multiplication and

division, the density of one tier in a 1/3 U space = the density of three tiers in a 1U space.

242. In this proposed modification, Fukui's two, three, four, and six coupled modules size would be configured to fit only two, three, four, and six receptacle modules because there is only one tier of receptacle modules.[10] Thus, even if Patent Owner argues for a narrow interpretation that Elements 1I that requires the cassette sizes fit "only" two, three, four, and six receptacle modules, that does not distinguish this modification.

243. Third, if Patent Owner argues Fukui is distinguishable from dependent claims 2, 10, and 18, a POSITA would find these dependent claims obvious based on the combination of Fukui and Sauter. These three dependent claims identically recite: "wherein the standard one width (1 W) unit is based on a standard SC Duplex width unit that is configured to fit a plurality of different type of LC, SC, and MPO connectors." Fukui itself discloses that the width fits a plurality of LC

[10]Fukui's two, three, four, and six coupled modules size would support 8, 12, 16, 24 cores. It was well known that various cables sizes have all of these numbers of cores. The industry standards also provided for MPO connectors (as would be plugged into the MPO adapter at the back of Fukui's modules) to have 8, 12, 16, and 24 fibers (cores). The TIA-604-5-E standard, discussed above, provided for all these fiber counts. As discussed above, the standard provides for the MPO connector to support m x n fibers and specifies the values of m and n in the two quoted tables, which includes (a) m= 1, n =8 for m x n = **8**, (b) m =1, n=12 for m x n = **12**, (c) m=2, n=8 for m x n =**16**, (d) m=2, n=12 for m x n = **24**.

connectors, e.g., four LC connectors. If Fukui's disclosure is not sufficiently express regarding "SC" and MPO connectors," Sauter provides further disclosure.

244. Sauter discloses that cassettes can be configured to accept SC and MPO connectors instead of LC connectors:

> Although FIG. 6 depicts adapters 126 that are configured to receive Lucent connectors (LC connectors), cassettes that accommodate other fiber optic connector types are also within the scope of one or more embodiments described herein. In various embodiments, the fiber optic cassettes can be configured to accept single-fiber connectors (e.g., LC, Standard Connector, etc.) and multi-fiber connectors (e.g., mechanical transfer pull-off, multi-fiber push-on, etc.)

EX1006 at 8:20-28. The term "Standard Connector" refers to an "SC" connector. The term "multi-fiber push-on" refers to "MPO" connectors.

245. ***Motivation to combine***. A POSITA would have been motivated to have Fukui's width unit fit SC and MPO connectors for interoperability with deployments that require SC and MPO connectors, e.g., deployments where the cables to be plugged into the front of the modules are already configured with SC or MPO connectors. A POSITA would have been motivated to have Fukui's width unit fit SC and MPO connectors to maximize deployment flexibility.

246. ***Reasonable expectation of success***. A POSITA could easily replace the LC adapters for LC connectors in Fukui with SC adapters for SC connectors or MPO adapters for MPO connectors. These components are all well-known, standardized, and commercially available. A POSITA would consider this a simple

substitution of one known component (e.g., an LC adapter for LC connector) for another known component (e.g., an SC adapter for an SC connector). Furthermore, this would not require any significant change to Fukui's width unit because the various widths of the connectors are standardized to be backwards compatible to fit within the same space of other connector types. Fukui's module 10 fits one quad LC adapter for four LC connectors. That same footprint will accommodate one SC duplex adaptor for two SC connectors, one quad LC adapter for four LC connectors, or two MPO adapters for two MPO connectors.

VII. Ground 3: Sauter combined with Dagley renders claims 1-30 obvious.

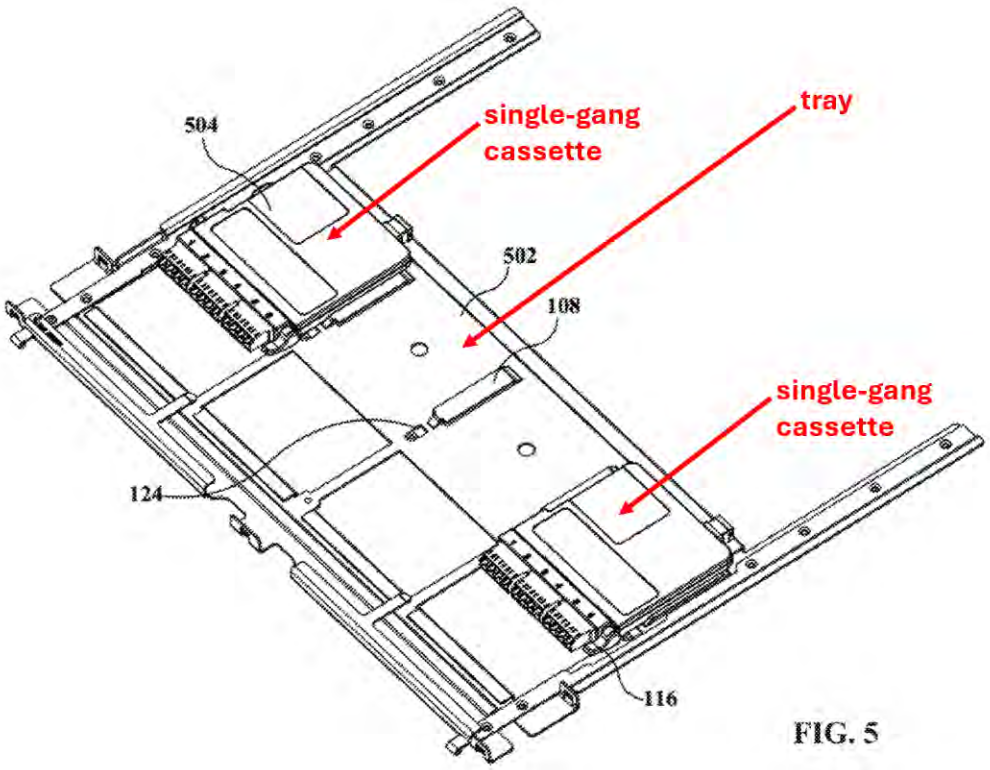
A. Independent Claim 1

247. Figures 1-16 of Sauter illustrate embodiments of fiber optic cassette systems. EX1006 at Figs. 1-16, 1:5-6 ("a fiber optic cassette system"). As explained by Sauter, "fiber optic cassettes are often used to organize and manage fiber optic connections within telecommunication wiring enclosures." EX1006 at 23-25. The system will include "an enclosure" within which are installed one or more fiber optic "trays" with one or more cassettes mounted on each tray. EX1006 at 1:25-28. Sauter explains that unlike prior systems (which typically were designed using a single cassette size), the tray and cassette systems disclosed in his specification "allow multiple different sizes of cassettes" to be mounted within the

system "on the same tray simultaneously" and "without modification of the tray or cassette system. EX1006 at 1:28-29, 51-58; 4:7-14; 9:60-63.

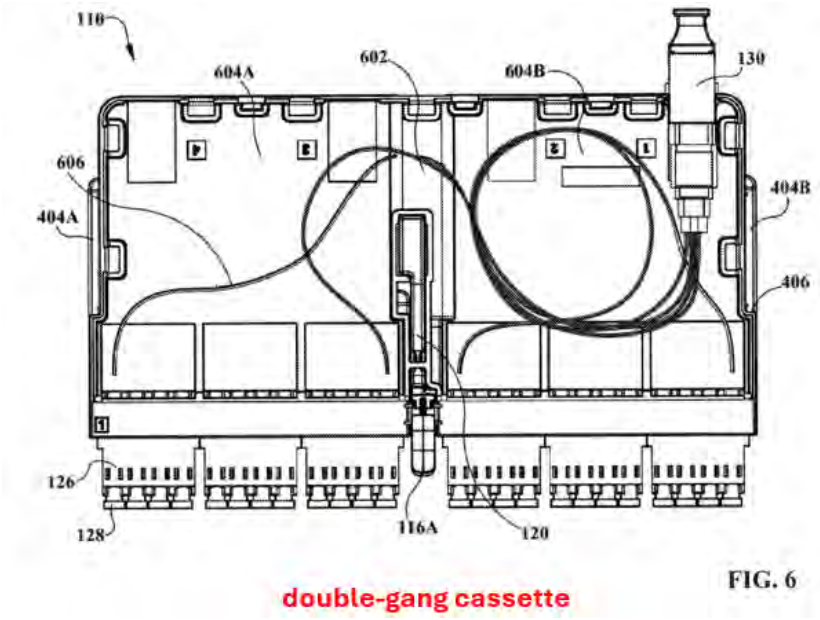
248. Sauter uses the term "single-gang" to describe a smaller cassette size and the term "multi-gang" to refer to larger cassette sizes. Sauter explains that this nomenclature is used because the larger "multi-gang" sizes are wider than the single gang by a "factor." EX1006 4:54-61. He describes examples such as a "dual-gang" or "double-gang" cassette which "is approximately twice as wide as a single-gang cassette" and a "triple-gang" cassette which is approximately "three times as wide as a single-gang cassette." EX1006 at 4:54-61; 6:47-56; 7:3-19; 7:38-47, 63-66.

249. Figure 5 of Sauter shows an example of a tray on which cassettes of different sizes can be mounted. As illustrated, two single-gang cassettes are shown.



EX1006 at Fig. 5.

250. Figure 6 of Sauter shows an example of a double-gang cassette.



EX1006 at Fig. 6.

251. Figure 7 of Sauter shows two different sized cassettes mounted to the same tray.

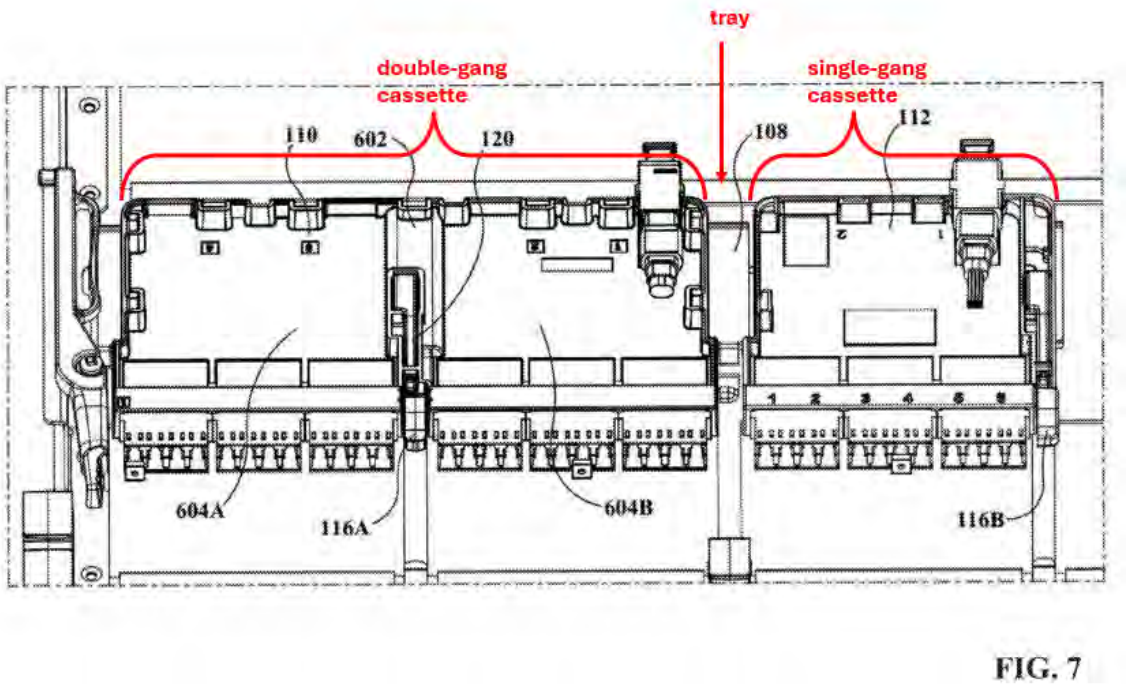


FIG. 7

EX1006 at Fig. 7.

1. Preamble

"A tray for providing a plurality of different modular fiber optic cassette configurations in a standard U-space fiber optic management system comprising:"

252. If limiting, Sauter's system discloses this preamble. Sauter discloses a fiber optic cassette tray for providing a plurality of different modular fiber optic cassette configurations in a standard U-space fiber optic management system. Sauter discloses fiber optic cassette trays, see, e.g., trays 102, 502, and 1510, that slide into a tray receiving space within an enclosure. Numerous passages within

Sauter disclose and describe trays. See, e.g., EX1006 at Abstract ("fiber optic tray"); 1:54-58 ("To this end, cassette trays of the system…"); 4:1-28 ("A fiber optic cassette system according to one or more embodiments described herein comprises one or more cassette trays on which cassettes of various sizes can be mounted…."); 2:44-45 ("Fig. 5 is a view of a single-layer cassette tray on which are mounted two single-gang cassettes."); Figs. 1-5, 7-8, 11, 15-16 (showing trays); 10:4-5 ("As shown in FIG. 15, multiple cassette trays 1510 can be stacked within the enclosure 1508."). Fig. 5 of Sauter, for example, shows tray 502.

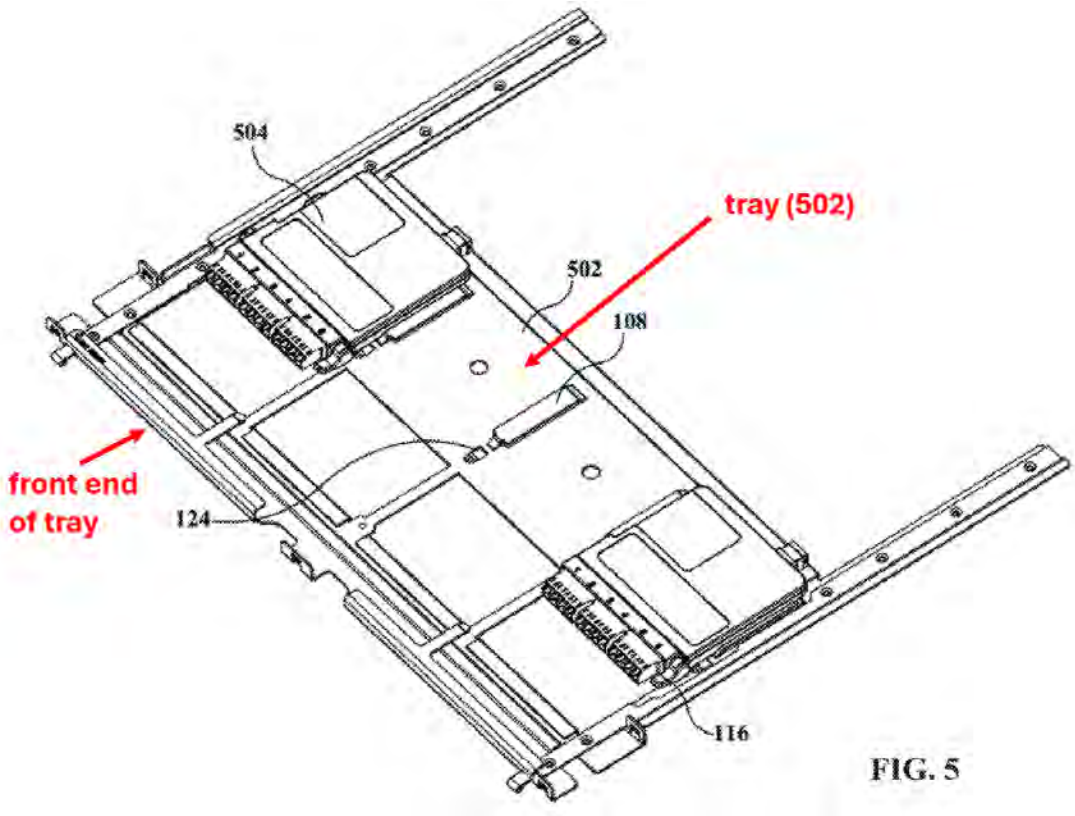


FIG. 5

253. The trays in Sauter are configured to receive and support modular fiber optic cassettes. The cassettes manage optical fibers and make optical fiber connections between fibers of a multi-fiber cable entering the rear of the cassettes with individual fiber adapters at the front of the cassettes. The tray can be populated in multiple different configurations using modular cassettes of different sizes releasably secured to the tray. Figures 1-16 of Sauter illustrate embodiments of Sauter's fiber optic cassette systems. EX1006 at Figs. 1-16, 1:5-6 ("a fiber optic cassette system"). Sauter describes his apparatus as "a fiber optic cassette system." EX1006 at 4:1-4:

> A fiber optic cassette system according to one or more embodiments described herein comprises one or more cassette trays on which cassettes of various sizes can be mounted. Rail guides on the cassette trays are configured to interface with corresponding rails of both single-gang and multi-gang cassettes to facilitate guiding the rails into position on the trays. The cassettes themselves have a structure that, in conjunction with the rail guide design, allows both single-gang and multi-gang cassettes to be mounted simultaneously and in various positions on a given tray. As such, different sizes of cassettes or adapter plates can be installed on the cassette tray without modification of the cassette system.

EX1006 at 4:1-14. Fiber optic cassettes are illustrated in each of Figures 2-16. For example, smaller size cassettes called single-gang cassettes are numbered 112 and 504 in the figures. Other examples of fiber optic cassettes, called "double-gang" or "dual-gang" cassettes, are numbered 110 in as can be seen for example in Figs. 2, 6, and 9. Sauter's cassettes are "fiber optic" cassettes because as explained by

Sauter, they are "used to organize and manage fiber optic connections within telecommunication wiring enclosures." (EX1006 at 1:23-25). For example, Sauter describes and illustrates that the cassettes include components for making connections between optical fibers entering the back side of the cassettes with fiber optic connector locations at the front of the cassettes defined by fiber optic adapters.

> As shown in FIG. 6 (as well as FIGS. 2-5), each cassette is configured to hold a horizontal row of fiber optic adapters 126 along the front edge of the cassette. Each adapter 126 is configured to receive multiple fiber optic connectors (dust caps 128 of which are shown in FIG. 6), which may be used to terminate respective optical fibers to be plugged into the adapters 126. An interfacing connector 130 is disposed on the rear side of the cassette 110. Individual fibers 606 of a fiber optic cable entering the cassette through the interfacing connector 130 can be broken out inside the cassette and terminated on the rear sides of fiber optic adapters 126 (in the case of adapter plates, unbundled individual fibers—rather than a fiber optic cable—may enter through the rear of the adapter plate). The adapters 126 provide connectivity between the fibers 606 terminated on the rear sides of adapters 126 and the fibers terminated on the front sides of adapters 126 using the fiber optic connectors.

EX1006 at 8:4-20.

254. Sauter's system includes modular cassettes. Different cassettes can be added and removed at various locations on the same tray and at various times. The system is flexible to be used in different configurations depending on which components (which size and type of cassettes) are chosen and where the components are installed on the tray, all without modifying the tray:

> The cassettes themselves have a structure that, in conjunction with the rail guide design, allows both single-gang and multi-gang cassettes to be mounted simultaneously and **in various positions** on a given tray. As such, **different sizes** of cassettes or adapter plates can be installed on the cassette tray without modification of the cassette system.

EX1006 at 4:7-13.

> As shown in FIGS. 2 and 3, the cassette mounting system allows a user to mount cassettes of different sizes (e.g., both single-gang and multi-gang cassettes) on the same cassette tray 102 simultaneously at any position on the mounting interfaces. In the example depicted in FIGS. 2 and 3, a single-gang cassette 112, a dual-gang cassette 110, and a single-gang adapter plate 114 are mounted on the upper mounting interface 104 of tray 102 in selected positions. As described in more detail below, any combination of single-gang cassettes (or adapter plates) and multi-gang cassettes (or adapter plates) can be disposed simultaneously on the upper and lower mounting interfaces of the cassette tray 102 subject to overall space limitations of the mounting surfaces.

255. EX1006 at 5:4-17; see also EX1006 9:60-62 ("…**any combination** of single-gang and multi-gang cassettes can be installed on a given tray 1510, subject to space limitations of the tray."); see also EX1006 Fig. 17 (illustrating method of adding and removing variously sized cassettes from same tray).

256. Sauter's tray fits multiple cassette configurations in a standard U-space fiber management system. One of ordinary skill in the art would recognize from, e.g., Figs. 15 and 5 that Sauter's tray is configured with dimensions that will allow the tray and its various cassette configurations to be mounted within a standard U-space. For all the reasons given below for Element 1B ("wherein the

tray width portion fits within a standard U-space width dimension") Sauter's tray system fits within a standard U-space.

2. Element 1A

"a tray having a first tray side end portion and a second tray side end portion defining a tray width portion that extends between the first tray side end portion and the second tray side end portion;"

257. Sauter discloses a tray, see, e.g., trays 102, 502, and 1510, as recited in Element 1A. See, e.g., EX1006 at Abstract ("fiber optic tray"); 1:54-58 ("To this end, cassette trays of the system…"); 4:1-28 ("A fiber optic cassette system according to one or more embodiments described herein comprises one or more cassette trays on which cassettes of various sizes can be mounted…."); 2:44-45 ("Fig. 5 is a view of a single-layer cassette tray on which are mounted two single-gang cassettes."); Figs. 1-5, 7-8, 11, 15-16 (showing trays); 10:4-5 ("As shown in FIG. 15, multiple cassette trays 1510 can be stacked within the enclosure 1508."). Fig. 5 of Sauter, for example, shows tray 502.

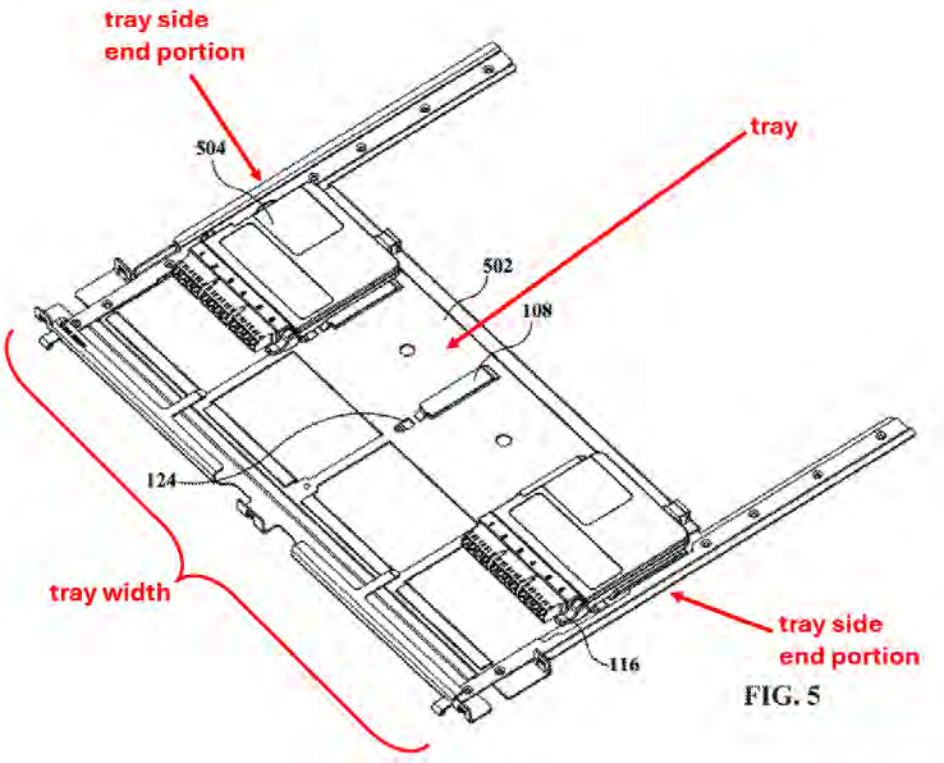


FIG. 5

3. Element 1B

"wherein the tray width portion fits within a standard U-space width dimension"

258. The width of Sauter's tray fits within a standard U-space width dimension. The parties have agreed that "a standard U-space width dimension" should be construed to mean "a width dimension defined in the EIA/ECA-310-E standard."

'423 Patent, Claim 1	"a standard U-space width dimension"	"a width dimension defined in the EIA/ECA-310-E standard"

EX1011, p. 2.

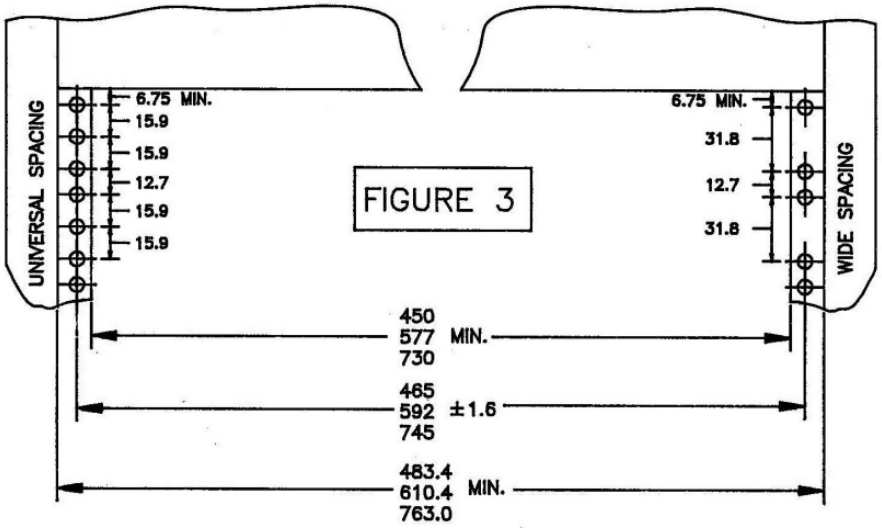
259. The standard referred to as EIA/ECA-310-E titled "EIA Standard – Cabinets, Racks, Panels, and Associated Equipment" (EX1008) defined certain

dimensions of a standard rack and panels to fit within that rack. It includes standardized dimensions and features for three different widths of racks and panels. EX1008 at p. 2:

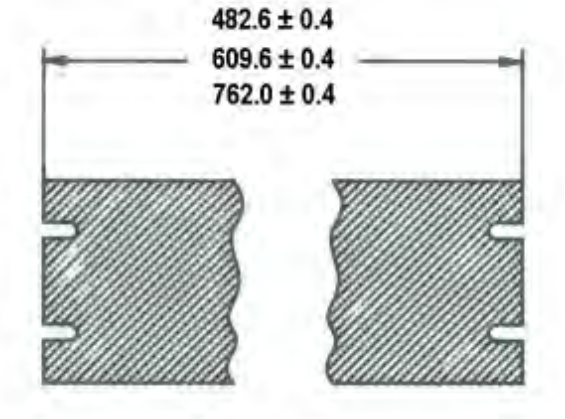
4.1 Classification
EIA-310-C identified three cabinet or rack openings to accommodate each of three standard panel widths 482.6 mm, 609.6 mm and 762.0 mm. The preferred panel width is 482.6 mm.

Note that 482.6 mm equals 19 inches; 609.6 mm equals 24 inches; and 762.0 mm equals 30 inches. The three widths are sometimes referred to as 19 inch, 24 inch and 30 inch racks (Version E of the standard was written to convert these dimension from imperial inches into metric millimeters). EX1008 p. 1 ("EA-310-E Section 4 is the soft metric conversion of superseded EIA-310-C to conform with U.S. Public Law 100-418."). The dimensions standardized in the document include measures such as the rack Unit (RU or U), vertical hole spacing, horizontal hole spacing, rack opening and front panel widths for mounting in standard rack sizes.

260. Figures 3 and 4 of the standard define various width and height dimensions for each of the three standardized rack and panel sizes.



EX1008, p. 2, Figure 3.

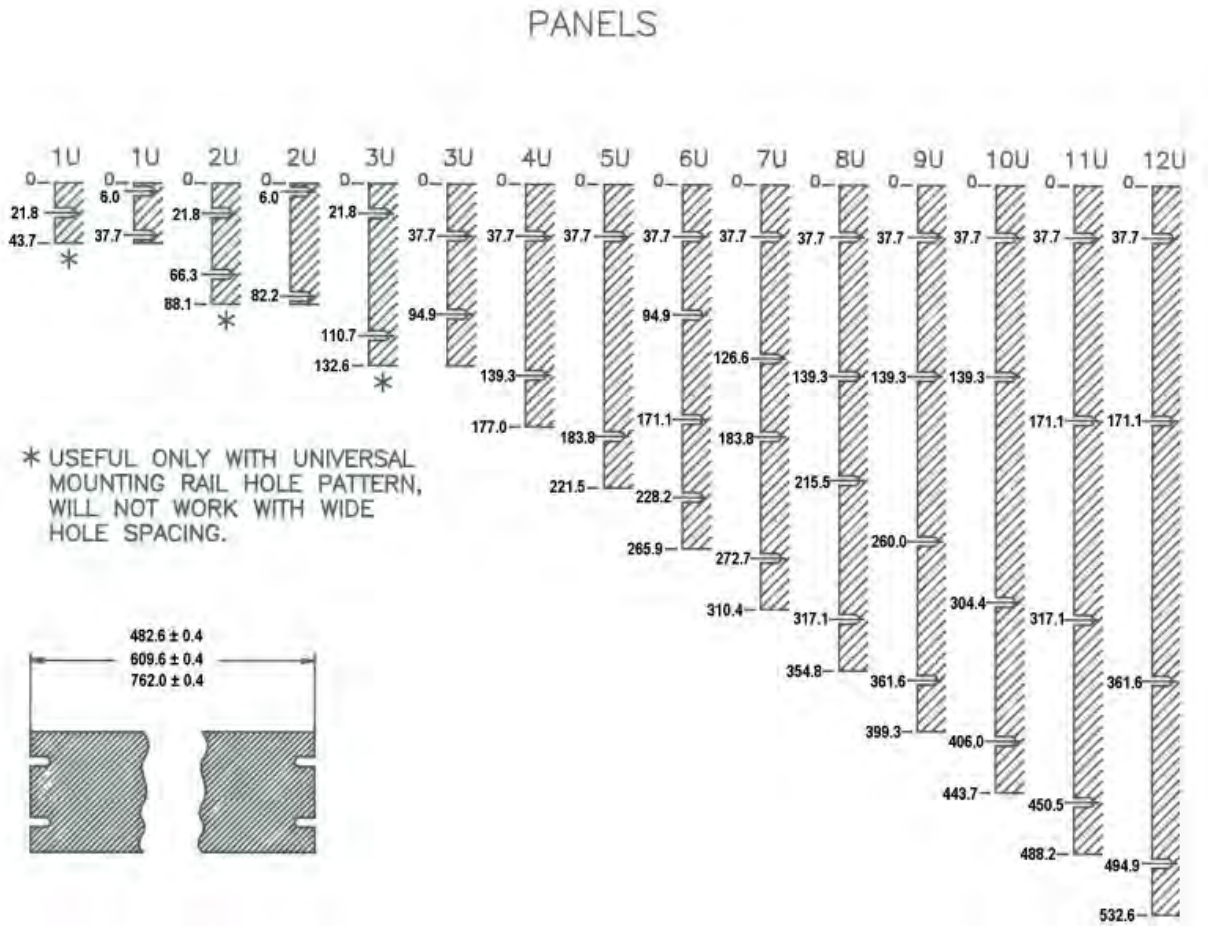


EX1008, p. 5, Figure 4. The preferred panel width shown in Figure 4 is 482.6 ± 0.4 mm. This is a measure of the outer dimension of the brackets used to mount the panel to the defined rack. For a tray to fit within the rack it must fit within the space defined by the opening dimension of the rack shown in Figure 3. For the smallest size rack that opening width dimension is defined as 450 mm.

261. The rack unit "U" defined in the standard refers to an amount of

vertical space and is defined to be 44.45 millimeters (exactly 1.75 inches) tall. See EX1008 at 2 (“ ‘U’—The modular unit ‘U’ on which panel heights are based is equal to 44.45 millimeters.”). The term is a unit of measure. That is, the height of a panel can be stated in terms of multiples of U. For example, a 2U panel would fit within a space 3.5 inches tall (2 x 1.75” = 3”). A single U space would be a space that is 1.75 inches tall. Figure 4 shows panel height dimensions for various multiples of U spaces. (1U, 2U, 3U etc…). As stated in the notes at the bottom of the figure, each panel height is calculated from the formula (n x U) - 0.8 mm.

EX1008, Figure 4:



...

4. PANEL HEIGHT = (n X U) – 0.8

Note that the vertical dimension for a 1U panel is given as 43.7 mm which fits within the overall 1U vertical space of 44.45 mm with room for some tolerance.

262. Turning back to the claim language of Element 1B, which refers to a width dimension, as shown in Figure 3 of the standard, there are three rack opening widths defined (450 mm, 577 mm, 730 mm). For a tray to fit within a width dimension from this standard, the tray must fit within one of these three width dimensions. The standard notes that the smallest is the preferred dimension. EX1008, p. 2.

263. One of ordinary skill in the art would recognize from, e.g., Figs. 15 and 5 that Sauter's tray is configured with dimensions that will fit the preferred 450 mm width dimension defined in this standard, which defines the minimum opening between vertical columns of the preferred 19" rack size. See EX1008, Figure 3. The dimensions of Sauter's tray can be recognized by the fact that the cassettes define standardized LC adapter ports. See EX1009 at p. 25 (e.g., Table A.4 listing maximum outside width dimension "GC" for a quad LC adapter as 25.9 mm, also maximum outside vertical dimension of a quad adapter as being 9.45 mm), see also EX1009 at 14, 16 (defining H_2 and N max dimensions to be 4.75 mm and 0.6 mm respectively); see also EX1009 defining vertical dimensions of LC adapters at 17,

15 (vertical dimension "AS" of an LC adapter port to be 6.6 - 6.8 mm). From these well-known dimensions of an LC adapter port, one of skill in the art would recognize that Sauter's cassettes and trays have dimensions that will fit within a U-space width dimension (e.g., it is less than 450 mm wide). Consider, for example, that the tray holds 4 single-gang cassettes that each have a width that is close to 3.5 quad adapters (4 cassettes x 3.5 quad widths per cassette x 25.9 mm per quad adapter = 362.6 mm). That still leaves just under 88 mm (450 mm – 362.6 mm) for the remaining edges of the tray and the enclosure to fit within the opening dimension of 450 mm of the defined 19" rack size. It would also easily fit into the larger standard U-space based on 24 inch or 30 inch racks defined in the standard. EX1008, Figure 3, pp. 4, 2 ("EIA-310-C identified three cabinet or rack openings to accommodate each of three standard panel widths 482.6 mm, 609.6 mm and 762.0 mm. The preferred panel width is 482.6 mm.)

264. A similar calculation applies to the vertical height of Sauter's tray. The height of Sauter's tray (see Fig. 5, 15) when populated with Sauter's cassettes is configured with a vertical dimension short enough to be mounted within a single U space in a rack (i.e., it is much shorter than the 1.75 inches of a single U-space). Constructing a tray with cassettes as taught by Sauter results in a total height equal to the height of the cassettes (which are barely taller than a single LC adapter) plus the height of a thin sheet that forms the bottom of Sauter's tray. One of skill in the

art would recognize that Sauter's trays are configured to be mounted with enclosure 1508 within a single U-space of the preferred 19 inch wide rack. Not only is this tray and cassette configuration short enough to fit within a 1.75 inch vertical rack space, but Fig. 15, shows that the trays are short enough to fit **three** trays within a one U space on a rack. One of skill in the art would recognize, therefore, that Fig. 15 is dimensioned to fit a standard U-space fiber management system. From the well-known dimensions of the LC adapters and the well-known mounting flanges shown in Fig. 15, one of skill in the art would recognize the entire enclosure 1508 with three trays will fit within a one U space in a rack.

265. As seen in Fig. 5 and 16, Sauter's trays are also configured with straight edges or flanges along its sides to allow the trays to be mounted by sliding the tray edges within grooves, such as the grooves 1604 defined by the enclosure 1508 that mounts to a rack.

Conforming Sauter's tray to fit a U-space width dimension would have been obvious

266. If it is argued that Sauter is not sufficiently express that his tray width "fits within a standard U-space width dimension," or similarly that the tray width portion fits "in a standard U-space fiber management system" then this would have been an obvious modification and application of Sauter's teaching. It would be highly unusual for a vendor to define a rack mounted panel that does not conform to the standard rack size already deployed in the industry. There is a very large,

already-installed base of telecommunications racks deployed in this industry that conform to the 19 inch rack dimensions defined in EX1008. For a manufacturer to make fiber optic equipment trays and an enclosure as shown in Sauter without conforming to the size of the equipment racks already owned and deployed by the telecommunications operators, would be highly unusual and would need a very compelling reason or justification for doing so. Sauter gives no such reason. One of skill in the art would be motivated when making a fiber optic enclosure and tray system as taught by Sauter to make the trays fit within a standard U-space width dimension so that customers can deploy the system into equipment racks that are already installed by the customers. Customers would be very reluctant to adopt new tray and enclosure systems that could not be deployed in the equipment racks already installed in the vast majority of telecommunications premises and offices. See, e.g., EX1037 ¶0003 ("Equipment racks having a width of 19 inches (482.6 mm) are most common, but racks with other widths are also used."); EX1038 ¶0007 ("…network equipment is typically mounted in standardized racks, the most common of which is called a 19 inch rack (named for its overall width). A standard 19" rack is divided up into vertical units called Rack Units (RU) each of which is 1.75" high. Maximizing the number of taps that can be installed in a 19" rack is a key factor in successful deployment of network tools."). One would have a reasonable expectation of success because the sizes of Sauter's components already

leave sufficient space to fit within the amount of space available within a standard U-space rack. If it doesn't already fit that space, it could easily be adjusted so that the enclosure and its trays can fit a standard U-space by choosing the width of the edges of the tray and the sidewalls of the receiving enclosure to fit within the amount of space left over after the width of the four single-gang cassettes is accommodated.

4. Element 1C

"wherein the tray is configured to fit a plurality of different modular fiber optic cassette configurations in the tray width portion in a standard U-space fiber management system;"

267. Sauter's trays are configured to receive a plurality of different modular fiber optic cassette configurations. Sauter's system includes modular cassettes. Different cassettes can be added and removed at various locations on the same tray and at various times. The tray system is flexible to be used in different configurations depending on which components (which size and type of cassettes) are chosen and where the components are installed on the tray, all without modifying the tray:

> The cassettes themselves have a structure that, in conjunction with the rail guide design, allows both single-gang and multi-gang cassettes to be mounted simultaneously and **in various positions** on a given tray. As such, **different sizes** of cassettes or adapter plates can be installed on the cassette tray without modification of the cassette system.

EX1006 at 4:7-13.

> As shown in FIGS. 2 and 3, the cassette mounting system allows a user to mount cassettes of different sizes (e.g., both single-gang and multi-gang cassettes) on the same cassette tray 102 simultaneously at any position on the mounting interfaces. In the example depicted in FIGS. 2 and 3, a single-gang cassette 112, a dual-gang cassette 110, and a single-gang adapter plate 114 are mounted on the upper mounting interface 104 of tray 102 in selected positions. As described in more detail below, any combination of single-gang cassettes (or adapter plates) and multi-gang cassettes (or adapter plates) can be disposed simultaneously on the upper and lower mounting interfaces of the cassette tray 102 subject to overall space limitations of the mounting surfaces.

EX1006 at 5:4-17; see also EX1006 9:60-62 ("…**any combination** of single-gang and multi-gang cassettes can be installed on a given tray 1510, subject to space limitations of the tray."); see also EX1006 Fig. 17 (illustrating method of adding and removing variously sized cassettes from same tray). An example of multiple configurations is provided by Sauter in his discussion of Fig. 5 at 6:42-56:

> FIG. 5 is a view of a single-layer cassette tray **502** on which are mounted two single-gang cassettes **504**. In this example, the single-gang cassettes **504** are installed on the left-most and right-most cassette bays, respectively, leaving two adjacent empty cassette bays in the middle of the tray. The mounting interface features described herein **allow the user to install either two more single-gang cassettes in these two empty cassette bays, or to install one double-gang cassette spanning the two adjacent cassette bays**. As described below, structural features of the double-gang cassette (and other multi-gang cassettes having more than two gangs) allow the cassette to be installed on the same cassette mounting system without physically modifying the cassette or the mounting interface.

In this passage, Sauter identifies a first configuration in which all four bays on the tray are occupied by single-gang cassettes and a second configuration in which the

two outer bays are single-gang cassettes and one double-gang cassette is positioned in the middle two bays of the tray.

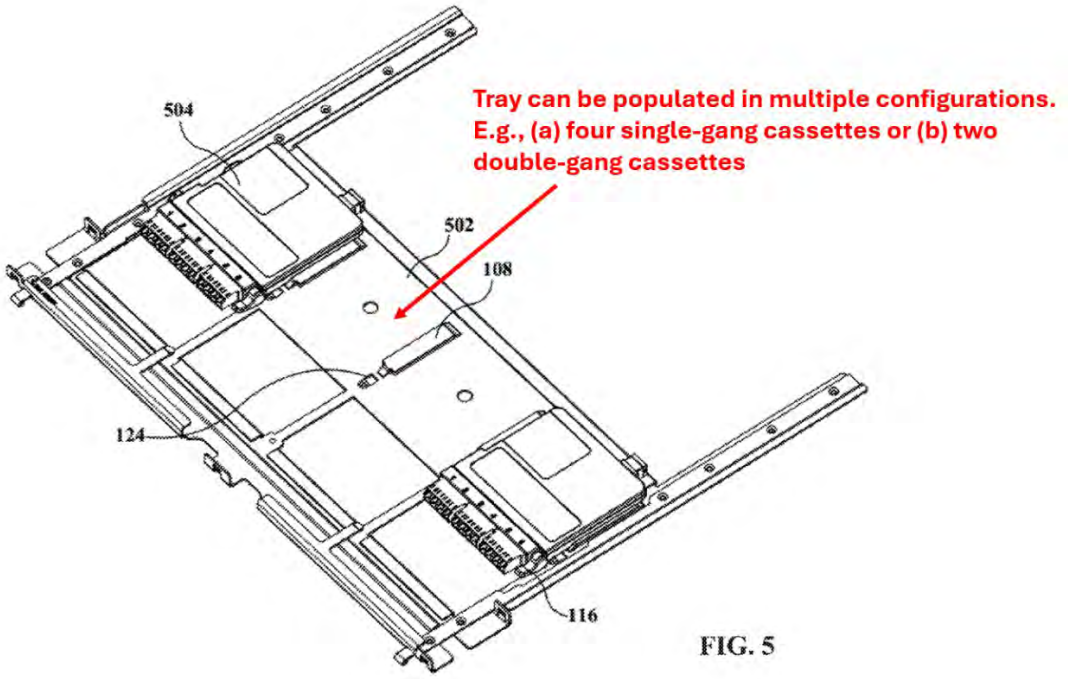


FIG. 5

268. The fastening features of the tray enable multiple configurations. For example, the fact that the width of the larger size cassettes are multiples of the width of the smaller size cassette enables multiple different size cassettes to be mounting to the same tray with one set of fastening features (rail guides and apertures on the surface of the tray).

269. Each of the different configurations can be arranged on the same tray that fits in a standard U-space fiber management system. For the reasons given above for Element 1B, Sauter's trays fit in a standard U-space fiber management system. For example, whether the tray is populated with four single-gang cassettes

or two double-gang cassettes, or one double-gang cassette and two single-gang cassettes, each of these configurations will fit on Sauter's tray which fits within a single U-space as shown above for Element 1B.

5. Element 1D

"wherein each of the plurality of different modular fiber optic cassette configurations include a modular fiber optic cassette that is configured to support a receptable module having a first module side end portion and a second module side end portion defining a module width portion that extends between the first tray side end portion and second tray side end portion;"

270. In Sauter, each of the multiple cassettes, that can be chosen to form the modular fiber optic cassette configurations, are configured to support receptacle modules. See EX1006 Figs. 2-7, 9-11, 13, 15, 16. Sauter shows LC adapters 126 which are examples of receptacle modules supported by the cassettes. EX1006 8:4-28:

> As shown in FIG. 6 (as well as FIGS. 2-5), each cassette is configured to hold a horizontal row of **fiber optic adapters 126** along the front edge of the cassette. Each adapter **126** is configured to receive multiple fiber optic connectors (dust caps **128** of which are shown in FIG. 6), which may be used to terminate respective optical fibers to be plugged into the adapters **126**. An interfacing connector **130** is disposed on the rear side of the cassette **110**. Individual fibers **606** of a fiber optic cable entering the cassette through the interfacing connector **130** can be broken out inside the cassette and terminated on the rear sides of fiber optic adapters **126** (in the case of adapter plates, unbundled individual fibers—rather than a fiber optic cable—may enter through the rear of the adapter plate). The adapters **126** provide connectivity between the fibers **606** terminated on the rear sides of adapters **126** and the fibers terminated on the front sides of adapters **126** using the fiber optic connectors. Although FIG. 6 depicts adapters **126** that are configured to receive **Lucent connectors (LC connectors),** cassettes that accommodate other fiber optic connector types are also within the scope of one or more embodiments described herein. In various embodiments, the fiber optic cassettes can be configured to accept single-fiber connectors (e.g., LC, Standard

> Connector, etc.) and multi-fiber connectors (e.g., mechanical transfer pull-off, multi-fiber push-on, etc.)

271. The adapters define receptacles, which in the Figures are shown and described as standardized LC receptacles. EX1006 8:4-28. The single-gang cassette includes three quad-LC adapter modules. See, e.g., Figs. 3, 5, 7, 13 and 16. Sauter's double-gang cassette includes six quad-LC adapter modules. See, e.g., Figs. 3, 6, 7, 9-10. As discussed above, Sauter's system enables various configurations of cassettes and can include, for example, four single-gang cassettes (see Fig. 15) or one double gang cassette and two single-gang cassettes (see Figs. 2, 3).

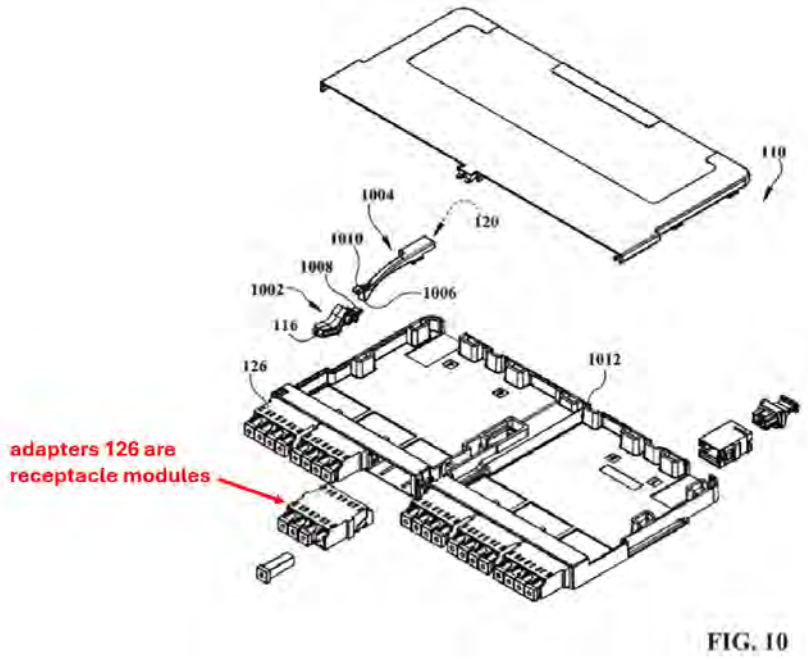


FIG. 10

EX1006, Fig. 10.

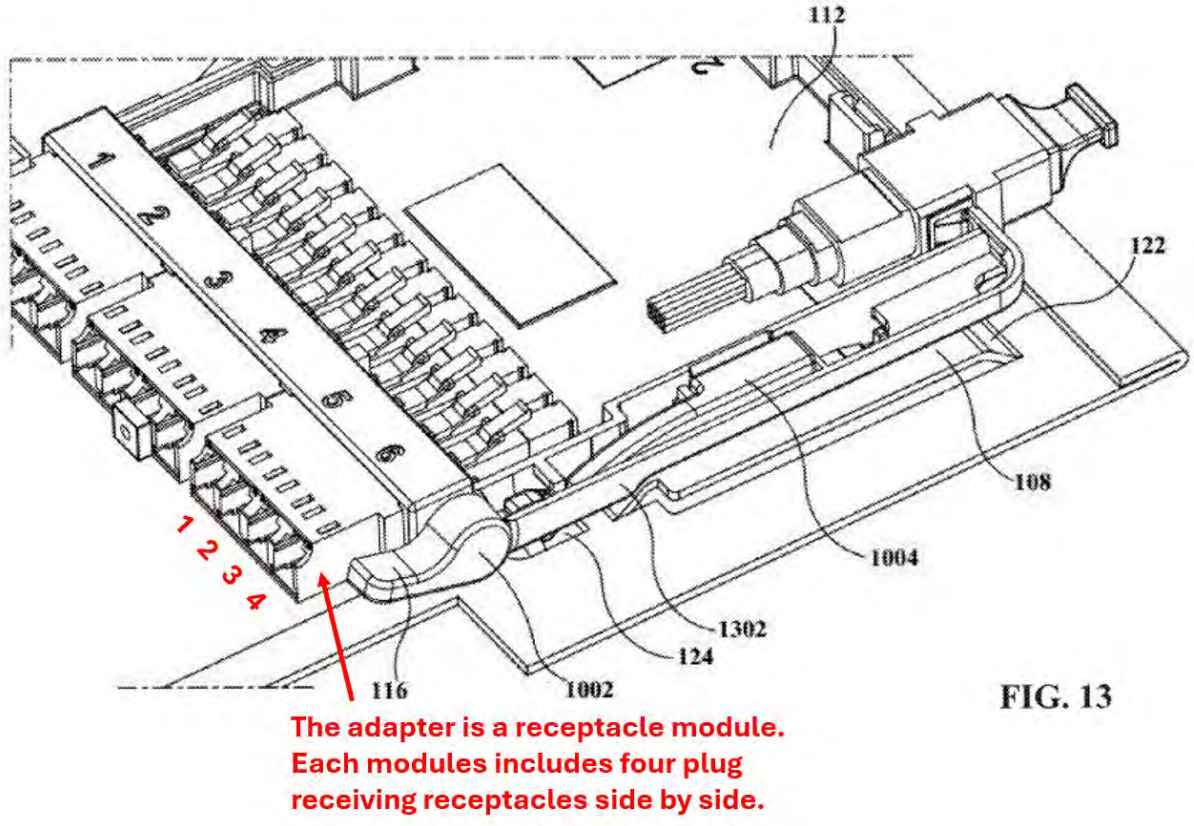


FIG. 13

EX1006, Fig. 13.

272. The modules each have a module width portion running between opposite side end portions.

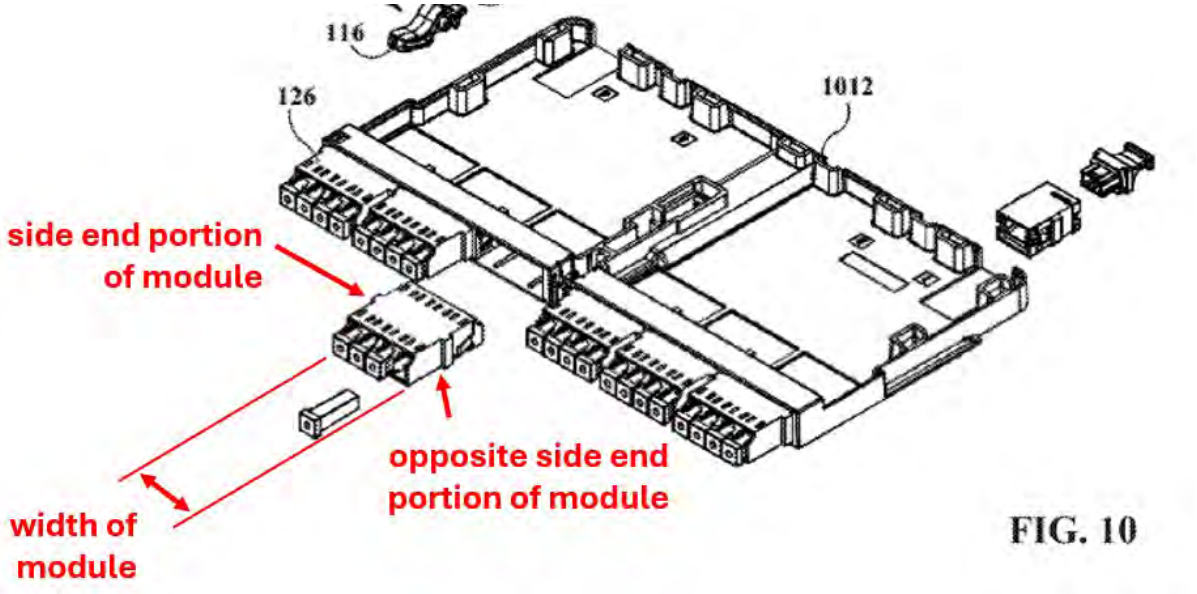


FIG. 10

EX1006, Fig. 10. When mounted on the trays, the width of the modules extend between the side end portions of the tray. The width of the modules run parallel to the width of the tray and are positioned between the opposite tray side end portions. See, e.g., EX1006 Figs. 2, 3, 5, 7, 11, 15, 16.

6. Element 1E

"wherein the module width portion is configured to fit in a standard one width (1 W) unit;"

273. Under Patent Owner's interpretation of a "standard one width (1 W) unit," Sauter's quad LC adapter modules satisfy this limitation. Patent Owner asserts a standard one width (1W) unit is "a unit of width that accommodates a single receptacle module, such as a LC Quad (SC Duplex) technology footprint comprising four connectors." EX1011 at Exhibit A p. 4. One third of the width of

Sauter's single-gang cassette (112, 504) accommodates a single receptacle module (126) having a LC Quad technology footprint comprising four connectors. As shown in Sauter's Figs. 5 and 7, the single-gang cassette 112, 504 has a width that accommodates **three** quad LC adapter modules along the front of the cassette.

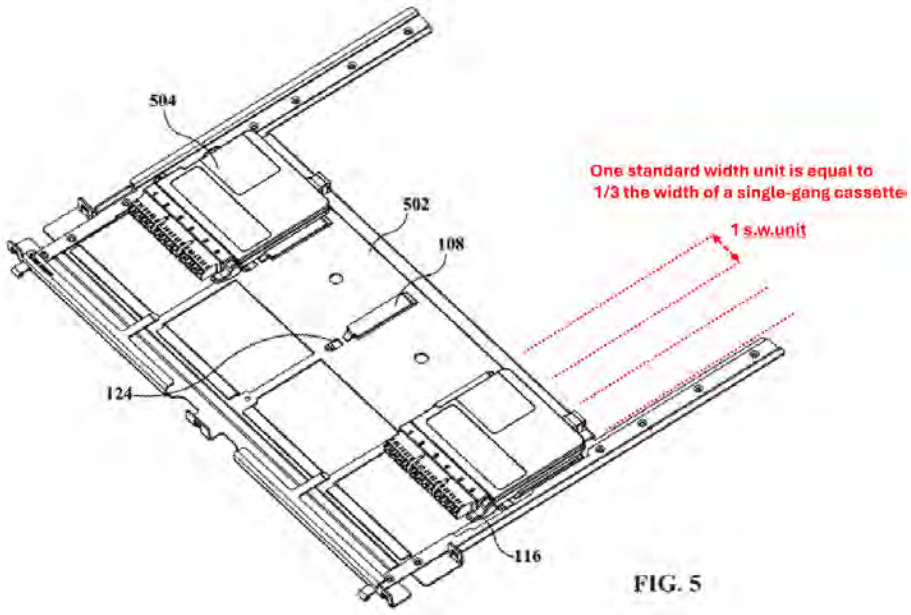


FIG. 5

EX1006, Fig. 5. Therefore, according to Patent Owner's interpretation, the single-gang cassette 112, 504 is an example of a cassette having a width of **three** standard width units. One third of the width of Sauter's single-gang cassette 112 would be an example of a "standard one width (1W) unit." Each quad LC adapter module 126 in Sauter is small enough to fit within one third of the width of Sauter's single-gang cassette.

274. Likewise, Sauter describes that the larger cassettes (dual-, triple-, multi-gang cassettes) are wider than the single-gang cassettes by multiple factors.

EX1006 at 4:50-61 ("As will be described in more detail below, since **multi-gang cassettes are wider than single-gang cassettes by multiple factors (e.g., a dual-gang cassette is approximately twice as wide as a single-gang cassette, a three-gang cassette is approximately three times as wide as a single-gang cassette, etc.**), a multi-gang cassette will span more than one rail guide."). Each multi-gang cassette size accommodates a larger number of adapter modules each having four connector ports. The double-gang cassette accommodates six quad LC adapter modules, each having four front connector ports. Under Patent owner's interpretation, therefore, the "double-gang" cassette 110 (sometimes called a "dual-gang" cassette) is an example of a cassette having a width of **six** standard width units.

275. In addition, even if the term "standard (1W) width unit" is not merely defined by the number of modules a unit of width can accommodate, but is actually about the mathematical relative width dimensions of different cassettes as measured from side to side and being based on a width standardized in the industry, Sauter's cassettes disclose this. Sauter discloses cassettes of different widths, specifically cassettes that that are a multiple in size relative to each other. EX1006 at 4:50-61. Sauter discloses cassettes such as double-gang cassette 110 can be mathematically equal to twice the size of the single-gang cassette. As noted above, Sauter states that the double-gang cassette is wider than the single-gang

cassette by a factor (i.e., a factor of 2), and that the double-gang cassette is "approximately twice as wide" as the single-gang cassette. EX1006 at 4:50-61. Figure 7 shows an example of the width of a double-gang cassette 110 relative to a single-gang cassette 112. The cassette 110 shown in Fig. 7 is not precisely equal to two times the width of the single-gang cassette because the latching mechanism 120 including release latch 116A is positioned in the middle of the cassette 110, and, therefore, cassette 110 is only approximately equal to twice the width of cassette 112 shown in Fig. 7. However, Sauter also teaches that the release latching mechanism 120 including latch 116 could alternatively be positioned along the side of the double-gang cassette just like the latching mechanism 120 including release latch 116B on the single-gang cassette 112. See EX1006 at 7:48-60:

> As shown in FIGS. 6 and 7 (as well as FIG. 9, which is a three-dimensional view of the dual-gang cassette 110), the latching mechanism 120 for the example dual-gang cassette 110 is disposed in a middle section of the cassette between the two gangs 604A and 604B, with release latch 116A protruding from the front of the cassette 110. **However, in some embodiments, the latching mechanism 120 for a double-gang cassette can be located on the left or right side of the cassette, similar to single-gang cassettes.** Similarly, for multi-gang cassettes having more than two gangs, the latching mechanism 120 can be located between any two adjacent gangs of the cassette, or on either the left or right side of the cassette.

See also EX1006 at 1:64-2:1 ("In order to lock the cassettes in place on the tray, both single-gang and multi-gang cassettes include a latching mechanism on the left

side, **on the right side**, or in a middle section of the cassette."). When the latching mechanism 120 including the release latch 116 is positioned along the right hand side of the double-gang cassette, the width of the double-gang cassette mathematically equals twice the width of the single-gang cassette., without any additional amount. The figures below illustrate what Sauter is teaching at 7:48-60.

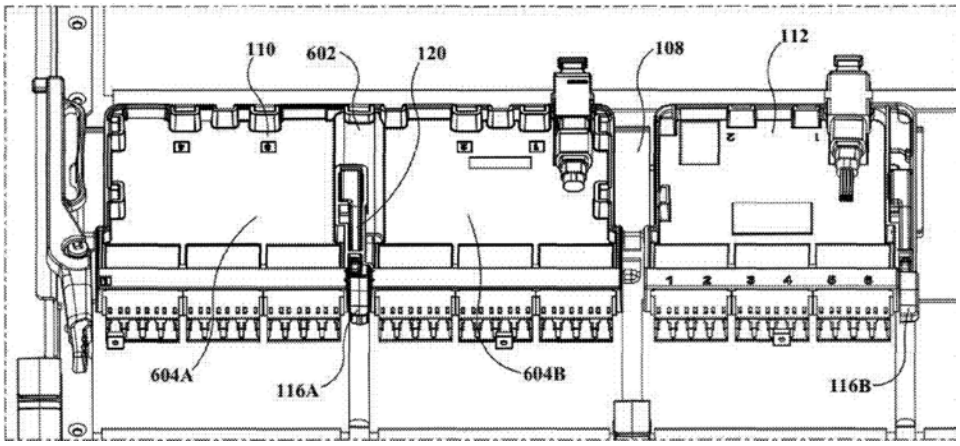
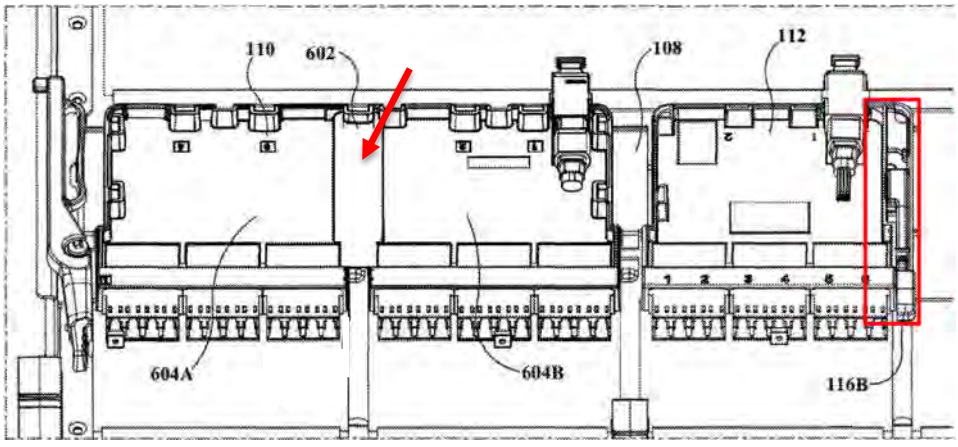
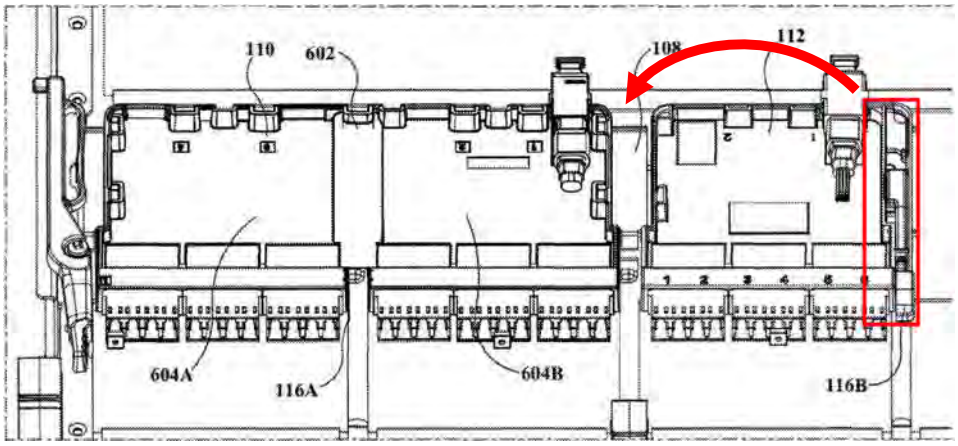
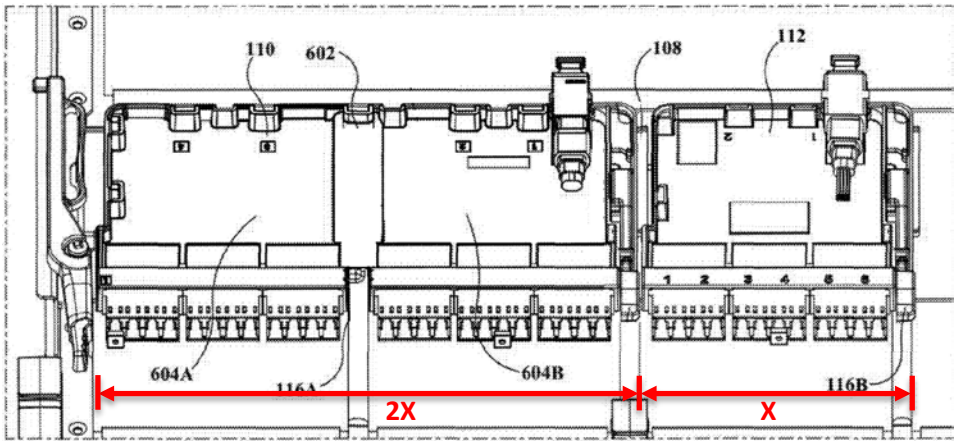
Fig. 7 as shown in Sauter (with latching mechanism 120 and 116A in the middle of cassette 110)	
Fig. 7 without middle latching mechanism 120 and 116A	

Fig. 7 indicating latch mechanism along right side of cassette 112 that Sauter teaches can be duplicated onto right side of cassette 110.	
Fig. 7 with latching mechanism located along right hand side of cassette 110 as taught by Sauter at 7:54-56.	

When the change taught by Sauter at 7:54-56 is made, cassette 110 mathematically equals twice the width of cassette 112, not merely approximately twice the width of cassette 112.

276. When the widths of the cassettes are multiples of each other, the width of each multi-gang cassette such as a double-gang cassette will be an exact multiple of any width unit that divides evenly into the width of the single-gang cassette. For example, if a standard width unit is chosen as 1/3 the width of the

single-gang cassette (which width is large enough to receive a single standardized LC Quad footprint with four connector receptacles), then the double-gang cassette will be equal to 6 times the standard width unit without any additional amount. The same standard width unit will divide evenly into each size cassette taught by Sauter. The double-gang cassette will be evenly divisible by 1/3 the width of the single-gang cassette, and the double-gang cassette will have the width equal to six standard width units (6W).

277. The same relationship would be true for the single-gang and double-gang cassettes as modified as discussed below in Elements 1F and 1K to allow both BASE-12 and BASE-8 cassettes on the same tray (e.g., as modified with clearance areas and module spacing to span additional, intermediate rail guides on the tray). The unit of width (1W) will still be defined to be one third of the modified 3W cassette. The double-gang cassette of both BASE-12 and BASE-8 will still be exactly twice the size of the single-gang cassettes, and will have as a common denominator the 1W width unit between them.

7. Element 1F

"wherein each of the modular fiber optic cassettes includes a first cassette side end portion and a second cassette side end portion defining a standard cassette width unit extending between the first cassette side end portion and the second cassette side end portion that comprises a standard two width (2 W) unit, a standard three width (3 W) unit, a standard four width (4 W) unit, or a standard a standard six width (6 W) unit relative to the standard one width (1 W) unit;"

278. Sauter discloses a single-gang cassette (112, 504) that has a cassette width (from side end portion to side end portion) equal to a standard three width (3W) unit. The width of Sauter's single-gang cassettes (112, 504) is equal to three times the standard width unit (which is one third of the width of the single-gang cassette) as set out in the discussion of Element 1E above. As discussed above for Element 1E (which I reincorporate here by reference), Sauter also discloses a double-gang cassette 110 that has a cassette width equal to a standard six width (6W) unit, i.e., its width is equal to six standard width units, when the latching mechanism is located along the right side as taught by Sauter as discussed above in Element 1E.

279. Sauter does not expressly show a cassette having a width of 2W or 4W (i.e., having a width equal to two standard width units or four standard width units) if the standard width unit is equal to one third the width of the single-gang cassette. It would have been obvious based on Sauter in combination with US 2017/0192191 ("Dagley")(EX1030) to include these two additional sizes of cassettes.

280. One of skill in the art would have found it obvious to include additional sizes of cassettes, specifically a 2W size and a 4W size, in order to support BASE-8 fiber systems that group and organize fibers into groups of eight

fibers or multiples of eight, rather than the more conventional groups or multiples of twelve fibers.

281. Traditional duplex fiber cable systems typically used components such as MPO connectors and fibers that employed fibers in groups of twelve. However, it was known that newer "parallel" fiber cable systems were migrating to grouping fibers in connectors and cables into groups of **eight**, not twelve. See, e.g., US 2017/0192191 to Dagley, especially paragraphs 003-005 that note the need to create cassette module sizes to support newer BASE-8 fiber systems:

> [0003] There are two dominant transmission forms used in data centers for fiber cabling today. A duplex (e.g., 2 fiber) solution uses dedicated transmit and receive optical channels paired together and **a parallel multi-fiber solution (e.g., 8-fiber solutions**) that transmits signals using multiple optical channels and recombines the multiple optical channels for transmitting at faster speeds. For instance, a parallel 100-Gigabit link may be transmitted along ten parallel 10-Gigabit lanes with the multiple 10-Gigabit signals being recombined from the parallel channels. Many customers desire to move back and forth between these different transmission forms at different locations in the network depending on network management requirements and link costs at different protocol speeds. Existing parallel solutions require an MTP type connector, which is designed to hold 12 fibers.
>
> [0004] Likewise, current duplex solutions also deploy 12-fiber MPO trunk cabling along with MPO/LC breakout modules. In the duplex solutions the plurality of optical channels of the MPO connecter are broken out into individual optical channels using modules with LC connections. Consequently, all of the optical channels can be accessed as LC ports at the front of the module. However, these network solutions do not allow the flexibility to easily migrate the system from a duplex transmission to a parallel transmission solution and vice-versa. Further, fiber utilization rates for the 12-fiber optical networks can be encountered if other fiber counts are needed for the network such as 8-

fiber solutions, either 4 fibers must be left dark or conversion modules must be employed, either of which may add cost, complexity and attenuation to the network systems.

[0005] Existing solutions for migration from a duplex transmission to a parallel transmission contemplate the cumbersome replacement of current MPO-LC modules with an MPO panel. However, there is also a need to easily migrate back to a duplex transmission when desired. This migration can provide challenges and result in extensive down time for the migration. For example, users are cabling cabinets in the data center space without prior knowledge if duplex or parallel transmission would be required in that cabinet (based on servers placed in that cabinet). In addition, new transceiver technology is always evolving in the market; thus a particular data rate today that might require parallel cabling could be replaced by a new duplex transceiver in the future at the same data rate. Thus, there is a need for flexibility in cabling and network infrastructure that allow the network operator an easy way to migrate between duplex and parallel transmission and vice versa at locations in the optical network.

…

[0045] The application discloses BASE-8 modules, fiber optic panel assemblies, and hybrid fiber optic modules for mounting in equipment trays that can be mounted in a movable fashion to a chassis. The assemblies disclosed provide the ability **to easily and quickly migrate an optical network between duplex transmission and 8-fiber parallel transmission**. The BASE-8 configurations are contrary to the installed BASE-12 optical networks that are widely deployed. Further, the BASE-8 components and assemblies can improve fiber utilization rates when requiring quick and easy migration path between duplex and parallel transmission in an optical network.

…

[0049] As used herein, BASE-8 means the component supports transmission of eight optical channels and connects with 8-fiber connectors, not 12-fiber connectors.

EX1030 (US2017/0192191) at ¶¶0003-0005, 0045, 0049; see also EX1030, Fig. 1A (showing a cassette sized to have eight LC fiber receptacles along the front instead of twelve):

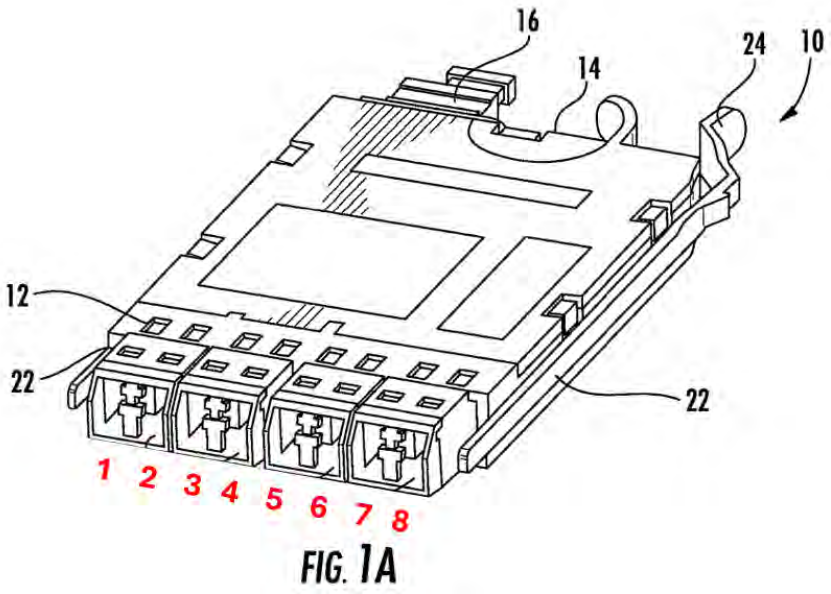


FIG. 1A

See also EX1030 ¶0052 (noting that adapters can be ganged into groups of four receptacles, not just groups of two); see also EX1031 (US 2017/0153406) at ¶¶0020-0027; EX1032 (U.S. Patent No. 8,873,922) 4:20-43 (describing multi-fiber connector ferrule that may terminate eight optical fibers).

282. To support fiber systems employing BASE-8 fiber cables and components it would have been obvious to modify Sauter's teaching to include single-gang and double-gang cassette sizes for BASE-8 systems. That is, it would have been obvious to a POSITA to modify Sauter to include a BASE-8 "single-gang" cassette having a width that would accommodate only **two** quad LC adapter

modules, instead of three. Thus, as modified, the BASE-8 single-gang cassette would include eight receptacle ports (not twelve) and would be an example of a cassette having a width of two standard width units. A BASE-8 "dual-gang" cassette would include sixteen receptacle ports (not twenty-four) and would be an example of a cassette having a width of four standard width units. A BASE-8 "three-gang" cassette would include twenty-four receptacle ports (not thirty-six).

283. Sauter's use of the generic term "gang" which refers to a set of items grouped together, itself suggests that the base number in one gang or group does not always have to be the same as in the preferred embodiment (ie. one "gang" does not always need to be twelve). The term suggests to define a group, and then create multiples of that number.

284. One of ordinary skill in the art would be motivated to include BASE-8 single and double-gang cassettes to match BASE-8 fiber systems. Because it was known that some systems were BASE-8 systems, that used components (e.g., MPO connectors and cables) that grouped fibers into groups of eight or multiples of eight, one of skill in the art would have been motivated to match the MPO connectors and cabling in a BASE-8 system to cassettes sized to match the number of fibers to make more efficient use of available cassette space and infrastructure. It would avoid leaving some cassette capacity wasted which would result if a BASE-12 cassette were used to terminate a BASE-8 cable or MPO connector. See,

e.g., EX1036 at 3:19-27 (describing MPO connectors entering rear wall of module, each MPO connector having sixteen fibers to be coupled to individual adapters at front of module).

285. Further, the Dagley reference points out that it would be desirable for the system to be able to transition back and forth between 12-fiber systems and 8-fiber systems (see EX1030 at ¶¶0045-0046 ("…flexibility to convert back…"). Dagley also teaches that it would be desirable to have **both** BASE-12 and BASE-8 cassettes in the same row within a tray system. EX1030 ¶0049 ("…support different sizes of BASE modules in the same row…BASE-8 modules and…BASE-12 modules, enabling a greater degree of customization."). Therefore, a POSITA using Sauter's teaching would have been motivated to include both BASE-12 size cassettes (3W and 6W) and BASE-8 cassettes (2W and 4W).

286. One of ordinary skill in the art would recognize that configuring the tray system for both BASE-8 and BASE-12 cassettes would require adding rail guides to the tray so that it could receive the smaller cassettes (see the discussion of Element 1K below), and Sauter already teaches how to accommodate additional rail guides on the tray by spacing the quad LC modules apart slightly and defining clearance areas 602 such as slots in the bottom surface of the larger cassette sizes to avoid intermediate rail guides that are only needed for a smaller cassette size.

EX1006, Fig. 8; 7:14-37. The clearance areas and spacing apart of the quad LC modules can be seen, for example, in Sauter's Figures 8, 11, and 9:

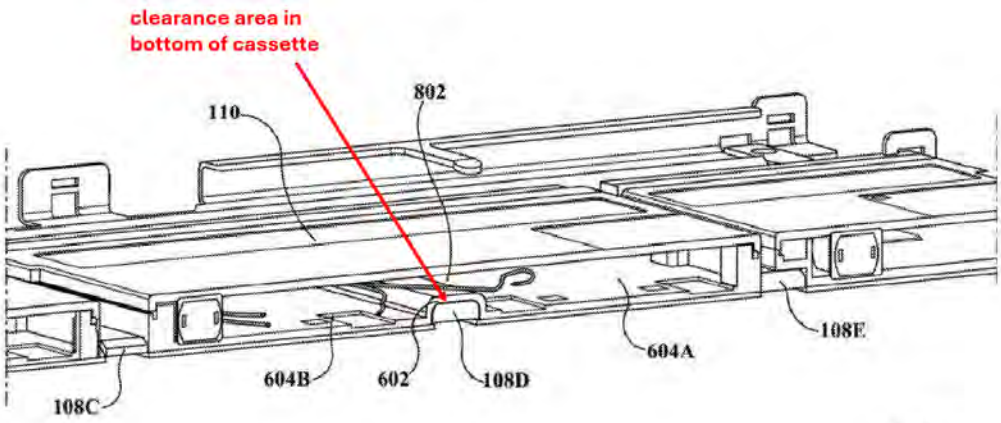


FIG. 8

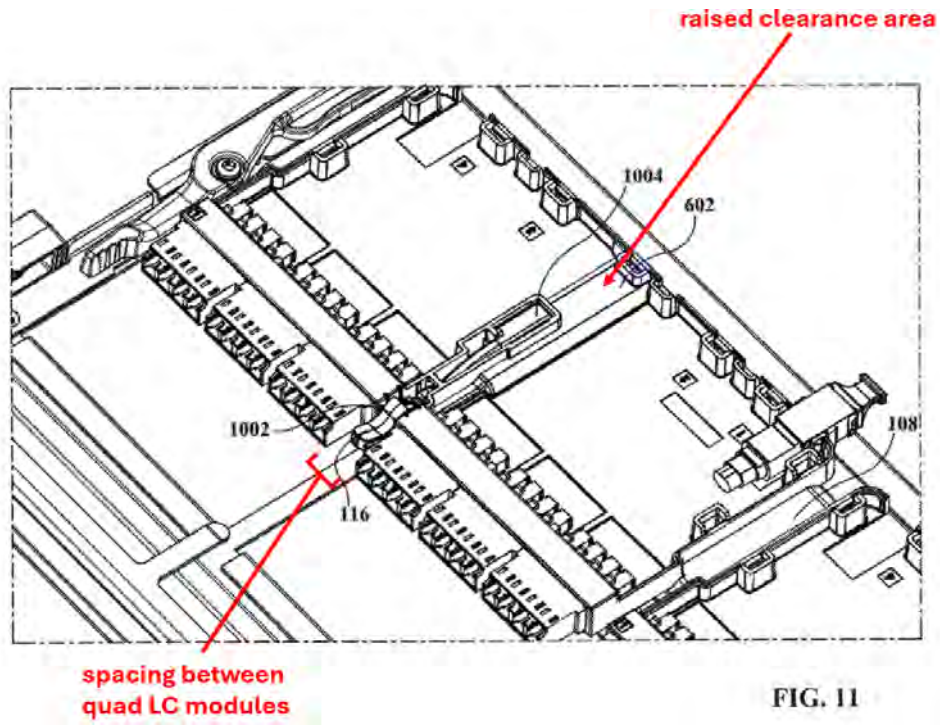
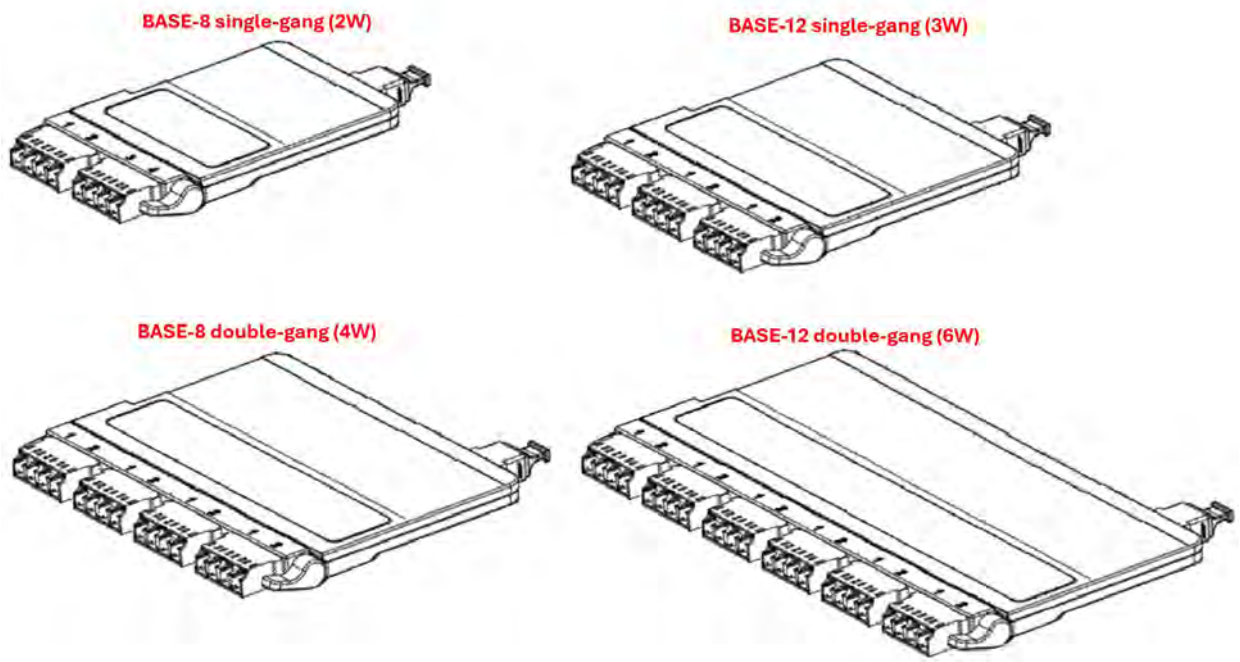


FIG. 11

287. The figures below show conceptually what a person of ordinary skill in the art would immediately envisage when modifying Sauter's cassettes so as to support both BASE-12 and BASE-8 systems on the same tray. The BASE-8

single-gang cassette is 2W wide and fits two quad receptacle modules. The BASE-8 double-gang cassette is 4W wide and fits four quad LC receptacle modules. Likewise the BASE-12 single-gang cassette is 3W wide and fits three receptacle modules, and the BASE-12 double-gang cassette is 6W wide and fits six quad LC receptacle modules.



288. A person of ordinary skill in the art would have had a reasonable expectation of success for multiple reasons. First, changing from 12 to 8 port cassette width because no new functionality would be needed. The same components would function the same way, but would merely incorporate fewer duplicate components (only two quad LC adapter modules, not three quad LC adapter modules).

289. Also, a person of ordinary skill would have a reasonable expectation of success because of the known amount of available space on a tray that would still fit the opening of a standard 1U rack. As mentioned above, the opening for the smallest standard 1U rack (the 19 inch rack) is 450 mm. EX1008, p. 4, Fig. 3. Devoting 10% of this space for purposes other than positioning cassettes (see FIG. 15 of Sauter and the amount of width space devoted to the sides of the cassette mounting area such as space used for the enclosure side walls and the unusable edges of trays), leaves about 400 mm of useful space for the cassettes on the tray. An opening for a quad LC receptacle module is defined to have a minimum width of 26.0 mm. EX1009 p. 25, Table A4 ("GD"). Twelve such openings to receive twelve quad receptacle modules only uses 312 mm of width, leaving 88 mm for the remaining spaces/rails. A person of ordinary skill in the art would have a reasonable expectation of success with this much width to devote to the remaining needed structures (e.g. cassette side walls, spacing between LC modules, and latch mechanism). Further, an abundance of space would be available if the system were designed to fit the standard 1U space of a standard 24 inch or 30 inch rack.

290. Finally, not only Dagley, but others in the art had already taught to make cassettes based on groups of 8. See, for example, Sedor (EX1005) at Figs. 9-10, 4:23-35:

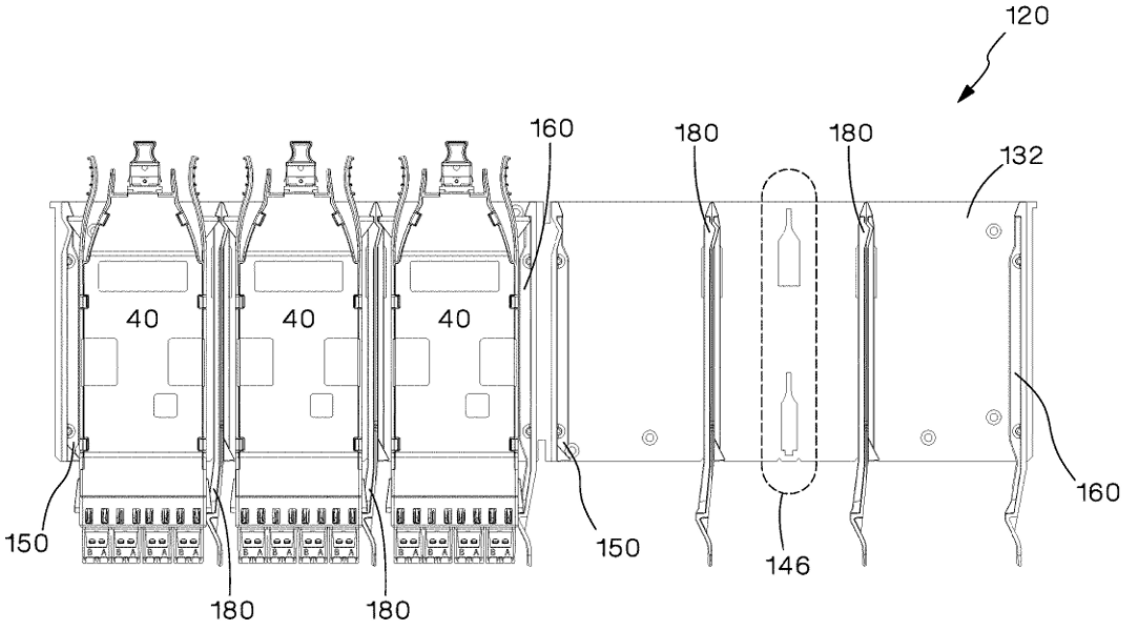


FIG.9

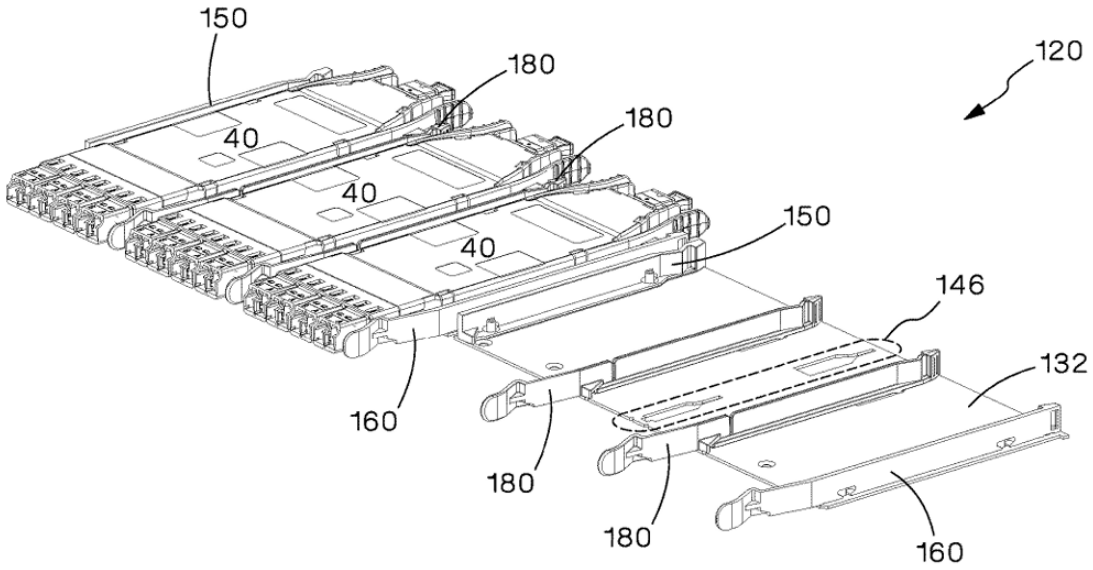


FIG.10

EX1005, 4:23-35:

> Referring to FIG. 5, in a preferred embodiment, the removable rails may be added or removed in order to support one 24-optical fiber module **20**, two 12-optical fiber modules **30**, or three 8-optical fiber modules **40**. The fiber optic modules shown in all of the Figures (for example, FIG. 7) of this application include duplex LC adapters at the front of the module that lead to 1 MPO adapter at the rear of the module. The 24-optical fiber module **20** shown in the Figures includes 12 LC adapters; the 12-optical fiber module **30** as shown in the Figures includes 6 LC adapters; and **the 8-optical fiber module 40 as shown in the Figures includes 4 LC adapters**. One of ordinary skill in the art would understand that different numbers of optical fibers and different numbers and types of adapters may be used in a fiber optic module that may be installed within the present invention.

8. Element 1G

"wherein the receptable module is configured to fit at least four fiber optic plug receiving receptacle portions in a standard one width (1 W) unit;"

291. Sauter's adapter modules 126 are configured to fit four fiber optic plug receiving receptacle portions in a standard one width (1 W) unit. Each quad LC adapter shown in Sauter includes four fiber optic plug receiving receptacles arranged side by side in a row, and each quad adapter fits within one third of the width of the single-gang (3W) cassette, which is the standard width (1W) unit. See EX1006 at Figs. 7, 10, 13 and 8:4-36 ("each cassette is configured to hold a horizontal row of fiber optic adapters 126 along the front edge of the cassette. Each adapter 126 is configured to receive multiple fiber optic connectors…which may be used to terminate respective optical fibers to be plugged into the adapters 126."):

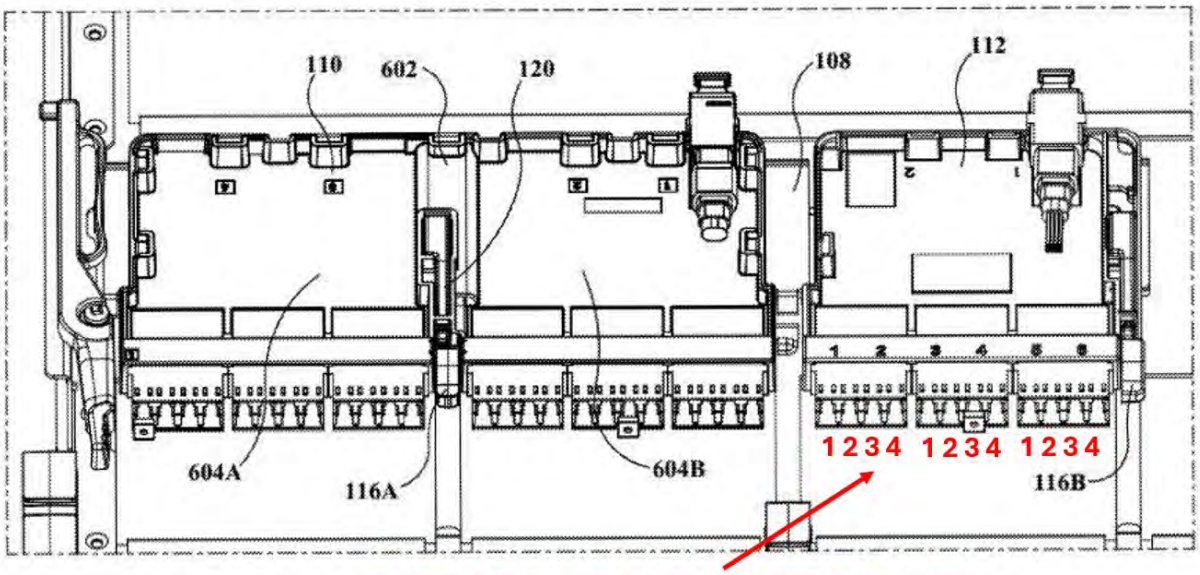

110
602
120
108
112
604A
116A
604B
1234 1234 1234
116B
Single-gang cassette includes three adapter modules each of which includes four plug receiving receptacle portions side by side in a row.

FIG. 7

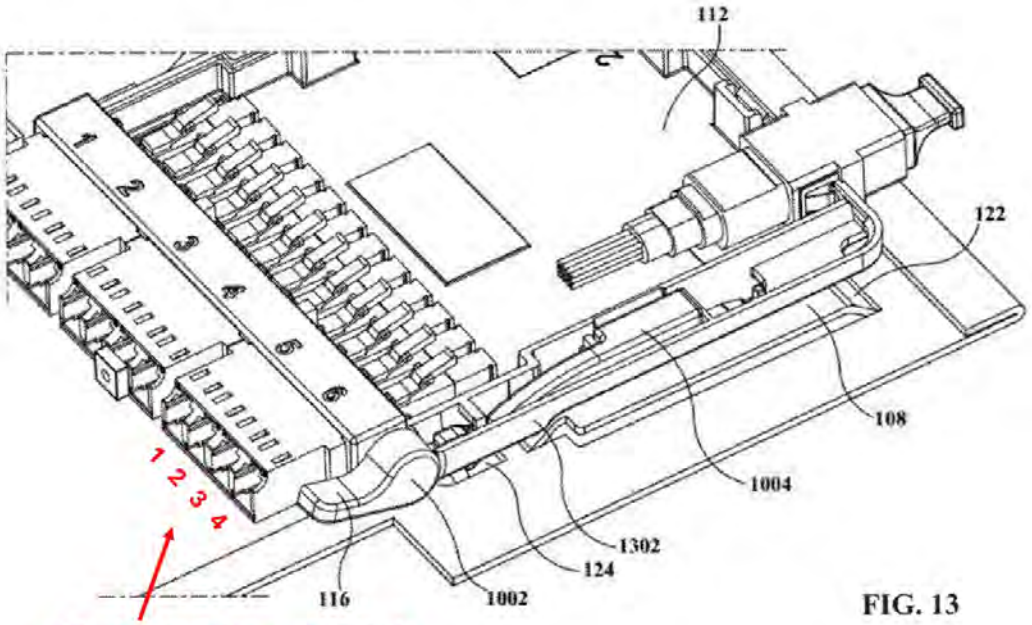

112
122
108
1004
1302
124
116
1002
Adapter modules each include four plug receiving receptacles side by side.

FIG. 13

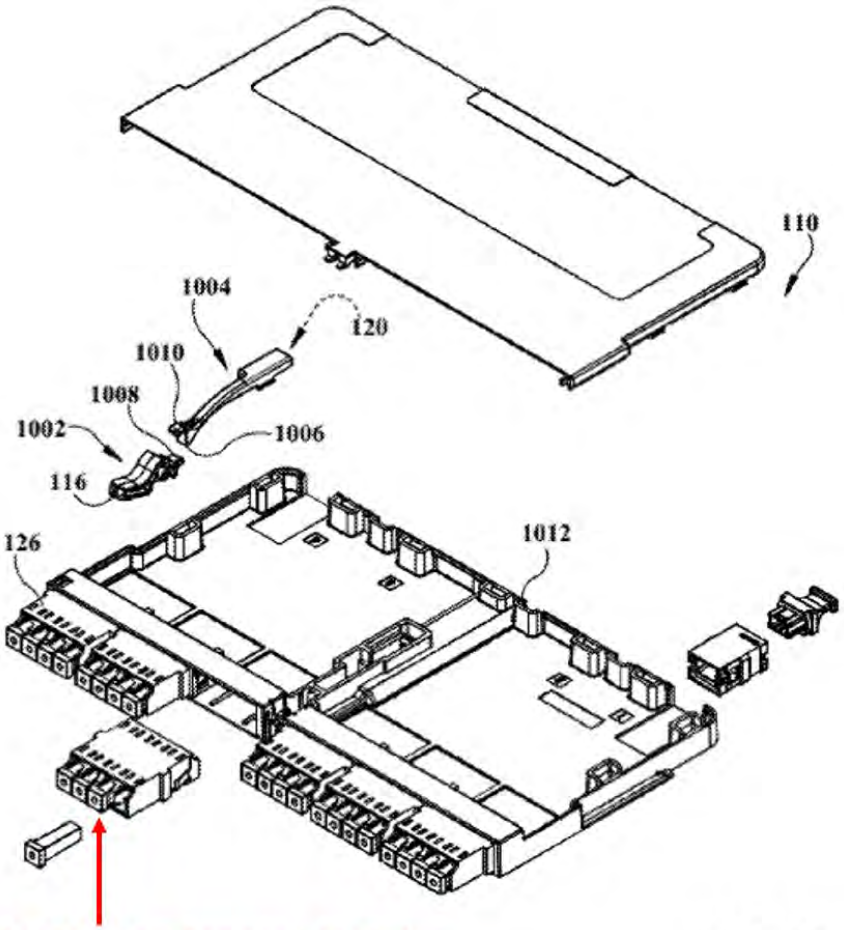


FIG. 10

9. Element 1H

"wherein the plurality of different modular fiber optic cassette configurations comprise:

a first modular fiber optic cassette configuration that includes six modular two standard width unit (2 W) cassettes that are each arranged side by side of each other along the tray such that a cassette side end portion of each modular two standard width (2 W) cassette adjacently faces a cassette side end portion of at least one other modular two standard width (2 W) cassette;

a second modular fiber optic cassette configuration that includes four modular three standard width unit (3 W) cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of each modular three standard width (3 W) cassette adjacently faces a cassette side end portion of at least one other modular three standard width (3 W) cassette;

a third modular fiber optic cassette configuration that includes three modular four standard width unit (4 W) cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of each modular four standard width (4 W) cassette adjacently faces a cassette side end portion of at least one other modular four standard width (4 W) cassette;

a fourth modular fiber optic cassette configuration that includes two modular six standard width unit (6 W) cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of one of the two modular six standard width (6 W) cassettes adjacently faces a cassette side end portion of the other modular six standard width (6 W) cassette; and

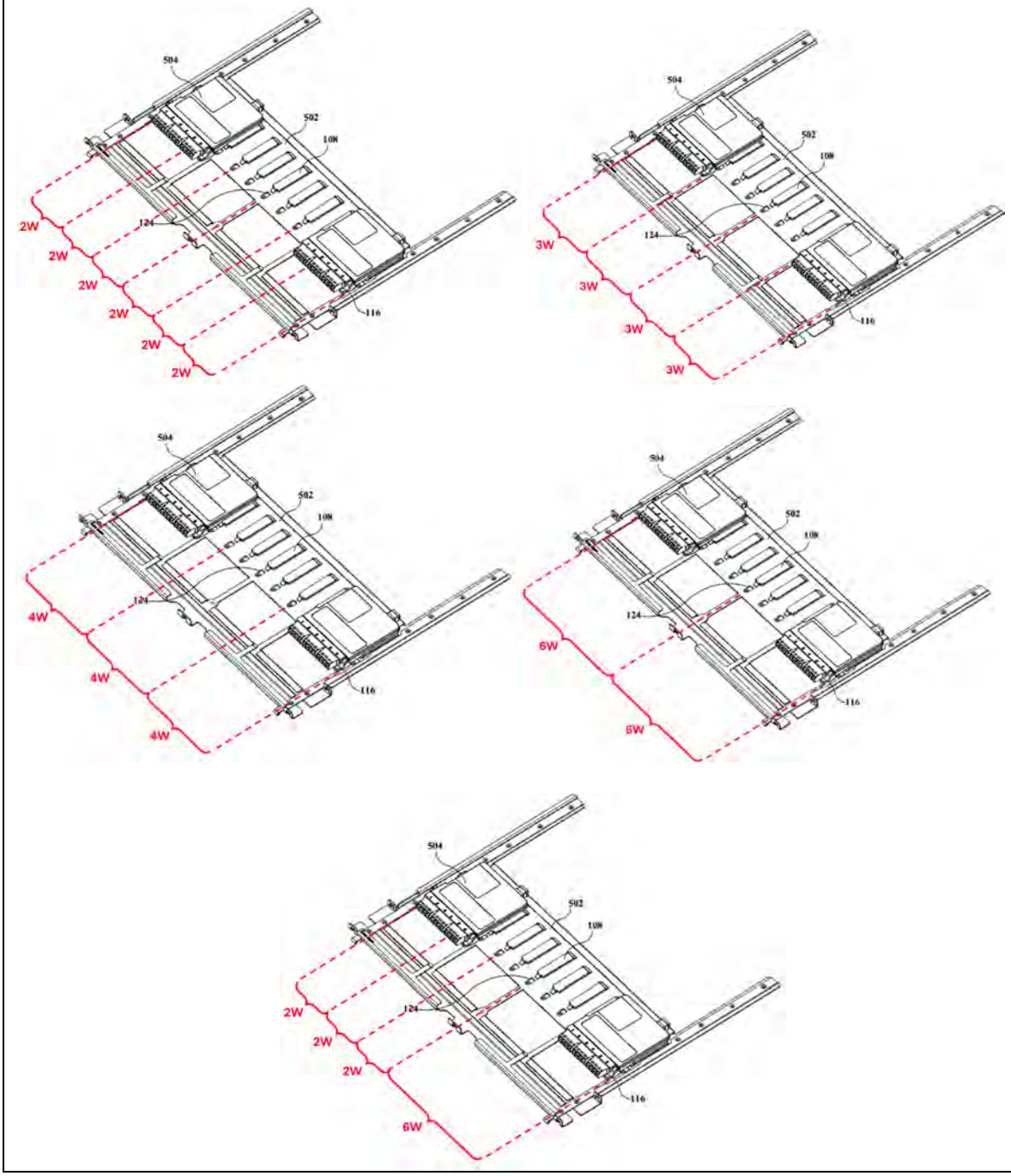
a fifth modular fiber optic cassette configuration that includes three modular two standard width unit (2 W) cassettes, which are each arranged side by side of each other in a row along the tray such that a cassette side end portion of one of the three modular two standard width (2 W) cassettes adjacently faces a cassette side end portion of one of the other modular two standard width (2 W) cassette, and one modular six standard width unit (6 W) cassette that is arranged side by side in a row along the tray with one of the three modular two standard width unit (2 W) cassettes, such that a cassette side end portion of the one modular six standard width unit (6 W) cassette adjacently faces a cassette side end portion of one of the other three modular two standard width unit (2 W) cassettes;"

292. As seen, for example, in Fig. 15, Sauter's tray is configured to fit twelve standard width units of cassettes. This means that it has the space required

to fit all five cassette configurations listed in Element 1H. Because it can fit twelve standard width units, it is configured to fit each of the cassette configurations listed in Element 1H, each one of which adds up to a total of twelve standard width units.

293. As discussed above regarding Element 1F, Sauter teaches both the 3W cassette size and the 6W cassette size, and, for the reasons given above under Element 1F, it would have been obvious to modify Sauter to include two additional cassette sizes (2W and 4W) to support BASE-8 systems (e.g., including adding additional rail guides to the tray to secure the smaller cassette size). This modification would not change the width or capacity of Sauter's tray. Because Sauter's tray will fit a total of 12 standard width units of cassettes, it would still be configured to fit all the cassette configurations recited in Element 1H. The figures below show conceptually how Sauter's tray would appear if modified as contemplated to fit not only four 3W cassettes or two 6W (BASE-12) cassettes as already shown in Fig. 5 of Sauter, but also to receive BASE-8 single-gang and double-gang cassettes (2W and 4W cassettes respectively).

Sauter's tray as modified to fit both BASE-12 and BASE-8 cassettes



294. In each configuration, the cassettes would be arranged side by side in a row along the tray such that a cassette side end portion of each modular cassette adjacently faces the side end portion of another cassette. This can be seen, for example, in Fig. 15 of Sauter, where all the cassettes are arranged side by side in a row with their side ends adjacently facing another cassette side end portion.

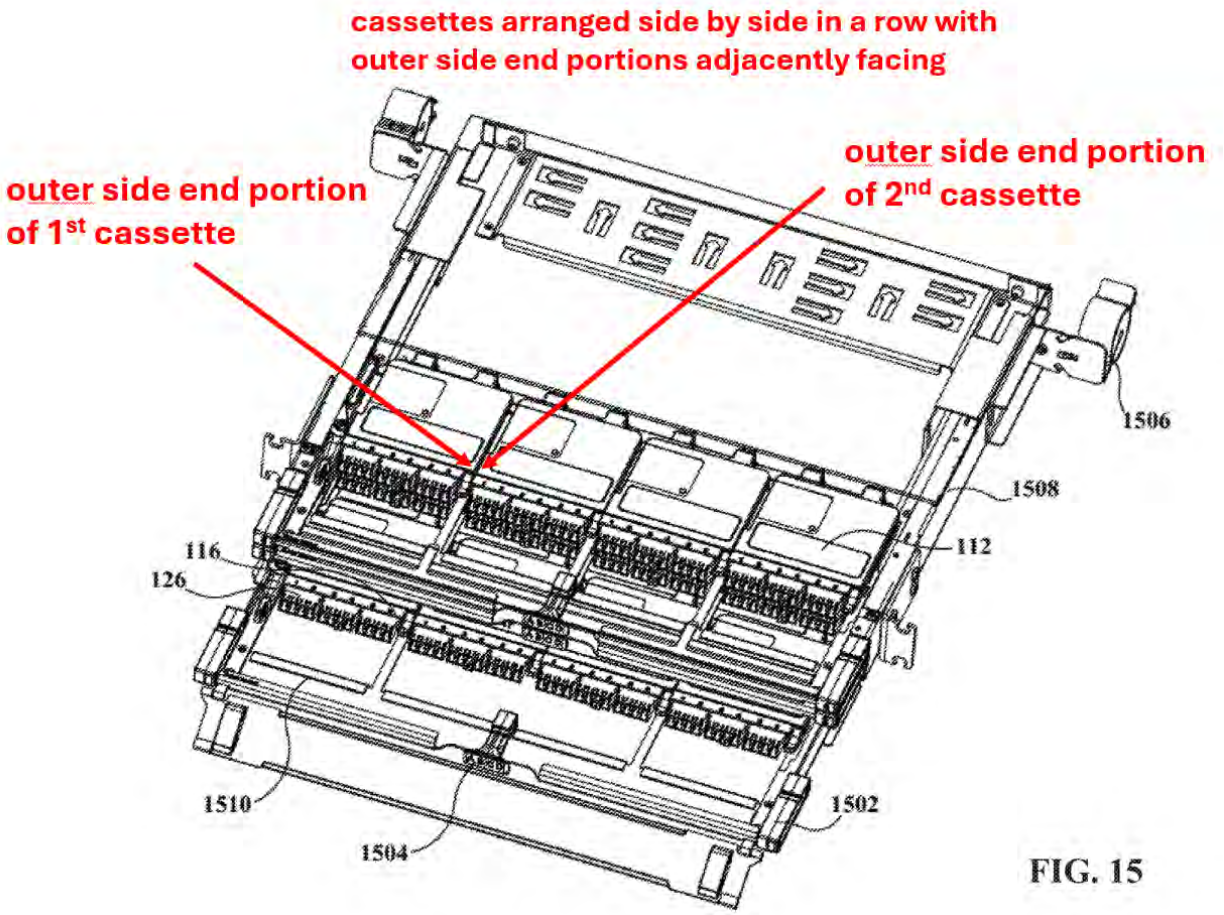


FIG. 15

Keep in mind that as discussed above regarding Element 1E and 1F, each cassette size would have the same latching mechanism located along the right side of the cassette as shown in Fig. 15 on the BASE-12 single-gang cassettes. Each interface between adjacent cassettes would therefore be the same as is shown above for the

3W cassettes in Fig. 15 of Sauter. Each cassette no matter whether 2W, 3W, 4W, or 6W in size would have the same relationship to the next adjacent cassette as is shown in Fig. 15, i.e., with sides that are adjacently facing the next cassette.

10. Element 1I

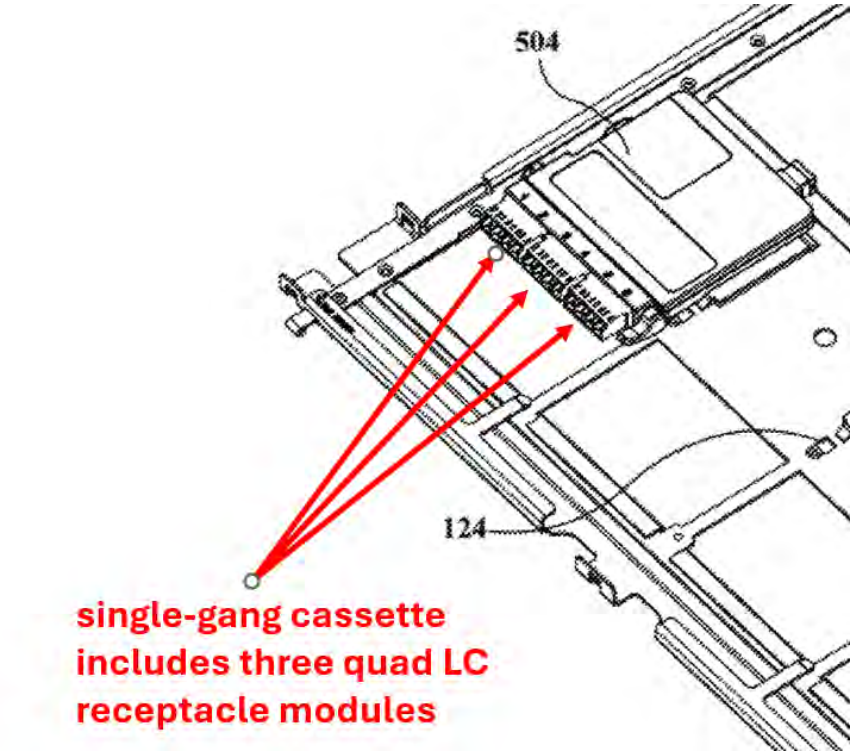
"wherein each modular two standard width (2 W) cassette is configured to fit two receptacle modules;

wherein each modular three standard width (3 W) cassette is configured to fit three receptacle modules;

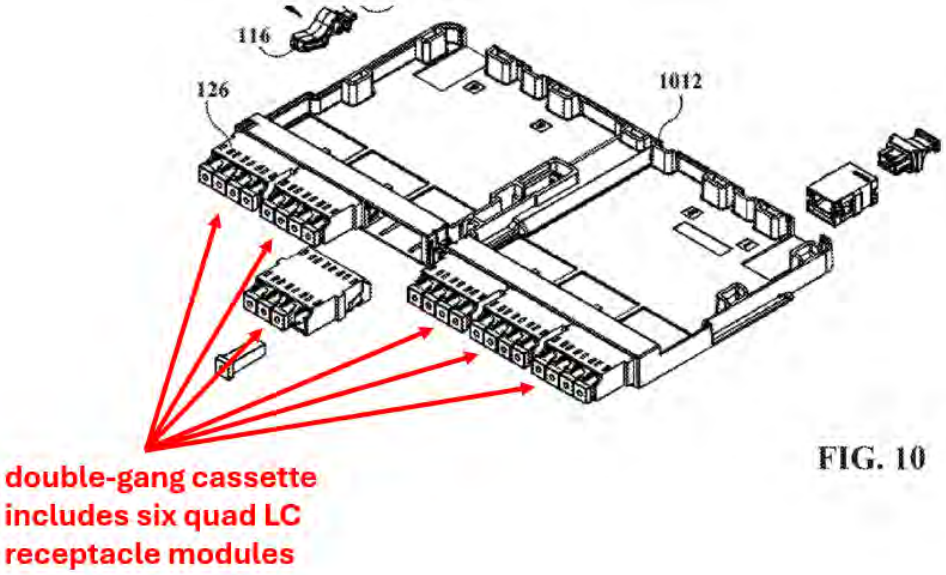
wherein each modular four standard width (4 W) cassette is configured to fit four receptacle modules;

wherein each modular six standard width (6 W) cassette is configured to fit six receptacle modules;"

295. Sauter's cassettes, including the 3W and 6W cassettes 504, 110 shown in Sauter's figures as well as the 2W and 4W cassette sizes contemplated by the modification of Sauter to also support BASE-8 fiber systems discussed above satisfy the limitations of Element 1I. That is, Sauter's single-gang cassette is a 3W cassette that is configured to fit three receptacle modules as shown, for example, in Figs. 2-4, 5, 7, 13, 15, 16:

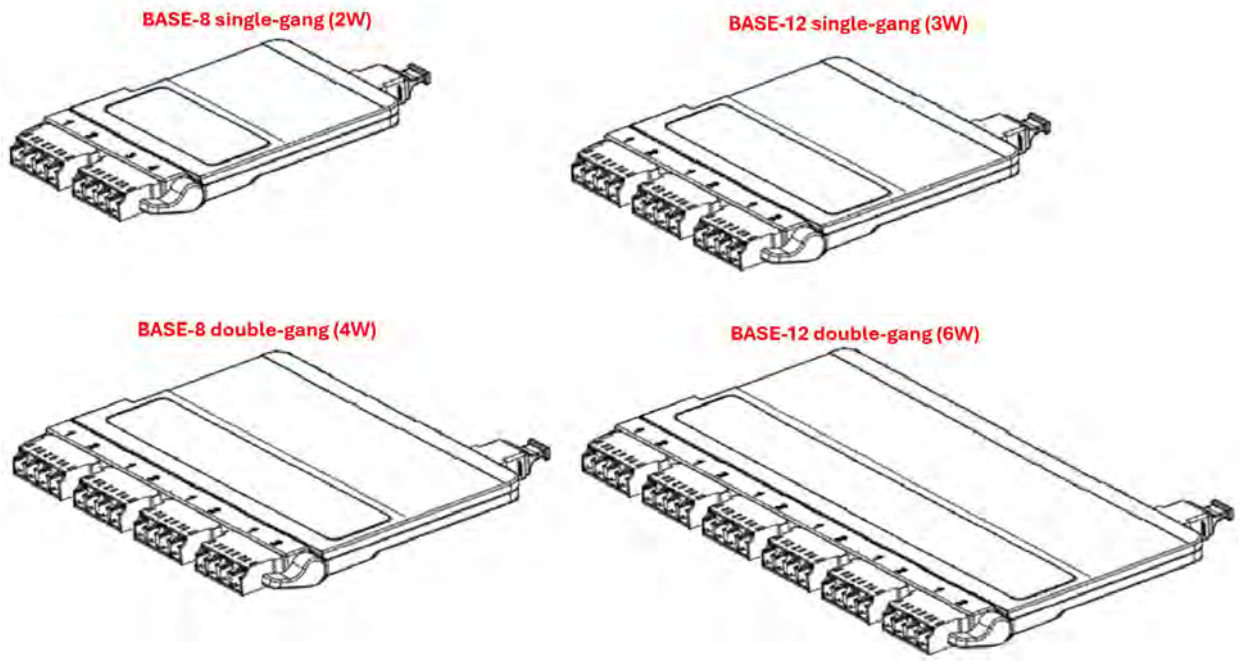


Likewise, Sauter's double-gang cassette is a 6W cassette that is configured to fit six receptacle modules as shown, for example, in Figs. 2, 3, 6, 7, 9, 10, and 11:



In addition, the BASE-8 single-gang cassette size and the BASE-8 double-gang cassette size would fit two modules and four modules respectively. As explained

above, the entire purpose of including these sizes in addition to the ones expressly shown in Sauter is to provide alternative numbers of receptacle modules (two and four) to provide flexibility to more efficiently support BASE-8 systems. The figures below show what I contemplate modified versions of Sauter's cassettes to support BASE-8 systems would look like, alongside the BASE-12 cassettes already taught by Sauter. The 2W cassette size fits two quad receptacle modules, and the 4W cassette size fits four quad receptacle modules.



11. Element 1J

"wherein the tray is configured to be removably secured to each modular fiber optic cassette when the tray fits the plurality of different modular fiber optic cassette configurations within the tray width portion in the standard U-space fiber management system; and"

296. Sauter's trays are configured with apertures 124 and rail guides 108 that cooperate with the latching mechanism 120 and rails 404 on the cassettes to removably secure Sauter's trays to the cassettes when the tray fits the plurality of different modular fiber optic cassette configurations within the tray width portion in the standard U-space fiber management system. The latching mechanism is described for example in the passages below as locking the cassettes in place when installed on the tray.

> The cassettes and adapter plates include integrated **latching mechanisms 120 that lock the cassettes and adapter plates in place on the mounting interface when fully installed on the tray.** For example, adapter plate 402 reaches the stopping position (e.g., when the notches 406 of the rails 404 engage with the front-facing end 132 of the rail guides), a locking protrusion of the latching mechanism 120 engages with an aperture 124 on the mounting surface (see also FIG. 1 for another view of the relative locations of the apertures 124 relative to the rail guides). Thus, when the adapter plate 402 is fully installed and locked into position, the rail guides 108 prevent rearward and sideways movement of the adapter plate 402, while the locking tab of latching mechanism 120 prevents forward and rearward movement of the adapter plate 402. The cassettes of the present cassette mounting system—both single-gang and multi-gang—include similar integrated latching mechanisms 120. Although the illustrations depict the integrated latching mechanism as comprising a locking protrusion that interfaces with an aperture 124, some embodiments of the cassette system may include other types of latching mechanisms without departing from the scope of this disclosure.

EX1006 at 5:60-6:14; see also Figs. 1-2, 5-8, 10-11, 13-14, 16.

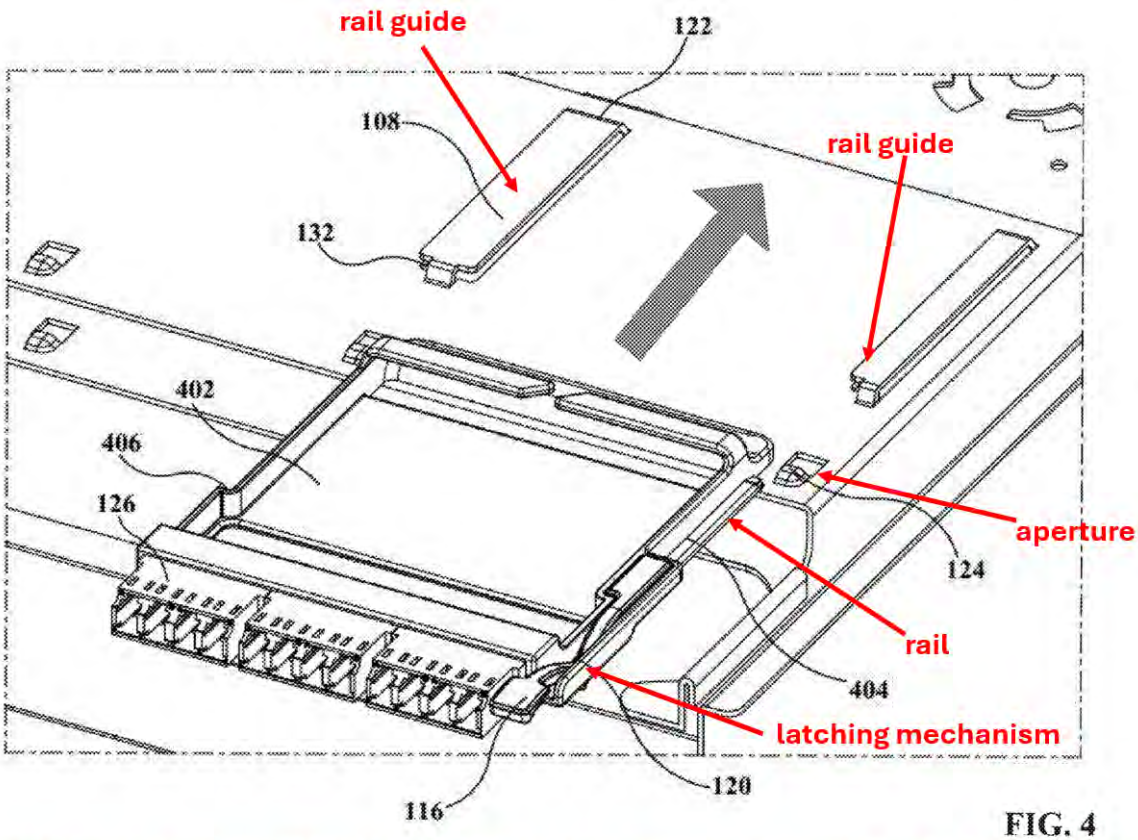


FIG. 4

Latching mechanism 120 and rails 404 on cassette are an example of a fastener that fit into rail guides 108 and aperture 124 on tray to releasably secure cassettes to tray.

297. Sauter explains that the latching mechanism makes the cassettes removable:

> The latching mechanisms 120 include front-facing **release latches 116**. Actuating the release latch 116 disengages the locking protrusion of the latching mechanism 120 from the mounting surface and unlocks the adapter plate 402 or cassette, **allowing the adapter plate 402 or cassette to be removed** through the front of the tray 102. As shown in FIGS. 2 and 3, single-gang cassette 112 and adapter plate 114 include release latches 116B and 116C located on the right side of their respective housings, while double-gang cassette 110 includes a release latch 116A located in a middle section between the two gangs of the cassette. Each release latch 116 is accessible from the front of the tray, allowing the user to easily access the release latch from the front.

EX1006 at 6:15-29.

298. Sauter explains that the cassettes include rails 404 along their sides that slide underneath rail guides 108 on the tray. EX1006 at 4:4-11; 4:46-50; Figs. 4, 5, 10, 11 and 12. A locking protrusion 1006 of the latching mechanism falls into aperture 124 in the tray when the cassette reaches its fully inserted position on the tray:

> A spring-loaded latching mechanism integrated in the cassette housing includes a latching tab or **protrusion that engages with an aperture on the tray when the cassette is fully engaged with the rail guides**. The latching mechanism includes a front-facing release latch that, when actuated, disengages the latching tab from the aperture, allowing the cassettes to be removed through the front of the tray. The latching tab comprises the sole locking point between the cassette and the tray, and thus the cassette can be unlocked for removal from the tray by actuating a single release latch that is easily accessible from the front of the tray (or from the front of the enclosure in which the tray is disposed).

EX1006 at 4:13-25; 8:63-66 ("…as the cassette is being inserted between a pair of rail guides 108, **locking protrusion 1006 will be received by aperture 124** when the cassette reaches the stopping position."); see also 4:61-67:

> In one or more embodiments, each cassette bay 106 has an associated locking aperture 124 disposed on the mounting surface near one of the guide rails. As will be described in more detail below, **the locking aperture 124 is configured to receive a spring-loaded locking protrusion built into the cassette to facilitate locking the cassette in place within the cassette bay 106**.

299. Sauter explains in the paragraph starting at 9:3 that the latching mechanism includes a release latch 116 which may be a button or lever lifts the

locking protrusion clear of the aperture 124 to remove the cassette from the tray.

EX1006 at 9:3-27; see also 6:16-29; 7:47-60; 8:37-49; and 9:63-10:3:

> As described in previous examples, each cassette 112 has an integrated latching mechanism, where each latching mechanism includes a release latch 116 facing toward the front of the tray 1510. This configuration allows a user to easily access and actuate the release latch 116 from the front of the enclosure 1508, thereby **unlocking the cassette and allowing the cassette to be removed through the front of the tray 1510.**

300. The modification of Sauter to include additional cassette sizes to support BASE-8 fiber systems includes adding additional intermediate rail guides on the tray to secure the smaller cassette sizes. This is discussed further in Element 1K below. Each cassette in each of the configurations listed in Element 1H would be removably secured to the tray using the same technique taught by Sauter, using rail guides and apertures in combination with rails and latching mechanisms on the cassettes.

301. When populated with cassettes Sauter's tray fits within the standard U-space of a fiber management system for the reasons given above under Element 1B.

12. Element 1K

> **"wherein the tray includes a plurality of cassette engaging portions that are configured to conform to the standard one width (1 W) so as to support the modular two standard width (2 W) cassette, the modular three standard width (3 W) cassette, the modular four standard width (4 W) cassette, and the modular six standard width (6 W) cassette."**

302. Modifying Sauter to include BASE-8 cassettes as discussed above would involve adding additional rail guides to the tray to support the additional cassette sizes. The resulting tray having additional rail guides positioned to support any combination of BASE-8 and BASE-12 cassette sizes would satisfy Element 1K.

303. Sauter teaches that the arrangement of rail guides as well as the clearance areas in the bottom of larger sized cassettes enable "any combination" of single-gang and double-gang cassettes to be installed on the tray. EX1006 9:56-62:

> As a result of the structural features described above—e.g., the placement and design of the rail guides on the mounting surfaces, inclusion of rail clearance areas located between the gangs of the multi-gang cassettes, etc.—any combination of single-gang and multi-gang cassettes can be installed on a given tray **1510**, subject to space limitations of the tray.

EX1006 9:56-62; see also 5:12-13 ("any combination" of cassettes can be disposed on the tray simultaneously).

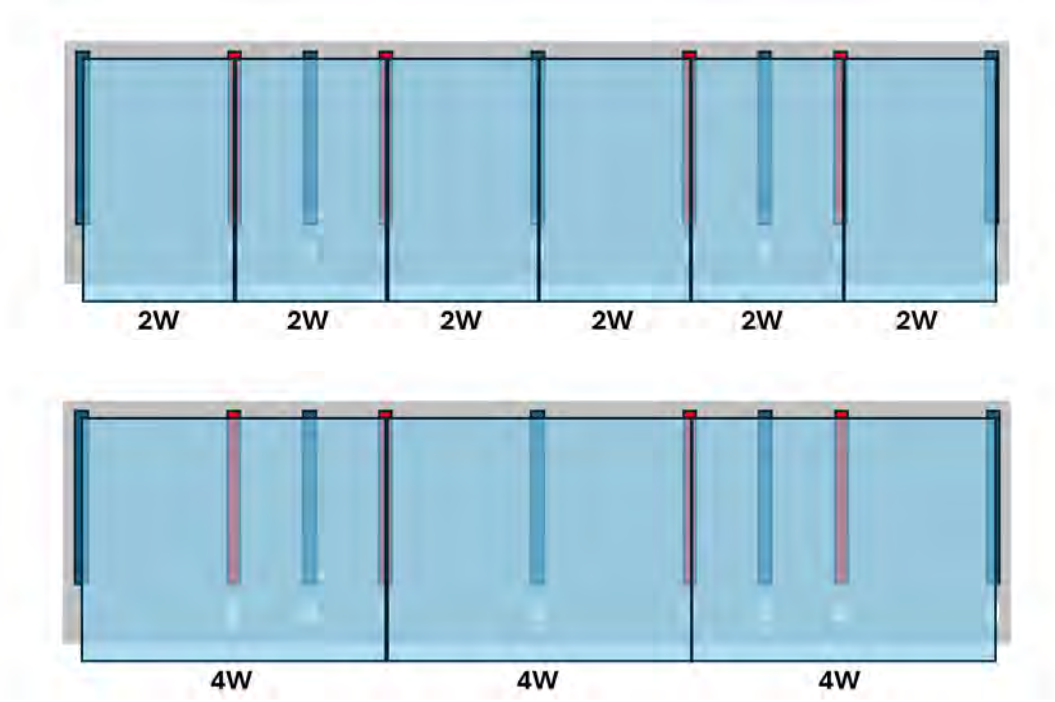
304. A POSITA would immediately recognize that additional rail guides would need to be added to Sauter's tray to secure additional sizes of cassettes to the tray. Adding the necessary rail guides to the tray surface to support any combination of the BASE-12 cassettes (3W and 6W) and BASE-8 cassettes (2W and 4W) as described above in Element 1F, would result in multiple cassette engaging portions (rail guides) that are configured to conform to the standard one

width (1 W) so as to support each of the four recited cassette sizes as recited in this claim element.

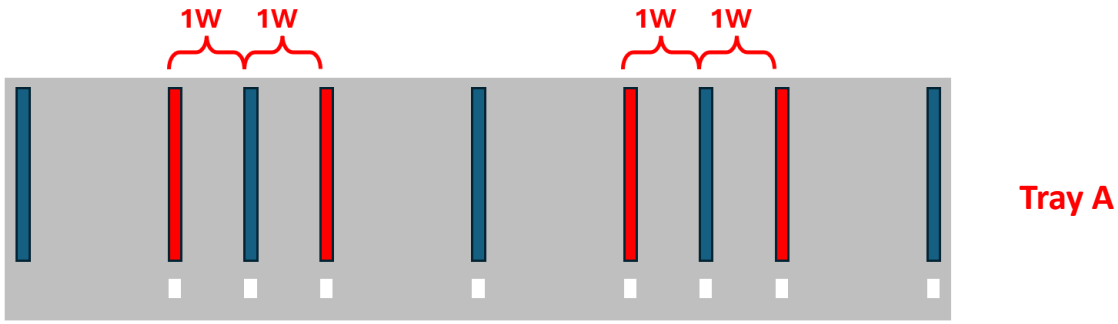
305. The figures below illustrate this point. They illustrate conceptually the cassette engaging portions of the tray. In order to support, for example, populating the tray with all 2W cassettes (BASE-8 single-gang cassettes) or all 4W cassettes (BASE-8 double-gang cassettes), at least four additional rail guides would need to be added to the tray as shown. Each of six 2W cassettes, when installed on the tray would use either a combination of one old and one new rail guide or two of the new rail guides. In the illustrations below, the blue rail guides show where Sauter already teaches to place rail guides (to support 3W and 6W cassettes), and the red rail guides show where new rail guides are needed to secure either all 2W cassettes or all 4W cassettes on the tray:

Adding rail guides to Sauter to support BASE-8 cassettes

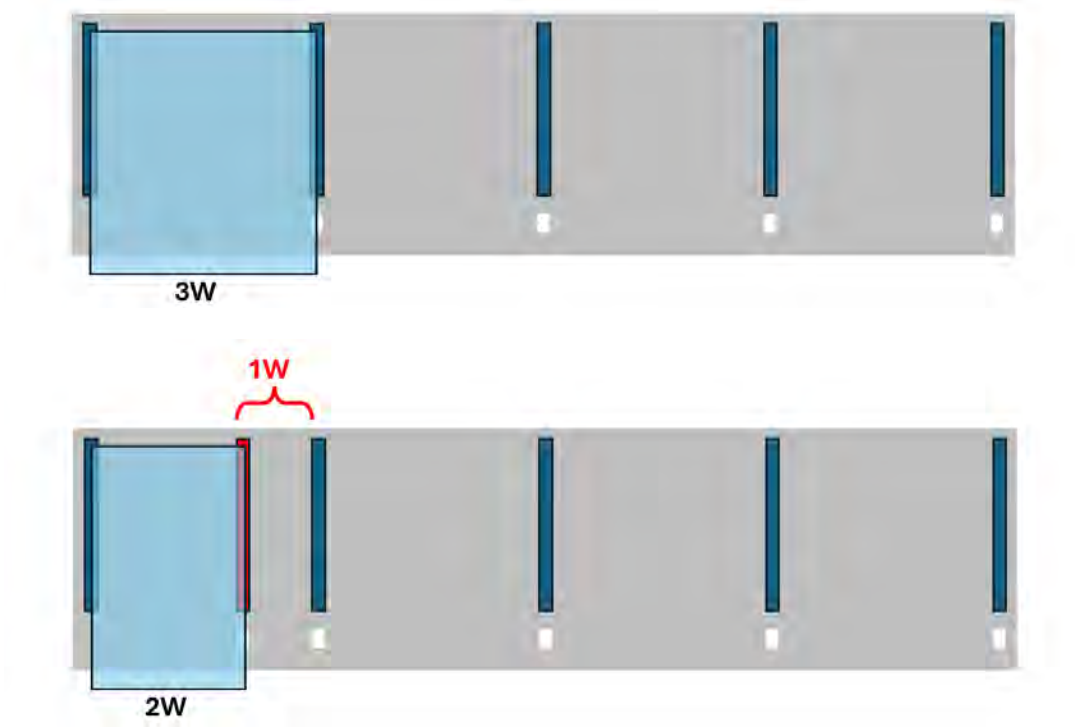




306. The rail guides shown on this modified tray satisfy the limitations of claim element 1K. There are a plurality (six) of rail guides on the tray (which are examples of cassette engaging portions) that conform to the standard one width 1W to support each of the recited cassette sizes 2W, 3W, 4W, 6W. Each of the four contemplated sizes can use at least one of these rail guides.



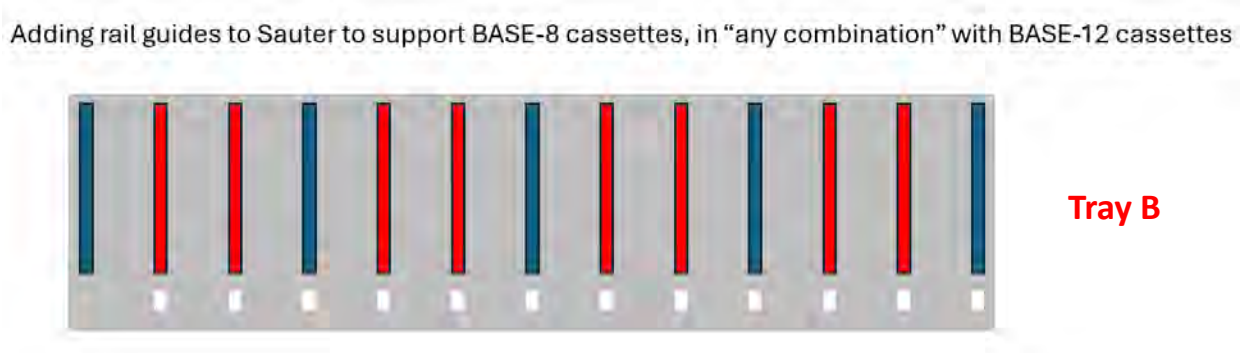
307. This result is immediately clear to a POSITA, for example, because in order to support the first cassette chosen being either a 3W cassettes or a 2W cassette for populating the left-most position on the tray, using Sauter's mounting technique, there will need to be some rail guides that conform to 1W spacing.



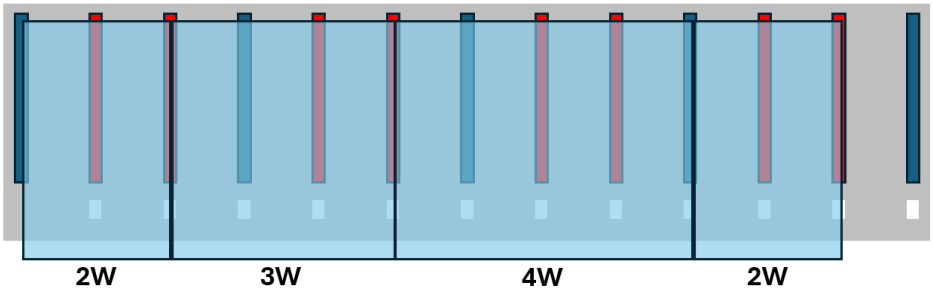
There are at least six rail guides in Tray A above that conform to the 1W width. One of skill in the art would immediately recognize that 1W is the least common denominator between the 2W and 3W sizes which also would have motivated a POSITA to position at least some the rail guides with a 1W spacing.

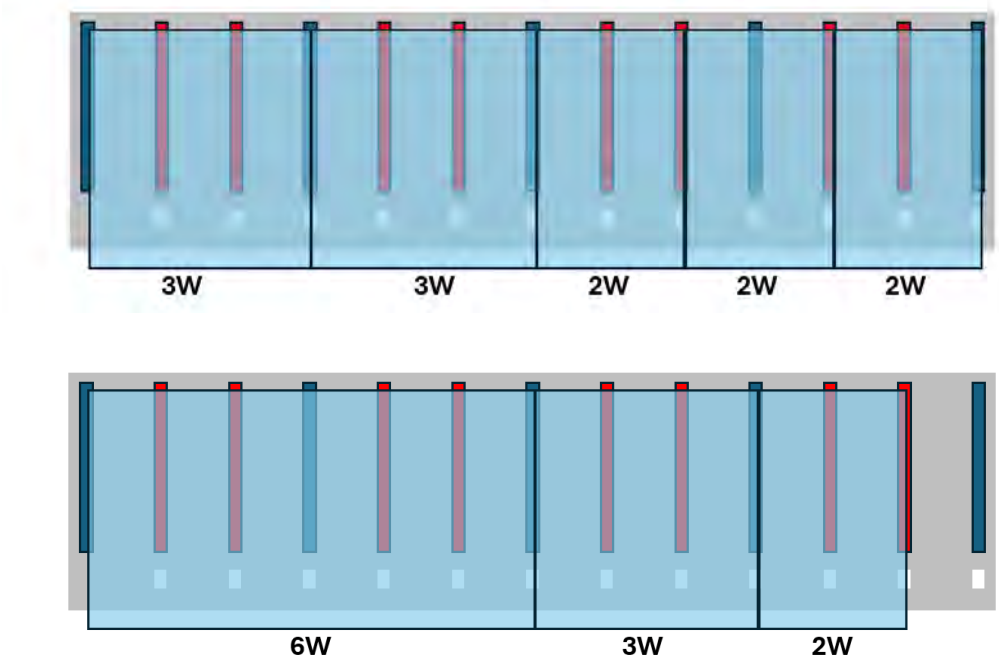
308. In addition, following Sauter's teaching to make it possible to mount simultaneously "any combination" of cassettes to the tray as well as Dagley's teaching that such combinations may include both BASE-8 and BASE-12 cassettes

in the same row, one of skill in the art would immediately recognize that additional rail guides could be added to the tray as shown in the figure below.



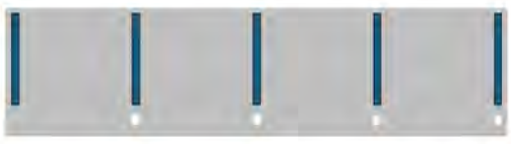
309. Adding the four more additional rail guides enables both BASE-8 and BASE-12 cassette sizes to be combined in "any combination" in the same row. The figures below illustrate some examples that show how the additional rail guides permit any combination of cassettes (subject to space limitations) to be mounted in the tray in any order. See EX1006 9:60-62 ("any combination of single-gang and multi-gang cassettes can be installed on a given tray **1510**, subject to space limitations of the tray.")

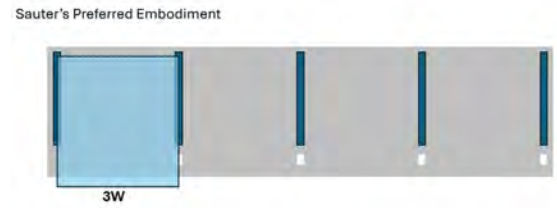
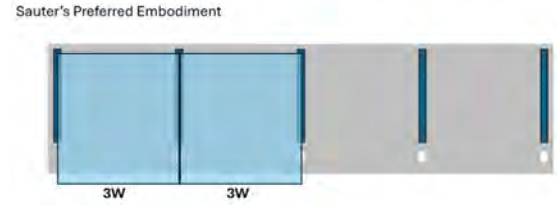
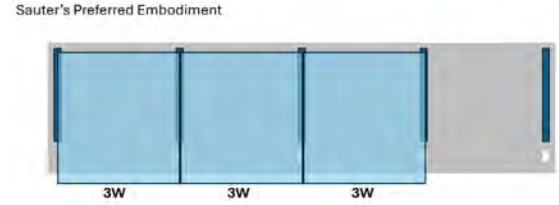
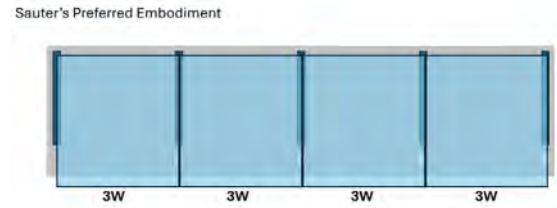
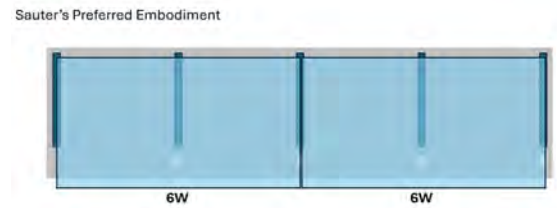
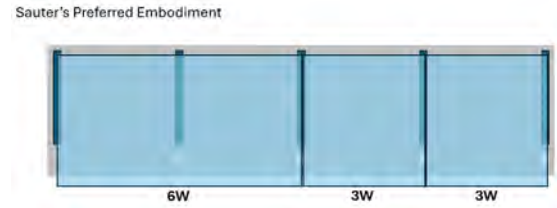
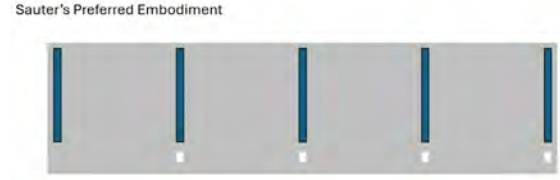


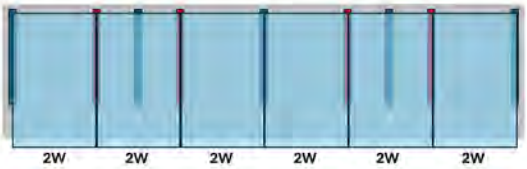
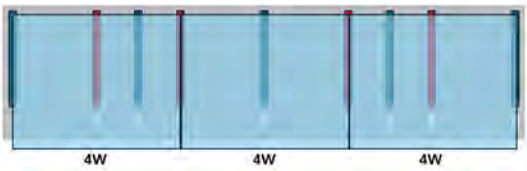
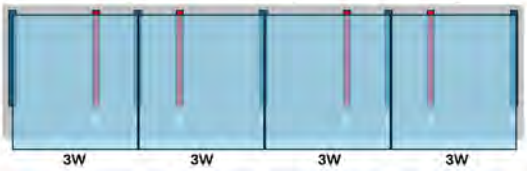
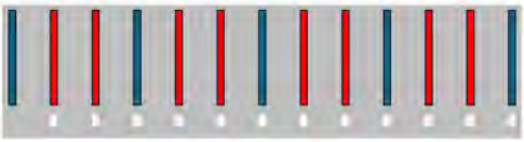
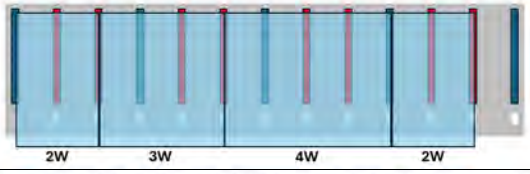
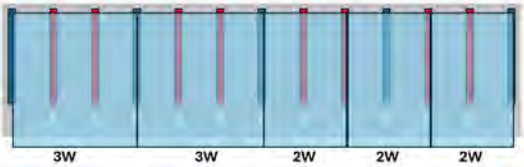


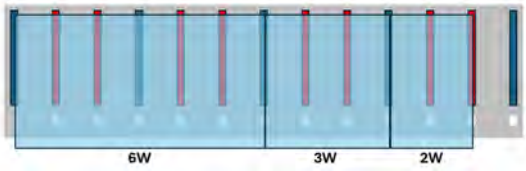
310. Tray B (the tray with thirteen rail guides shown above), satisfies the limitations of Element 1K. There are multiple rail guides, each of which is an example of cassette engaging portions, each of which also conforms to the standard width unit 1W spacing to support the four sizes of cassettes.

311. The figures below may be useful to illustrate how a tray would be populated with rail guides, once the obvious decision to support both BASE-8 and BASE-12 cassettes is made.

Sauter's Preferred Embodiment 	Simplified illustration of Sauter's preferred embodiment of tray with rail guides.

	Simplified illustration of Sauter's preferred embodiment with **one** single-gang cassette.
	Simplified illustration of Sauter's preferred embodiment, with **two** single-gang cassettes.
	Simplified illustration of Sauter's preferred embodiment, with **three** single-gang cassettes.
	Simplified illustration of Sauter's preferred embodiment, with **four** single-gang cassettes.
	Simplified illustration of Sauter's preferred embodiment, with two **double**-gang cassettes.
	Simplified illustration of Sauter's preferred embodiment, with one double-gang cassette and two single-gang cassettes.
	Simplified illustration of Sauter's preferred embodiment of tray with rail guides.

Adding rail guides to Sauter support BASE-8 cassettes 	Adding rail guides to Sauter's tray to also support either all 2W or all 4W cassettes.
Adding rail guides to Sauter to support BASE-8 cassettes 	Sauter's tray with added rail guides with six 2W cassettes.
Adding rail guides to Sauter to support BASE-8 cassettes 	Sauter's tray with added rail guides with three 4W cassettes.
Adding rail guides to Sauter to support BASE-8 cassettes 	Sauter's tray with added rail guides still supports original configurations of BASE-12 cassettes (e.g., four 3W cassettes).
Adding rail guides to Sauter to support BASE-8 cassettes, in "any combination" with BASE-12 cassettes 	Sauter's tray with added rail guides to support "any combination" of BASE-8 and BASE-12 cassettes.
Adding rail guides to Sauter to support BASE-8 cassettes, in "any combination" with BASE-12 cassettes 	Sauter's tray with added rail guides to support "any combination" of BASE-8 and BASE-12 cassettes, e.g., a 2W, 3W, 4W, and 2W cassette.
Adding rail guides to Sauter to support BASE-8 cassettes, in "any combination" with BASE-12 cassettes 	Sauter's tray with added rail guides to support "any combination" of BASE-8 and BASE-12 cassettes, e.g., a 3W, 3W, 2W, 2W, and 2W cassette.

Adding rail guides to Sauter to support BASE-8 cassettes, in "any combination" with BASE-12 cassettes  	Sauter's tray with added rail guides to support "any combination" of BASE-8 and BASE-12 cassettes, e.g., a 6W, 3W, and 2W cassette.

312. One of skill in the art would have been motivated to add the additional rail guides for all the same reasons given above in Element 1E that would have motivated including additional cassette sizes in the system, e.g., to support flexible transition back and forth between BASE-8 systems and BASE-12 systems and even simultaneous BASE-8 and BASE-12 systems. One of skill in the art would have had a reasonable expectation of success because no new functionality is required, and Sauter already teaches how to accommodate the extra, intermediate rail guides on the tray that are not needed when installing a particular chosen cassette size. Sauter teaches that the cassettes will include "clearance areas" in the bottom surface of the cassettes to slide over unused intermediate rail guides. EX1006 at 7:19-37, 9:49-56, Fig. 8 (clearance areas 602).

313. Sauter trays include double-sided rail guides 108 and apertures 124 (see, e.g., Figs. 5 and 1) defining adjacent bays that enable multiple cassettes to be selected and mounted to the trays, so that multiple cassettes can be aligned side-by-side along the width of the tray.

> FIG. 5 is a view of a single-layer cassette tray 502 on which are mounted two single-gang cassettes 504. In this example, the single-gang cassettes 504 are installed on the left-most and right-most **cassette**

> **bays**, respectively, leaving two adjacent empty cassette bays in the middle of the tray. **The mounting interface features described herein allow the user to install** either two more single-gang cassettes in these two empty cassette bays, or to install one double-gang cassette spanning the two adjacent cassette bays. As described below, structural features of the double-gang cassette (and other multi-gang cassettes having more than two gangs) allow the cassette to be installed on the same cassette mounting system without physically modifying the cassette or the mounting interface.

EX1006 at 6:42-56; see also 5:60-6:29 and 8-29-9-39 (describing latching mechanisms and apertures); 5:36-59 and 9:40-62 (describing rail guides); 7:3-36 (describing clearance spaces for multi-gang cassettes to span intermediate rail guides).

314. Any combination of single-gang, double-gang, triple-gang, or other multi-gang cassette sizes can be selected, limited only by the available number of bays in the tray. EX1006 at 5:12-17 ("As described in more detail below, **any combination** of single-gang cassettes (or adapter plates) and multi-gang cassettes (or adapter plates) can be disposed simultaneously on the upper and lower mounting interfaces of the cassette tray 102 subject to overall space limitations of the mounting.").

B. Independent Claim 9

315. In nearly all respects, independent claim 9 recites substantially the same limitations as Claim 1 or is broader than claim 1. As shown in the comparison of claim 1 and claim 9 below, Claim 9 eliminates several limitations

from claim 1.[11] For example, Claim 9 does not include equivalent language for claim elements 1A and 1I, and portions of Element 1D. With one exception (Element 9B addressed below), Claim 9 does not add any substantial limitation that is not already disclosed or rendered obvious by Sauter in combination with Dagley for the reasons already given under Claim 1.

Comparison of Claim 1 to Claim 9 of the '423 Patent[12]	
(Preamble) 1. A tray for providing a plurality of different modular fiber optic cassette configurations in a standard U-space fiber optic management system comprising:	(Preamble) 9. A tray for providing a plurality of different modular fiber optic cassette configurations in a standard U-space fiber optic management system comprising:
(Element 1A) a tray having a first tray side end portion and a second tray side end portion defining a tray width portion that extends between the first tray side end portion and the second tray side end portion;	
(Element 1B) wherein the tray width portion fits within a standard U-space width dimension;	(Element 9A) a tray configured to fit in a standard U-space and
(Element 1C) wherein the tray is configured to fit a plurality of different modular fiber optic cassette configurations	support a plurality of different modular fiber optic cassette

[11] The designations in red are added for ease of reference.
[12] Note that although not included in the claims as originally published in the '423 patent, a certificate of correction inserted a "W" after the numeral 2 at several places in claim 9 (and later claims), which I indicate here using brackets.

in the tray width portion in a standard U-space fiber management system; (Element 1D) wherein each of the plurality of different modular fiber optic cassette configurations include a modular fiber optic cassette that is configured to support a receptable module having a first module side end portion and a second module side end portion defining a module width portion that extends between the first tray side end portion and second tray side end portion; (Element 1E) wherein the module width portion is configured to fit in a standard one width (1 W) unit; (Element 1F) wherein each of the modular fiber optic cassettes includes a first cassette side end portion and a second cassette side end portion defining a standard cassette width unit extending between the first cassette side end portion and the second cassette side end portion that comprises a standard two width (2 W) unit, a standard three width (3 W) unit, a standard four width (4 W) unit, or a standard a standard six width (6 W) unit	configurations in the standard U-space; (Element 9B) wherein each of the plurality of different modular fiber optic cassette configurations includes a plurality of different sizes of modular fiber optic cassettes; (Element 9C) wherein each of the plurality of different sizes of modular fiber optic cassettes is configured to support a fiber optic receptable module that is configured to fit in a standard one width (1 W) unit; (Element 9D) wherein the plurality of different sizes of modular fiber optic cassettes include a 2[W] cassette size that is configured to fit a standard two width (2 W) unit relative to the standard one width (1 W) unit, a 3 W cassette size that is configured to fit a standard three width (3 W) unit relative to the standard one width (1 W) unit, a 4 W cassette size that is configured to fit a standard four width (4 W) unit relative to the

relative to the standard one width (1 W) unit;	standard one width (1 W) unit, and a 6 W cassette size that is configured to fit a standard six width (6 W) unit relative to the standard one width (1 W) unit;
(Element 1G) wherein the receptable module is configured to fit at least four fiber optic plug receiving receptacle portions in a standard one width (1 W) unit;	
(Element 1H) wherein the plurality of different modular fiber optic cassette configurations comprise: a first modular fiber optic cassette configuration that includes six modular two standard width unit (2 W) cassettes that are each arranged side by side of each other along the tray such that a cassette side end portion of each modular two standard width (2 W) cassette adjacently faces a cassette side end portion of at least one other modular two standard width (2 W) cassette; a second modular fiber optic cassette configuration that includes four modular three standard width unit (3 W) cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of each modular three standard width (3	(Element 9E) wherein the plurality of different modular fiber optic cassette configurations comprise: a first modular fiber optic cassette configuration that includes six modular 2[W] standard width unit size cassettes that are each arranged side by side of each other along the tray such that a cassette side end portion of each modular 2[W] standard width unit size cassette adjacently faces a cassette side end portion of at least one other modular 2[W] standard width size cassette; a second modular fiber optic cassette configuration that includes four modular 3 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of each modular 3 W standard width size cassette

W) cassette adjacently faces a cassette side end portion of at least one other modular three standard width (3 W) cassette;	adjacently faces a cassette side end portion of at least one other modular 3 W standard width size cassette;
a third modular fiber optic cassette configuration that includes three modular four standard width unit (4 W) cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of each modular four standard width (4 W) cassette adjacently faces a cassette side end portion of at least one other modular four standard width (4 W) cassette;	a third modular fiber optic cassette configuration that includes three modular 4 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of each modular 4 W standard width size cassette adjacently faces a cassette side end portion of at least one other modular 4 W standard width size cassette;
a fourth modular fiber optic cassette configuration that includes two modular six standard width unit (6 W) cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of one of the two modular six standard width (6 W) cassettes adjacently faces a cassette side end portion of the other modular six standard width (6 W) cassette; and	a fourth modular fiber optic cassette configuration that includes two modular 6 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of one of the two modular 6 W standard width size cassettes adjacently faces a cassette side end portion of the other modular 6 W standard width size cassette; and
a fifth modular fiber optic cassette configuration that includes three modular two standard width unit (2 W) cassettes, which are each arranged side by side of each other in a row along the tray such	a fifth modular fiber optic cassette configuration that includes three modular 2[W] standard width unit size cassettes, which are each arranged side by side of each other in a row along the tray such that a cassette side

that a cassette side end portion of one of the three modular two standard width (2 W) cassettes adjacently faces a cassette side end portion of one of the other modular two standard width (2 W) cassette, and one modular six standard width unit (6 W) cassette that is arranged side by side in a row along the tray with one of the three modular two standard width unit (2 W) cassettes, such that a cassette side end portion of the one modular six standard width unit (6 W) cassette adjacently faces a cassette side end portion of one of the other three modular two standard width unit (2 W) cassettes; (Element 1I) wherein each modular two standard width (2 W) cassette is configured to fit two receptacle modules; wherein each modular three standard width (3 W) cassette is configured to fit three receptacle modules; wherein each modular four standard width (4 W) cassette is configured to fit four receptacle modules; wherein each modular six standard width (6 W) cassette is configured to fit six receptacle modules;	end portion of one of the three modular 2[W] standard width size cassettes adjacently faces a cassette side end portion of one of the other modular 2[W] standard width size cassette, and one modular 6 W standard width unit size cassette that is arranged side by side in a row along the tray with one of the three modular 2[W] standard width unit size cassettes, such that a cassette side end portion of the one modular 6 W standard width unit size cassette adjacently faces a cassette side end portion of one of the other three modular 2[W] standard width unit size cassettes;

(Element 1J) wherein the tray is configured to be removably secured to each modular fiber optic cassette when the tray fits the plurality of different modular fiber optic cassette configurations within the tray width portion in the standard U-space fiber management system; and	(Element 9F) wherein the tray is configured to be removably secured to each modular fiber optic cassette when the tray fits the plurality of different modular fiber optic cassette configurations within a tray width portion in the standard U-space fiber management system; and
(Element 1K) wherein the tray includes a plurality of cassette engaging portions that are configured to conform to the standard one width (1 W) so as to support the modular two standard width (2 W) cassette, the modular three standard width (3 W) cassette, the modular four standard width (4 W) cassette, and the modular six standard width (6 W) cassette.	(Element 9G) wherein the tray includes a plurality of cassette engaging portions that are configured to conform to the standard one width (1 W) so as to support the modular 2[W] standard width unit size cassette, the modular 3 W standard width unit size cassette, the modular 4 W standard width unit size cassette, and the modular 6 W standard width unit size cassette.

1. Element 9B

"wherein each of the plurality of different modular fiber optic cassette configurations includes a plurality of different sizes of modular fiber optic cassettes"

316. The parties dispute the meaning of Element 9B. Ultimately, resolving the dispute is not necessary because Sauter discloses or renders obvious this limitation under either party's construction. Here are the two party's claim construction positions as presented in the district court action:

Claim Term	Patent Owner's Construction	Petitioner's Construction
"wherein each of the plurality of different modular fiber optic cassette configurations includes a plurality of different sizes of modular fiber optic cassettes" '423 Patent (Claim 9)	"Each of the plurality of different modular fiber optic cassette configurations includes a plurality of different sizes of modular fiber optic cassettes, such as the fifth modular fiber optic cassette configuration, which includes three modular 2 W standard width size cassettes and one modular 6 W standard width size cassettes"	"This requires each of the first, second, third, fourth, and fifth modular fiber optic cassette configurations includes a plurality of different sizes of modular fiber optic cassettes."

EX1011, Ex. A, p. 24.

317. Patent Owner has taken the position that satisfying Element 9E is one way to satisfy Element 9B. That is, if the tray supports the first through fifth configurations, which includes the fifth configuration in which there are three cassettes having the 2W cassette size and one cassette having the 6W cassette size, then that is sufficient to satisfy claim element 9B. In other words, configurations one, two, three, and four do not need to include multiple different sizes of cassettes. If this is the case, then Claim Element 9B is rendered obvious based on Sauter in combination with Dagley for the same reasons given in the analysis of Claim Elements 1H and 1F which already address why each of the first through

fifth configurations would have been obvious based on Sauter or Sauter in light of Dagley.

318. The correct interpretation of Element 9B, however, is not satisfied merely by satisfying the fifth cassette configuration of Element 9E. Element 9B requires that "**each** of the plurality" of cassette configurations includes different sizes of cassettes. It is not satisfied by a single configuration, but must be met by "each" configuration in the plurality of configurations. Element 9E enumerates five different configurations that must be in the plurality. To satisfy Element 9B, each of the five configurations described in Element 9E, must also satisfy Element 9B. "Each of" means every one of two or more things.

319. To meet both 9B and 9E, the tray must be sized to support more than a total of 12W in cassette widths. For example, it would need to be wide enough to fit a total of 15W in cassette widths. With a wider tray that can support more than 12W of cassette width, both Elements 9B and 9E can be satisfied by one tray. The cassettes called for in each of the first, second, third, and fourth configurations could be supported on the tray in addition to at least one more cassette of a different width to satisfy Element 9B. For example, a tray that was wide enough to support a total of 15W of cassette widths would meet both claim limitations. Populating the 15W wide tray with six 2W cassettes and one 3W cassette would occupy the entire tray and would be a configuration that satisfies both the "first"

configuration of 9E as well as the requirement of 9B (two different cassette sizes). Likewise, populating a 15W wide tray with four 3W cassettes and one 2W cassette would occupy fourteen out of the fifteen available spaces in the tray and would satisfy both 9B and the "second" configuration of Element 9E. The same analysis applies to the third and fourth configurations.

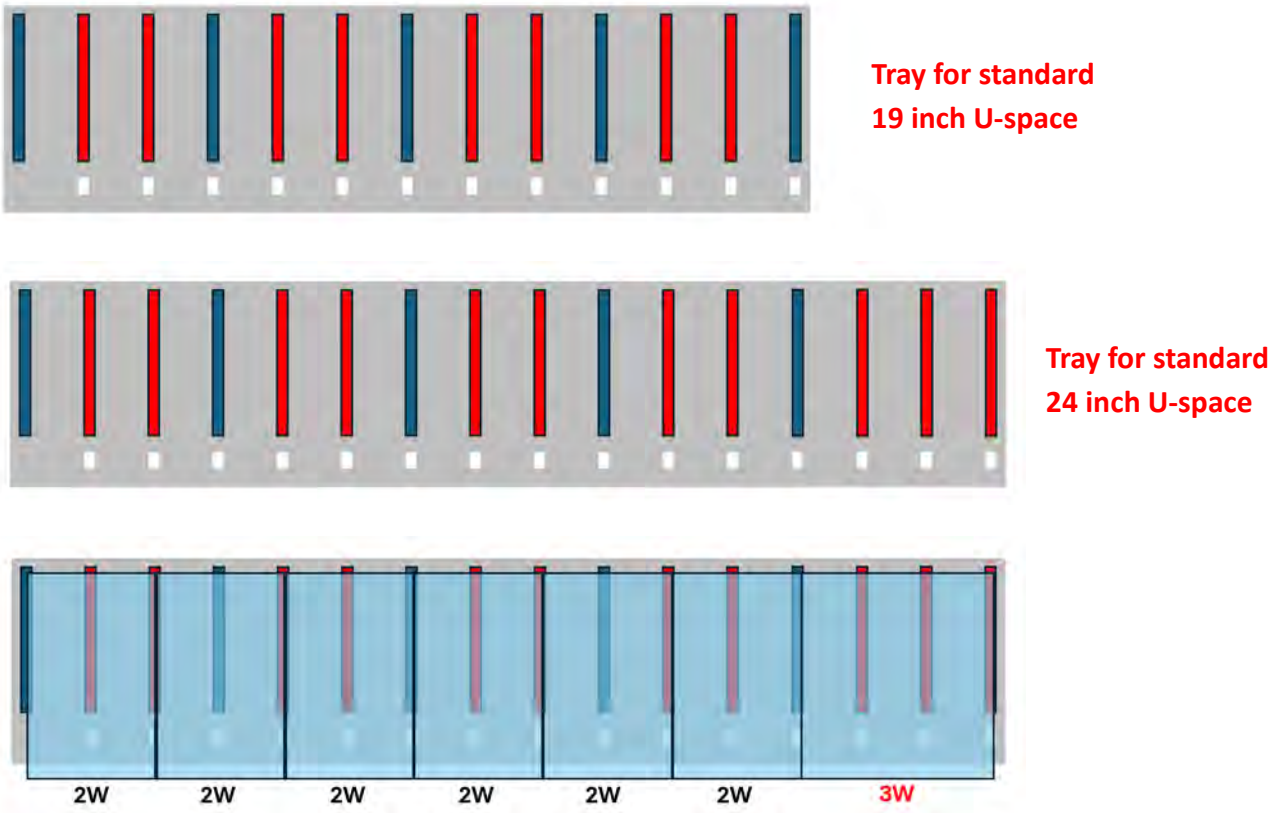
320. There is nothing in claim 9 that limits the tray to fit **only** 12W in cassette widths. Claim 9 does require that the tray "fit in a standard U-space." As explained in the analysis of claim Element 1B, the standard that defines the dimensions of a U-space provides that there are three standard panel widths which are: 19 inches, 24 inches, or 30 inches (482.6 mm, 609.6 mm, 762.0 mm respectively).

4.1 Classification
EIA-310-C identified three cabinet or rack openings to accommodate each of three standard panel widths 482.6 mm, 609.6 mm and 762.0 mm. The preferred panel width is 482.6 mm.

EX1008 at p. 2. Note that 482.6 mm equals 19 inches; 609.6 mm equals 24 inches; and 762.0 mm equals 30 inches. The three widths are sometimes referred to as 19 inch, 24 inch and 30 inch racks (Version E of the standard was written to convert these dimension from imperial inches into metric millimeters). EX1008 p. 1 ("EA-310-E Section 4 is the soft metric conversion of superseded EIA-310-C to conform with U.S. Public Law 100-418."). The "U" space defined in the standard refers to the amount of vertical space for any of the three standard panel widths.

321. Although for the reasons given above under Element 1B, one of ordinary skill in the art would recognize that the enclosure and trays shown in Sauter are configured to fit within the smallest standard U-space (the 19 inch wide size), it would have been equally obvious to one of ordinary skill in the art that the same system could be modified for use in either of the two the larger standard sizes (24 inch or 30 inch panels) to accommodate more cassettes on one tray. One of ordinary skill in the art would recognize that if 12W of cassette width could fit in Sauter's tray for a 19 inch panel, then scaling proportionally (which is a conservative estimate because all of the additional space could be used for expanding the capacity of the tray) a tray for a 24 inch panel could fit at least 15W of cassette width. Likewise, scaling proportionally, a 30 inch panel could fit at least 18W of cassette width.

322. The figures below illustrate that a tray that fits within a standard 24 inch U-space system would include space for an additional 3W cassette width (shown with three red rail guides at right).



323. In addition, the language of dependent claim 16 which depends from claim 9, also suggests that the tray contemplated by the claims could have more than 12W of total cassette capacity. Claim 16 recites:

> 16. The tray of claim 9, wherein the tray has first tray end portion, a second tray end portion spaced away from the first tray end portion so as to define a tray width extending between the first tray end portion and the second tray end portion, and wherein the tray width is configured to support **at least twelve** standard one width (1 W) units side by side along the tray.

By reciting "at least twelve" units side by side along the tray, the patentee expressly allowed for the claims to read on trays that support **more than** twelve width units.

324. One of skill in the art would be motivated to use a larger standard panel and tray width for customers who already have existing racks in these larger sizes and to make most efficient use of valuable and limited available rack space. One of skill in the art would have a reasonable expectation of success because no new functionality would be required, merely adding additional width and accompanying rail guides to support 15W rather than merely 12W in total cassette width on each tray.

2. Other differences between Claim 9 and Claim 1

325. For completeness I note that claim 9 recites that the tray is configured to "support" a plurality of cassette configurations where claim 1 recited that the tray is configured to "fit" a plurality of cassette configurations. Sauter's tray both supports and fits the cassettes. The bottom wall of Sauter's tray supports each cassette configuration mounted to the tray.

326. I also note that claim 9 refers to "a standard U-space" where claim 1 referred to a "standard U-space width." To the extent there is any difference between these two phrases, both are disclosed or obvious based on Sauter's disclosures for the reasons provided for Claim 1 Preamble, Element 1B and Element 1C. Although one of skill in the art understands the term "1U" to refer to a height dimension, if "standard U-space" is here meant to include both a width dimension and a height dimension, as discussed under the Preamble of Claim 1 and

Elements 1B and 1C, based on the well-known standardized dimensions of the LC adapter components on Sauter's trays, of the one of skill in the art would recognize Sauter's tray would fit within both the vertical dimension of the 1U space (1.75 inches) as well as any of the horizontal openings allowed in a 1U space such as for a 19 inch panel (to fit a rack opening of 450 mm), a 24 inch panel (to fit a rack opening of 577 mm), or a 30 inch panel (to fit a rack opening of 730 mm). EX1008, pp. 4-5, Figures 3 and 4.

327. Each of the other limitations in Claim 9 are disclosed or rendered obvious by Sauter in combination with Dagley for the reasons given for corresponding language in the discussion of Claim 1 as set forth in the table below:

Preamble of Claim 9:	See Preamble of Claim 1.
Element 9A:	See Preamble of Claim 1, Element 1B, and Element 1C.
Element 9C:	See Element 1E, 1D.
Element 9D:	See Element 1F.
Element 9E:	See Element 1H.
Element 9F:	See Element 1J.
Element 9G:	See Element 1K.

C. Independent Claim 17

328. As shown in the comparison of claims 9 and 17 below, independent claim 17 tracks almost verbatim the language of claim 9, except it is broader in the

following respects. Claim 17 eliminates Element 9F and eliminates the requirement for the "fifth" cassette configuration of 9E. Also, Claim 17 does not include the "each of" language that appears in Element 9B discussed above. Claim 17, therefore, is broader than Claim 9 and is, in fact, the broadest claim of the '423 patent.

Comparison of Claim 9 to Claim 17 of the '423 Patent[13,14]	
(Preamble) 9. A tray for providing a plurality of different modular fiber optic cassette configurations in a standard U-space fiber optic management system comprising:	(Preamble) 17. A tray for providing a plurality of different modular fiber optic cassette configurations in a fiber optic management system comprising:
(Element 9A) a tray configured to fit in a standard U-space and support a plurality of different modular fiber optic cassette configurations in the standard U-space;	(Element 17A) a tray member configured to support a plurality of different modular fiber optic cassette configurations in a standard U-space width;
(Element 9B) wherein each of the plurality of different modular fiber optic cassette configurations includes a plurality of different sizes of modular fiber optic cassettes;	(Element 17B) wherein the plurality of different modular fiber optic cassette configurations include different sizes of modular fiber optic cassettes;

[13] Note that although not included in the claims as originally published in the '423 patent, a certificate of correction inserted a "W" after the numeral 2 at several places in claim 17 (and later claims), which I indicate here using brackets.
[14] The designations in red are added for ease of reference.

(Element 9C) wherein each of the plurality of different sizes of modular fiber optic cassettes is configured to support a fiber optic receptable module that is configured to fit in a standard one width (1 W) unit;	(Element 17C) wherein each of the different sizes of modular fiber optic cassettes is configured to support a fiber optic receptable module that is configured to fit in a standard one width (1 W) unit;
(Element 9D) wherein the plurality of different sizes of modular fiber optic cassettes include a 2[W] cassette size that is configured to fit a standard two width (2 W) unit relative to the standard one width (1 W) unit, a 3 W cassette size that is configured to fit a standard three width (3 W) unit relative to the standard one width (1 W) unit, a 4 W cassette size that is configured to fit a standard four width (4 W) unit relative to the standard one width (1 W) unit, and a 6 W cassette size that is configured to fit a standard six width (6 W) unit relative to the standard one width (1 W) unit;	(Element 17D) wherein the plurality of different sizes of modular fiber optic cassettes include a 2[W] cassette size that is configured to fit a standard two width (2 W) unit relative to the standard one width (1 W) unit, a 3 W cassette size that is configured to fit a standard three width (3 W) unit relative to the standard one width (1 W) unit, a 4 W cassette size that is configured to fit a standard four width (4 W) unit relative to the standard one width (1 W) unit, and a 6 W cassette size that is configured to fit a standard six width (6 W) unit relative to the standard one width (1 W) unit;
(Element 9E) wherein the plurality of different modular fiber optic cassette configurations comprise: a first modular fiber optic cassette configuration that includes six modular 2[W] standard width unit size cassettes that are each arranged side by side of each other along the tray such that a cassette side end portion of each modular 2[W]	(Element 17E) wherein the plurality of different modular fiber optic cassette configurations comprise: a first modular fiber optic cassette configuration that includes six modular 2[W] standard width unit size cassettes that are each arranged side by side of each other along the tray member such that a cassette side end portion of each modular 2[W]

standard width unit size cassette adjacently faces a cassette side end portion of at least one other modular 2[W] standard width size cassette;	standard width unit size cassette adjacently faces a cassette side end portion of at least one other modular 2[W] standard width size cassette;
a second modular fiber optic cassette configuration that includes four modular 3 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of each modular 3 W standard width size cassette adjacently faces a cassette side end portion of at least one other modular 3 W standard width size cassette;	a second modular fiber optic cassette configuration that includes four modular 3 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray member such that a cassette side end portion of each modular 3 W standard width size cassette adjacently faces a cassette side end portion of at least one other modular 3 W standard width size cassette;
a third modular fiber optic cassette configuration that includes three modular 4 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of each modular 4 W standard width size cassette adjacently faces a cassette side end portion of at least one other modular 4 W standard width size cassette;	a third modular fiber optic cassette configuration that includes three modular 4 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray member such that a cassette side end portion of each modular 4 W standard width size cassette adjacently faces a cassette side end portion of at least one other modular 4 W standard width size cassette; and
a fourth modular fiber optic cassette configuration that includes two modular 6 W standard width unit size cassettes	a fourth modular fiber optic cassette configuration that includes two modular 6 W standard width unit size cassettes

that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of one of the two modular 6 W standard width size cassettes adjacently faces a cassette side end portion of the other modular 6 W standard width size cassette; and a fifth modular fiber optic cassette configuration that includes three modular 2[W] standard width unit size cassettes, which are each arranged side by side of each other in a row along the tray such that a cassette side end portion of one of the three modular 2[W] standard width size cassettes adjacently faces a cassette side end portion of one of the other modular 2[W] standard width size cassette, and one modular 6 W standard width unit size cassette that is arranged side by side in a row along the tray with one of the three modular 2[W] standard width unit size cassettes, such that a cassette side end portion of the one modular 6 W standard width unit size cassette adjacently faces a cassette side end portion of one of the other three modular 2[W] standard width unit size cassettes; (Element 9F) wherein the tray is configured to be removably secured to each	that are each arranged side by side of each other in a row along the tray member such that a cassette side end portion of one of the two modular 6 W standard width size cassettes adjacently faces a cassette side end portion of the other modular 6 W standard width size cassette; and

modular fiber optic cassette when the tray fits the plurality of different modular fiber optic cassette configurations within a tray width portion in the standard U-space fiber management system; and	
(Element 9G) wherein the tray includes a plurality of cassette engaging portions that are configured to conform to the standard one width (1 W) so as to support the modular 2[W] standard width unit size cassette, the modular 3 W standard width unit size cassette, the modular 4 W standard width unit size cassette, and the modular 6 W standard width unit size cassette.	(Element 17F) wherein the tray member is configured to conform to the standard one width (1 W) so as to support the modular 2[W] standard width unit size cassette, the modular 3 W standard width unit size cassette, the modular 4 W standard width unit size cassette, and the modular 6 W standard width unit size cassette.

329. Claim 17 is rendered obvious by Sauter in combination with Dagley for the same reasons given above for the corresponding claim elements in Claims 9 and 1. See the chart below which identifies claim elements discussed for claims 1 and 9 that correspond to the language in each Element of claim 17.

Element of Claim 17	Corresponding Claim Language and Analysis
Preamble of Claim 17:	See Preamble of Claims 9 and 1.
Element 17A:	See Element 9A, Preamble of Claim 1, Element 1B, and Element 1C.
Element 17B:	See Element 17E, and the discussion below.
Element 17C:	See Element 9C, 1E, 1D.

Element 17D: See Elements 9D, 1F.

Element 17E: See Elements 9E, 1H.

Element 17F: See Elements 9F, 1J.

Element 17G: See Element 9G, 1K.

330. I note that Claim 17 recites a "tray member" instead of simply a "tray." Sauter's tray 502 is both a tray and a "tray member." There is no material difference between these two terms for the purpose of applying Sauter.

331. Element 17B does not recite that "each of" the plurality of cassette configurations must include different sizes of cassettes. Instead, it merely recites that "the plurality" of cassette configurations includes different sizes of cassettes. Here, unlike claim Element 9B/9E, satisfying the four configurations recited in Element 17E will satisfy Element 17B because taken collectively, not individually, the four configurations recited do include multiple different sizes of cassettes. Therefore, Element 17B is satisfied for the same reasons that Element 17E (and 9E, and 1H) is satisfied.

332. Element 17F recites that "the tray member" is configured to conform to the standard one width. By comparison, Claim 9 Element 9F had recited that the "tray includes a plurality of cassette engaging portions" that are configured to conform to the standard one width (1 W). The rail guides (108) and apertures (104) are formed from the bottom wall of Sauter's tray and are part of the tray member. EX1006 Fig. 4, 5:40-42 ("…each rail guide 108 comprises an elongated

section of the mounting surface that is raised to form a ledge on both sides of the elongated section.") These rail guides and apertures are features of the tray member and for that reason and for the reasons given previously for Elements 1K and 9G, these features satisfy limitation 17G.

D. Dependent Claims 2, 10, and 18

2. The tray of claim 1, wherein the standard one width (1 W) unit is based on a standard SC Duplex width unit that is configured to fit a plurality of different type of LC, SC, and MPO connectors.

10. The tray of claim 9, wherein the standard one width (1 W) unit is based on a standard SC Duplex width unit that is configured to fit a plurality of different type of LC, SC, and MPO connectors.

18. The tray member of claim 17, wherein the standard one width (1 W) unit is based on a standard SC Duplex width unit that is configured to fit a plurality of different type of LC, SC, and MPO connectors.

333. As seen in Sauter's figures (Figs. 2-7, 9-11, 13, 15, 16) and noted at EX1006 8:20-28, each of Sauter's single-gang cassettes incorporates three Quad LC adapter modules side by side.

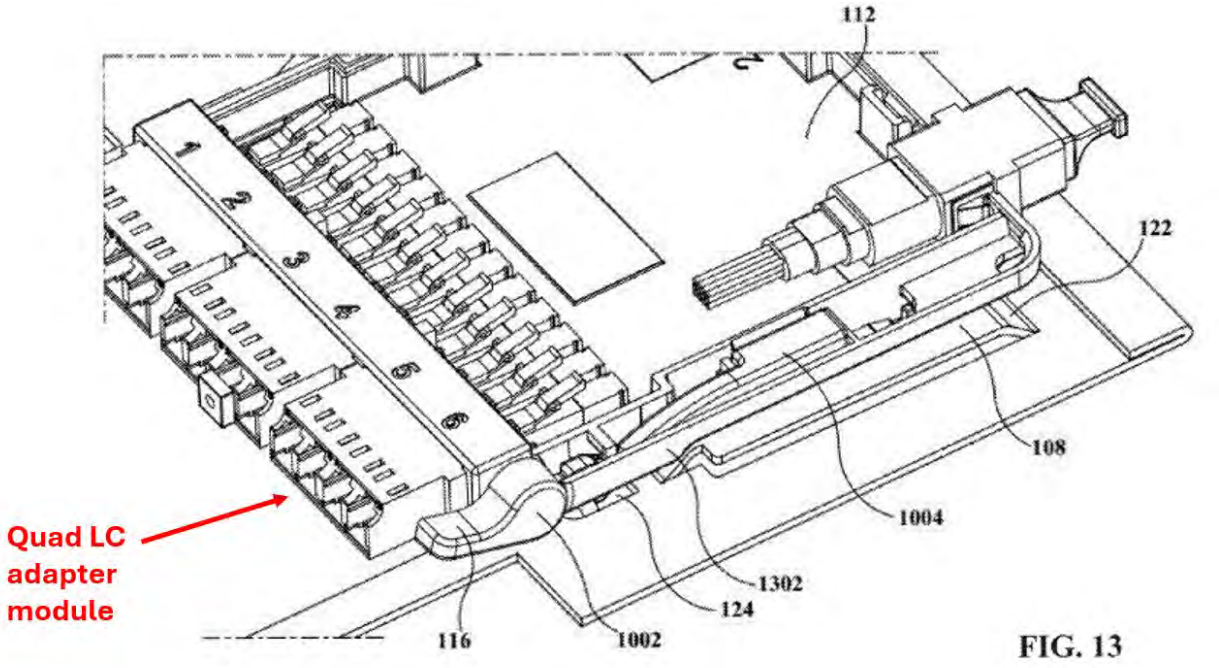


FIG. 13

The standard one width 1W unit in Sauter (one third the width of Sauter's single-gang cassette) is based on the same standardized LC Quad technology as is shown in the '423 patent. As pointed out by the '423 patent, the standard Quad LC adapter fits within the same footprint as an SC Duplex adapter. See EX1001 ('423 patent) at 8:58-60 ("…width W is based on a LC Quad (SC Duplex) technology footprint comprising four (4) connectors…"). The Quad LC adapter module has a standardized footprint that fits the standard SC Duplex footprint and will also fit the dual MPO footprint. The LC connector technology was intended to double the density compared to SC technology. The LC connectors and adapters were designed to fit four ports into the same space that would also fit one Duplex SC connector port (a Duplex SC footprint). See EX1006 at 8:20-28:

> Although FIG. 6 depicts adapters 126 that are configured to receive Lucent connectors (LC connectors), cassettes that accommodate other fiber optic connector types are also within the scope of one or more embodiments described herein. In various embodiments, the fiber optic cassettes can be configured to accept single-fiber connectors (e.g., **LC, Standard Connector**, etc.) and **multi-fiber connectors** (e.g., mechanical transfer pull-off, multi-fiber push-on, etc.)

The 1W width in Sauter, therefore, will fit a plurality of different type of LC, SC, and MPO connectors.

E. Dependent Claims 3, 11, and 19

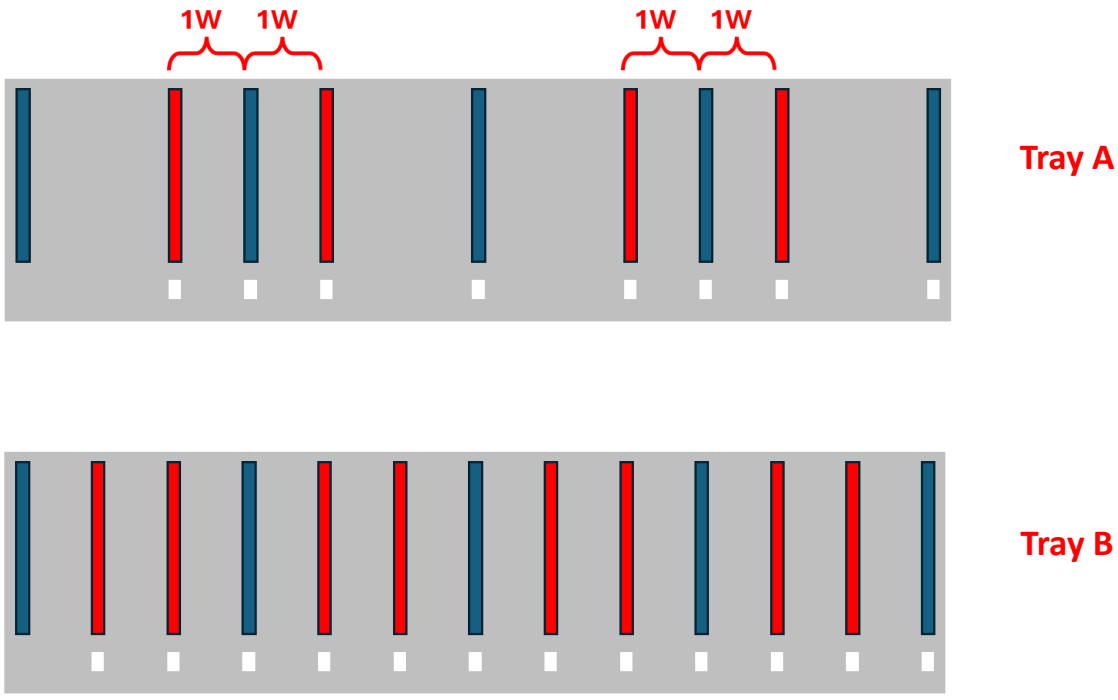
3. The tray of claim 1, wherein the plurality of cassette engaging portions of the tray are spaced apart from one another so as to conform to the standard one width (1 W) and support the modular two standard width (2 W) cassette, the modular three standard width (3 W) cassette, the modular four standard width (4 W) cassette, and the modular six standard width (6 W) cassette.

11. The tray of claim 9, wherein the plurality of cassette engaging portions of the tray are spaced apart from one another so as to conform to the standard one width (1 W) and support the modular 2 standard width unit size cassette, the modular 3 W standard width unit size cassette, the modular 4 W standard width unit size cassette, and the modular 6 W standard width unit size cassette.

19. The tray member of claim 17, wherein the tray member includes a row of cassette engaging portions that are spaced apart from one another so as to conform to the standard one width (1 W) and support the modular 2[W] standard width unit size cassette, the modular 3 W standard width unit size cassette, the modular 4 W standard width unit size cassette, and the modular 6 W standard width unit size cassette.

334. The limitations recited in Claims 3, 11, and 19 are rendered obvious by Sauter in combination with Dagley for the same reasons given above for

Element 1K. Element 1K requires that the cassette engaging portions of the tray "conform to" the standard 1W width. As explained for Element 1K, the way the rail guides (which are Sauter's "cassette engaging portions") conform to the 1W width, when configured to support both BASE-8 and BASE-12 cassettes, is by being spaced apart in a repeating pattern that has a pitch of 1W. For Tray A, there are at least some rail guides that the center to center distance between successive rail guides is 1W, and for Tray B, the center to center distance between successive rail guides is 1W for every rail guide. As explained above under Element 1K, the configuration of both Tray A and Tray B would have been obvious based on Sauter in combination with Dagley to additionally support BASE-8 cassettes.



F. Dependent Claims 4, 12, and 22

4. The tray of claim 1, wherein the tray is configured to be slidingly received in at least a portion of a tray receiving space of a case of a fiber optic management system.

12. The tray of claim 9, wherein the tray is configured to be slidingly received in at least portion of a tray receiving space of a case of a fiber optic management system.

22. The tray member of claim 17, wherein the tray member is configured to be slidingly received in at least portion of a tray member receiving space of a case of a fiber optic management system.

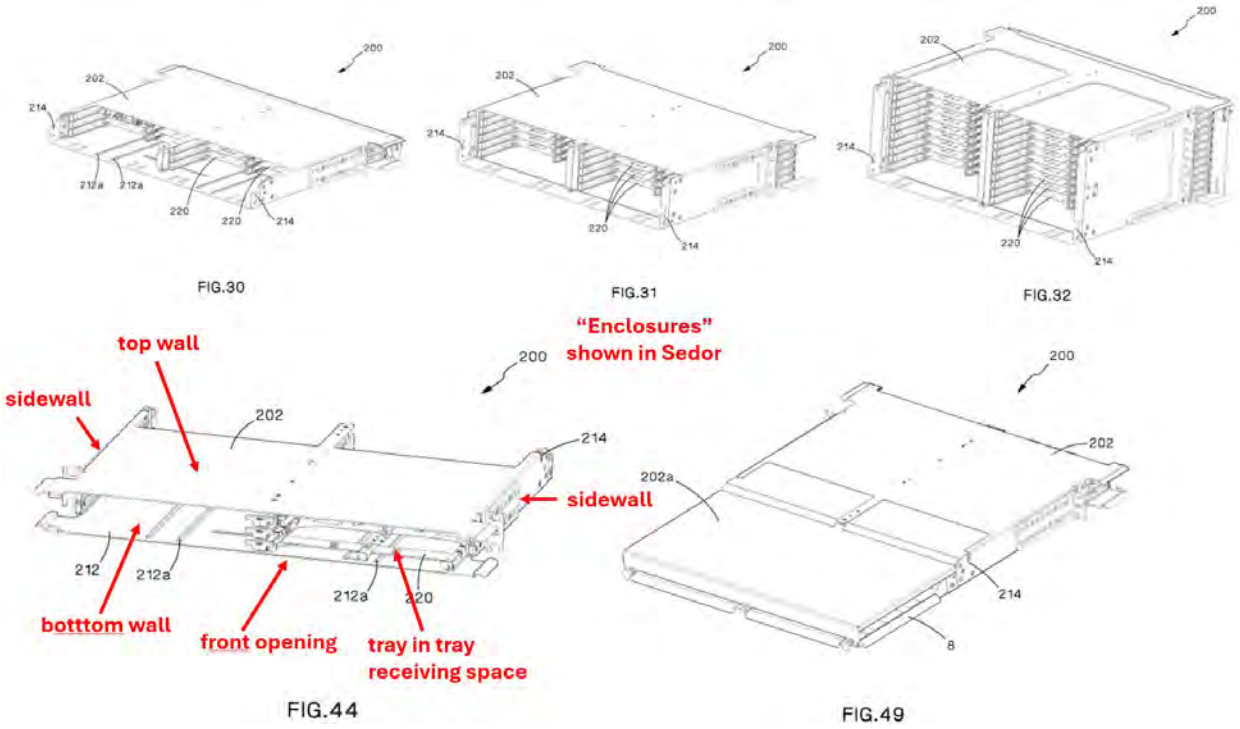
335. Sauter's trays (e.g. 102, 502, and 1510) are configured to be slidingly received in at least a portion of a tray receiving space of a case of a fiber optic management system. The enclosure 1508 is a case. EX1006 at 10:18-34, Figs. 15, 16:

> **Enclosure 1508 is configured to hold multiple trays** 1510 in a stacked formation. FIG. 16 is a view depicting **an example cassette tray 1602 being installed within an enclosure**. In this example, cassette tray 1602 is inserted through the front opening of the enclosure, such that the **left and right edges of the cassette trays engage with corresponding guide channels 1604 formed in left and right tray guides 1606 mounted on the inside left and right inside walls of the enclosure 1508** (FIG. 16 shows only the left tray guide for clarity). The guide channels 1604 guide the tray 1602 into the correct position within the enclosure. One or more locking indentations 1608 located near each guide channel 1604 are configured to receive a corresponding spring-loaded locking tab of a tray latch mounted to the side of the tray 1602 when the rear edge of the tray 1602 reaches the end of travel at the rear end of the guide channel, thereby locking the tray 1602 in place within the enclosure.

See also, EX1006 at 4:1-28 ("the enclosure in which the tray is disposed"); 4:32-34 ("Example tray 102 is designed… to be installed in a fiber optic enclosure."); 6:39-40 ("…increasing the connectivity density of the enclosure in which the tray is installed."); 9:40-44 ("As noted above, the fiber optic cassette mounting system described herein can be incorporated in fiber optic cassette systems in which fiber optic cassettes and/or adapter plates are mounted to cassette trays, which can then be installed in a fiber optic enclosure."); 10:4-5 ("As shown in FIG. 15, multiple cassette trays 1510 can be stacked within the enclosure 1508."). Sauter's trays include side edges that are configured to be slidingly receiving into guide channels 1604 of enclosure 1508. The enclosure 1508 shown in Fig. 15 and 16 defines a tray receiving space and receives three trays. The claims of the present '423 patent appear to be directed at the tray itself, not the housing per se. The edges of the tray are flat narrow, straight edges that make the tray configured to be received into any case of a fiber optic management system having similarly shaped grooves for receiving the flat edges of the tray as shown in Fig. 16 of Sauter.

336. Although the claims do not recite that the contemplated case must include top and bottom walls, if Patent Owner argues the case must have top and bottom walls, one of skill in the art understands that "an enclosure" includes a top wall, bottom wall, and side walls that define a case or box that encloses the trays. See, for example, the art already made of record during prosecution of the '423

Patent. U.S. Patent No. 10,215,594 ("Sedor") illustrates "enclosures" for fiber cabling systems, including enclosures for receiving stacks of trays. EX1005 (Sedor) at Figs. 30-32, 44-50; 1:13-15 ("The present invention relates to data center management, and in particular enclosures for high speed data transport fiber cabling systems."); 3:1-41 ("…a High Density Fiber Enclosure ('HDFE')…FIG. 44 is a perspective view of a HDFE enclosure…"); 13:5-7 ("an enclosure having a top portion, a bottom portion, a first side and a second side").



Figures from EX1005 (10,215,944 to Sedor) illustrating examples of "enclosures" having top, bottom, side walls that receive fiber optic trays. Each of the enclosures illustrated in these figures includes top, bottom, and opposing side walls with edges joined defining a tray receiving space and front edges defining a front

opening for receiving trays that slide into the enclosure. Similarly, by disclosing that his trays are configured to be received within "an enclosure" one of skill in the art would have understood Sauter, like Sedor, disclosed the limitations in Claims 4, 12, and 22.

337. In addition, Figures 15 and 16 of Sauter show an enclosure with top and bottom walls. Figure 15 is described as showing "a three-dimensional view of a fiber optic enclosure in which are installed a number of fiber optic cassette trays." EX1006 at 3:1-3. Sauter's specification identifies the enclosure as element 1508. It is easy to see the opposed side walls and bottom wall of the enclosure in Figures 15 and 16 of Sauter. The top wall is more difficult to see, but it is there. The top wall has been made transparent so that the internal components can be seen (to show the stack of trays with cassettes inside the enclosure). For example, the edges of the two-piece top wall can be seen in Figure 15 of Sauter as well as the fastener mounting holes (for receiving fasteners such as screws to secure the top wall to the sidewall). Annotations have been added to Figs. 15 and 16 below to highlight these features of the enclosure.

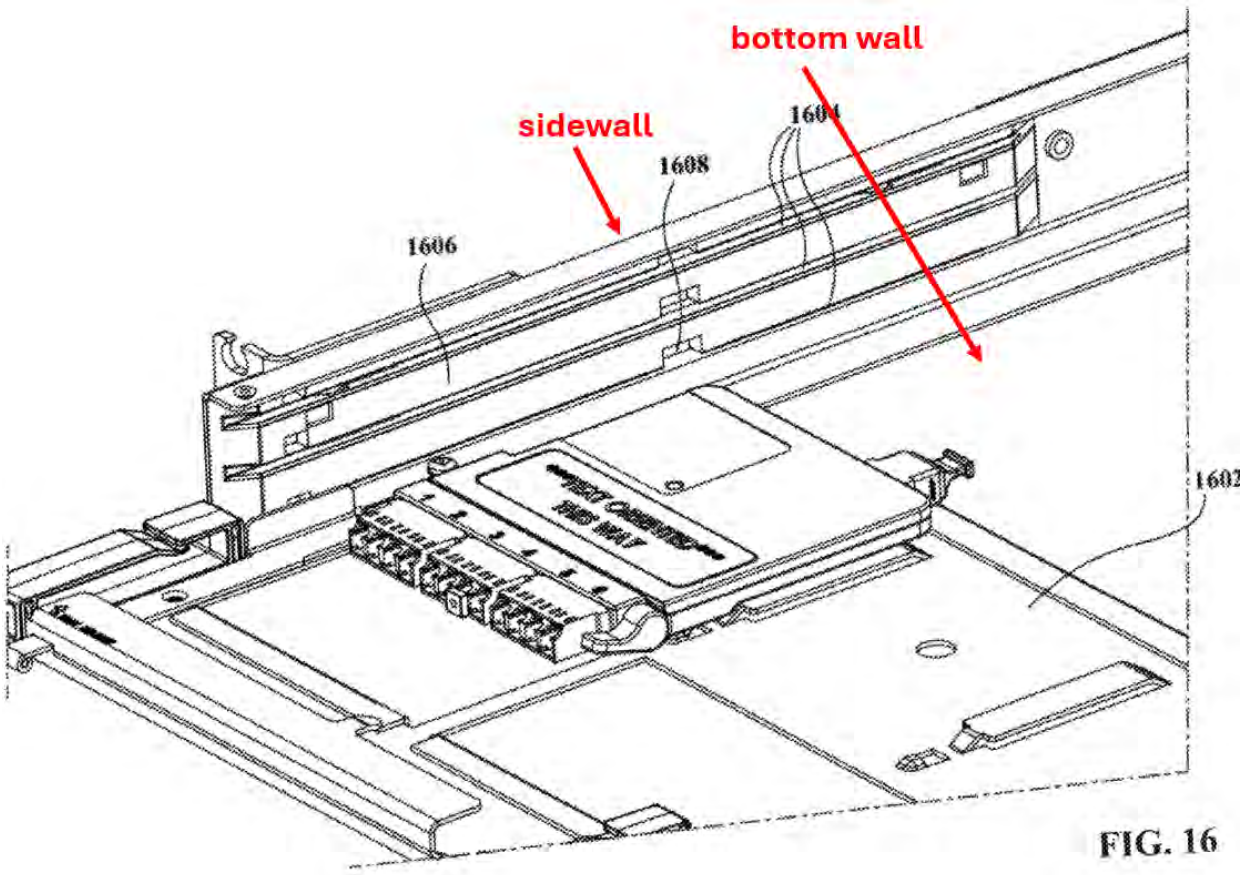
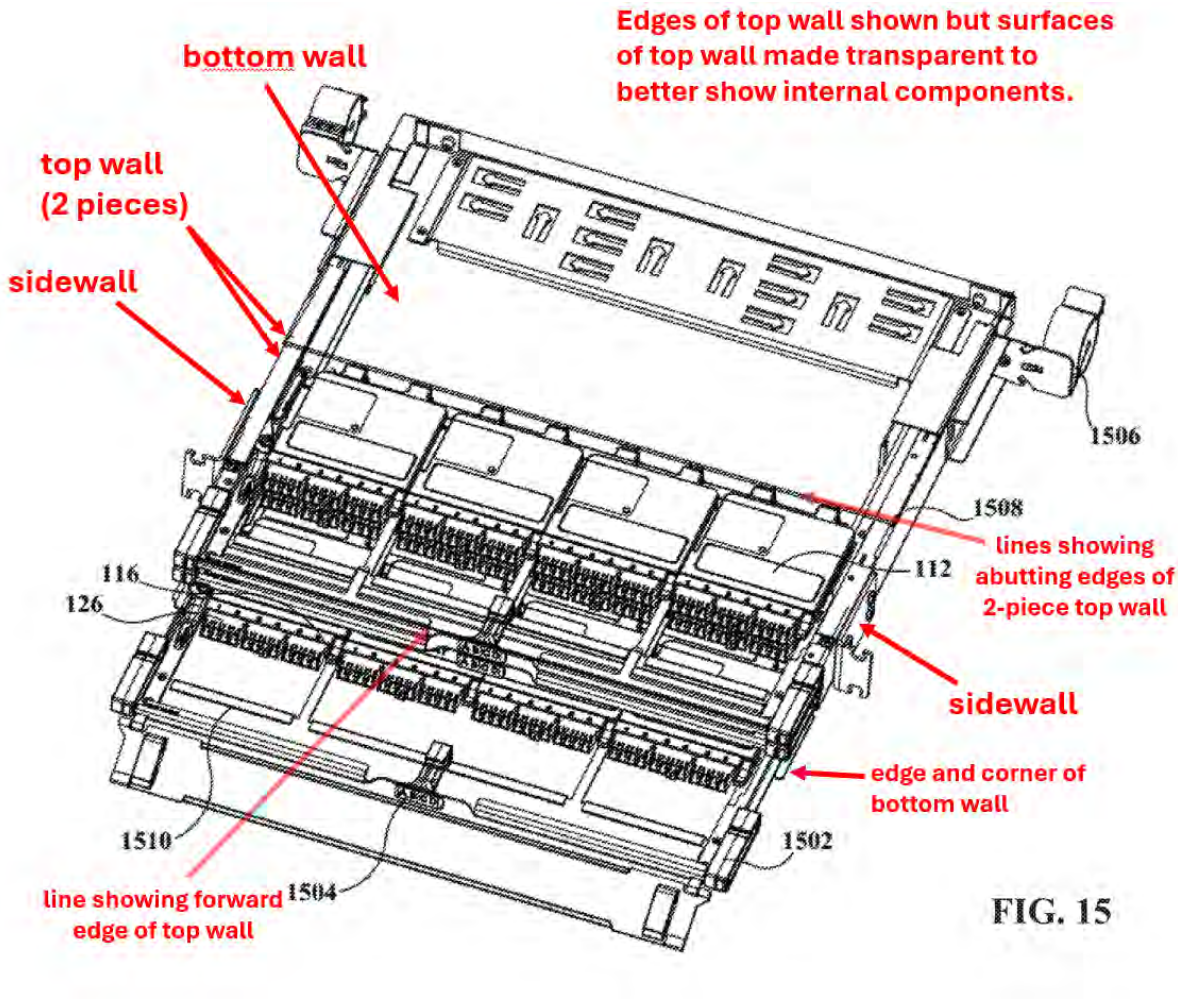


FIG. 16

EX1006, Fig. 16.



EX1006, Fig. 15.

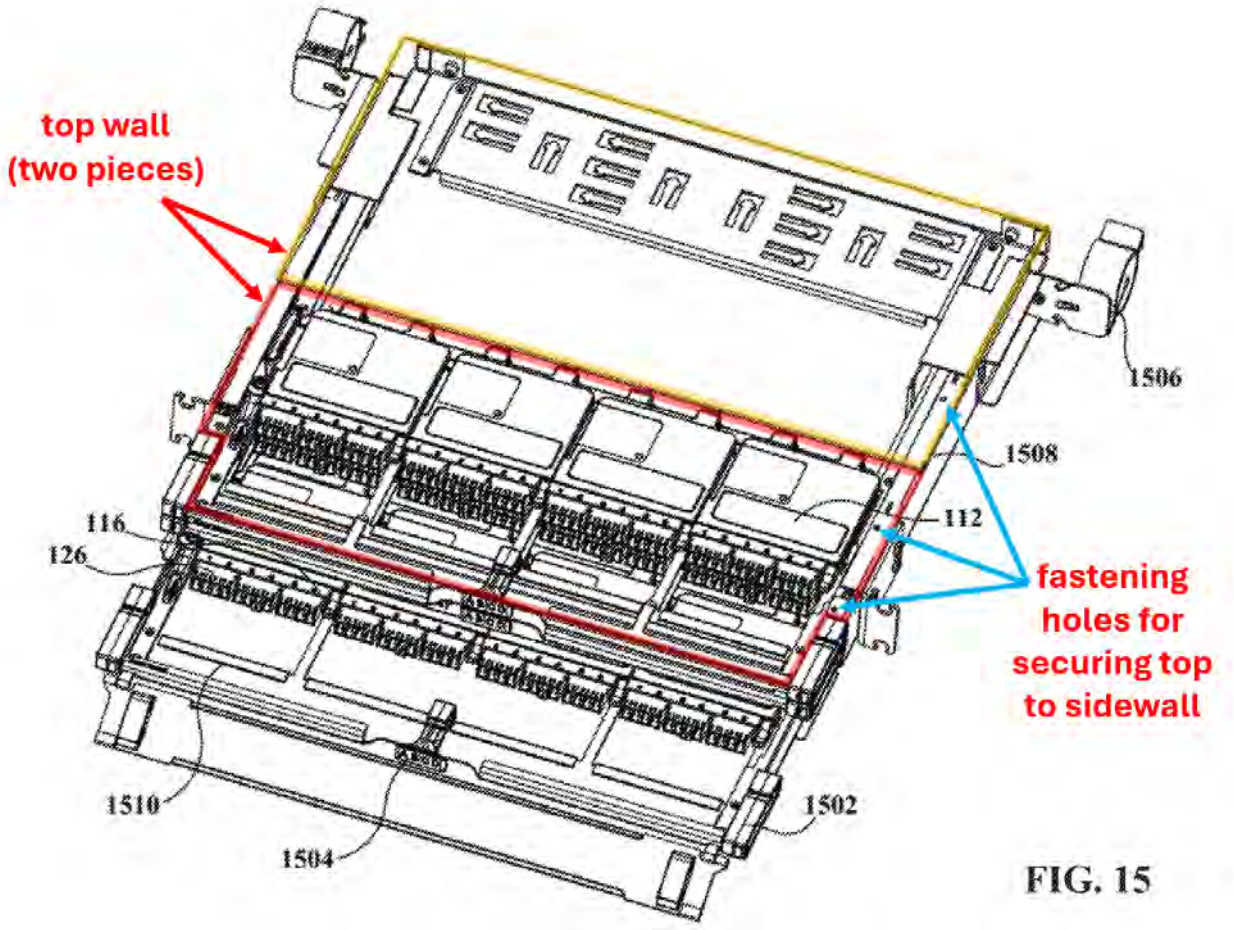


FIG. 15

EX1006, Fig. 16.

338. It is evident that Sauter, often without saying so, has made transparent or omitted several top structures in a number of his drawings (including Fig. 15) so that internal components can be identified. For example, in Fig. 11 showing a double-gang cassette, Sauter does not mention that the top cover of the cassette is not being shown, but we know, for example, from prior Figs. 9-10 that the double-gang cassette does include a top cover enclosing the internal components of the cassette. See also Fig. 13 (showing cassette 112 installed on tray without mentioning that the top cover of cassette 112 is not being shown).

339. That one of skill in the art would understand that the enclosure illustrated in Figure 15 includes top and bottom walls is further supported by the drawings originally filed by Sauter at the patent office with his application. The drawings initially included greyscale shading that helped to identify certain structures, but that tended to partially obscure elements behind the shaded surfaces. See for example, the original versions of Sauter's Figs. 15 and 16 filed with his original application on Nov. 10, 2015:

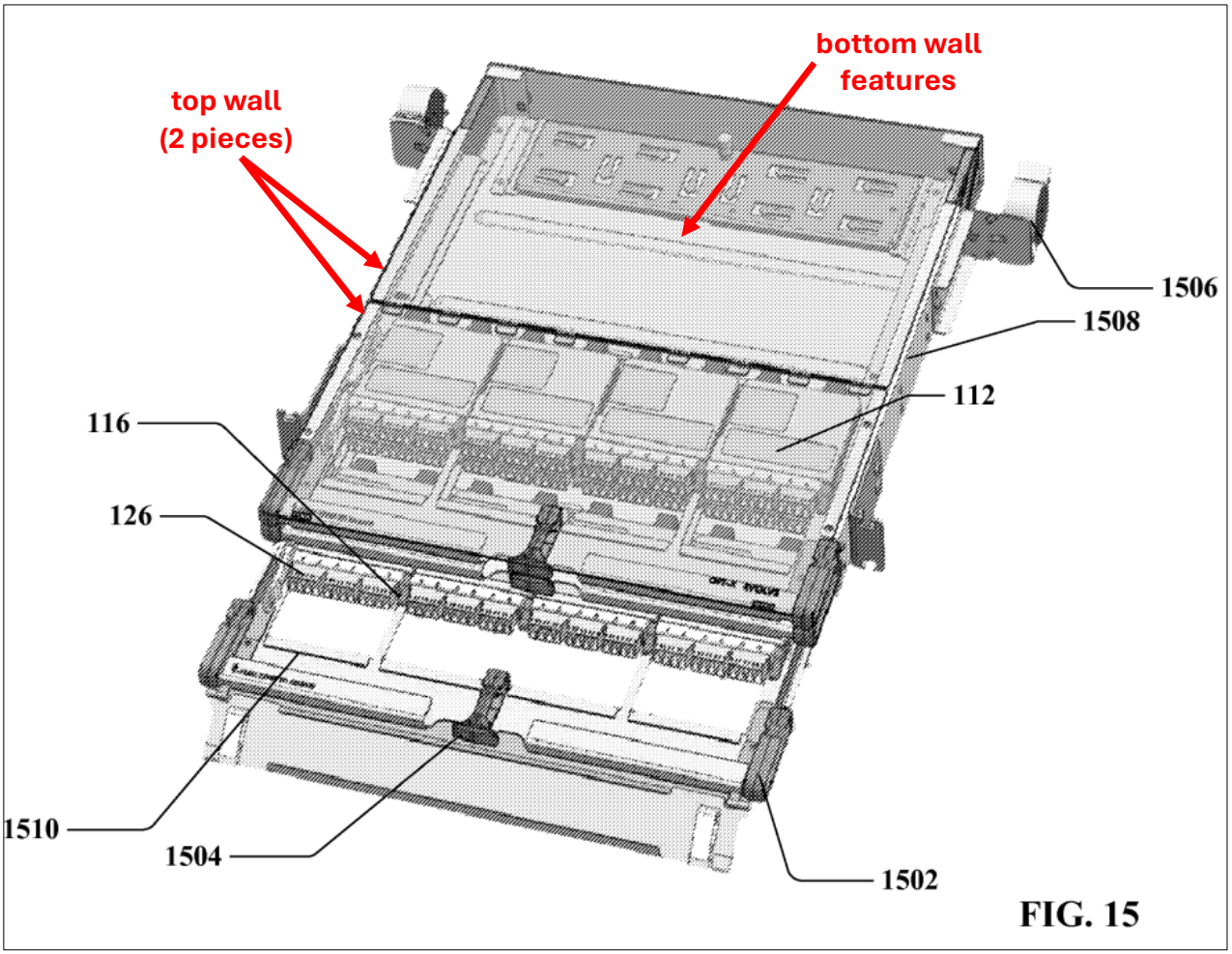


Figure 15 as originally filed by Sauter included greyscale shading.

See, EX1013 (Prosecution File History for Sauter) at p. 37. The shading in Figs. 15 and 16 as originally filed by Sauter make it easier to see the top and bottom surfaces of the enclosure 1508.

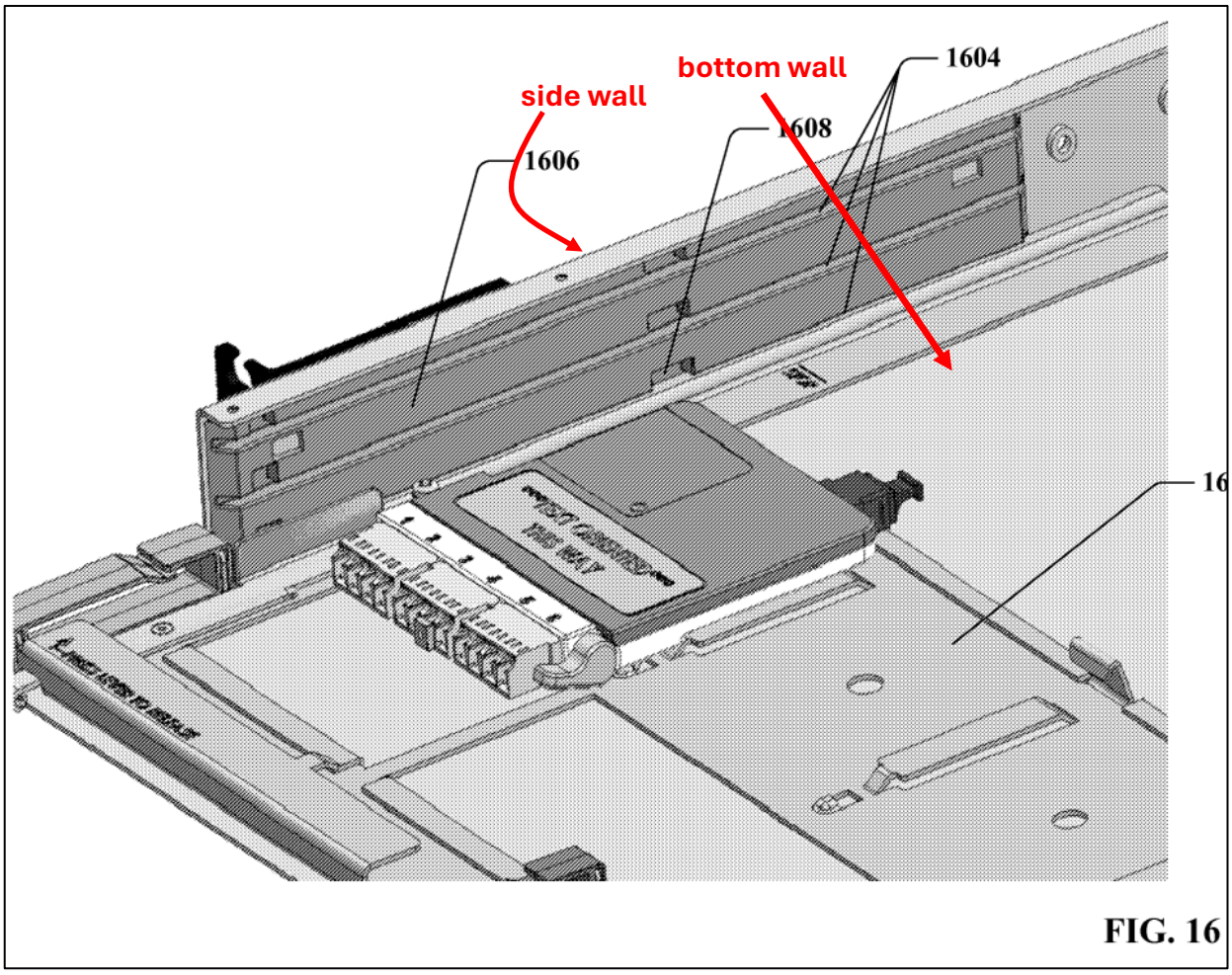


Figure 16 as originally filed by Sauter included greyscale shading.

See, EX1013 (Prosecution File History for Sauter) at 38. The shading of the top and bottom walls was removed from Sauter's drawings during prosecution to make it easier to see the elements that were underneath the shaded elements. See EX1013 at 110 ("The attached sheets contain revisions to FIGS. 1-16 of the drawings to render those drawings more clear. …Specifically, the originally filed grayscale drawings have been replaced with line drawings for clarity. These amendments to the drawings add no new matter."). The original drawings

corroborate my opinion that one of skill in the art would understand that the enclosure disclosed by Sauter does include a top, bottom, and side walls.

Including a top and/or bottom wall would have been obvious

340. Even if patent owner argues that the enclosure disclosed in Sauter is not a case as recited in Claims 4, 12, and 22 because it does not include a top or bottom wall, including these walls on Sauter's enclosure to define a housing would have been obvious based on Sauter alone or in combination with Dagley, which shows a case having top and bottom walls to slidingly receive the trays. It is well known that optical fibers are inherently fragile because they rely on very thin glass structures to carry communication signals. It would have been obvious to protect the fiber optic components within Sauter's enclosure by including top and bottom walls to surround the components above and below.

341. In addition, Dagley shows a tray case (chassis) that includes both a top and bottom surface that, just like Sauter's enclosure, receives three trays with fiber optic cassettes that fits within a 1-U space. EX1030, ¶¶0006-0007 ("chassis having a 1-U rack space footprint"), Figs. 3A, 3B, 10A, 10B, ¶0025 ("FIGS. 3A-3D are respective perspective, front, top, and side views of the equipment tray of FIGS. 2A and 2B disposed in a 1-U space chassis"); ¶0094 (referring to "the top of the chassis" and "the bottom of the chassis").

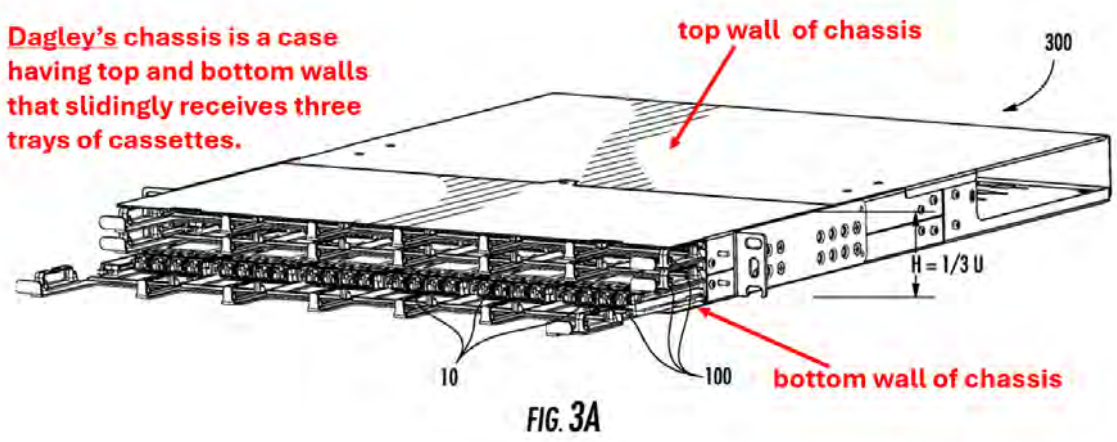


FIG. 3A

EX1030, Fig. 3A.

342. One of ordinary skill in the art would have been motivated to protect the fragile fiber components within Sauter's enclosure by including top and bottom walls on the enclosure. Enclosing the components would protect the fiber optic components, for example, from inadvertent damage while technicians are working near the system (e.g., above or below) and would protect the fragile components from objects dropped from above as well as from objects being inserted below the enclosure within a telecommunications rack. Adding simple flat pieces of sheet metal to the top and/or bottom of the enclosure would have been well within the level of ordinary skill in the art. One of ordinary skill would have a reasonable expectation of success adding a top and/or bottom wall because doing so requires only a static mechanical connection that could be secured with simple screws. Sauter's figures even include suggested fastener hole locations for making the connection.

G. Dependent Claims 5, 13, 23

5. The tray of claim 1, wherein each of the modular fiber optic cassettes includes a cassette side end portion that is directly adjacent to a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.

13. The tray of claim 9, wherein each of the modular fiber optic cassettes includes a cassette side end portion that is directly adjacent to a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.

23. The tray member of claim 17, wherein each of the modular fiber optic cassettes includes a cassette side end portion that is directly adjacent to a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.

343. The relationship of the side end portions of Sauter's adjacent cassettes can be seen, for example, in Fig. 15.

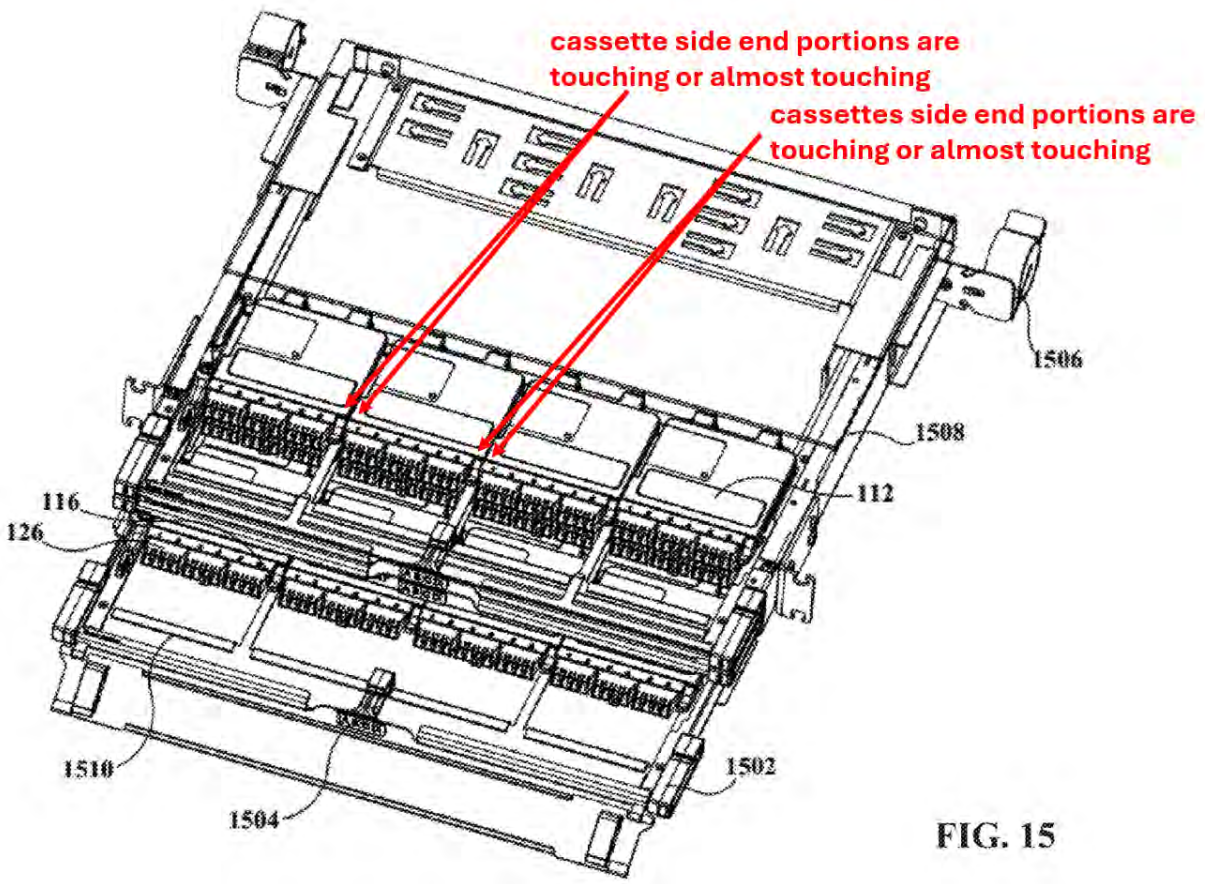


FIG. 15

As shown above each cassette includes a side end portion that is touching or almost touching the adjacent cassette side end portion. Each cassette size in the contemplated cassette configurations would have this same relationship to its neighboring cassette.

344. During prosecution of the claim language "directly adjacent" in the grandparent '542 patent, the Patent Owner stated very specifically that the term "directly" when modifying "adjacent" excluded arrangements that included "any intervening structures" such as an intervening "rail."

> Additionally, the optical fiber modules cannot be said to be directly adjacent to at least one other selected cassette. In this regard,

> Applicant notes that all of the modules of Sedor et al. are separated by a rail. Applicant also notes that according to the Examiner, on a broadest reasonable interpretation, "directly adjacent" would not preclude an intervening structure between the objects. Applicant respectfully disagrees. Indeed, such an interpretation effectively assigns no weight to the adjective "directly". Applicant also submits that a person of ordinary skill in the art would clearly understand that the modification of adjacent by "directly" was clearly intended to exclude any intervening structure, and such that, although the cassettes may be separated by a relatively small gap, cassettes which are "directly adjacent" are almost touching or touching without any intervening structure.
>
> Applicant submits, therefore, that Sedor et al. fails to disclose a system where the cassettes are directly adjacent to one another as claimed at Claim 1.

EX1002 (Pros History of '542, at 12/10/2021 Remarks p. 7) at pdf p. 135 (underlining in original, highlighting added).

345. Patent Owner repeated these remarks again in Patent Owner's next response to the examiner who had maintained the rejection:

> Additionally, the optical fiber modules cannot be said to be directly adjacent to at least one other selected cassette. In this regard, Applicant notes that all of the modules of Sedor et al. are separated by a rail. Applicant also notes that according to the Examiner, on a broadest reasonable interpretation, "directly adjacent" would not preclude an intervening structure between the objects. Applicant respectfully disagrees. Indeed, such an interpretation effectively assigns no weight to the adjective "directly". Applicant also submits that a person of ordinary skill in the art would clearly understand that the modification of adjacent by "directly" was clearly intended to exclude any intervening structure, and such that, although the cassettes may be separated by a relatively small gap, cassettes which are "directly adjacent" are almost touching or touching without any intervening structure.

> Applicant submits, therefore, that Sedor et al. fails to disclose a system where the cassettes are directly adjacent to one another as claimed at Claim 1.

EX1002 (Pros History of '542, at 2/21/2022 Remarks p. 6) at pdf p. 189 (underlining in original, highlighting added).

346. In light of the prosecution history, Patent Owner has taken the position that the "directly adjacent" limitation in this claim means "an outer side edge of each of said selected cassettes is almost touching or touching, without any intervening structure, an outer side edge of at least one other selected cassette." EX1011 (Joint Claim Construction Chart, Exhibit A, p. 15) at pdf. 19 (proposed construction for 'directly adjacent').

347. Patent Owner has applied this term to accuse a cassette and tray system that has rails on the tray that only partially separate the cassettes. In other words: (a) the accused system has rails on the tray that are not as tall as the accused cassettes, (b) the rails are not as deep as the cassettes and (c) the accused cassettes at least partially overlap the rails. See, e.g., EX1012 17-19 (showing accused system), at p. 19 (showing accused tray includes rails and citing User Manual); EX1016 (CommScope Propel Panel User Manual) at pp. 27, 20, Figs. 26-28, 17, 18 (illustrating rails on tray compared to cassettes); EX1017 (screen capture of Propel instructional video at https://www.youtube.com/watch?v=_agZJP5tZWc at 1:55)(showing cassette being mounted on rails):



The accused tray includes rails that:

(a) are shorter than the cassettes,

(b) are not as long as the cassettes, and

(c) are at least partially overlapped by the cassettes.

348. At least under Patent Owner's proposed construction and application of this term, Sauter discloses this limitation. The rail guides in Sauter only partially separate adjacent cassettes when the cassettes are mounted to the tray, leaving some side portions of adjacent cassettes that are almost touching each other. The rail guides are not as tall as the cassettes. The rail guides on the tray are not as long as the cassettes (i.e., the rail guides do not extent to the front of the

cassettes). The cassettes at least partially overlap the rail guides on the tray. See, for example, Sauter at Figs. 5, 16, 13, and Fig. 8 annotated below:

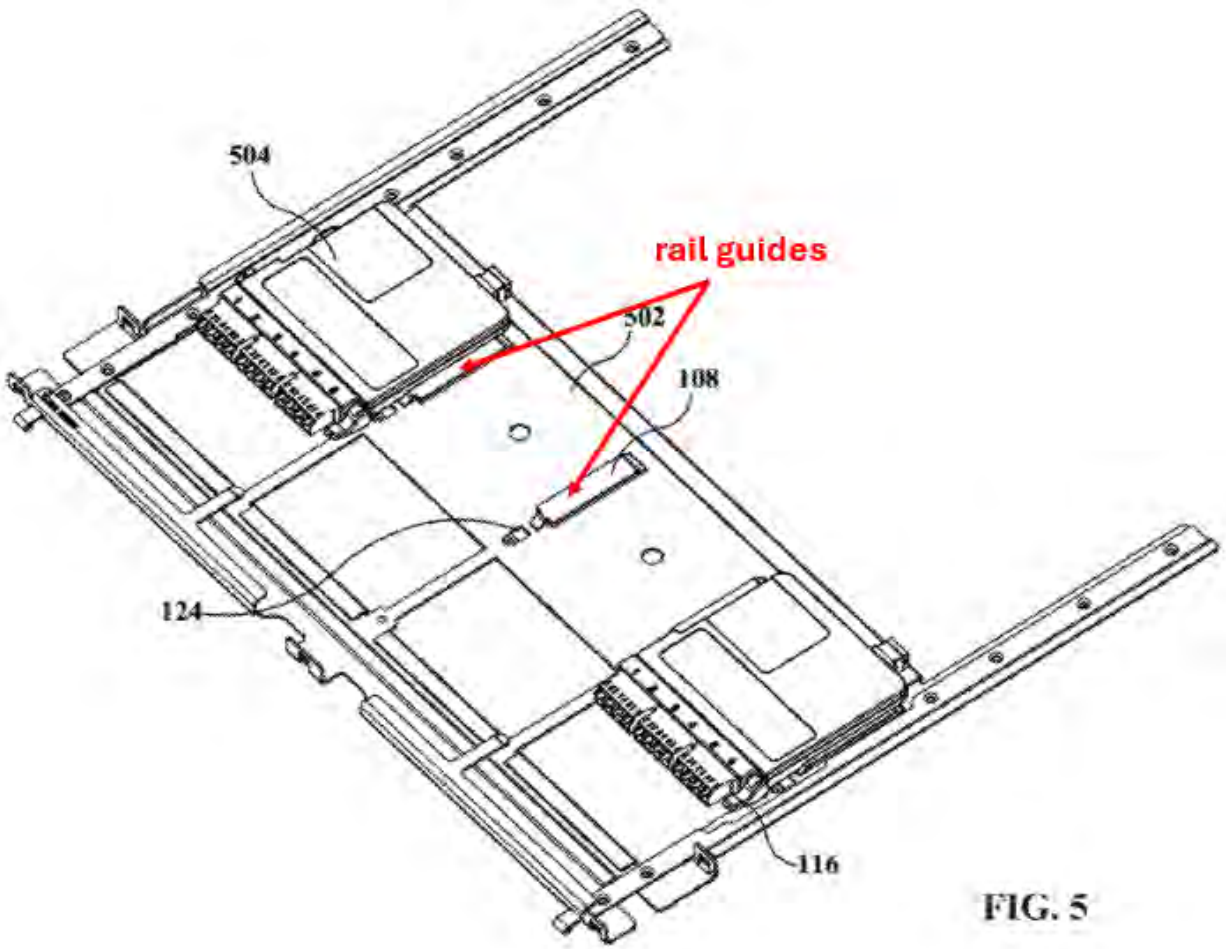


FIG. 5

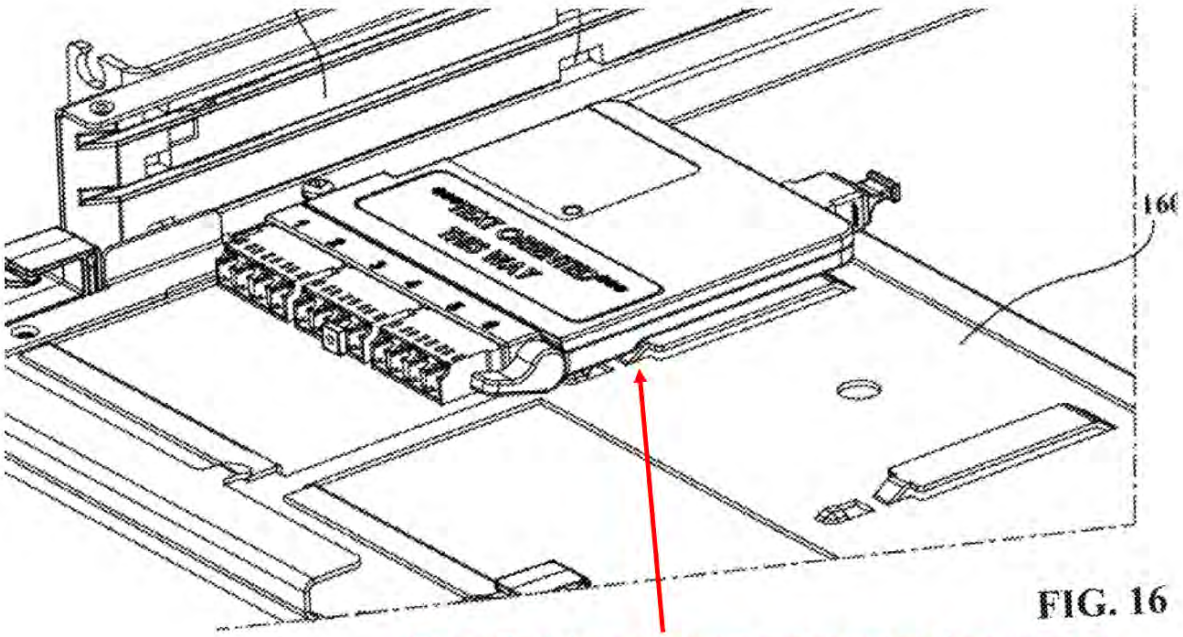


FIG. 16

The rail guides on tray are not as tall as the cassettes.
The cassettes at least partially overlap the rail guides.
The rail guides only partially separate adjacent cassettes.

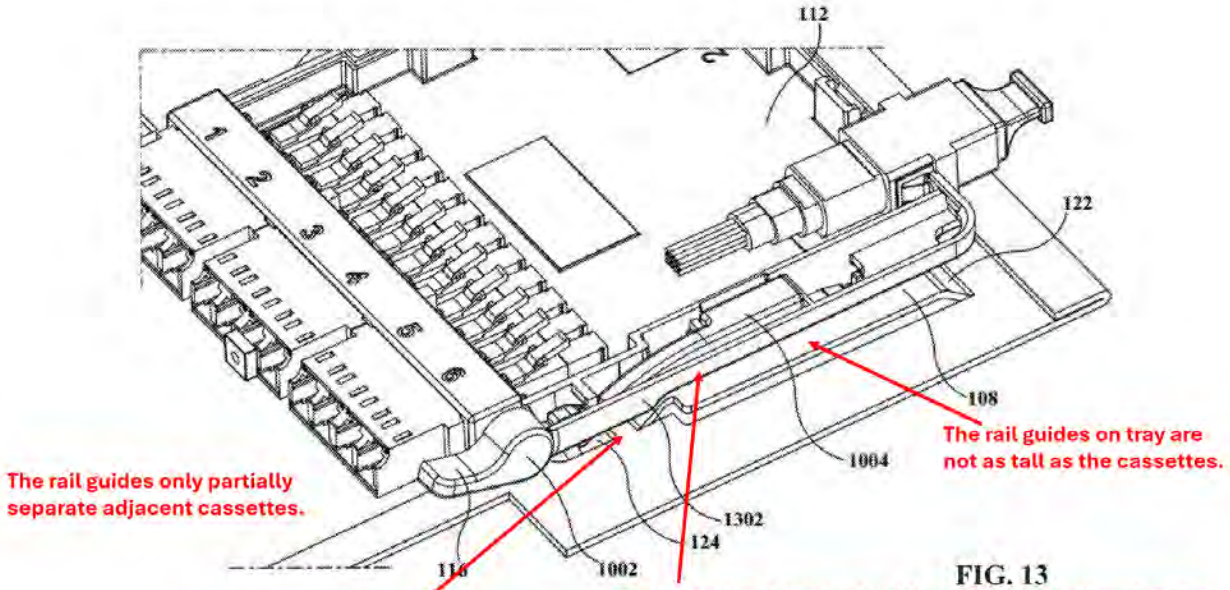


FIG. 13

The rail guides only partially separate adjacent cassettes.

The rail guides on tray are not as tall as the cassettes.

The rail guides are not as deep as the cassettes. (The rail guides do not extent to the front of the cassettes).

The cassettes (along right side where latching mechanism is located) at least partially overlap the rail guides.

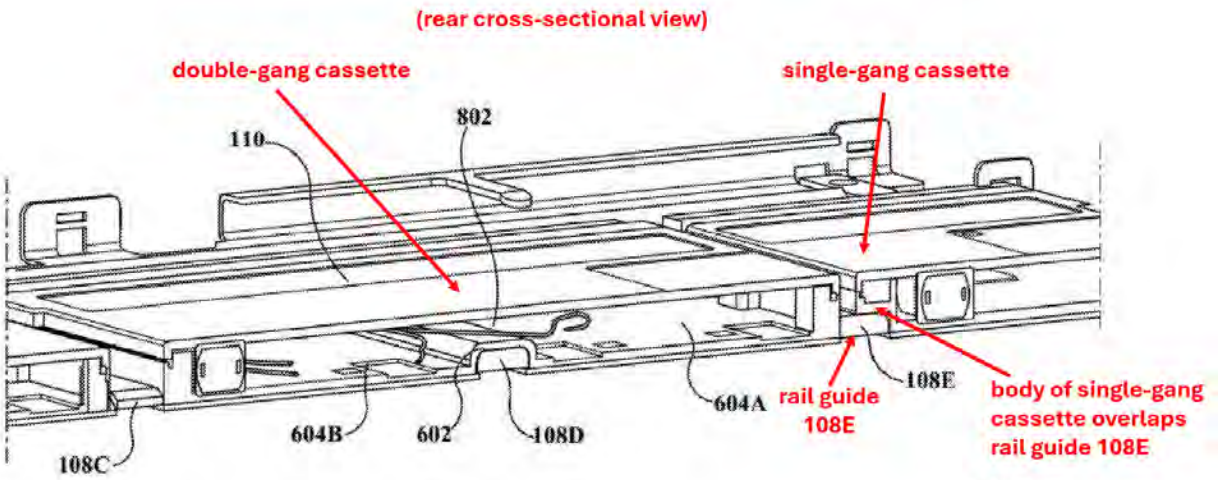


FIG. 8

349. The figures in Sauter show that portions of the sides of the cassettes are almost touching. See for example, Fig. 15 (annotated below):

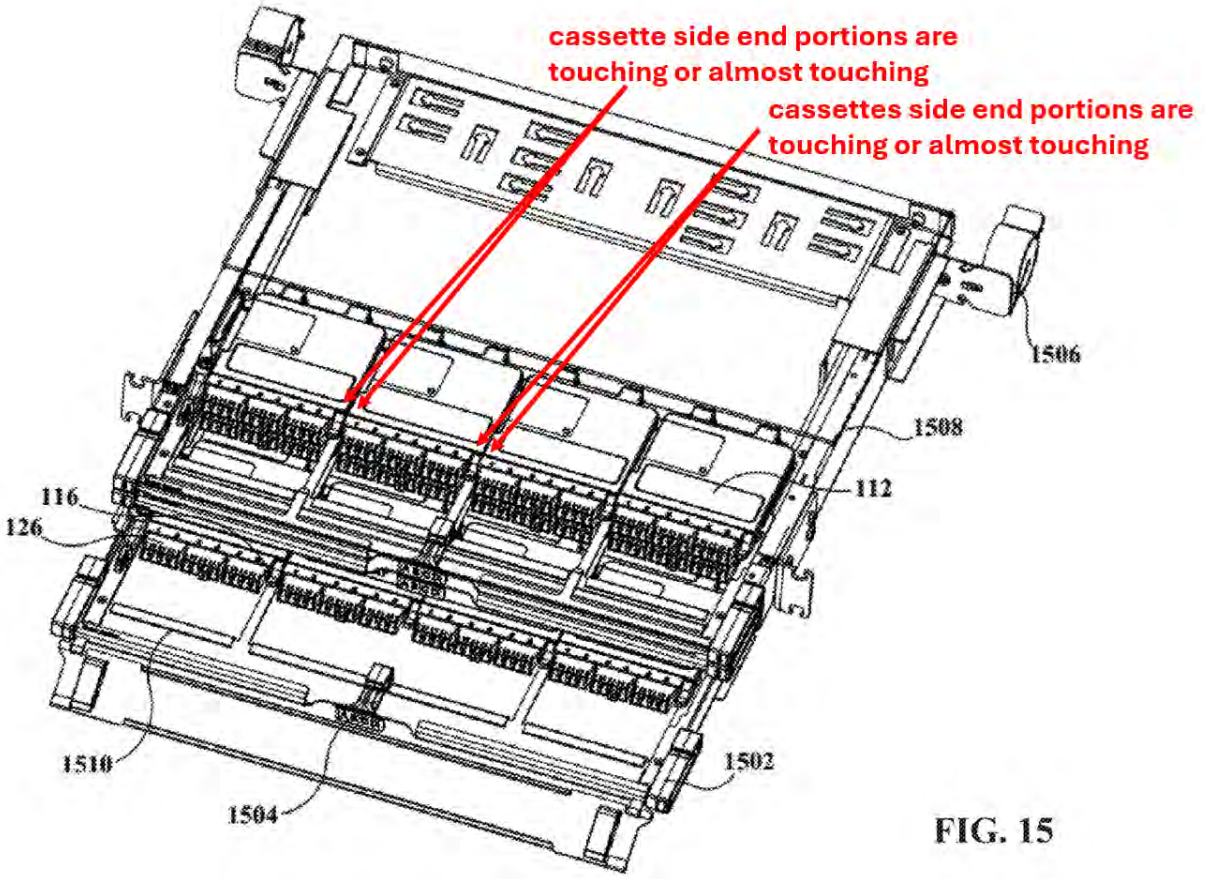


FIG. 15

350. In addition, both Sauter's single-gang cassettes and Sauter's multi-gang cassettes (such as the double-gang cassette) are almost touching. Although the double-gang cassette 110 illustrated in Fig. 7 of Sauter is not almost touching the adjacent cassette 112, Sauter teaches an alternative double-gang cassette configuration where the latching mechanism is repositioned to the right side of the double-gang cassette rather than being positioned in the middle of the cassette. Sauter teaches that the release latching mechanism 120 including latch 116 could alternatively be positioned along the side of the double-gang cassette just like the

latching mechanism 120 including release latch 116B on the single-gang cassette 112. See EX1006 at 7:48-60:

> As shown in FIGS. 6 and 7 (as well as FIG. 9, which is a three-dimensional view of the dual-gang cassette 110), the latching mechanism 120 for the example dual-gang cassette 110 is disposed in a middle section of the cassette between the two gangs 604A and 604B, with release latch 116A protruding from the front of the cassette 110. **However, in some embodiments, the latching mechanism 120 for a double-gang cassette can be located on the left or right side of the cassette, similar to single-gang cassettes.** Similarly, for multi-gang cassettes having more than two gangs, the latching mechanism 120 can be located between any two adjacent gangs of the cassette, or on either the left or right side of the cassette.

See also EX1006 at 1:64-2:1 ("In order to lock the cassettes in place on the tray, both single-gang and multi-gang cassettes include a latching mechanism on the left side, **on the right side**, or in a middle section of the cassette."). When the latching mechanism 120 including the release latch 116 is positioned along the right hand side of the double-gang cassette, the double-gang cassette will be touching or almost touching the adjacent cassette to the right (which is cassette 112 in Fig. 7. The figures below illustrate what Sauter is teaching at 7:48-60.

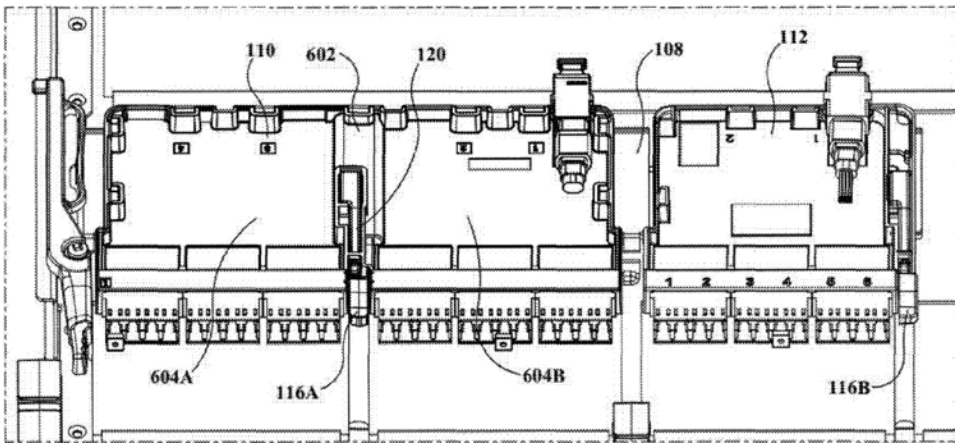
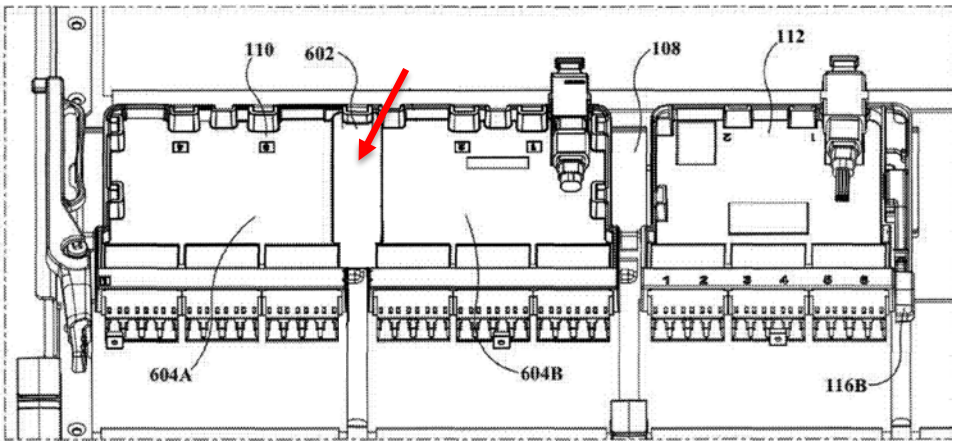
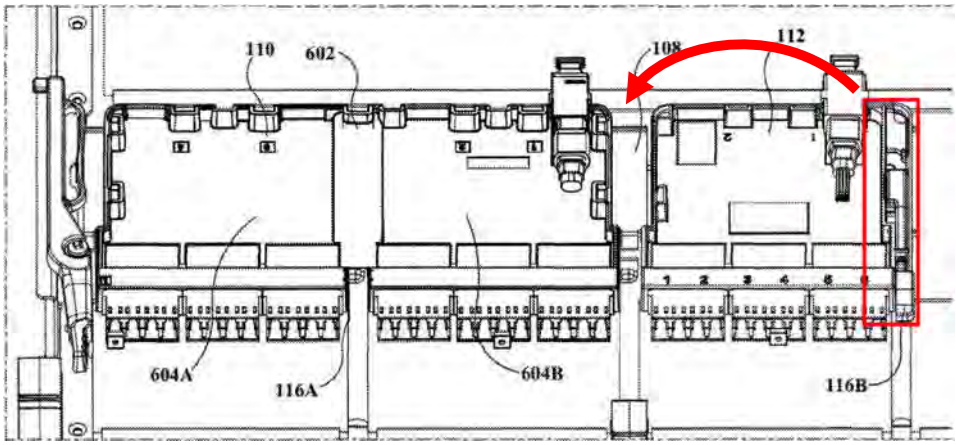
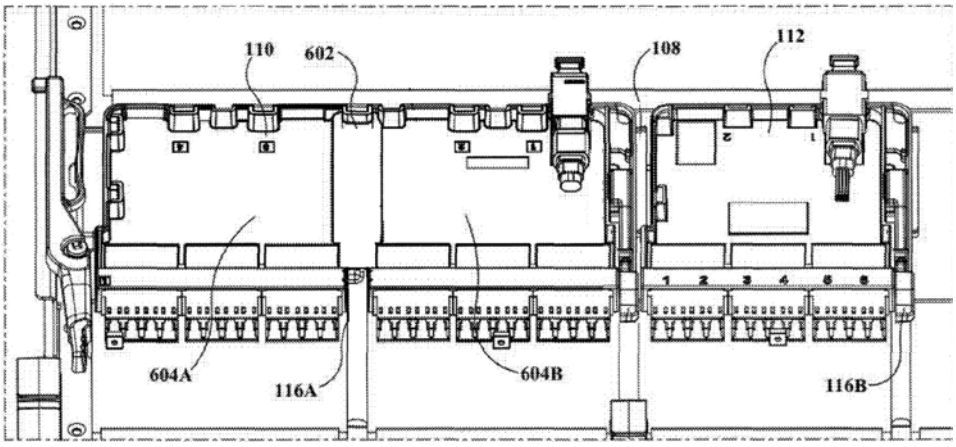
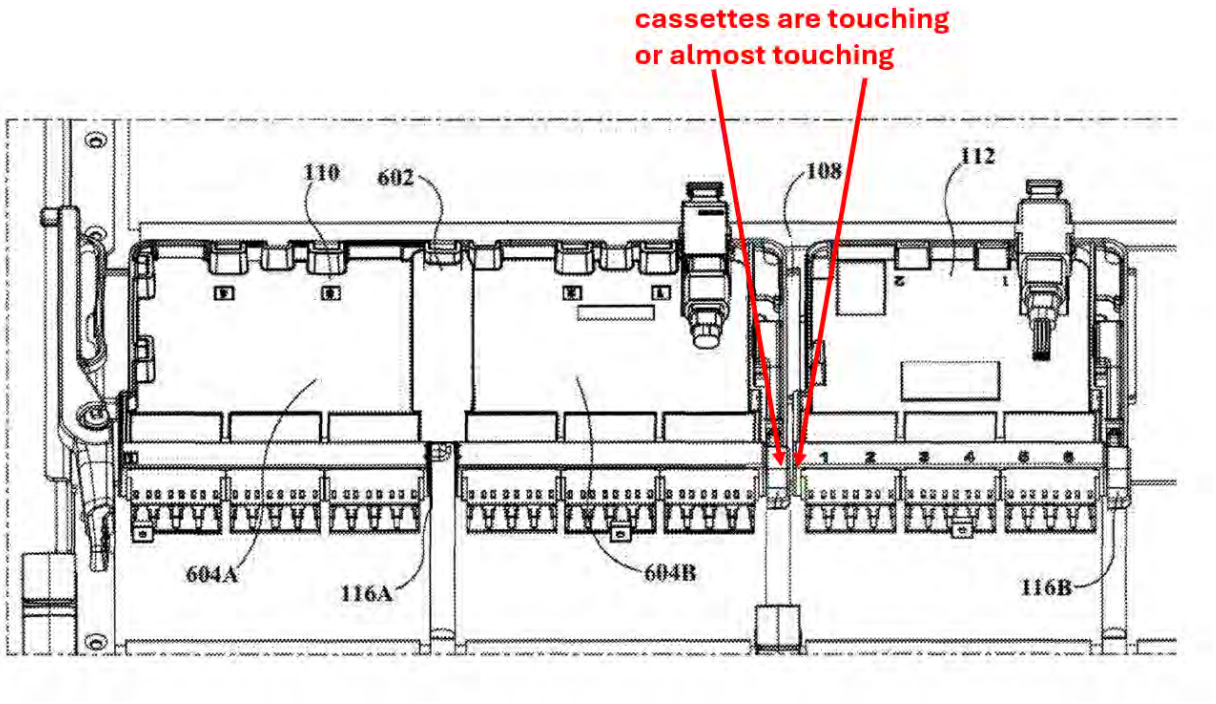
Fig. 7 as shown in Sauter (with latching mechanism 120, 116A in the middle of cassette 110)	
Fig. 7 without middle latching mechanism 120 (including without release latch 116A)	

Fig. 7 indicating latch mechanism along right side of cassette 112 that Sauter teaches can be duplicated onto right side of cassette 110.	
Fig. 7 with latching mechanism located along right hand side of cassette 110 as taught by Sauter at 7:54-56.	



351. Therefore, at least under Patent Owner's proposed construction and application of this claim limitation, Sauter discloses this limitation because even though Sauter includes rail guides on the tray that partially separate the cassettes, there remain other side portions of adjacent cassettes that are touching or almost touching.

352. Each cassette size in the contemplated cassette configurations recited in the independent claims would have this same relationship to its neighboring cassette because each cassette size uses the same latching mechanism to mount to the tray.

H. Dependent Claims 6, 14, 24

6. The tray of claim 1, wherein each of the modular fiber optic cassettes includes a cassette side end portion that is <u>adjacent to</u> a cassette side end portion of another module fiber optic cassette when

each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.

14. The tray of claim 9, wherein each of the modular fiber optic cassettes includes a cassette side end portion that is <u>adjacent to</u> a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.

24. The tray member of claim 17, wherein each of the modular fiber optic cassettes includes a cassette side end portion that is <u>adjacent to</u> a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.

353. These claims recite that the side end portions of the cassettes are merely "adjacent to" a side end portion of another cassette when mounted on the tray in the different configurations. These claims differ from similar claims 5, 13, and 23 which used the term "directly adjacent." Sauter's tray and cassette system discloses that when the tray is full each cassette on the tray will have a side end portion "adjacent to" another cassette on the tray. This relationship of the side end portions of Sauter's adjacent cassettes can be seen, for example, in Fig. 15.

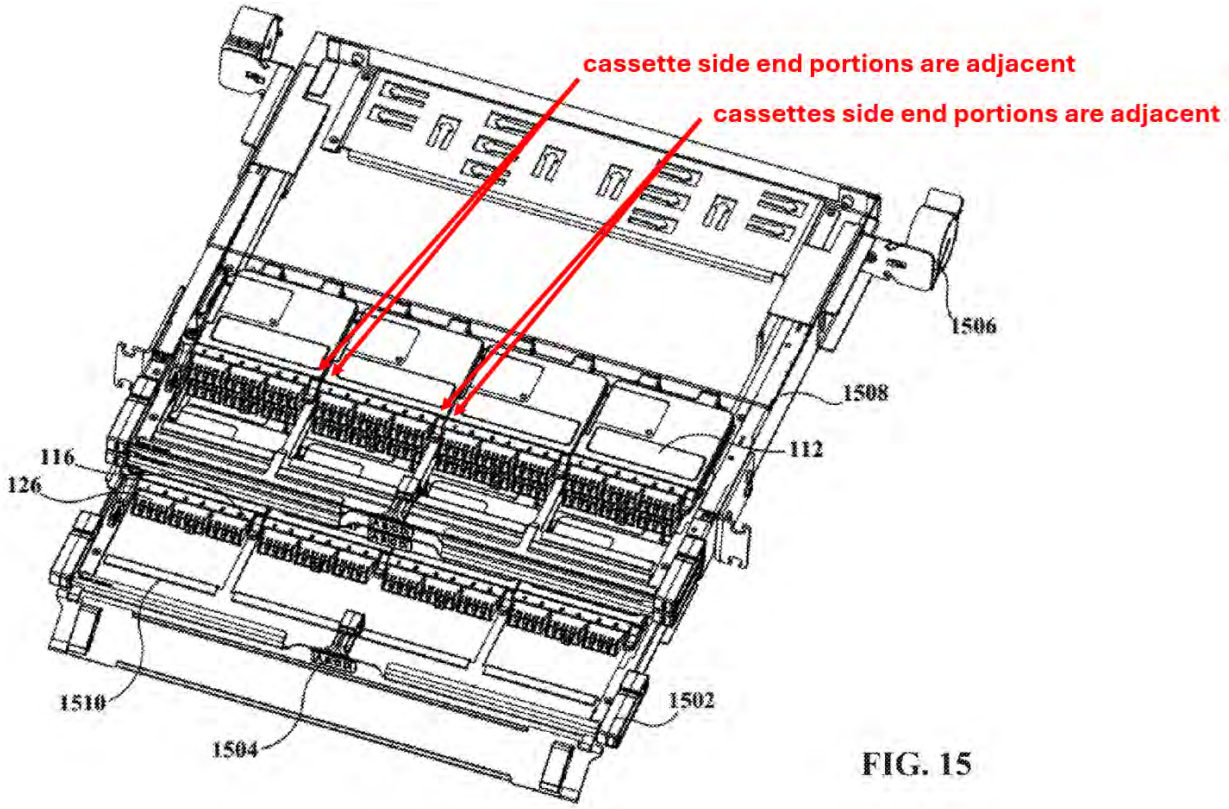


FIG. 15

As shown above each cassette includes a side end portion that is adjacent the side end portion of the next cassette on the tray. Each cassette size in the contemplated cassette configurations recited in the independent claims would have this same relationship to its neighboring cassette because each cassette size uses the same latching mechanism to mount to the tray.

I. Dependent Claims 7, 15, 25

7. The tray of claim 1, wherein each of the modular fiber optic cassettes includes a cassette side end portion <u>that touches</u> a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.

15. The tray of claim 9, wherein each of the modular fiber optic cassettes includes a cassette side end portion <u>that touches</u> a

cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.

25. The tray member of claim 17, wherein each of the modular fiber optic cassettes includes a cassette side end portion <u>that touches</u> a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.

354. In Sauter, when the cassettes are arranged on the tray side-by-side, the cassette side end portions are either touching or almost touching. For example, as shown in Fig. 15, there is no visible space between the cassettes.

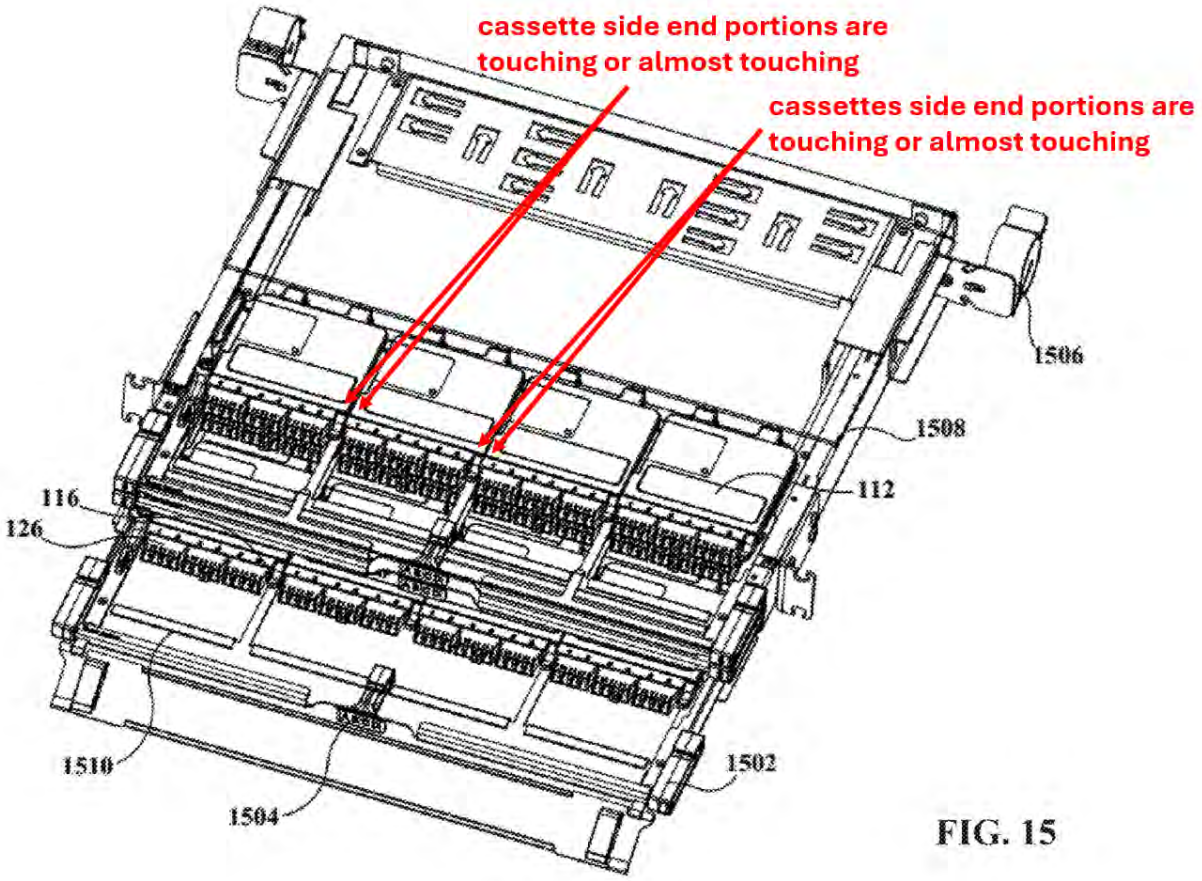
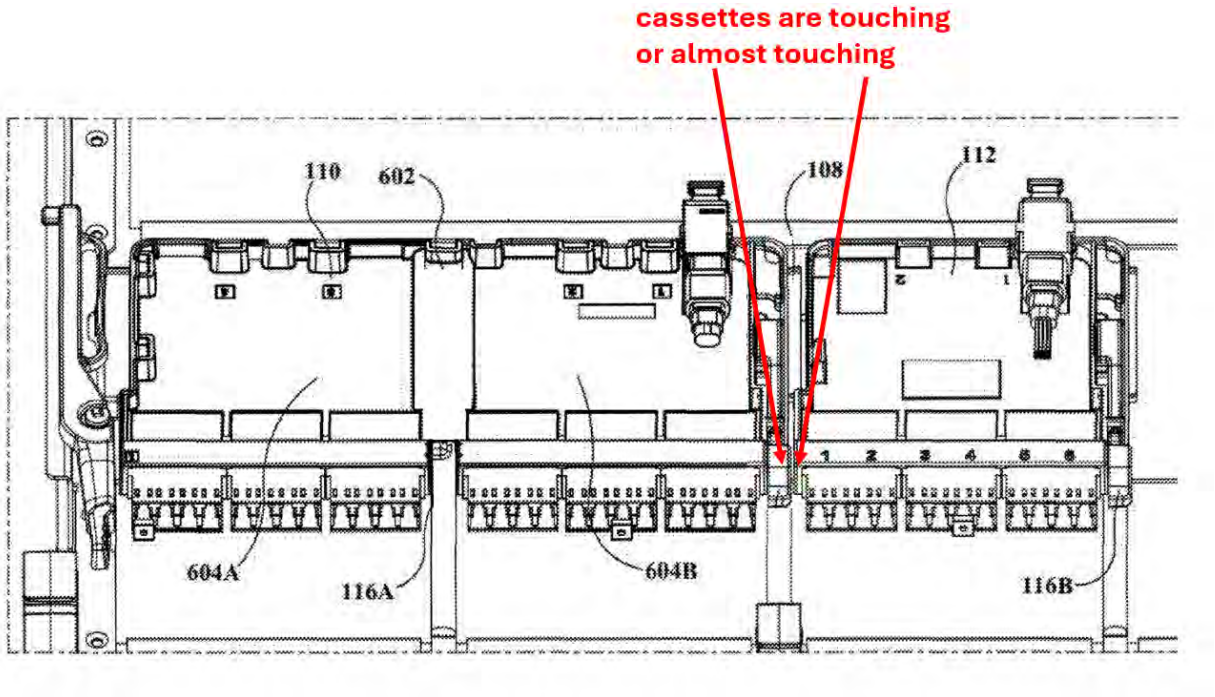


FIG. 15

355. In addition, as I explained above, Sauter teaches to place the latching mechanism of a double-gang cassette on the right side of the cassette, instead of in the middle of the cassette. The resulting modification of Fig. 7 figure would look like this in which the right side of the double-gang cassette is touching or almost touching the single-gang cassette:



356. Each cassette size in the contemplated cassette configurations recited in the independent claims would have this same relationship to its neighboring cassette because each cassette size uses the same latching mechanism to mount to the tray.

357. Even if there is a tiny gap (that cannot be seen) between the cassettes when mounted on the tray as shown for example, in Fig. 15, then it would have been obvious based on Sauter alone to modify Sauter's cassettes so that they touch.

This is, at most, an insignificant modification to Sauter. Any such gap is already so small it is not even visible in Fig. 15. Sauter never discusses much less assigns any significance to there being a tiny gap between the cassettes shown in Fig. 15. A POSITA could easily make this modification (to the extent any modification is even needed) by simply making the cassettes a tiny amount wider or making the pitch of the fastening features on the tray a tiny amount narrower.

358. Motivation. A POSITA would have been motivated to make the cassettes touch for multiple reasons:

359. First, a POSITA would have been motivated to make the cassette sides touch when installed on the tray to aid in aligning cassettes as they are being installed. Each new cassette could be properly positioned by bringing the cassette into contact with the side of an already installed cassette and then sliding the cassette backward into place. It would provide a convenient, easy, and intuitive registration feature. Allowing the cassettes to touch would aid in quickly positioning each new cassette on the tray.

360. Second, a POSITA would have been motivated to make the cassettes wide enough to touch to provide for additional or stronger cassette components. The additional lateral size would allow features of the cassettes to be made stronger without sacrificing internal dimensions of the cassettes. For example, the

additional width could be used by incorporating slightly thicker outer walls of the cassette to make them more resistant to accidental damage when handling.

361. Reasonable expectation of success. A POSITA would have a reasonable expectation of success. At most, this is an insignificant modification. A POSITA could easily achieve this modification by adjusting the thickness of the side walls of the cassette or adjusting the dimension of the overall cassette by a very small amount, or narrowing the spacing of the fastening elements on the tray. Further, it was already known in the art to make adjacent cassettes touch. See, e.g., EX1026 (Translation of NL2008155) at 3:4-9 ("…the housings of two adjacent patch cassettes are contiguous, meaning they extend adjacent to each other without significant or even no clearance. Thus, a rigid assembly is achieved."), Figs. 5 (showing adjacent cassettes touch); EX1010 at Figs. 3-4 (showing adjacent cassettes touch); EX1004 at Fig. 8, 7:46-51.

J. Dependent Claims 8, 16, 26, 27

8. The tray of claim 1, wherein the tray has a first tray end portion, a second tray end portion spaced away from the first tray end portion so as to define a tray width extending between the first tray end portion and the second tray end portion, and wherein the tray width is configured to fit at least twelve standard one width (1 W) units side by side along the tray width.

16. The tray of claim 9, wherein the tray has first tray end portion, a second tray end portion spaced away from the first tray end portion so as to define a tray width extending between the first tray end portion and the second tray end portion, and wherein the tray width is

configured to support at least twelve standard one width (1 W) units side by side along the tray.

26. The tray member of claim 17, wherein the tray member has a tray member width that is configured to support at least twelve standard one width (1 W) units side by side along a row.

27. The tray member of claim 17, wherein the tray member has first tray member end portion, a second tray member end portion spaced away from the first tray member end portion so as to define a tray member width extending between the first tray member end portion and the second tray member end portion, and wherein the tray member width is configured to support at least twelve standard one width (1 W) units side by side along the tray member.

362. Sauter teaches to configure the tray to fit at least twelve standard width units side by side in a row along the width of the tray or the width of the tray member. Sauter's tray has a width dimensioned to receive at least twelve standard width units (1W) side by side. Where the standard width unit is one third of the width of a single-gang cassette as discussed above for Element 1E, then as shown, for example, in Fig. 15, the trays are wide enough to accommodate four single-gang cassettes (each single gang cassette accommodating 3 quad LC adapter modules). Four cassettes times 3 standard width units per cassette results in a tray that is dimensioned to receive at least 12 standard width units side by side in a row.

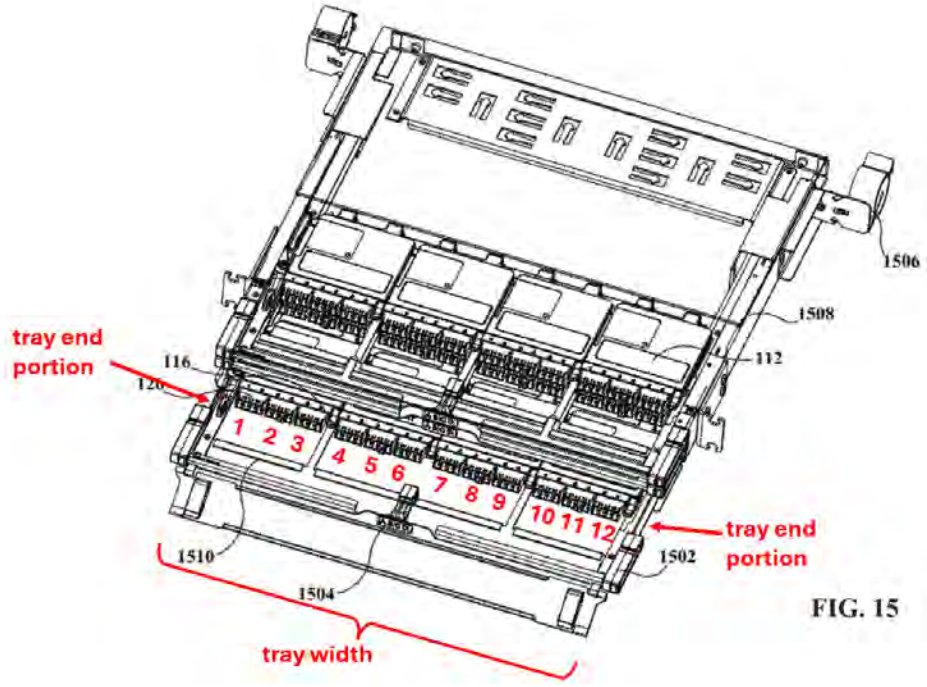


FIG. 15

See also Figs. 2 and 3, annotated below:

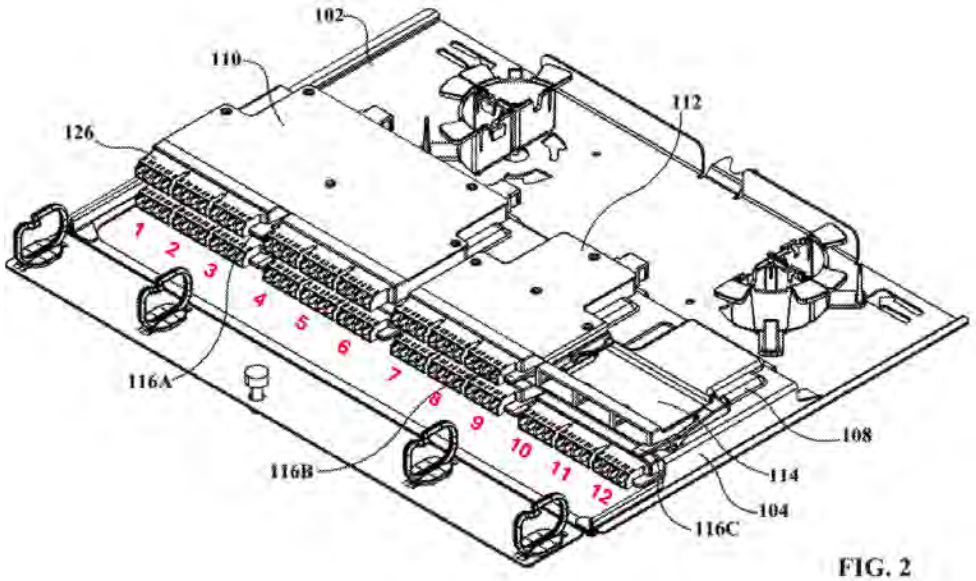


FIG. 2

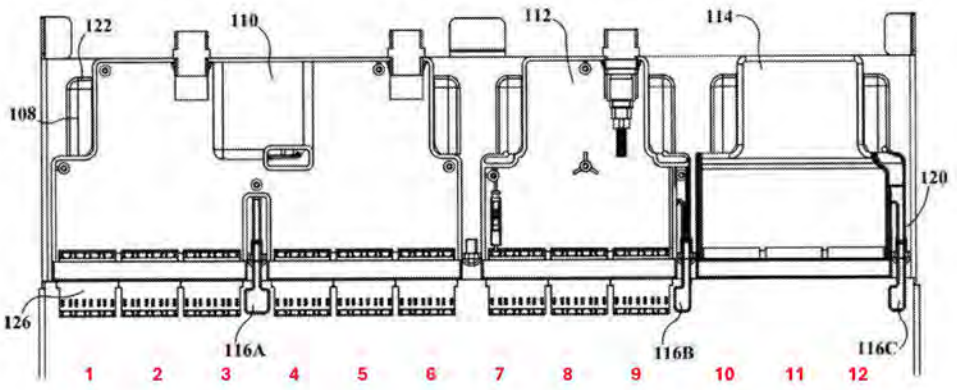


FIG. 3

K. Dependent Claim 20

20. The tray member of claim 19, wherein the row of cassette engaging portions comprises a first row of cassette engaging portions, and the tray includes a second row of cassette engaging portions that is spaced away from the first row of cassette engaging portions.

363. Sauter teaches the limitations of claim 20 because both the row of apertures and the row of rail guides on the tray are "cassette engaging portions." Both the rail guides and the locking apertures engage the cassettes. The rail guides engage at least the rails of the cassettes, and the apertures 124 engage the locking mechanism of the cassettes (e.g., locking protrusion 1006). The rail guides are arranged in a row, and the apertures are arranged in a similar corresponding row but are located farther forward on the tray and spaced away from the rail guides. See, e.g., Figs. 5 and 1 of Sauter.

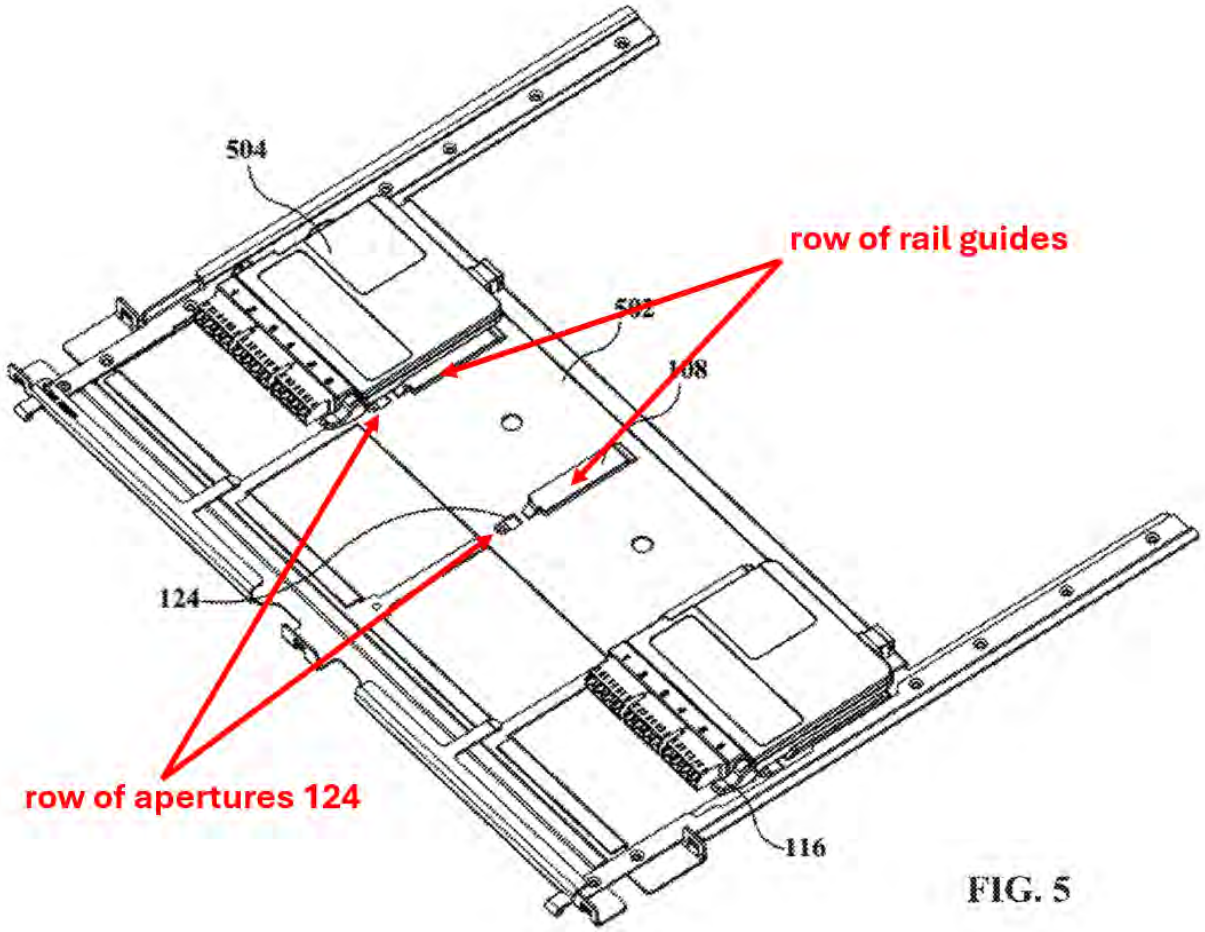

504
row of rail guides
502
108
124
row of apertures 124
116

FIG. 5

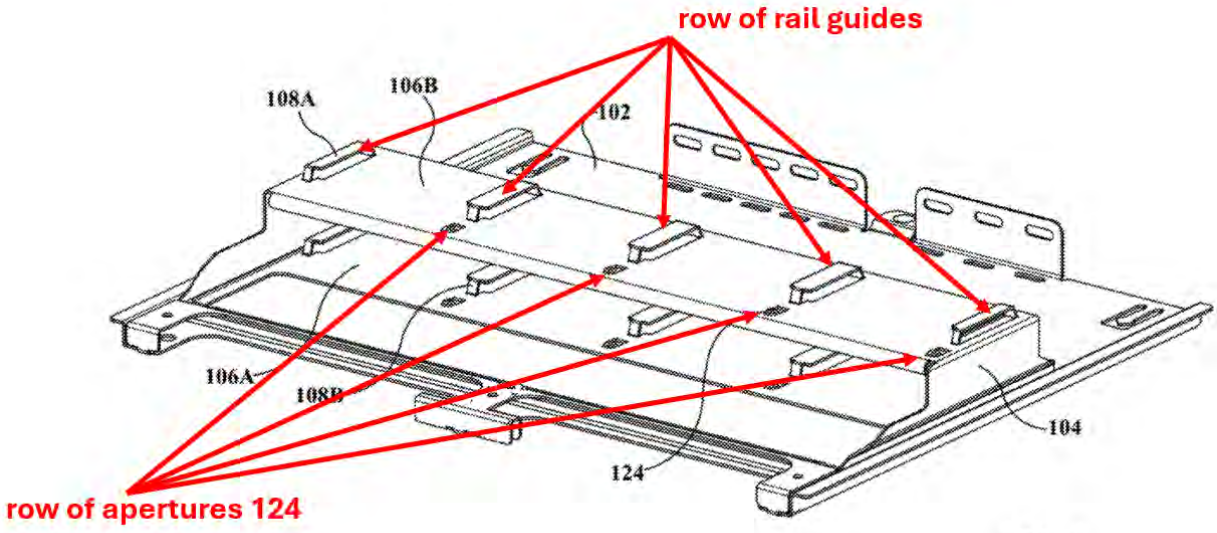

row of rail guides
108A
106B
102
106A
108B
104
124
row of apertures 124

FIG. 1

L. Dependent Claim 21

21. The tray member of claim 20, wherein the first row of cassette engaging portion comprises a first row of slot portions that are each configured to engage a tab portion of each modular cassette.

364. The apertures on Sauter's tray are a first row of cassette engaging portions. The apertures define a row of slot portions. As seen, for example, in Figs. 5, 1, 4, 13, 14, and 16 of Sauter, the apertures include slots formed in the surface of the tray. Figures 12 and 14 show that the cassettes include protrusions (1006) on the latching mechanisms of Sauter's cassettes are a "tab portion." The protrusion 1006 of the cassette fit into the apertures to help secure the cassette in place on the tray.

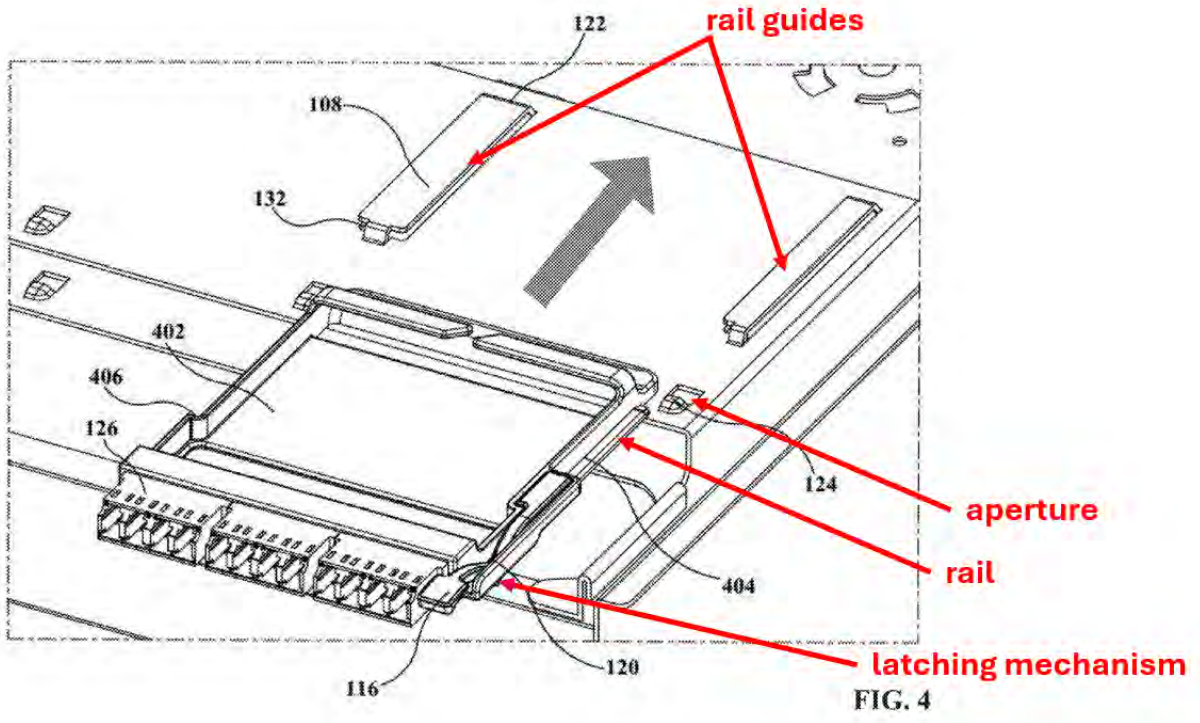


FIG. 4

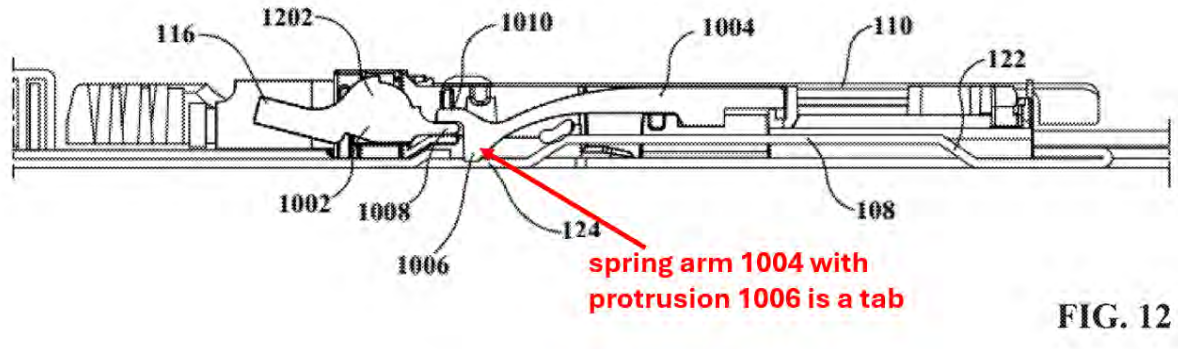


FIG. 12

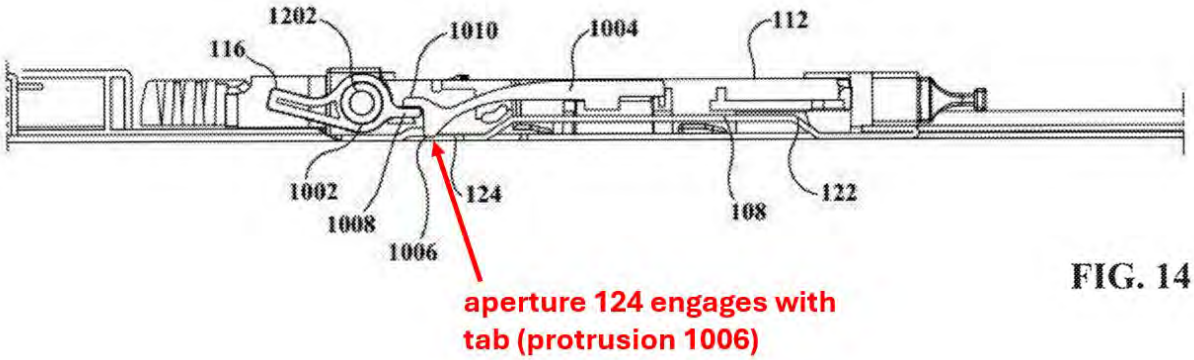


FIG. 14

See, EX1006 at 8:39-49:

> Spring 1004 includes a locking **protrusion 1006** on the bottom of the front end of the spring 1004 configured **to engage with an aperture 124** disposed on the mounting surface of the cassette tray near a rail guide 108 (see FIGS. 1, 4, 5 for views of apertures 124), thereby locking the cassette in place on the tray when installed (see, e.g., FIG. 4 and the associated description above). Release mechanism 1002 includes the release latch 116 that facilitates disengagement of the locking protrusion 1006 from the aperture and removal of the cassette through the front of the tray.

M. Dependent Claim 28

28. The tray member of claim 17, wherein each of the modular fiber optic cassettes comprises a multi-fiber connector receiving receptacle portion arranged on a rear portion thereof.

365. Sauter discloses that his cassettes include an interfacing connector 130 at the rear of the cassettes in a connector receptacle which is a multi-fiber

connector receiving receptacle portion. See, for example, EX1006 at 8:4-28 and Figs. 10, 7, 6, 13:

> As shown in FIG. 6 (as well as FIGS. 2-5), each cassette is configured to hold a horizontal row of fiber optic adapters 126 along the front edge of the cassette. Each adapter 126 is configured to receive multiple fiber optic connectors (dust caps 128 of which are shown in FIG. 6), which may be used to terminate respective optical fibers to be plugged into the adapters 126. **An interfacing connector 130 is disposed on the rear side of the cassette 110**. **Individual fibers 606 of a fiber optic cable entering the cassette through the interfacing connector 130 can be broken out inside the cassette and terminated on the rear sides of fiber optic adapters 126** (in the case of adapter plates, unbundled individual fibers—rather than a fiber optic cable—may enter through the rear of the adapter plate). The adapters 126 provide connectivity between the fibers 606 terminated on the rear sides of adapters 126 and the fibers terminated on the front sides of adapters 126 using the fiber optic connectors. Although FIG. 6 depicts adapters 126 that are configured to receive Lucent connectors (LC connectors), cassettes that accommodate other fiber optic connector types are also within the scope of one or more embodiments described herein. In various embodiments, the fiber optic cassettes can be configured to accept single-fiber connectors (e.g., LC, Standard Connector, etc.) and multi-fiber connectors (e.g., mechanical transfer pull-off, multi-fiber push-on, etc.).

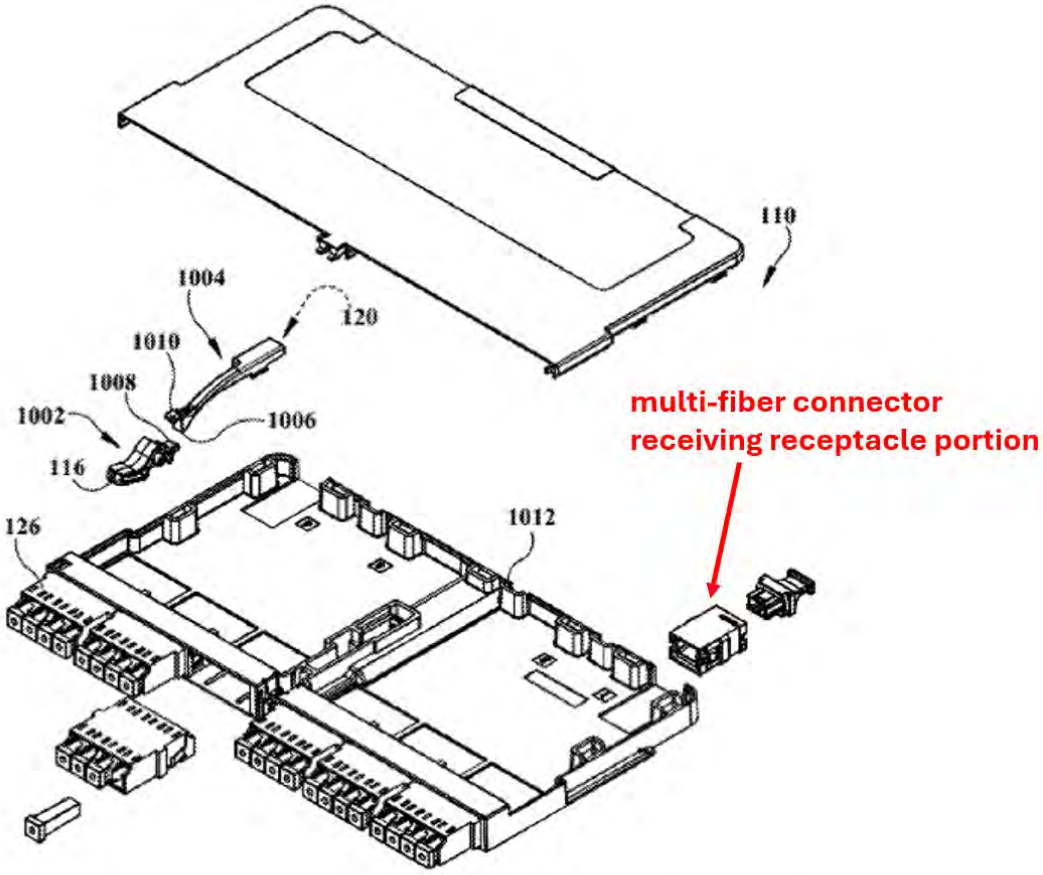

110
1004
120
1010
1008
1002
1006
116
126
1012
multi-fiber connector
receiving receptacle portion

FIG. 10

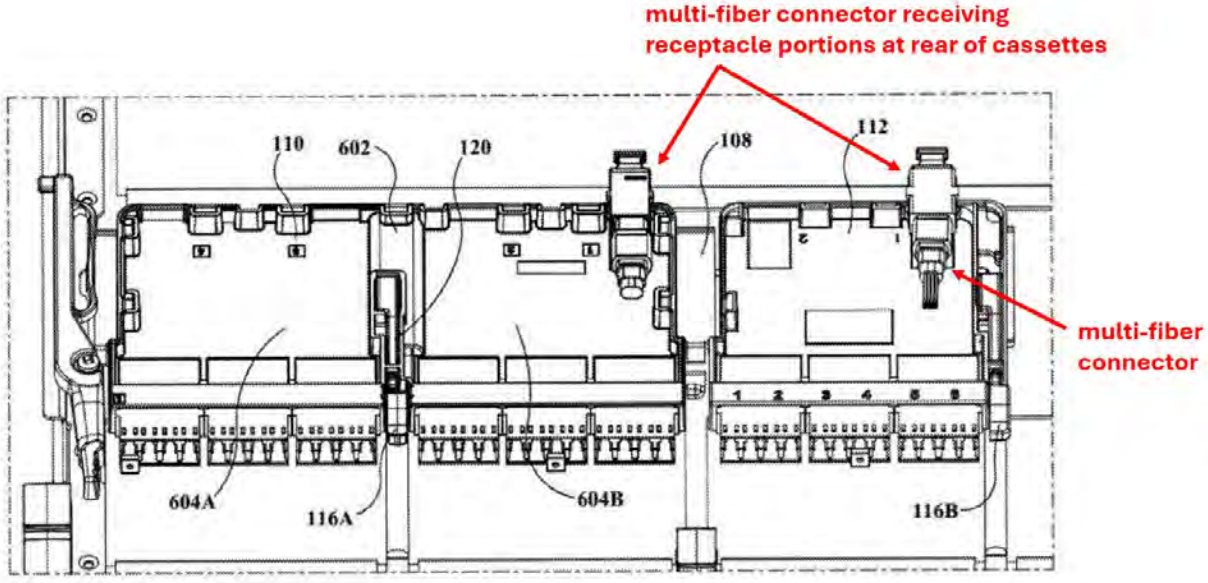

multi-fiber connector receiving
receptacle portions at rear of cassettes
110
602
120
108
112
multi-fiber
connector
604A
116A
604B
116B

FIG. 7

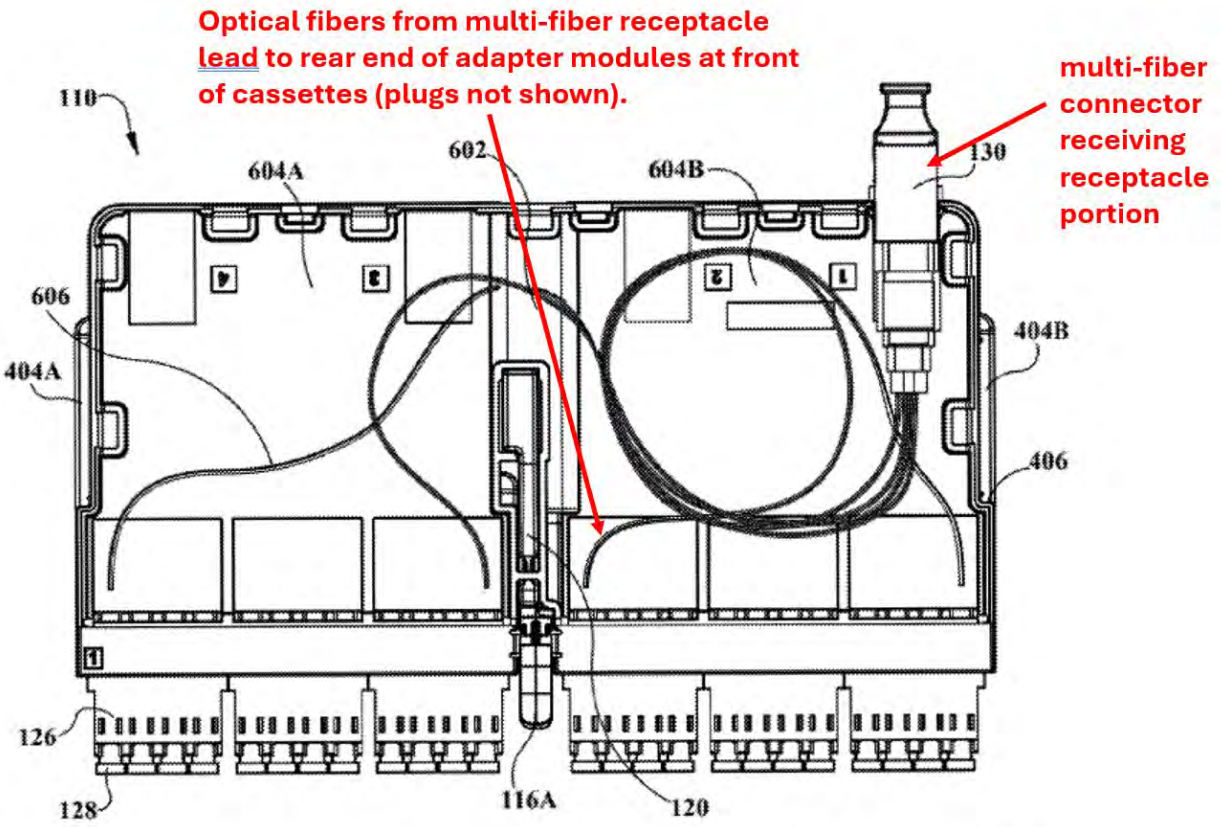


FIG. 6

N. Dependent Claim 29

29. The tray member of claim 17, wherein each of the modules fiber optic cassettes comprises four fiber optic plug receiving receptacle portions configured to be arranged side by side in a row along a front portion thereof for each standard width (1 W) unit.

366. Sauter's cassettes include quad LC adapter modules along a front of each cassette. Each quad LC adapter module includes four fiber optic plug receiving receptacles arranged side by side in a row, and there is one quad adapter module in a cassette for each standard width unit of the cassette. For example, the single-gang cassette (which is three standard width units wide) includes three quad LC adapter modules arranged side by side. In addition, the double-gang cassette

(which is six standard width units wide) includes six quad LC adapter modules. See EX1006 at Figs. 7, 10, 13 and 8:4-36 ("each cassette is configured to hold a horizontal row of fiber optic adapters 126 along the front edge of the cassette. Each adapter 126 is configured to receive multiple fiber optic connectors…which may be used to terminate respective optical fibers to be plugged into the adapters 126."):

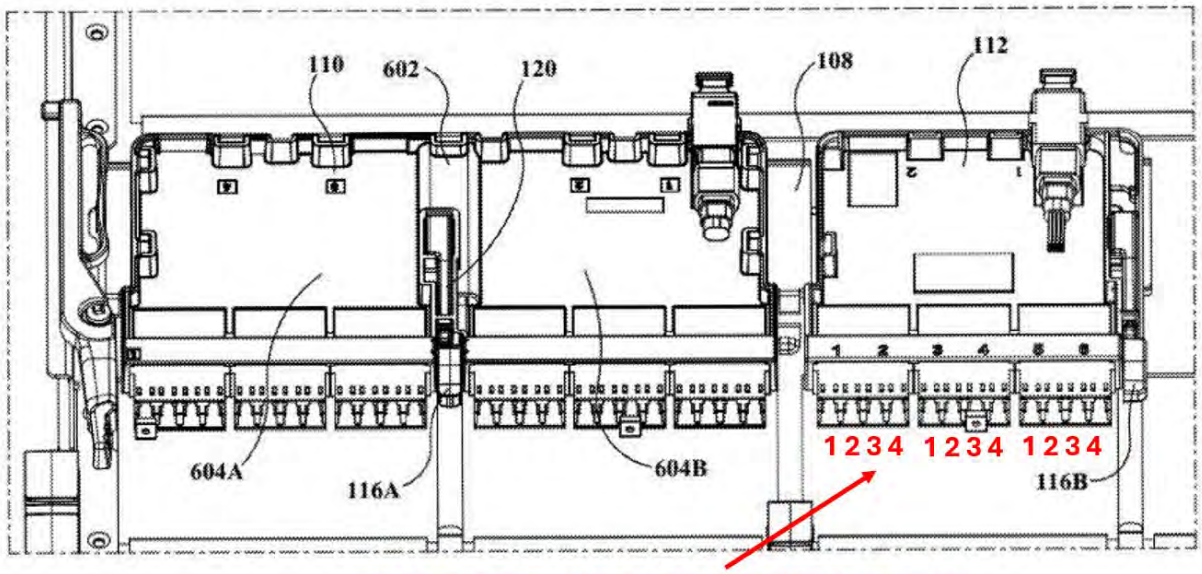


FIG. 7

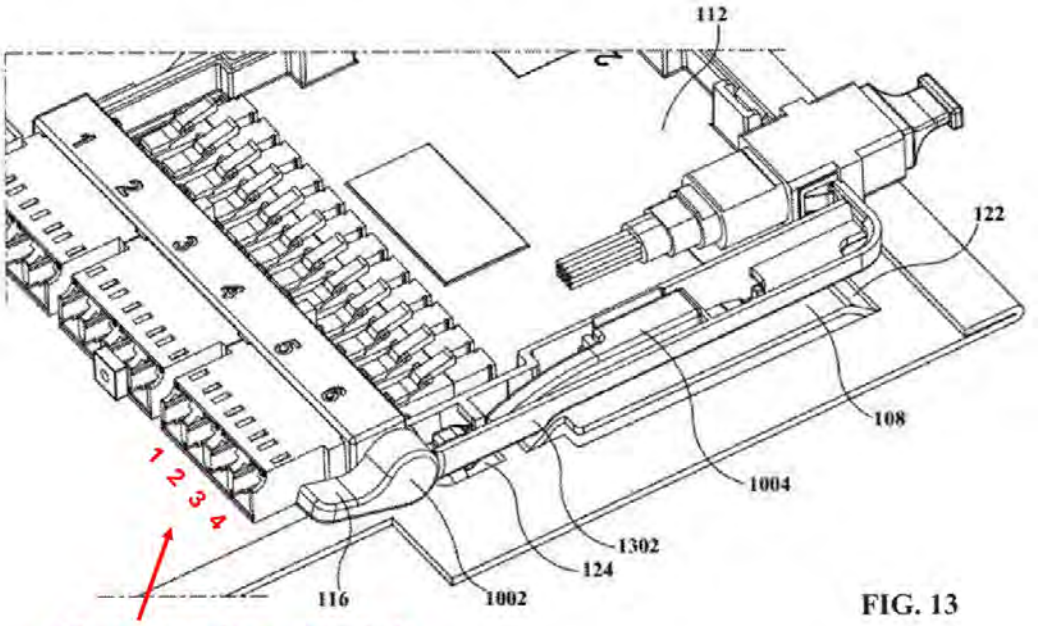
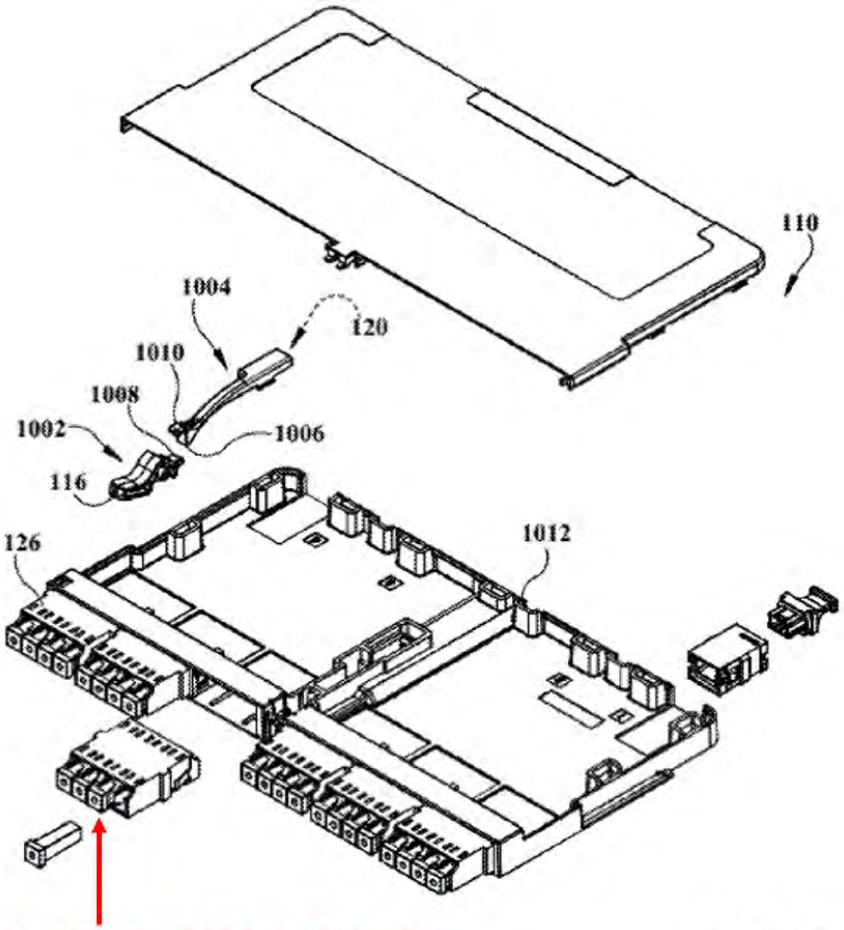


FIG. 13

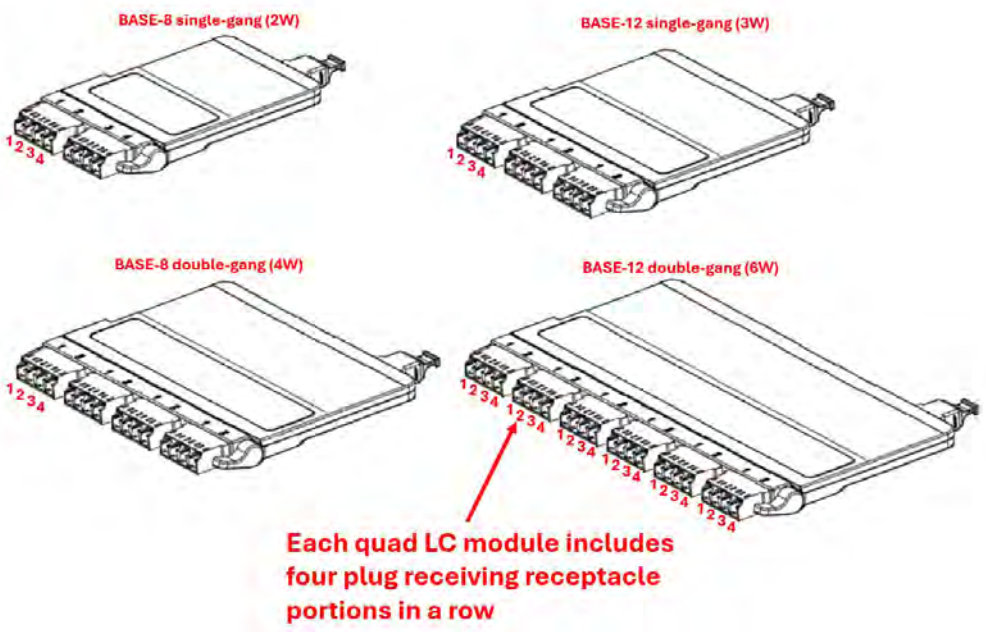
Adapter modules each include four plug receiving receptacles side by side.



Adapter modules each include four plug receiving receptacles side by side.

FIG. 10

367. The same is true for the cassettes when modified to support both BASE-8 and BASE-12 systems.



O. Dependent Claim 30

30. The tray member of claim 17, wherein the tray member comprises a cassette fastening portion that is configured to removably secure the tray member to each modular fiber optic cassette.

368. Sauter's trays are configured with apertures 124 and rail guides 108 that form a cassette fastening portion that is configured to removably secure the tray to each cassette. The rail guides and apertures on the tray cooperate with the latching mechanism 120 and rails 404 on the cassettes to removably secure Sauter's trays to the cassettes. The latching mechanism is described for example in the passages below as locking the cassettes in place when installed on the tray.

The cassettes and adapter plates include integrated **latching mechanisms 120 that lock the cassettes and adapter plates in place**

> **on the mounting interface when fully installed on the tray.** For example, adapter plate 402 reaches the stopping position (e.g., when the notches 406 of the rails 404 engage with the front-facing end 132 of the rail guides), a locking protrusion of the latching mechanism 120 engages with an aperture 124 on the mounting surface (see also FIG. 1 for another view of the relative locations of the apertures 124 relative to the rail guides). Thus, when the adapter plate 402 is fully installed and locked into position, the rail guides 108 prevent rearward and sideways movement of the adapter plate 402, while the locking tab of latching mechanism 120 prevents forward and rearward movement of the adapter plate 402. The cassettes of the present cassette mounting system—both single-gang and multi-gang—include similar integrated latching mechanisms 120. Although the illustrations depict the integrated latching mechanism as comprising a locking protrusion that interfaces with an aperture 124, some embodiments of the cassette system may include other types of latching mechanisms without departing from the scope of this disclosure.

EX1006 at 5:60-6:14; see also Figs. 1-2, 5-8, 10-11, 13-14, 16.

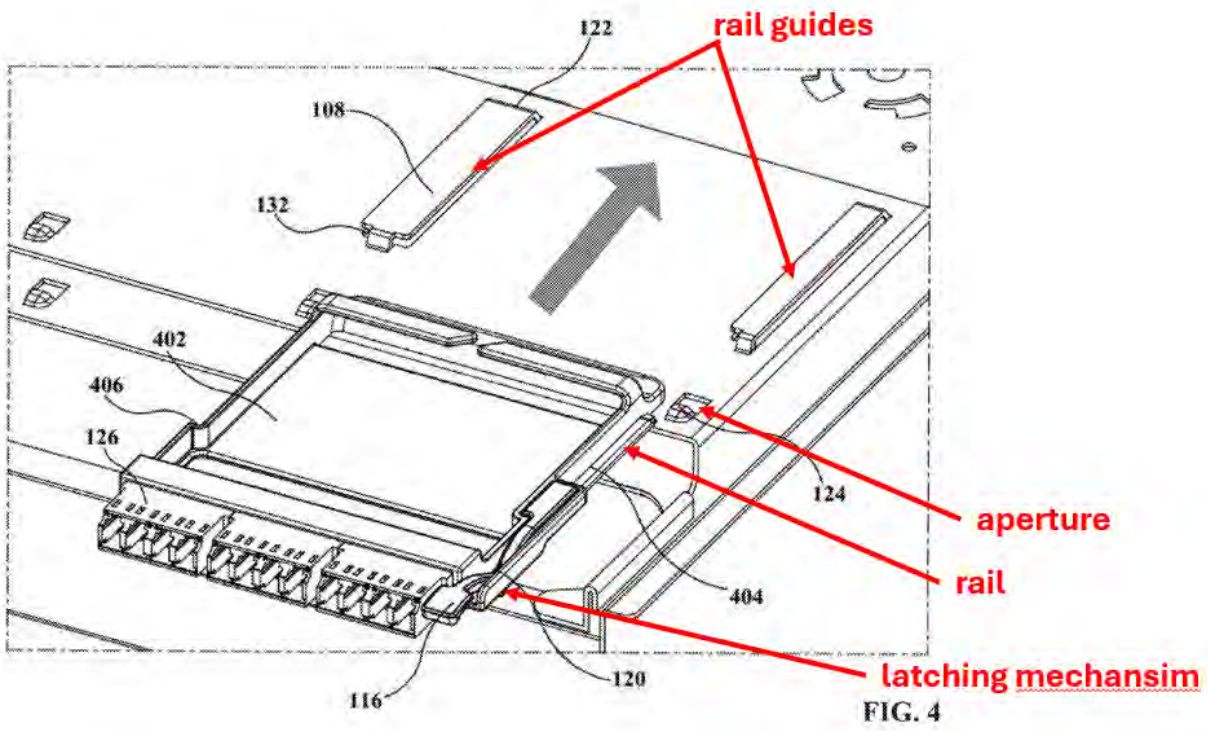


FIG. 4

369. Sauter explains that the latching mechanism makes the cassettes removable:

> The latching mechanisms 120 include front-facing **release latches 116**. Actuating the release latch 116 disengages the locking protrusion of the latching mechanism 120 from the mounting surface and unlocks the adapter plate 402 or cassette, **allowing the adapter plate 402 or cassette to be removed** through the front of the tray 102. As shown in FIGS. 2 and 3, single-gang cassette 112 and adapter plate 114 include release latches 116B and 116C located on the right side of their respective housings, while double-gang cassette 110 includes a release latch 116A located in a middle section between the two gangs of the cassette. Each release latch 116 is accessible from the front of the tray, allowing the user to easily access the release latch from the front.

EX1006 at 6:15-29.

370. Sauter explains that the cassettes include rails 404 along their sides that slide underneath rail guides 108 on the tray. EX1006 at 4:4-11; 4:46-50; Figs. 4, 5, 10, 11 and 12. A locking protrusion 1006 of the latching mechanism falls into aperture 124 in the tray when the cassette reaches its fully inserted position on the tray:

> A spring-loaded latching mechanism integrated in the cassette housing includes a latching tab or **protrusion that engages with an aperture on the tray when the cassette is fully engaged with the rail guides**. The latching mechanism includes a front-facing release latch that, when actuated, disengages the latching tab from the aperture, allowing the cassettes to be removed through the front of the tray. The latching tab comprises the sole locking point between the cassette and the tray, and thus the cassette can be unlocked for removal from the tray by actuating a single release latch that is easily accessible from the front of the tray (or from the front of the enclosure in which the tray is disposed).

EX1006 at 4:13-25; 8:63-66 ("…as the cassette is being inserted between a pair of rail guides 108, **locking protrusion 1006 will be received by aperture 124** when the cassette reaches the stopping position."); see also 4:61-67:

> In one or more embodiments, each cassette bay 106 has an associated locking aperture 124 disposed on the mounting surface near one of the guide rails. As will be described in more detail below, **the locking aperture 124 is configured to receive a spring-loaded locking protrusion built into the cassette to facilitate locking the cassette in place within the cassette bay 106**.

371. Sauter explains in the paragraph starting at 9:3 that the latching mechanism includes a release latch 116 which may be a button or lever lifts the locking protrusion clear of the aperture 124 to remove the cassette from the tray. EX1006 at 9:3-27; see also 6:16-29; 7:47-60; 8:37-49; and 9:63-10:3:

> As described in previous examples, each cassette 112 has an integrated latching mechanism, where each latching mechanism includes a release latch 116 facing toward the front of the tray 1510. This configuration allows a user to easily access and actuate the release latch 116 from the front of the enclosure 1508, thereby **unlocking the cassette and allowing the cassette to be removed through the front of the tray 1510.**

VIII. Ground 4: Sauter combined with Dagley in further light of Fukui renders claims 1-30 obvious

A. Dependent Claims 5, 13, 23 "directly adjacent"

372. If it is argued that the combination of Sauter and Dagley fails to render these claims obvious because it is asserted that Sauter's cassette side end portions are not "directly adjacent" as recited in claims 5, 13 and 23 then Sauter combined with Dagley in further light of Fukui (EX1004) also renders these claims

obvious. That is, Patent Owner may attempt to argue that Sauter's method for removably securing the cassettes to the tray does not result in the cassette side end portions being "directly adjacent." Patent Owner may, for example, point to Sauter's rail guides on the trays that engage rails along the sides of Sauter's cassettes and argue that the presence of these elements, like the rails on the trays of the Sedor reference (EX1005) discussed during prosecution of the parent '524 patent, prevent any outer side edges or side edge portions of the cassettes from being "directly adjacent" when the cassettes are mounted on the tray. Nevertheless, it would have been obvious to use the cassette fastening features from Fukui on Sauter's cassettes to eliminate the need for any rail guides on Sauter's tray.

373. Fukui shows that fiber optic cassettes of varying widths can be secured to a tray without the need for rails or rail guides on the tray. Fukui shows that cassettes (called modules 10, 20 in Fukui) can be releasably secured to a tray using hooks that protrude from the bottom face of the cassette housing. EX1004 at 8:52-56:

> Two holes 33 a and 33 b are provided to each of these areas 32, and **two hooks 11 i and 11 j (see FIG. 2)** protruding from the bottom face of the housing 11 of each conversion module 10 engage with these holes 33 a and 33 b such that each conversion module 10 is easily fixed to the base member 30.

The hooks can be seen in Fig. 2 of Fukui, shown below:

Fig.2

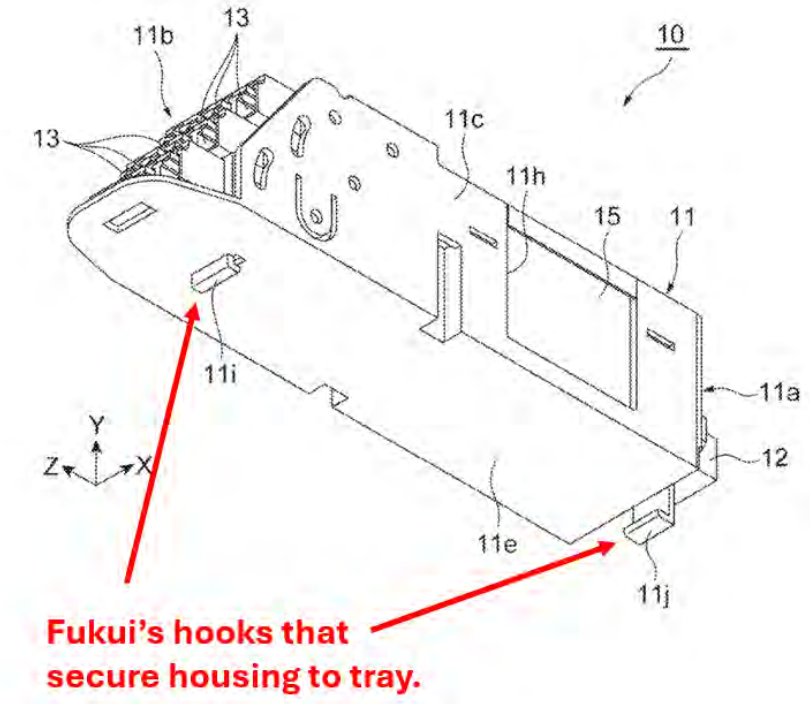
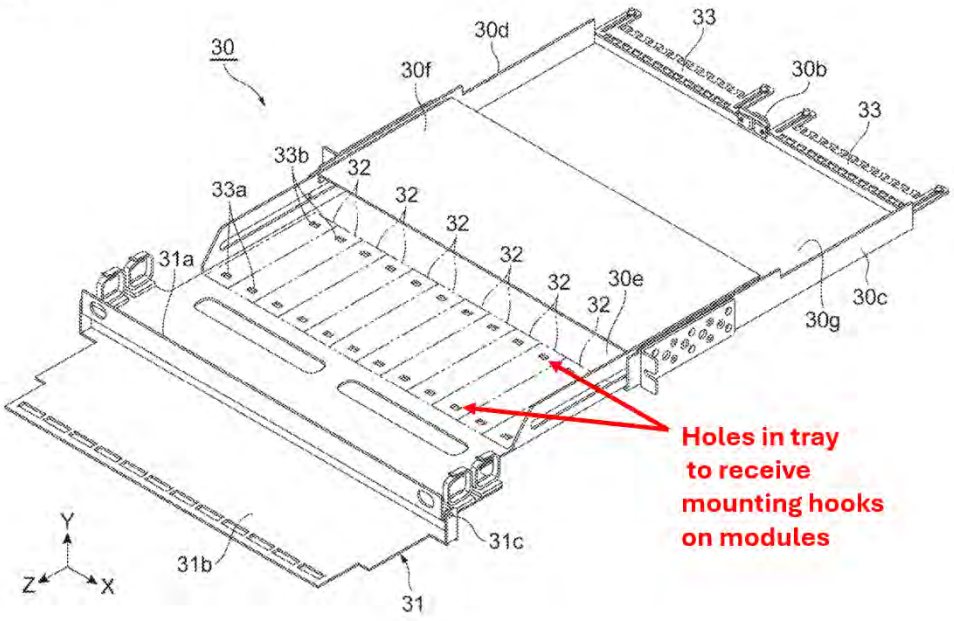


Fig. 9 of Fukui shows that the tray includes corresponding holes to receive the hooks to secure the fiber optic modules to the tray:

Fig.9



374. It is significant that the examiner did not consider Fukui during prosecution of the '422 patent or any of its parent patents (e.g., the '107 or '542 patents). In fact, the examiner appears to have believed that there was no alternative to the use of rails on the trays for mounting the cassettes. During prosecution of the great grandparent '107 patent, the examiner stated that the rails on the tray in Sedor were "essential" and "necessary" to affix modules to the tray:

> Each of these essential rails are positioned between adjacent ones of the modules, and therefore Sedor et al fails to disclose the *highlighted* portion of the claims. Moreover, one of ordinary skill would not have been motivated to remove the rails in Sedor et al… as the rails are necessary to affix the modules to the tray.

EX1007 (File History of '107 Patent at Notice of Allowability, 5/19/2020, p. 3). The examiner, apparently, was not aware that Fukui taught an alternative

method for affixing fiber optic modular cassettes to trays that did not require the use of rails on the trays.

375. One of skill in the art would have been motivated to use the mounting technique taught by Fukui (hooks underneath the cassette housings that match corresponding mounting holes on the tray) on Sauter's cassettes for multiple reasons. First, eliminating the space occupied by the rail and latching mechanism would allow the cassettes to occupy less space in the width dimension. For example, each cassette could be made narrower by eliminating the portion devoted to the rails/latch mechanism and instead using hooks underneath the cassettes to secure the cassettes to the tray.

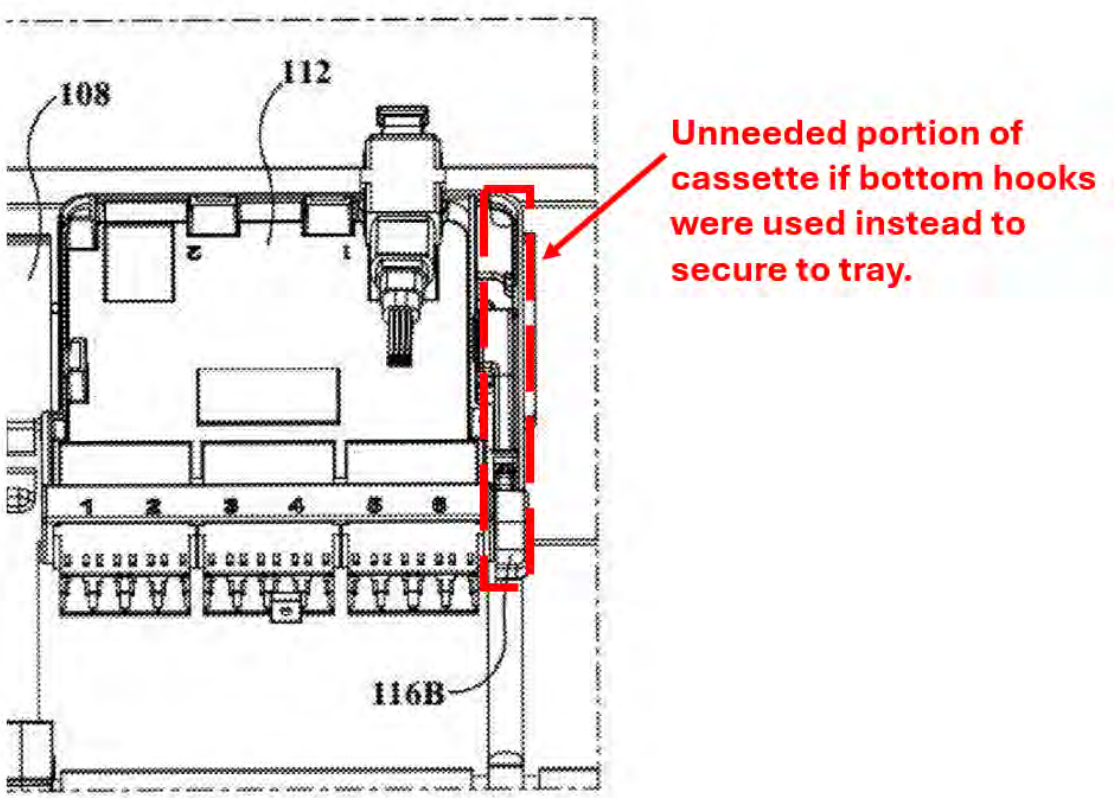


FIG. 7

More available space creates the possibility to fit more components within the same panel. Second, making this modification would also free up additional space within Sauter's cassettes. Sauter's use of rail guides on the tray requires Sauter to sacrifice interior space within each multi-gang cassette to create a "clearance area 602" that spans over intermediate rail guides on the tray. See EX1006 at Fig. 8, 7:19-28:

> This intermediate rail guide 108D is located underneath a middle portion of the cassette 110 corresponding to the joint area between the two gangs 604A and 604B. In order to accommodate this intermediate rail guide 108D, a clearance area 602—such as a slot or raised area—

> is formed along the bottom surface of the cassette 110 between the two gangs 604A and 604B. This clearance area 602 allows the intermediate rail guide 108D to pass underneath the cassette 110 when the cassette is installed on the mounting surface.

By contrast, Fukui's hook approach does not need to sacrifice internal space inside the cassettes to create clearance for any raised features on the tray. Fukui's approach, therefore, makes it easier to mount cassettes of different widths because Fukui's approach does not need to design clearance areas into the cassettes. This additional space could be used for additional flexibility and options for housing fiber optic components inside the cassettes such as splitters, connectors, splices, and fiber management guides. Third, even if the same number of connections is provided for, making the cassettes occupy less space can relax the bending requirements on fibers closest to the sides of the tray. Fibers that connect to the front of the cassettes need to be bent toward the sides to be routed into channels that typically run along the sides of a rack. Mounting narrower cassettes side-by-side in the middle of the tray means the fiber connection locations closest to the sides of the tray will actually be adjusted toward the middle of the tray and thus have more room to bend 90 degrees toward the sides. The radius of this curvature will be relaxed, protecting fibers from the risk of bending beyond their minimum bend radius.

376. One of skill in the art would be further motivated to make this modification based on the similarity in the cassette design approach of Sauter and

Fukui. Both references identify that it would be advantageous to make cassettes or modules of different widths to accommodate different numbers of fibers being routed to the cassettes. Both references recognize that it would be advantageous to allow the different sized cassettes/modules to be mounted in the same tray. Both references also teach to accommodate this, it would be advantageous to make the larger cassette sizes by multiples of a smaller cassette size. (Sauter calls these "double-gang" or "triple-gang" cassettes. Fukui creates these multiples by coupling together multiple single modules.) That both systems are providing for cassettes of multiple sizes, each having a width that is a multiple of a smaller sized cassette, would have motivated one of skill in the art following Sauter to look also to Fukui's features for mounting the cassettes to the tray.

377. One of skill in the art would have a reasonable expectation of success making this design change to Sauter's cassettes. Sauter's technique already relies on holes/apertures in the tray that receive tabs on the cassettes when mounting the cassettes to the tray. The holes in Sauter's trays are called "locking apertures 124" that receive protrusions 1006 on the cassettes. See EX1006 at Figs. 4, 12, 14, 1.

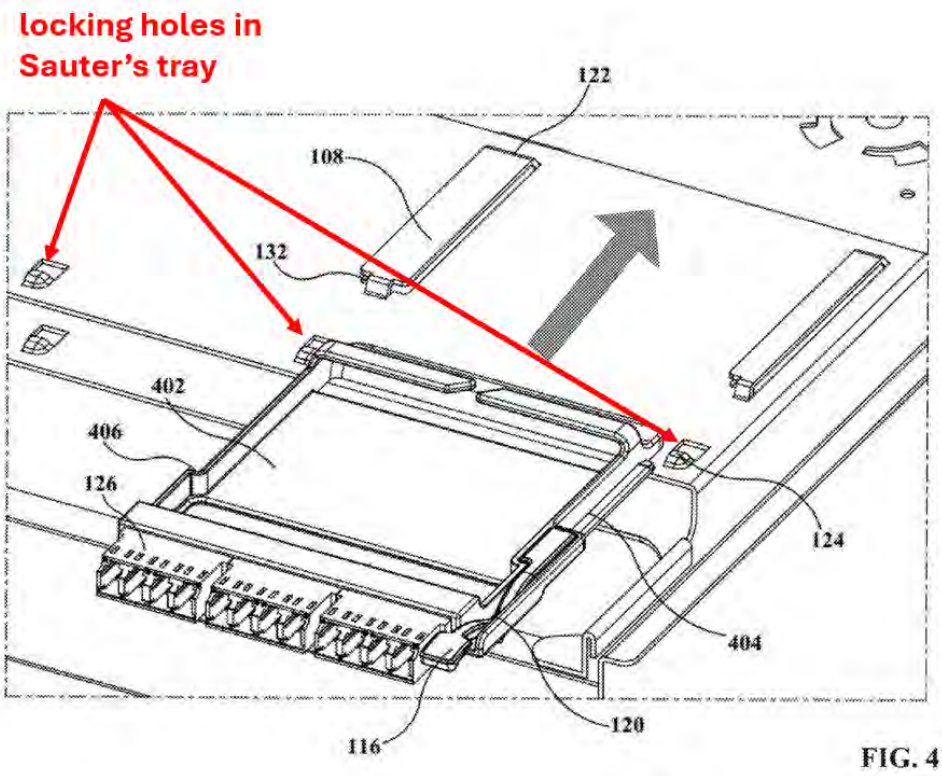


FIG. 4

That Sauter already relied in part on holes formed in the tray to mount the cassettes demonstrates one of ordinary skill in the art would have had a reasonable expectation of success in making holes as taught by Fukui to secure the cassettes with hooks under each cassette.

378. When using Fukui's hook features to mount Sauter's cassettes to the tray, there would no longer be any intervening structure at all between cassettes. The outer side edges of adjacent cassettes would be "directly adjacent" because there would no longer be any rail guides on Sauter's tray.

379. With this modification, the structures that correspond to the following claim limitations would be found in the hooks and matching apertures that are

taught in Fukui, instead of the rail guides and cassette rails taught in Sauter. In this combination, for example, the following claim elements would be found in the hooks and the matching apertures in the tray for all the reasons provided above in my analysis of Fukui:

i. In Elements 1J and 9F, the tray would be configured to be removably secured to each cassette via the Fukui hooks and matching pattern of apertures in the tray;

ii. In Elements 1K, 9G, 17F and Claims 3, 11, 19, the cassette engaging portions on the tray spaced to conform to the 1W width would be the two row pattern of apertures taught by Fukui that engage corresponding hooks on the bottom of the cassettes;

iii. In Claim 20, the first and second rows of cassette engaging portions would be the two rows of apertures in the tray as taught by Fukui that receive and engage the hooks;

iv. In Claim 21, the slot and tab would be the apertures in the tray and the hooks on the cassettes respectively that are taught by Fukui;

v. In Claim 30, the cassette fastening portion would be the apertures in the tray that engage with the corresponding hooks taught by Fukui.

Therefore I incorporate my analysis of these claim terms from my discussion above relating to Fukui.

B. Cassette Size Limitations in Independent Claims 1, 9, 17

380. If Patent Owner argues that Sauter's cassettes, either as disclosed or as modified to support BASE-8 and BASE-12 system, do not satisfy the size limitations of the claims relating to the widths of the different sized cassettes being multiples of a standard width unit (as recited, e.g., in Elements 1F, 9D, and 17D),

then at least the combination of Sauter and Dagley in further light of Fukui renders the claims obvious. Similar to Sauter's "multi-gang" cassettes, Fukui discloses creating larger width fiber optic modules by coupling together multiple smaller modules. This is facilitated by the mounting features (i.e., the hooks and holes) that secure the modules to the tray in Fukui without needing Sauter's side latching mechanism on the cassettes or the rail guides on the tray. It would have been obvious to incorporate the mounting features from Fukui into Sauter's cassettes and tray, and when Fukui's mounting features are used instead of Sauter's rails, rail guides, and latch, the resulting cassettes would be exact multiples in width of the smallest gang cassette.

381. Specifically, Fukui teaches to form a pattern of holes in the tray that have a pitch equal to the width of the smallest module. See Fukui at Fig. 9 (holes 32a and 32b). In this way, when needed, multiple single modules can be coupled together to form one larger module and still mount to the same holes in the tray, and each set of hooks appears on the cassettes at the same relative location as the holes in the tray. Using this mounting technique on Sauter's cassettes instead of Sauter's rail guides and latching features, especially in light of Sauter's teaching to make the "multi-gang" cassettes multiples in width of the "single-gang" cassette, would result in Sauter's cassettes being like Fukui's in that they are exact multiples in width of the smallest "single-gang" cassette, with hooks positioned at locations

underneath the cassettes at the same regular pitch as the holes in the tray for a single-gang cassette. One of ordinary skill in the art would be motivated to make this modification (use Fukui's mounting features instead of rails and rail guides and latch) and would have a reasonable expectation of success doing so for the same reasons discussed above under the "directly adjacent" claim limitation.

IX. Ground 5: Either of Grounds 3 or 4 in further light of Laarveld renders claims 7, 15, and 25 obvious

382. If it is argued that Sauter's description does not disclose or render obvious that the cassette are "touching" each other as recited in dependent claims 7, 15, and 25, it would have been obvious to modify Sauter so that the cassettes touch in light of Laarveld. EX1026. Laarveld discloses fiber optic cassettes much like Sauter's cassettes, that include rows of LC adapters (90) along the front wall that make connections via internal fibers to MPO connection locations at adapters (6) in the back wall of the cassettes.

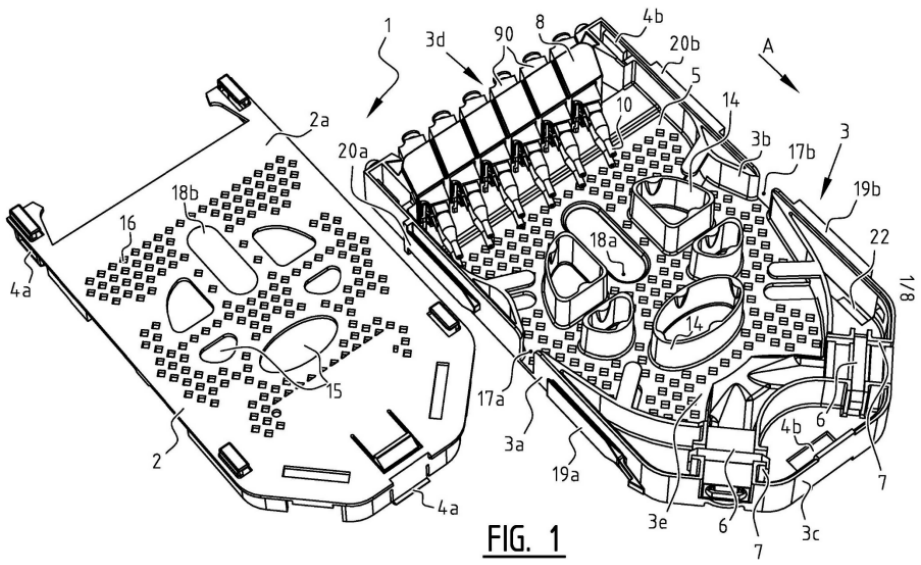


FIG. 1

EX1026, Fig. 1, 10:19-20 ("Figures 1 and 2 schematically show a patch cassette in a disassembled state in perspective;"), 11:18-19 ("Near the front wall 3d, a bracket 8 is provided in which adapters 9, 90 can be clicked."); 11:11-12 ("In the back wall 3c, two holders 7 are provided in which MPO adapters 6 can be slid in the open state as shown in Figures 1 and 2.")

383. Laarveld also discloses that two cassettes can be positioned to touch each other as shown in Fig. 5 so that fiber can transition directly from one cassette to another adjacent cassette via passageways through their adjacent walls.

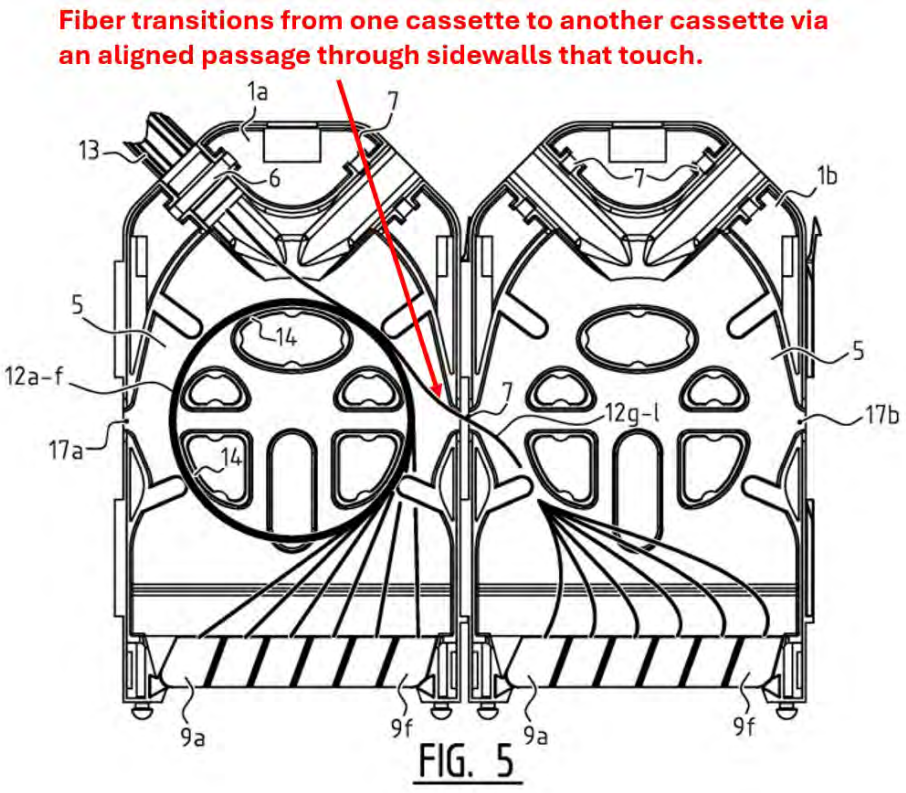


FIG. 5

EX1026 at Fig. 5; 10:28-29 ("Figure 5 schematically shows a top view of an assembly of two cassettes connected side by side") ; 14:23-15:14 ("…the cables 12g-1 from the distribution space 5 of the first cassette la are guided to the distribution space 5 of the second cassette lb via the passage 17. … The cables of a distribution cable can then be distributed both horizontally and vertically across different cassettes…"); 3:4-9 ("The connecting means are preferably located on the housing of the patch cassette and are more preferably designed to interconnect patch cassettes in such a way that the housings of two adjacent patch cassettes are contiguous, meaning they extend adjacent to each other without significant or even no clearance. Thus, a rigid assembly is achieved.").

384. It would have been obvious to modify Sauter's cassettes so that they touch as taught by Laarveld. One of ordinary skill in the art would have been motivated for multiple reasons. A POSITA would be motivated by the same reasons already articulated above in the analysis of Sauter with regard to Claims 7, 15, and 25, i.e., to aid in aligning cassettes as they are being installed and to provide space for additional or stronger cassette components. In addition, Laarveld provides an additional motivation, to permit fibers to transition horizontally from one cassette to another so that fibers entering a first cassette can be routed to adapter locations at the front of an adjacent cassette. Laarveld's adjacent cassettes touch and are coupled together to align passageways through their sidewalls so that when needed, fibers entering the back of one cassette can be routed to another adjacent cassette. This could be particularly useful when a cassette with sufficient connection locations along the front is not available but could be formed by coupling two cassettes together and transitioning some fibers from one cassette to the other. Bringing the cassettes into contact also ensures that a fiber transitioning from one cassette to another will be enclosed and protected, not exposed, as it transitions from one cassette to another.

385. Reasonable expectation of success. A POSITA would have a reasonable expectation of success. At most, this is an insignificant modification. A POSITA could easily achieve this modification by adjusting the thickness of the

side walls of the cassette or adjusting the dimension of the overall cassette by a very small amount, or narrowing the spacing of the fastening elements on the tray and forming a passageway for transitioning fibers. Further, it was already known in the art to make adjacent cassettes touch (see, e.g., EX1010 at Figs. 3-4 (showing adjacent cassettes touch); EX1004 at Fig. 8, 7:46-51) and other had also already taught that cassette modules could be coupled to transition fibers from one cassette to another (see EX1004 Fig. 5, 7:34-8:6).

386. I 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 that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both (under 18 U.S.C. 1001).

Executed on: 29 Aug 2024

Dr. Stephen E. Ralph

Claims Listing Appendix

U.S. Patent No. 11,740,423
Challenged Claims: 1-30

Designation	Claim 1
Preamble	1. A tray for providing a plurality of different modular fiber optic cassette configurations in a standard U-space fiber optic management system comprising:
Element 1A	a tray having a first tray side end portion and a second tray side end portion defining a tray width portion that extends between the first tray side end portion and the second tray side end portion;
Element 1B	wherein the tray width portion fits within a standard U-space width dimension;
Element 1C	wherein the tray is configured to fit a plurality of different modular fiber optic cassette configurations in the tray width portion in a standard U-space fiber management system;
Element 1D	wherein each of the plurality of different modular fiber optic cassette configurations include a modular fiber optic cassette that is configured to support a receptable module having a first module side end portion and a second module side end portion defining a module width portion that extends between the first tray side end portion and second tray side end portion;
Element 1E	wherein the module width portion is configured to fit in a standard one width (1 W) unit;
Element 1F	wherein each of the modular fiber optic cassettes includes a first cassette side end portion and a second cassette side end portion defining a standard cassette width unit extending between the first cassette side end portion and the second cassette side end portion that comprises a standard two width (2 W) unit, a standard three width (3 W) unit, a standard four width (4 W) unit, or a standard a standard six width (6 W) unit relative to the standard one width (1 W) unit;

Element 1G	wherein the receptable module is configured to fit at least four fiber optic plug receiving receptacle portions in a standard one width (1 W) unit;
Element 1H	wherein the plurality of different modular fiber optic cassette configurations comprise: a first modular fiber optic cassette configuration that includes six modular two standard width unit (2 W) cassettes that are each arranged side by side of each other along the tray such that a cassette side end portion of each modular two standard width (2 W) cassette adjacently faces a cassette side end portion of at least one other modular two standard width (2 W) cassette; a second modular fiber optic cassette configuration that includes four modular three standard width unit (3 W) cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of each modular three standard width (3 W) cassette adjacently faces a cassette side end portion of at least one other modular three standard width (3 W) cassette; a third modular fiber optic cassette configuration that includes three modular four standard width unit (4 W) cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of each modular four standard width (4 W) cassette adjacently faces a cassette side end portion of at least one other modular four standard width (4 W) cassette; a fourth modular fiber optic cassette configuration that includes two modular six standard width unit (6 W) cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of one of the two modular six standard width (6 W) cassettes adjacently faces a cassette side end portion of the other modular six standard width (6 W) cassette; and a fifth modular fiber optic cassette configuration that includes three modular two standard width unit (2 W) cassettes, which are each

	arranged side by side of each other in a row along the tray such that a cassette side end portion of one of the three modular two standard width (2 W) cassettes adjacently faces a cassette side end portion of one of the other modular two standard width (2 W) cassette, and one modular six standard width unit (6 W) cassette that is arranged side by side in a row along the tray with one of the three modular two standard width unit (2 W) cassettes, such that a cassette side end portion of the one modular six standard width unit (6 W) cassette adjacently faces a cassette side end portion of one of the other three modular two standard width unit (2 W) cassettes;
Element 1I	wherein each modular two standard width (2 W) cassette is configured to fit two receptacle modules; wherein each modular three standard width (3 W) cassette is configured to fit three receptacle modules; wherein each modular four standard width (4 W) cassette is configured to fit four receptacle modules; wherein each modular six standard width (6 W) cassette is configured to fit six receptacle modules;
Element 1J	wherein the tray is configured to be removably secured to each modular fiber optic cassette when the tray fits the plurality of different modular fiber optic cassette configurations within the tray width portion in the standard U-space fiber management system; and
Element 1K	wherein the tray includes a plurality of cassette engaging portions that are configured to conform to the standard one width (1 W) so as to support the modular two standard width (2 W) cassette, the modular three standard width (3 W) cassette, the modular four standard width (4 W) cassette, and the modular six standard width (6 W) cassette.

Claim 2	2. The tray of claim 1, wherein the standard one width (1 W) unit is based on a standard SC Duplex width unit that is configured to fit a plurality of different type of LC, SC, and MPO connectors.
Claim 3	3. The tray of claim 1, wherein the plurality of cassette engaging portions of the tray are spaced apart from one another so as to conform to the standard one width (1 W) and support the modular two standard width (2 W) cassette, the modular three standard width (3 W) cassette, the modular four standard width (4 W) cassette, and the modular six standard width (6 W) cassette.
Claim 4	4. The tray of claim 1, wherein the tray is configured to be slidingly received in at least a portion of a tray receiving space of a case of a fiber optic management system.
Claim 5	5. The tray of claim 1, wherein each of the modular fiber optic cassettes includes a cassette side end portion that is directly adjacent to a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.
Claim 6	6. The tray of claim 1, wherein each of the modular fiber optic cassettes includes a cassette side end portion that is adjacent to a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.
Claim 7	7. The tray of claim 1, wherein each of the modular fiber optic cassettes includes a cassette side end portion that touches a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.
Claim 8	8. The tray of claim 1, wherein the tray has a first tray end portion, a second tray end portion spaced away from the first tray end portion

	so as to define a tray width extending between the first tray end portion and the second tray end portion, and wherein the tray width is configured to fit at least twelve standard one width (1 W) units side by side along the tray width.
Designation	**Claim 9**
Preamble	9. A tray for providing a plurality of different modular fiber optic cassette configurations in a standard U-space fiber optic management system comprising:
Element 9A	a tray configured to fit in a standard U-space and support a plurality of different modular fiber optic cassette configurations in the standard U-space;
Element 9B	wherein each of the plurality of different modular fiber optic cassette configurations includes a plurality of different sizes of modular fiber optic cassettes;
Element 9C	wherein each of the plurality of different sizes of modular fiber optic cassettes is configured to support a fiber optic receptable module that is configured to fit in a standard one width (1 W) unit;
Element 9D	wherein the plurality of different sizes of modular fiber optic cassettes include a 2 cassette size that is configured to fit a standard two width (2 W) unit relative to the standard one width (1 W) unit, a 3 W cassette size that is configured to fit a standard three width (3 W) unit relative to the standard one width (1 W) unit, a 4 W cassette size that is configured to fit a standard four width (4 W) unit relative to the standard one width (1 W) unit, and a 6 W cassette size that is configured to fit a standard six width (6 W) unit relative to the standard one width (1 W) unit;
Element 9E	wherein the plurality of different modular fiber optic cassette configurations comprise:

	a first modular fiber optic cassette configuration that includes six modular 2 standard width unit size cassettes that are each arranged side by side of each other along the tray such that a cassette side end portion of each modular 2 standard width unit size cassette adjacently faces a cassette side end portion of at least one other modular 2 standard width size cassette; a second modular fiber optic cassette configuration that includes four modular 3 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of each modular 3 W standard width size cassette adjacently faces a cassette side end portion of at least one other modular 3 W standard width size cassette; a third modular fiber optic cassette configuration that includes three modular 4 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of each modular 4 W standard width size cassette adjacently faces a cassette side end portion of at least one other modular 4 W standard width size cassette; a fourth modular fiber optic cassette configuration that includes two modular 6 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray such that a cassette side end portion of one of the two modular 6 W standard width size cassettes adjacently faces a cassette side end portion of the other modular 6 W standard width size cassette; and a fifth modular fiber optic cassette configuration that includes three modular 2 standard width unit size cassettes, which are each arranged side by side of each other in a row along the tray such that a cassette side end portion of one of the three modular 2 standard width size cassettes adjacently faces a cassette side end portion of one of the other modular 2 standard width size cassette, and one modular 6 W standard width unit size cassette that is arranged side by side in a row along the tray with one of the three modular 2 standard width unit size cassettes, such that a cassette side end portion of the one modular

	6 W standard width unit size cassette adjacently faces a cassette side end portion of one of the other three modular 2 standard width unit size cassettes;
Element 9F	wherein the tray is configured to be removably secured to each modular fiber optic cassette when the tray fits the plurality of different modular fiber optic cassette configurations within a tray width portion in the standard U-space fiber management system; and
Element 9G	wherein the tray includes a plurality of cassette engaging portions that are configured to conform to the standard one width (1 W) so as to support the modular 2 standard width unit size cassette, the modular 3 W standard width unit size cassette, the modular 4 W standard width unit size cassette, and the modular 6 W standard width unit size cassette.
Claim 10	10. The tray of claim 9, wherein the standard one width (1 W) unit is based on a standard SC Duplex width unit that is configured to fit a plurality of different type of LC, SC, and MPO connectors.
Claim 11	11. The tray of claim 9, wherein the plurality of cassette engaging portions of the tray are spaced apart from one another so as to conform to the standard one width (1 W) and support the modular 2 standard width unit size cassette, the modular 3 W standard width unit size cassette, the modular 4 W standard width unit size cassette, and the modular 6 W standard width unit size cassette.
Claim 12	12. The tray of claim 9, wherein the tray is configured to be slidingly received in at least portion of a tray receiving space of a case of a fiber optic management system.
Claim 13	13. The tray of claim 9, wherein each of the modular fiber optic cassettes includes a cassette side end portion that is directly adjacent to a cassette side end portion of another module fiber optic cassette

	when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.
Claim 14	14. The tray of claim 9, wherein each of the modular fiber optic cassettes includes a cassette side end portion that is adjacent to a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.
Claim 15	15. The tray of claim 9, wherein each of the modular fiber optic cassettes includes a cassette side end portion that touches a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.
Claim 16	16. The tray of claim 9, wherein the tray has first tray end portion, a second tray end portion spaced away from the first tray end portion so as to define a tray width extending between the first tray end portion and the second tray end portion, and wherein the tray width is configured to support at least twelve standard one width (1 W) units side by side along the tray.
Designation	**Claim 17**
Preamble	17. A tray for providing a plurality of different modular fiber optic cassette configurations in a fiber optic management system comprising:
Element 17A	a tray member configured to support a plurality of different modular fiber optic cassette configurations in a standard U-space width;
Element 17B	wherein the plurality of different modular fiber optic cassette configurations include different sizes of modular fiber optic cassettes;

Element 17C	wherein each of the different sizes of modular fiber optic cassettes is configured to support a fiber optic receptable module that is configured to fit in a standard one width (1 W) unit;
Element 17D	wherein the plurality of different sizes of modular fiber optic cassettes include a 2 cassette size that is configured to fit a standard two width (2 W) unit relative to the standard one width (1 W) unit, a 3 W cassette size that is configured to fit a standard three width (3 W) unit relative to the standard one width (1 W) unit, a 4 W cassette size that is configured to fit a standard four width (4 W) unit relative to the standard one width (1 W) unit, and a 6 W cassette size that is configured to fit a standard six width (6 W) unit relative to the standard one width (1 W) unit;
Element 17E	wherein the plurality of different modular fiber optic cassette configurations comprise: a first modular fiber optic cassette configuration that includes six modular 2 standard width unit size cassettes that are each arranged side by side of each other along the tray member such that a cassette side end portion of each modular 2 standard width unit size cassette adjacently faces a cassette side end portion of at least one other modular 2 standard width size cassette; a second modular fiber optic cassette configuration that includes four modular 3 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray member such that a cassette side end portion of each modular 3 W standard width size cassette adjacently faces a cassette side end portion of at least one other modular 3 W standard width size cassette; a third modular fiber optic cassette configuration that includes three modular 4 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray member such that a cassette side end portion of each modular 4 W standard width size

	cassette adjacently faces a cassette side end portion of at least one other modular 4 W standard width size cassette; and a fourth modular fiber optic cassette configuration that includes two modular 6 W standard width unit size cassettes that are each arranged side by side of each other in a row along the tray member such that a cassette side end portion of one of the two modular 6 W standard width size cassettes adjacently faces a cassette side end portion of the other modular 6 W standard width size cassette; and
Element 17F	wherein the tray member is configured to conform to the standard one width (1 W) so as to support the modular 2 standard width unit size cassette, the modular 3 W standard width unit size cassette, the modular 4 W standard width unit size cassette, and the modular 6 W standard width unit size cassette.
Claim 18	18. The tray member of claim 17, wherein the standard one width (1 W) unit is based on a standard SC Duplex width unit that is configured to fit a plurality of different type of LC, SC, and MPO connectors.
Claim 19	19. The tray member of claim 17, wherein the tray member includes a row of cassette engaging portions that are spaced apart from one another so as to conform to the standard one width (1 W) and support the modular 2 standard width unit size cassette, the modular 3 W standard width unit size cassette, the modular 4 W standard width unit size cassette, and the modular 6 W standard width unit size cassette.
Claim 20	20. The tray member of claim 19, wherein the row of cassette engaging portions comprises a first row of cassette engaging portions, and the tray includes a second row of cassette engaging portions that is spaced away from the first row of cassette engaging portions.

Claim 21	21. The tray member of claim 20, wherein the first row of cassette engaging portion comprises a first row of slot portions that are each configured to engage a tab portion of each modular cassette.
Claim 22	22. The tray member of claim 17, wherein the tray member is configured to be slidingly received in at least portion of a tray member receiving space of a case of a fiber optic management system.
Claim 23	23. The tray member of claim 17, wherein each of the modular fiber optic cassettes includes a cassette side end portion that is directly adjacent to a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.
Claim 24	24. The tray member of claim 17, wherein each of the modular fiber optic cassettes includes a cassette side end portion that is adjacent to a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.
Claim 25	25. The tray member of claim 17, wherein each of the modular fiber optic cassettes includes a cassette side end portion that touches a cassette side end portion of another module fiber optic cassette when each of the modular fiber optic cassettes are in the plurality of the plurality of different modular fiber optic cassette configurations.
Claim 26	26. The tray member of claim 17, wherein the tray member has a tray member width that is configured to support at least twelve standard one width (1 W) units side by side along a row.
Claim 27	27. The tray member of claim 17, wherein the tray member has first tray member end portion, a second tray member end portion spaced away from the first tray member end portion so as to define a tray

	member width extending between the first tray member end portion and the second tray member end portion, and wherein the tray member width is configured to support at least twelve standard one width (1 W) units side by side along the tray member.
Claim 28	28. The tray member of claim 17, wherein each of the modular fiber optic cassettes comprises a multi-fiber connector receiving receptacle portion arranged on a rear portion thereof.
Claim 29	29. The tray member of claim 17, wherein each of the modules fiber optic cassettes comprises four fiber optic plug receiving receptacle portions configured to be arranged side by side in a row along a front portion thereof for each standard width (1 W) unit.
Claim 30	30. The tray member of claim 17, wherein the tray member comprises a cassette fastening portion that is configured to removably secure the tray member to each modular fiber optic cassette.

Petitioner's Exhibit List

Number	Description
EX1001	U.S. Patent No. 11,740,423 (the challenged patent)
EX1002	Prosecution history of U.S. Patent No. 11,435,542
EX1003	Declaration of Dr. Stephen Ralph
EX1004	U.S. Patent No. 10,101,551 ("Fukui")
EX1005	U.S. Patent No. 10,215,944 ("Sedor)"
EX1006	U.S. Patent 9,690,064 ("Sauter")
EX1007	Prosecution history of U.S. Patent No. 10,795,107
EX1008	EIA Standard, Cabinets, Racks, Panels, and Associated Equipment (EIA/ECA-310-E)
EX1009	International Standard, Part 20: Type LC connectors Family (IEC 61754-20)
EX1010	U.S. Patent Publication No. 2014/0099064 ("Fabrykowski")
EX1011	Joint Claim Construction Chart from co-pending litigation
EX1012	Exhibits D, E, and F filed by Plaintiff Belden with its Complaint for Patent Infringement in the matter of *Belden Canada ULC v. CommScope, Inc. et al.*, 1:23-cv-00810 (D. Del. Jul. 27, 2023)
EX1013	Prosecution history of U.S. Patent 9,690,064 ("Sauter")
EX1014	U.S. Patent No. 9,690,065 ("Wiltjer")
EX1015	U.S. Patent No. 9,250,409 ("Blackwell")
EX1016	CommScope's user manual
EX1017	U.S. Patent No. 7,509,015
EX1018	U.S. Patent No. 9,008,485
EX1019	U.S. Patent No. 9,075,216
EX1020	U.S. Patent Publication No. 2016/0062050
EX1021	U.S. Patent No. 8,712,206
EX1022	Product literature for Leviton: FIBER SYSTEMS, Enclosure and Panel Selection Guide
EX1023	Product literature from Corning: EDGE™ HD Solutions
EX1024	Product literature from Panduit: HD Flex Fiber Cabling System

EX1025	WO2010148325A1
EX1026	NL2008155C2 (“Laarveld”) (English translation)
EX1027	Declaration certifying translation of NL2008155C2
EX1028	NL2008155C2 (“Laarveld”) (original in Dutch)
EX1029	Screen capture of Propel instructional video at https://www.youtube.com/watch?v=_agZJP5tZWc at 1:55)(showing cassette being mounted on rails)
EX1030	U.S. Patent App. Publication No. 2017/0192191 (“Dagley”)
EX1031	U.S. Patent App. Publication No. 2017/0153406
EX1032	U.S. Patent No. 8,873,922
EX1033	Prosecution history of U.S. Patent No. 11,656,422
EX1034	U.S. Patent No. 11,435,542
EX1035	U.S. Patent No. 10,795,107
EX1036	U.S. Patent No. 9,885,845
EX1037	U.S. Patent App. Publication No. 2008/0298014
EX1038	U.S. Patent App. Publication No. 2006/0261015
EX1039	Prosecution history of U.S. Patent No. 11,740,423
EX1040	U.S. Patent No. 11,656,422
EX1041	“Belden’s Opening Claim Construction Brief” in the matter of Belden Canada ULC v. CommScope, Inc. et al., No. 1:23-cv-00810 (D. Del. Jul. 19, 2024).
EX1042	“CommScope’s Answering Claim Construction Brief” in the matter of Belden Canada ULC v. CommScope, Inc. et al., No. 1:23-cv-00810 (D. Del. Aug. 23, 2024).
EX1043	Exhibit P to CommScope’s Claim Construction Brief in the matter of Belden Canada ULC v. CommScope, Inc. et al., No. 1:23-cv-00810 (D. Del. Aug. 23, 2024).
EX1044	U.S. Pat. App. Pub. No. 20070146997A1
EX1045	U.S. Patent No. 9,095,070

STEPHEN E. RALPH

Georgia Institute of Technology
Professor
School of Electrical and Computer Engineering
July 2024

I. Earned Degrees

Graduate	**Cornell University**, Ithaca, NY School of Electrical Engineering Ph.D.; minor: Physics	1981-1988
Undergraduate	**Georgia Institute of Technology**, Atlanta, GA Bachelor of Electrical Engineering With highest honor	1976-1980

II. Employment

Full Professor, Glen Robinson Chair in Electro-Optics, Georgia Institute of Technology	2020-present
Principal Research Scientist, Georgia Tech Research Institute	2020-present
Director, Georgia Electronic Design Center	2011-present
Full Professor, Georgia Institute of Technology	2007-2020
Director, Optical Technologies, Quellan Inc.	2001-2004
Associate Professor, Georgia Institute of Technology, GA	1998-2007
Assistant Professor, Emory University, GA	1992-1998
Visiting Scientist, IBM Watson Research Center, Yorktown Heights, NY	1990-1992
Post-Doctoral Research, AT&T Bell Laboratories, Murray Hill, NJ	1987-1990
Graduate Research Assistant, Cornell University, Ithaca, NY	1981-1987
Design Engineer, Harris Corporation, Melbourne, FL	1980-1981

III. Honors and Awards

Glen Robinson Chair in Electro-Optics, January 2020, “in recognition of your significant contributions to photonics technologies ... and demonstrated skills working across institutional boundaries.” Glen Robinson was a pioneer in satellite technology and a founder of Scientific Atlanta now part of Cisco.

Principal Research Scientist and Joint Appointment at the Georgia Tech Research Institute, January 2020. GTRI is the applied research division of the Georgia Institute of Technology.

Elected to IEEE Photonics Society Board of Governors (term 2019 to 2022)

Fellow of the Optical Society of America (OSA)

Plenary Talk "Short Reach Optical Interconnects," "IEEE Components Packaging and Manufacturing Society symposium," Kyoto University, Kyoto Japan, November 20-22, 2017.

Best Student Paper Award, SAIC Inc., 2000
Todd Ulmer and S. E. Ralph "Resonant-cavity-enhanced surface-emitted second-harmonic generation for all-optical time division demultiplexing," April 26, 2000.

21st International Conference on VLSI Design 2008, Best Paper: Arun K. Choudhury, S. Bandyopadhyay, P. Mandal (*IIT, Kharagpur*), S. E. Ralph (*Georgia Tech*) K. Pedrotti (*UCSC*) "Integrated TIA-Equalizer for High-Speed Optical Link," Hyderabad, India, 4-8 January 2008.

Finalist, Corning Outstanding Student Paper, Optical Fiber Conference 2011
A. J. Stark, Y. Hsueh, S. Searcy, T. Detwiler, M. Filer, S. Tibuleac, G. Chang, and S. E. Ralph, "Scaling 112 Gb/s PDM-QPSK Hybrid Optical Networks," *Optical Fiber Comm. Conf.* (OFC), 6-10 Mar. 2011.

Finalist, Corning Outstanding Student Paper, Optical Fiber Conference 2016
J. Lavrencik, S. Kota Pavan, A. Melgar and S. E. Ralph, "Direct Measurement of Transverse Mode Correlation and Fiber-Enhanced RIN through MMF using 850nm VCSELs," *Optical Fiber Communication Conference* (OFC), Anaheim, CA, March 20-24, 2016.

Finalist, Corning Outstanding Student Paper, Optical Fiber Conference 2020
J. Lavrencik, A. Melgar and S. E. Ralph, "168Gbps PAM-4 Multimode Fiber Transmission through 50m using 28GHz 850nm Multimode VCSELs," *Optical Fiber Communication Conference* (OFC), San Diego, CA, March 8-12, 2020.

IV. Research, Scholarship, and Creative Activities

A. Areas of Current Research:

High-capacity optical systems, particularly the intersection of electronics, photonics and signal processing/machine learning and where integrated photonics is a key area of innovation. Dr. Ralph is a leading innovator in the use of Machine learning for performance monitoring and transceiver assessment and in the use of signal processing in power efficient optical interconnects. He has recently been awarded 5 patents in these areas.

Dr. Ralph is the Director of the Georgia Electronic (and Photonic) Design Center a cross-disciplinary center of the Georgia Institute of Technology focused on the development of photonics, electronics, and the innovative use of machine learning to achieve breakthrough system performance. The primary mission is the rapid transition of GEDC innovations to deployed systems by the creation of strong industrial partnerships and consortia. With more than 12 active faculty, over 120 graduate students and annual research expenditure of ~$10M, the GEDC is one of the world's largest university-based research centers of its kind.

Dr. Ralph is PI on the recently awarded NSF IUCRC (Industry University Collaborative Research Centers). The effort is ***"Electronic-Photonic Integrated Circuits for Aerospace" (EPICA).*** EPICA's objective is to enable the next wave of communications and sensing technologies for aerospace and space-borne platforms by designing architectures and validating the performance and reliability of advanced electronic-photonic integrated circuits, systems and packaging technologies. The center is now comprised of more than 12 companies and national labs.

Dr. Ralph has collaborated for many years with the Georgia Tech Research Institute in an effort to transition his innovations to DoD customers. He was a key contributor to the development of an integrated photonics effort within the Electro-Optical Systems Lab.

B. Recent Principal Related Scientific/Technical Accomplishments:

Dr. Ralph has widely published in peer-reviewed journals and at conferences and holds 16 patents in the fields of photonic devices and communications. He is actively involved as a reviewer, and committee member of various journals and conferences. He is an elected member of the Board of Governors for the IEEE Photonics Society and was recently a member of the technical advisory council for the IEEE Photonics Society. Dr. Ralph is a Fellow of the Optical Society of America.

Dr. Ralph is founder and director of the Georgia Tech Terabit Optical Networking Consortium: An industry-academia collaboration formed to investigate deployment issues related to high-capacity optical systems. Dr. Ralph vision recognized that improvements in electronic processing speeds and photonic components are enabling the use of sophisticated signal processing. These modulation, equalization, forward error correction and impairment mitigation strategies transcend the optical and electronic components, influencing the entire signal path; hence systems must be jointly optimized across multiple technologies.

- **Integrated Photonics:** Initiated comprehensive efforts to integrate signal processing and device efforts (photonic and electronic) and establish GaTech and GEDC as a leader in integrated photonics research; established multiple integrated photonics efforts; with GlobalFoundries, AIM photonics, Sandia National Labs, Harvard University, GTRI and IHP to design, fabricate and test high-speed optical systems. These efforts directly enabled GaTech's successful NSF IUCRC program.
  - Developed an open source, density-based topology optimization framework that robustly designs compact, broadband photonic devices for different semiconductor process nodes. This effort is key to the GlobalFoundries partnership enabling Georgia Tech access to multiple MPW runs annually.
  - Dr. Ralph initiated GaTech's efforts with AIM Photonics; a US Federally funded (USAF) Institute for Manufacturing Innovation focusing on integrated photonics. The "Analog RF Photonics" program team includes Raytheon, Harris and Lockheed Martin.
  - Developed fiber attach, packaging and test methods that include use of machine learning.
  - Teamed with BYU, and Harvard to develop thin film lithium niobate components for Quantum communication

- **Topology Optimization:** Large-scale photonic integration provides a promising route towards high-density, high bandwidth interferometric photonic systems on a chip (SoC) analogous to electronic VLSI systems. Dr. Ralph's team has made foundational advances related to two challenges of commercial foundry processing: fabrication variability and design complexity. These efforts are a key pillar of the newly NSF funded IUCRC.
  - Density-based topology optimization (TO) is an inverse design methodology used to iteratively optimize every voxel of a device geometry to minimize a user-specified figure of merit while incorporating robustness and manufacturing constraints. TO allows completely unexpected designs with unprecedented performance to emerge. Dr. Ralph's team has become an established leader in this emerging technology with 8 conference publications in 2023.

- **Towards Artificially Intelligent Communications:** Dr. Ralph's team has demonstrated advantages and deployment scenarios for various modulation formats specifically focusing on implementation penalties associated with various signaling strategies and limitations of photonic and electronic components.

  - Waveform Estimation from Nonlinear Systems Using Machine Learning: for Rapid Simulation and Design His team developed comprehensive component and communication link simulation tools and network scaling rules actively used by the consortium members.
  - Optimization and performance monitoring of DWDM fiber systems: Dr. Ralph's team has published more than 12 journal articles and presented >40 conference papers advancing the understanding of nonlinearities within optically amplified links and crosstalk in high spectral efficiency communications systems. Dr. Ralph showed the efficacy of various signal formats and the potential of transmitter and receiver-based signal processing. His team created and validated design rules for understanding link performance in the presence of nonlinearities and crosstalk.
  - Blind Signal Identification: Dr. Ralph and his team developed robust decoding algorithms that identify and decode nearly any modulation format including legacy formats at arbitrary baud rate without any prior knowledge of signal parameters. The innovations and experimental validation have been documented in >16 conference presentations and journal publications. *The intellectual property has been licensed to Harris Corp.* (with royalties to GTRC and COE).

- **Optical Interconnects:** Dr. Ralph's pioneering work in the use of signal processing in VCSEL based optical interconnects and advanced simulation methods support the scaling of these power efficient sources for deployment in data centers, access networks and high-performance computing. His team established multiple world record performances for VCSEL/MMF links and influenced both IEEE and Fibre channel standards. He has been awarded a recent patent and has one pending related to optical interconnects.

  Dr. Ralph has produced more than 50 conference presentations and 14 journal articles with multiple academic collaborators and industry sponsors (Chalmers University, OFS, Finisar, HP, Avago (Broadcom). He has presented more than 20 invited talks on both fundamental and practical issues related to VCSEL based links including a tutorial, OFC2016, and Plenary Talk, "*Short Reach Optical Interconnects*," IEEE CPMS symposium, Kyoto Japan, 2017.

  Dr. Ralph and his team:

  - Were the first to demonstrate >100Gbps OOK using direct modulated VCSELs over 50m of OM5 fiber error free (no FEC) VCSEL/100m MMF (PD-IEEE IPC 2019) using practical, readily deployable, signal processing techniques.
  - Demonstrated record 168Gbps using PAM-4 (OFC2020), Corning Best Student paper finalist.
  - Demonstrated error-free SWDM 850nm to 1060nm VCSEL links and thereby the feasibility of 800Gbps/8λ.
  - Quantified noise and impairment penalties thereby enabling his team to develop comprehensive VCSEL/fiber models and equalization tools.
  - Created parameter extraction techniques that enable accurate modeling of both bandwidth and noise characteristics of high-speed VCSELs.
  - Demonstrated that mode partition noise (MPN) in MMF/VCSEL links is not as severe as the IEEE standards methods suggest. This result influenced both IEEE standards and Fibre

Channel standards and supports deployment of 50Gps and greater PAM-4 links, a goal of the IEEE, and many manufacturers.

- Were the first to directly quantify transverse mode correlations in VCSELs and optical links quantifying the source of MPN, demonstrating the origin of increased RIN with dispersion and explained the observed low mode partition noise. Subsequently developed a new model of multi-transverse mode lasers to incorporate MPN from basic principles consistent with the new experimental correlation results. Corning Best Student paper finalist 2016.
- Demonstrated and explained the unexpected high bandwidth in graded index perflourinated plastic optical fiber (POF). Reported the first statistical study of POF, showed the importance of mode coupling, developed simulation tools and demonstrated a number of record performance metrics including 40Gbps with 100m reach.
- Invented and demonstrated a spatially selective optical detector that effectively removes differential modal delay and demonstrated the utility of Raman gain in MMF.

Summary

Over 360 refereed publications

92 refereed journal papers (15 since 2019)
230 refereed conference proceedings (52 since 2019)
52 Invited talks (16 since 2019) (1 Plenary)
1 Book Chapter
17 U.S. patents issued, (6 since 2019)

Sponsored Research

- **Active Research projects**: 6 w/total funding of >1M$/yr @Georgia Tech (not incl. GEDC state funding)
- PI on newly awarded NSF IUCRC with 20 companies, $7.25M over 5 years, ~$3M at GaTech, with Vanderbilt and CREOL, UCF.
- Currently advising 8 PhD students and two Post-Doctoral Students*
  * Research Associates of GEDC

GEDC Director

As Director of the Georgia Electronic Design Center, Dr. Ralph created an initiative in integrated photonics including significant investments in testing infrastructure and establishing access to multiple foundry services including GlobalFoundries, Infinera and AIM photonics. Working with other faculty he expanded the shared infrastructure including multiple collaborative efforts with GTRI teams. The GEDC has additional total annual Center memberships this year valued at $800k. Five fulltime staff including two research associates are direct reports. The center has more than 100 GRAs, postdocs and visiting scientists. His current responsibilities also include the Technology Square Research Building (>220,000 SF).

Dr. Ralph also ensured that new faculty have proper lab and GRA space and infrastructure to be successful and ensured space is used as effectively as possible. As an industry-focused center with multidisciplinary capabilities, the technical domain spans a number of related areas each of which enables revolutionary applications. Each of the areas exploits machine learning and signal processing applied to these systems.

These areas of primary focus include:

- **THz Electronics:** Communications and sensing primarily in the range from 100GHz to 10THz
- **AI/ML for RF:** Joint application of high-speed electronics/photonics for spatial and spectral awareness
- **Photonics for Aerospace:** Integrated photonics/electronics for aerospace/space and harsh environments
- **RF MEMs:** Intersection of MEMs technologies with RF systems, includes phononics
- **Quantum Systems:** Photonics for a quantum including communications, sensing and computing

The Center provides thought leadership, support and has created technology roadmaps for each focus area.

Dr. Ralph established the GEDC as a leader in integrated photonics in part by the creation of a shared laboratory within the GEDC. The shared resource model is an effective method to enable our faculty to have the most up to date equipment available as soon as possible.

Within these efforts Dr. Ralph envisioned a new center focused on integrated photonics for Aerospace and Space deployment culminating in the recently awarded NSF IUCRC (Industry University Collaborative Research Centers) where he is PI. The new NSF center (within GEDC) is ***"Electronic-Photonic Integrated Circuits for Aerospace" (EPICA).*** EPICA's objective is to enable the next wave of communications and sensing technologies for aerospace and space-borne platforms by designing architectures and validating the performance and reliability of advanced electronic-photonic integrated circuits and systems. EPICA is a multidisciplinary center that includes Co-PIs Cressler (ECE) and Gunter (AE), the University of Central Florida and Vanderbilt University. More than 20 companies and government agencies are members, a major accomplishment for a first year IUCRC.

C. Books and Book Chapters

1. "Optical Access Networks," *Broadband Access Technologies*, ed. Nikil Jayant, Marcel Decker, pp.333-385, May 2005.

D. Refereed Publications

D.1 Refereed Journal Publications
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186. J. Lavrencik, E. Simpanen, N. Haghighi, S. Varughese, J. S. Gustavsson, E. Haglund, W. V. Sorin, S. Mathai, M. Tan, J. A. Lott, A. Larsson and S. E. Ralph, “Error-Free 850nm to 1060nm VCSEL Links: Feasibility of 400Gbps and 800Gbps 8λ-SWDM,” ECOC 2019, 22–26 Sept. 2019, Dublin Ireland.

187. D. Lippiatt, S. Varughese, T. Richter, S. Tibuleac and S. E. Ralph, “Machine-learning-based optical Performance Monitoring using Carrier Phase Recovery,” ECOC 2019, 22–26 Sept. 2019, Dublin, Ireland.

188. S. Varughese, T. Richter, S. Tibuleac and S. E. Ralph, “Joint Optimization of DAC and ADC Based on Frequency Dependent ENoB Analysis for High-Speed Optical Systems,” ECOC 2019, 22–26 Sept. 2019, Dublin, Ireland.

189. J. Lavrencik, S. Varughese, V. A. Thomas, J. S. Gustavsson, E. Haglund, A. Larsson and S. E. Ralph, “102 Gbps PAM-2 over 50m OM5 Fiber using Multimode 850nm VCSEL,” Post Deadline Paper, IEEE IPC San Antonio TX 3 Oct 2019.

190. J. Langston, K. Bagnell, R. DeSalvo, S. E. Ralph, “Spectral Correlation Computation Using Nonlinear Optical Signal Processing,” IEEE AVFOP conference, Arlington VA Nov. 5-6, 2019.

191. H. J. Cho, D. Lippiatt, S. Varughese and S. E. Ralph, “Convolutional Neural Networks for Optical Performance Monitoring,” IEEE AVFOP conference, Arlington VA Nov. 5-6, 2019.

192. B. B. Yang, Brandon Lovelace, B. R. Wier, G. Vinson, M. Bolding, K. Davis, R. Bhattacharjea, C. Ward, A. Stark, C. Bottenfield, S. E. Ralph, M. Gehl, A. Lentine “Photonic Integrated Circuits for Simultaneous Channelization and Downconversion,” IEEE AVFOP conference, Arlington VA, Nov. 5-6, 2019.

193. D. Lippiatt, S. Varughese, T. Richter, S. Tibuleac, and S. E. Ralph, "Joint Linear and Nonlinear Noise Estimation by Exploiting Carrier Phase Recovery," Optical Fiber Communications Conference (OFC), San Diego, CA, March 7-12, 2020.

194. S. Varughese, D. Lippiatt, T. Richter, S. Tibuleac, and S. E. Ralph, “Low Complexity Soft Failure Detection and Identification in Optical Links using Adaptive Filter Coefficients,” Optical Fiber Communications Conference (OFC), San Diego, CA, March 7-12, 2020.

195. S. Varughese, D. A. Garon, A. Melgar, V. A. Thomas, P. Zivny, S. Hazzard and S. E. Ralph, “Accelerating TDECQ Assessments using Convolutional Neural Networks,” Optical Fiber Communications Conference a (OFC), San Diego, CA, March 7-12, 2020.

196. H. J. Cho, S. Varughese, D. Lippiatt, and S. E. Ralph, “Convolutional Recurrent Machine Learning for OSNR and Launch Power Estimation: A Critical Assessment,” Optical Fiber Communications Conference (OFC), San Diego, CA, March 7-12, 2020.

197. J. Lavrencik, S. Varughese, N. Ledentsov Jr., L. Chorchos, N. N. Ledentsov, S. E. Ralph, "168Gbps PAM-4 Multimode Fiber Transmission through 50m using 28GHz 850nm Multimode VCSELs," Optical Fiber Communications Conference (OFC), San Diego, CA, March 7-12, 2020.

198. V. A. Thomas, A. Melgar, S. J. Varughese, D. Garon, K. Tan, S. A. Hazzard, M. Agoston, P. Zivny and S.E. Ralph, "TDECQ Sensitivity to Algorithmic Implementation and Noise Characterization," Optical Fiber Communications Conference (OFC), San Diego, CA, March 7-12, 2020.

199. J. Langston, R. DeSalvo, S. E. Ralph, “Spectrum Sensing Applications of FWM-based Optical Cyclostationary Processor,” Optical Fiber Communications Conference (OFC), San Diego, CA, March 7-12, 2020.

200. S. Zeinolabedinzadeh, P. Goley, M. Frounchi, S. Rao, C. G. Bottenfield, Gareeyasee Saha, S. E. Ralph, M. Kaynak, L. Zimmermann, S. Lischke, C. Mai and J. D. Cressler, “A Co-integrated Electronic-Photonic Wideband and High-Power Signal Source,” Optical Fiber Communications Conference and Exposition (OFC), San Diego, CA, March 7-12, 2020.

201. N. N. Ledentsov1, V.A. Shchukin1, V.P. Kalosha1, N. Ledentsov Jr., L. Chorchos, J. P. Turkiewicz, U. Hecht, P. Kurth, F. Gerfers, J. Lavrencik, S. Varughese, and S. E. Ralph, “Optical Interconnects Using Single-Mode and Multi-Mode VCSEL and Multi-Mode Fiber,” Optical Fiber Communications Conference and Exposition (OFC), San Diego, CA, March 7-12, 2020.

202. A. Hammond, A. Oskooi, S. Johnson, S. E. Ralph, “Robust Topology Optimization of Foundry-Manufacturable Photonic Devices: An Open-Source FDTD Toolbox,” FTh1C.4, OSA Frontiers in Optics + Laser Science, 14-17 September 2020.

203. C. G. Bottenfield, R. DeSalvo, and S. E. Ralph, “Synthetic Pockels Modulators in Silicon,” in Conference on Lasers and Electro-Optics, CLEO, San Jose, California, 9–14 May 2021.

204. V. A. Thomas, S. Varughese, A. Stark and S. E. Ralph, “40GBaud Quasicoherent Receiver,” in Conference on Lasers and Electro-Optics, CLEO, San Jose, California, 9–14, May, 2021.

205. G. Saha and S. E. Ralph, Widely Tunable Apodized Bragg Grating Filter Fabricated in a Commercial Silicon Photonic Foundry, Optical Fiber Communications Conference (OFC), San Francisco, CA, June 6-11, 2021.

206. C. G. Bottenfield, M. Hoff, R. DeSalvo, A. Winoto, Y. Zhou, A. Bhardwaj, G. E. Hoefler, S. E. Ralph. “High Performance Microwave Photonic Downconversion in a Commercial InP Platform,” Optical Fiber Communications Conference (OFC), San Francisco, CA, June 6-11, 2021.

207. A. M. Hammond, S. E. Ralph, “System-Level Inverse Design for Stokes Receivers on a Commercial Foundry Platforms,” Optical Fiber Communications Conference (OFC), San Francisco, CA, June 6-11, 2021.

208. M. T. Hoff, C. G. Bottenfield, V. A. Thomas, A. Winoto, Y. Zhou, A. Bhardwaj, G. E. Hoefler, and S. E. Ralph, “Self-Homodyne Photonic Transmitter in a Monolithic InP Platform for RF Applications,” Optical Fiber Communications Conference (OFC), San Francisco, CA, June 6-11, 2021.

209. D. Lippiatt, A Melgar, V A. Thomas, S. Varughese, P. Zivny, S. Hazzard, and S. E. Ralph, “Impairment Identification for PAM-4 Transceivers and Links Using Machine Learning,” Optical Fiber Communications Conference (OFC), San Francisco, CA, June 6-11, 2021.

210. A . M. Hammond and S. E. Ralph, "Fabrication Tolerant Interferometric Subsystems for Large- Scale Photonic Integration," Integrated Photonics Research, Silicon and Nanophotonics, 2021 Washington, DC United States26–29 July 2021

211. S. Varughese, D. Lippiatt, H. J. Cho, and S. E. Ralph, "Transforming the Digital Coherent Receiver into a Test and Measurement Equipment using Machine Learning," SpTh1D.1 Signal Processing in Photonic Communications 2021, Washington, DC United States, 26–29 July 2021

212. A. E. Pérez, O. D. Vargas Bonett, S. E. Ralph and J. J. Granada Torres, "Spectral Spacing Estimation in Gridless Nyquist-WDM Systems using Local Binary Patterns," 2021 IEEE Photonics Conference (IPC), Vancouver, BC, Canada, 2021, pp. 1-2. doi: 10.1109/IPC48725.2021.9593007

213. M. Hammond, J. Slaby, G. Saha and S. E. Ralph, "Robust Topology Optimization for Foundry-Photonics Inverse Design: Examining Compact and Arbitrary Power Splitters," 2021 European Conference on Optical Communication *(ECOC)*, Bordeaux, France, 2021, pp. 1-4. doi: 10.1109/ECOC52684.2021.9606156.

214. K. D. Choquette, S. E. Ralph, A. Melgar, N. Jahan, W. North and J. A. Tatum, "Supermode Dynamics for VCSEL Modulation," 2021 IEEE Photonics Conference (IPC), 2021, pp. 1-2, doi: 10.1109/IPC48725.2021.9592985.

215. C. G. Bottenfield, V. A. Thomas, S. E. Ralph and R. DeSalvo, "Design Guide for Photonic Frequency Converters," 2021 IEEE Photonics Conference (IPC), 2021, pp. 1-2, doi: 10.1109/IPC48725.2021.9592880.

216. D. Lippiatt, H. J. Cho, A. Kaylor, V. A. Thomas, S. Searcy, T. Richter, S. Tibuleac, and S. E. Ralph, "Optical Performance Monitoring for Commercial Transceivers: Practical Considerations and Limitations" Optical Fiber Communications Conference (OFC), San Diego, CA, March 5-9, 2022.

217. A. Khurana, Varghese A. Thomas, John T. Gallo, and Stephen E. Ralph, "Impact of Link Limitations in 50 Gbps PAM-2 VCSEL MMF Links: Alignment, Equalization and Fiber Type ," in Conference on Lasers and Electro-Optics, CLEO, San Jose, California, 15–19, May 2022.

218. G. Saha, S. E Ralph, "Parameter Optimization of Foundry-Enabled Modified Bragg Grating Filters," Integrated Photonics Research, Silicon and Nanophotonics, part of Advanced Photonics Conference, 24–28 July 2022, Maastricht,Limburg, Netherlands.

219. A. M. Hammond, C. A. Kaylor, Joel Slaby, Michael Probst, Stephen E. Ralph, "Photonic Inverse Design of Compact Stokes-Vector Receivers on Commercial Foundry Platforms", 48th European Conference on Optical Communication, (ECOC); September 18-22, Basel, Switzerland ECOC 2022.

220. J. B Slaby, A. M Hammond and S. E Ralph "Compact Inverse Designed Integrated 1 x 3 Silicon Nitride Balanced Optical Power Splitter," IEEE Photonics Conference (IPC), 10-13 November 2022, Vancouver CN.

221. M. J Probst, A. M Hammond, J. B Slaby, S. E Ralph, "Inverse-designed, normal incidence grating couplers for multi-core fiber I/O," IEEE Photonics Conference (IPC), 10-13 November 2022, Vancouver CN.

222. A. Kaylor, D. Lippiatt, V. A Thomas, D. Patterson, R. DeSalvo and S. E Ralph, "Low Complexity Blind Baud Rate Estimation in the Presence of Hidden Interference," IEEE Photonics Conference (IPC), 10-13 November 2022, Vancouver CN.

223. A. Khurana, J. B. Slaby, A. M. Hammond and S. E. Ralph, "Inverse-Designed Photonic Polarization Control for High-Density Integration on Foundry Platforms," IEEE Silicon Photonics Conference, 2023, April 4-7, Arlington, VA 22202.

224. J. B. Slaby, A. M Hammond and S. E Ralph "Low-Loss High-Density Inverse-Designed Structures for High Power Signal Routing on Integrated Silicon Photonics Foundry Platforms," Conference on Lasers and Electro-Optics, CLEO, San Jose, California, 7-12, May 2023.

225. A. Khurana, J. J. Wong, V. A. Thomas, J. Tatum, L. A. Graham, J. Guenter, K. D. Choquette, and S. E. Ralph, " Optical Resonance Conditions of Coupled Cavity VCSELs," Conference on Lasers and Electro-Optics, CLEO, San Jose, California, 7-12, May 2023.

226. M. T. Hoff, S. E. Ralph and R. C. Stevens, "Photonic Signal Transport on Aerospace Platforms: is Analog Signaling Ever Useful?" IEEE Research and Applications of Photonics in Defense Conference, RAPID, Miramar, FL, September, 2023.

227. J. Krzyston, D. Lippiatt, D R. Bhattacharjea, A. Stark, and S. E. Ralph, “Waveform Estimation from Nonlinear Systems Using Machine Learning for Rapid Simulation and Design,” IEEE Research and Applications of Photonics in Defense Conference RAPID, Miramar, FL, September, 2023.

228. J. B. Slaby, A. M. Hammond, S. E. Ralph, “Low-Loss High-Density Inverse-Designed Structures for High Power Signal Routing on Integrated Silicon Photonics Foundry Platforms,” Conference on Lasers and Electro-Optics, CLEO, San Jose, California, 7-12, May 2023.

229. M. J. Probst, A. M. Hammond and S. E. Ralph, "Topology Optimized Integrated SiN Mode Converters," 2023 IEEE Photonics Conference (IPC), Orlando, FL, USA, 2023, pp. 1-2, doi: 10.1109/IPC57732.2023.10360633.

230. R. P. Pesch, A. Khurana, J. B. Slaby, J. Hiesener and S. E. Ralph, "Analysis of Local Optimization Behavior: Toward a Novel Inverse Design Paradigm," 2023 IEEE Photonics Conference (IPC), Orlando, FL, USA, 2023, pp. 1-2, doi: 10.1109/IPC57732.2023.10360565.

E. Presentations

E.1 Invited Presentations: (52)

Plenary Presentations

1. “Short Reach Optical Interconnects,” “IEEE Components Packaging and Manufacturing Society symposium”, Kyoto University, Kyoto Japan, November 20-22, 2017.

Invited

2. "Space charge and THz beams," *1992 Spring Meeting of the Materials Research Society*, San Francisco, CA, April 27, 1992.
3. "Terahertz characterization of materials," *2nd International Conference on Wideband Short Pulse Electromagnetics*, Brooklyn, NY, April 3, 1994.
4. "Femtosecond terahertz spectroscopy," *Proceedings of the Seventh International Conference on Time Resolved Vibrational Spectroscopy*, Santa Fe, NM, June 12-17, 1995.
5. "Ultrafast carrier dynamics and optical nonlinearities of low growth temperature multiple quantum wells," *Ultrafast Phenomena in Semiconductors, SPIE International Conference on Optoelectronics* ‘98, San Jose, CA, January 24-30, 1998.
6. "Picosecond dynamics of intersubband transitions without LO phonon emission," *American Physical Society March Meeting*, Los Angeles, CA, March 16-20, 1998.
7. "Time resolved carrier kinetics in semiconductor nanostructures: Fundamental principles and new results," *40th Electronic Materials Conference*, Charlottesville, VA, June 1998.
8. "Ultrafast optical devices for high-speed optical data links," SPIE Proceedings, Vol. 3803, p. 51, Conference on Guided Wave Optics for Optical Data Processing, Denver, CO, July 18-23, 1999.
9. “Spectral method for the simultaneous determination of uncorrelated and correlated amplitude and timing jitter,” *OSA Annual Meeting*, Orlando FL, September 29-October 3, 2002.
10. “Enabling Technologies for Optical Access: Technologies for next generation high-capacity telecommunications,” *2002 NSF Workshop on "Ultra-High-Capacity Optical Communications and Networking: Challenges in Broadband Optical Access, Materials Processing, and Manufacturing*," Workshop Co-Chairs A. Willner, F. Bartoli, and B. Mukherjee, Washington, DC, October 2002.
11. “Intelligent receivers for multimode fiber: optical and electronic equalization of differential modal delay;” *Lasers and Electro-Optics Society (LEOS)*, Glasgow Scotland, Vol. 1, pp. 295-296, November 2002.
12. “Integrated nonlinear optical structures for ultrafast optical signal processing,” *87th OSA Annual Meeting/Laser Science-XIX*, Tucson, Arizona, October 5-9, 2003.
13. “Intelligent integrated electronic/photonics for optical signal processing,” *Optics in the Southeast (OISE)*, Orlando, Florida, November 12-13, 2003.
14. "Integrated electronic/optical structures for ultrafast optical signal processing," MIT Lincoln Laboratories and IEEE LEOS Boston Chapter, MIT Lincoln Laboratory, Lexington, MA, March, 2005.
15. "Changing the channel: Impairment mitigation in high-speed communications channels," National Semiconductor, Santa Clara, CA, October 27, 2005.
16. “Electronic dispersion compensation and multi-mode fiber links: Steps to 20, 40 Gb/s serial and 100G WDM," Optical Fiber Solutions, Norcross, GA, March 19, 2006.
17. “Multigigabit Transmission over POF,” POF World West, Santa Clara, CA, June 20-23, 2006.
18. "New methods for investigating mode coupling in multimode fiber," Symposium on Optical Fiber Measurements (SOFM), NIST, Boulder, CO, September 18-20, 2006.
19. “High Data Rate Multimode Fiber Access Systems” *Lasers and Electro-Optics Society LEOS, The 20th Annual Meeting of the IEEE*, pp. 935-936, Lake Buena Vista FL. ThDD1, October 21-25, 2007.
20. "100m, 40 Gb/s Plastic Optical Fiber Link," A. Polley, S. E. Ralph, *Optical Fiber Communication/National Fiber Optic Engineers Conference*, OFC/NFOEC, 24-28 Feb. 2008.

.

21. “25G short reach links,” 2011 Advanced Photonics Congress, Access Networks and In-house Communications (ANIC), OSA, June 12-15, 2011, Toronto, Canada.
22. "VCSEL-based 100m 25Gb/s Plastic Optical Fiber Links," *POF World* 2011, Nov. 8-10 Santa Clara, California.
23. “25G VCSEL-based GI-POF Links,” *20th International Conference on Plastic Optical Fibers*, Bilbao, Spain, 14-16 September 2011.
24. “25G POF Links,” *International Conference on Advanced Photonic Polymers* (ICAPP), Dec 2-3, 2011, Yokohama, Japan.
25. “Signal processing and Impairments in Next-Generation MMF links,” *IEEE Avionics and Vehicle Fiber-Optics and Photonics Conference* (AVFOP 2012), Cocoa Beach, FL, 11-13 September 2012.
26. "Software Defined Optical Network and Terabit Optical Networks”, *Korea-USA International Tech Forum*, City of Ulsan, South Korea, Oct 25th, 2013.
27. “Noise in VCSEL-based Links,” *23rd International Conference on Plastic Optical Fibers*, Yokohama Japan, 5-8 September 2014.
28. “Trends in high-speed Telecom” *IEEE Avionics Fiber-Optics and Photonics Conference*, AVFOP, Atlanta GA, November 11-13, 2014.
29. “Autonomous Signal Identification and Reconstruction,” *National Special Communication Board Forum, National Reconnaissance Office*, Chantilly VA, January 14, 2016.
30. “Requirements and Results for Practical VCSEL Transmission using PAM-4 over MMF” Invited Tutorial at *Optical Fiber Communication Conference* (OFC) 2016, Anaheim CA 20-24 March 2016.
31. “VCSELs and MMF” Fibre Channel T11.2 meeting, Portland ME, June 7, 8, 2016.
32. “VCSEL modal dynamics and implications for 100Gbps links,” *SPIE Photonics West*, San Francisco, CA, 28 - Jan. 2 Feb. 2017.
33. “Performance Optimization of 64QAM for Next-Generation High-Capacity Transmission Link,” IEEE Photonics Conference, 30th Annual Conference of the IEEE Photonics Society, Lake Buena Vista, FL 1 - 5 October 2017.
34. “Linearization of Wideband Links” *IEEE Conference on Avionics and Vehicle Fiber-Optics and Photonics Conference* (AVFOP), New Orleans, LA, Nov 7-9, 2017.
35. “Terabit Optical Interconnects,” *IEEE Optical Interconnects Conference*, 4-6 June, Santa Fe, NM 2018.
36. "100G VCSEL Links," SPIE Photonics West, San Francisco, CA, Feb. 2-7, 2019.
37. "High Capacity VCSEL Links," Optical Fiber Communications Conference and Exposition (OFC), San Diego, CA, March 2019.
38. “Integrated Photonics for Space Applications: Reliability and Packaging,” Jet Propulsion Lab, Workshop, 29-30 July 2020.
39. “Integrated Photonics for Aerospace Applications,” IEEE International Photonics, Conference Vancouver Canada, 27 September – 1 Oct 2020.
40. “Electronic-Photonic Integrated Circuits for Aerospace EPICA” The 12th Annual NASA Electronic Parts and Packaging (NEPP) Program's Electronics Technology Workshop (ETW), June 14 to 17, 2021.
41. “Foundry Capabilities for Quantum”,” Scalable Information Processing with Quantum Nano-Photonics (SIPQNP), Snowbird, Utah, 12-13 Jan. 2022.
42. “NSF Center on Electronic-Photonic Integrated Circuits for Aerospace EPICA” Aerospace Corporation annual 2022 Microelectronics Reliability & Qualification Workshop MRQW, February8 to 10, 2022.
43. “Recent Advances in Photonics: Silicon Photonics to Machine Learning Applications” IEEE WRAP 2022, 4 to 6 March 2022, IIT Bombay, VMCC, Powai, Mumbai, Maharashtra, India.
44. Foundry capabilities supporting integrated quantum photonics and how can future users take advantage of these capabilities” SIPQNP 2023 , Tucson AZ Feb 12-14, 2023.

45. “Machine Learning Methods for Integrated Photonics”, Tutorial, OFC March 2023.
46. “How can academic research enhance US-base in integrated electronics and photonics?” MIT LL Advanced Technology for National Security Workshop (ATNS) 2023, MIT Lincoln Lab, April 2023.
47. “Georgia Tech Innovations in Microelectronics and Photonics,” Sandia National Labs S2-EDGE Workshop, August 30, 2023.
48. “Topology Optimization Strategies for Compact Integrated Photonics,” National Institute of Standards and Technology, NIST, Boulder, CO, 14 December, 2023.
49. “Integrated Photonics for Harsh Environments: EPICA an NSF center,” Microelectronics Reliability and Qualification Workshop (MRQW), The Aerospace Corporation, El Segundo, CA, February 6-8, 2024.
50. “Silicon Photonics: Advancements and Validation for Spaceborne and Aerospace Platforms,” MITRE Corp. Summit 2024: Spectrum Control for Resilient Space Operations, June 12- 14, Burlington, MA 2024.
51. “EPICA, Electronics and Photonic Integrated Circuits for Aerospace Platforms,” MIT, Cambridge, MA, June 12, 2024.
52. “Academia and the Defense Industry Ecosystem,” Argentinian Ministry of Defense and the US Embassy Bilateral Defense Summit, Buenos Aires, Argentina, June 18-21, 2024.
53.

E.2 Conference and IEEE Standards Presentations without Proceedings (28)

1. D. D. Nolte, R. M. Brubaker, M. R. Melloch, J. M. Woodall and S. E. Ralph, "Nonlinear optics of quantum anti-dots in bulk GaAs," *Conf. on Nonlinear Optics: Materials, Fundamentals and Applications*, Maui, Hawaii, August 17-21, 1992.
2. D. D. Nolte, M. R. Melloch, J. M. Woodall and S. E. Ralph, "High density holographic storage based on nano-size arsenic clusters in GaAs," *Optical Society of America Annual Meeting*, Albuquerque NM, September 21-25, 1992.
3. M. R. Melloch, D. D. Nolte, R. M. Brubaker, J. M. Woodall and S. E. Ralph, "GaAs containing arsenic precipitates as a novel high density optical storage medium," *Device Research Conference*, 1992.
4. S. E. Ralph, D. Grischkowsky and N. Katzenellenbogen, “THz Spectroscopy of CdTe structures," *Annual Meeting of the American Physical Society*, Seattle, WA, March 1993.
5. P. Juodawlkis, C. Verber, M. Hargis, S. E. Ralph, P. Chin and J. Woodall, “Femtosecond exciton and free carrier dynamics of low growth temperature InGaAs/InAlAs and InGaAs/InGaAsP multiple quantum wells," *Annual Meeting of the American Physical Society*, St. Louis, MO, March 1996.
6. T. Ulmer, R. K. Tan, W. S. Astar, P. Juodawlkis, B. Washburn, Z. Zhou, S. E. Ralph and A. J. SpringThorpe, "Progress towards a surface emitted second harmonic generation based demultiplexer for optical time division multiplexed communications," *Optical Society of America Annual Meeting*, Baltimore, MD, October 5-9, 1998.
7. P. Juodawlkis, B. Washburn, Z. Zhou, S. E. Ralph, D. T. McInturff, S. E. Chen, M. Sutherland and A. J. SpringThorpe, "Optical properties of selectively low temperature grown InGaAs/InAlAs multiple quantum well waveguides," *Optical Society of America Annual Meeting*, Baltimore, MD, October 5-9, 1998.
8. M. Gross, P. Juodawlkis, J. S. Rodgers, S. E. Ralph, R. P. Kenan, C. Verber and D. T. McInturff, "Passive modelocking of a fiber laser by an ultrafast low-temperature-grown InGaAs multiple quantum well saturable absorber," *Optical Society of America Annual Meeting*, Baltimore, MD, October 5-9, 1998.
9. J. T. Simmons, B. R. Washburn, T. G. Ulmer, W. S. Astar, R. P. Kenan, C. M. Verber, S. E. Ralph, D. Charlton and R. O. Maschmeyer, “Femtosecond pulse performance of an integrated optical tapped delay line,” *Optical Society of America Annual Meeting*, Santa Clara, CA, September 26-30, 1999.
10. T. G. Ulmer, M. C. Gross, K. M. Patel, B. R. Washburn, W. S. Astar, S. E. Ralph, R. P. Kenan, C. M. Verber and A. J. SpringThorpe, “Optical time-division demultiplexing with resonant-cavity-enhanced surface-emitted

second-harmonic generation," *Optical Society of America Annual Meeting*, Santa Clara CA, September 26-30, 1999.

11. B. R. Washburn, J. Buck and S. E. Ralph, "Temporal and spectral characterization of an ultrashort laser pulse in optical fiber by frequency resolved optical gating," *Optical Society of America Annual Meeting*, Santa Clara, CA, September 26-30, 1999.
12. T. G. Ulmer, M. Hanna, B. R. Washburn and S. E. Ralph, "Microcavity-enhanced $\chi^{(2)}$ Nonlinearities in Semiconductor Waveguides: "Surface-Emitted second-harmonic generation in the subpicosecond regime", *Alaska Conference on Fundamental Optical Properties of Semiconductors*, Alyeska, AK, September 5-9, 2001.
13. K. M. Patel and S. E. Ralph "Differential mode delay compensation using spatially resolved detection," *Optical Society of America Annual Meeting*, Long Beach, CA, October 14-18, 2001.
14. B. Washburn, R. Windeler and S. E. Ralph, "Optimizing supercontinuum generation in microstructure fiber: the role of dispersion and excitation pulse chirp," *Optical Society of America Annual Meeting*, Long Beach, CA, October 14-18, 2001.
15. M. C. Gross, K. M. Patel, M. Hanna and S. E. Ralph, "Impulse train driven, gain-switched laser diode: understanding uncorrelated and correlated jitter," *Optical Society of America Annual Meeting*, Long Beach, CA, October 14-18, 2001.
16. S. E Ralph, "Signal processing strategies in optical networks" *International Conference on Photonics in Switching*, Versailles, FR, September 28-October 2, 2003.
17. J. J. Lillie, M. A. Thomas, K. A. Dennis, C. L. Henderson, N. M. Jokerst and S. E. Ralph, "Modal pattern analysis of multimode interferometric sensors applied to fully integrated silicon based chem/bio sensors," *Optical Society of America Annual Meeting*, Rochester, NY, October 11-14, 2004.
18. S. M. Madison, W. Henderson, K. M. Patel, G. Namkoong, K.-K. Lee, S. E. Ralph and W. A. Doolittle, "III-Nitride HEMTs on LiNbO3 for integrated electro-optic applications," *Workshop on Compound Semiconductor Microwave Materials and Devices: WOCSEMMAD*, Coconut Grove, Miami, FL, February 20-23, 2005.
19. K. M. Patel and S. E. Ralph, "MMF reach extension for 10 Gbps by spatially resolved equalization," *IEEE 802.3aqLRM Standards committee meeting*, Portland, OR, July 2004.
20. K. Balemarthy, S. E. Ralph, R. Lingle, Jr., G. Oulundsen, Y. Sun, J. George, J. Abbott, "Fiber modeling resolution and assumptions: Analysis, data, and recommendations," *IEEE 802.3aqLRM Standards committee meeting*, San Antonio, TX, December 2004.
21. K. Balemarthy, K. Patel, S. E. Ralph, Y. Sun, G. Oulundsen, R. Lingle, Jr., and J. George, "PIE-D analysis of 1998 FDDI fibers," *IEEE 802.3aqLRM Standards committee meeting*, Vancouver, Canada, January 2005.
22. R. Lingle, Jr., G. Oulundsen, J. George, K. Balemarthy and S. E. Ralph, "Validation of using measured DMD from long fiber spools to characterize the installed base," *IEEE 802.3aqLRM Standards committee meeting*, Atlanta, GA, March 2005.
23. R. Lingle, Jr., K. Balemarthy and S. E. Ralph, "Finite equalizer performance for TP3 stressed sensitivity test on Gen67YY," *IEEE 802.3aq LRM Standards committee meeting*, Atlanta, GA, March 2005.
24. R. Lingle, Jr., K. Balemarthy and S. E. Ralph, "Analysis of TP3 candidate stressor sets," *IEEE 802.3aqLRM Standards committee meeting*, May, 2005.
25. K. Balemarthy, S. E. Ralph, R. Lingle, Jr., J. George and J. Abbot, "Duplex coverage estimates for selection of TP3 stressors," *IEEE 802.3aq LRM Standards committee meeting*, July, 2005.
26. K. Balemarthy, S. E. Ralph, R. Lingle, Jr., J. George, P. Kolesar, J. Abbott and S. Swanson, "Study of center launch specification and analysis of draft D2.2 TP3 stressors," *IEEE 802.3aq LRM Standards committee meeting*, Nashua, NH, October 2005.
27. C. P. Caputo, S. E. Ralph, Y. Sun, X. Jiang, R. Lingle, Jr., "Experimental Studies of VCSEL-MMF Transmission Impairments at 850nm," IEEE Next Generation 100Gb/s Optical Ethernet Study Group Interim Meeting, 24-25 Jan. 2012, Newport Beach, CA, USA

E.3 Seminar Presentations

1. *"Transient photorefractive effects in graded-gap superlattices,"* Fraunhofer Institute for Applied Solid State Physics, Freiburg, Germany, January 22, 1989.
2. *"Electronic Raman scattering,"* Florida Institute of Technology, Melb. FL, June 22, 1989.
3. *"Progress in terahertz spectroscopy,"* Brooklyn Polytechnic University, April 1994.
4. "*Ultrafast optical processes in semiconductors and other materials*," MiRC Seminar, Georgia Tech, February 24, 1999.
5. "*Components and systems for 160 Gb/s optical data links*," Seminar, Georgia Tech Lorraine, Metz, France, October 18, 1999.

F

G. Other Scholarly Accomplishments

Patents

G.1 Issued: (16)

1. "Nonlinear optical device structure with compound semiconductor having graded chemical composition," S. E. Ralph and F. C. Capasso, U.S. 4,999,485. 12 March 1991.
2. "Compensation of modal dispersion in optical waveguides," S. E. Ralph and K. Patel, U.S. 6,771,856. August 3, 2004.
3. "Spatially resolved equalization and forward error correction for multimode fiber links," C. Argon, K. M. Patel, S. W. McLaughlin and S. E. Ralph, U.S. 6,847,760, January 25, 2005.
4. "Segmented photodetectors for detection and compensation of modal dispersion in optical waveguides," S. E. Ralph and Ketan Patel, U.S. no. 6,870,152, March 22, 2005.
5. "Multilevel pulse position modulation for efficient fiber optic communication," M. G. Vrazel, S. E. Ralph, V. M. Hietala, December 2006, US 7149256.
6. "Increasing data throughput in optical fiber transmission systems," M. G. Vrazel, S. E. Ralph, J. Laskar, S. Jung, V. M. Hietala, E. Gebera, December 2007, US 7307569.
7. "Increasing data throughput in optical fiber transmission systems," M. G. Vrazel, S. E. Ralph, J. Laskar, S. Jung, V. M. Hietala, E. Gebera, February 2007, US 7173551.
8. "Multilevel pulse position modulation for efficient fiber optic communication," M. G Vrazel, S. E Ralph, V. M. Hietala, 1 April 2008, US 7352824.
9. "High-speed analog-to-digital conversion with improved robustness to timing uncertainty," A. J. Kim, S. E Ralph, S. Bajekal, 26 April 2011, US 7934144.
10. "High-speed analog-to-digital conversion with improved robustness to timing uncertainty," A. J. Kim, S. E Ralph, S. Bajekal, 10 July 2012, US 8,219,893.
11. "Systems and Methods for Autonomous Signal Modulation Format Identification," P. Isautier K. Mehta, A.J. Stark, and S. E. Ralph, US 9,729,362, issued August 8, 2017.
12. "Systems and Methods for Autonomous Signal Modulation Format Identification," P. Isautier and S. E. Ralph, US 9,735,991, issued August 15, 2017.
13. "Systems and Methods for Autonomous Signal Modulation Format Identification," P. Isautier and S. E. Ralph, US 9,768,874, issued September 19, 2017.

14. “Systems and Methods for Identification and Demodulation of Complex Signal Formats,” P. Isautier and S. E. Ralph, US 9,794,092 issued October 17, 2017.

15. “Methods and Devices for Input Signal Conversion Simulation,” S. Varughese, J. S. Langston, V. A. Thomas and S. E. Ralph, US 10,666,277, issued January 2020.

16. “Systems and Methods for Improved Data Transmission in Short-Reach Links,” US Patent Application No.: 16/127,177, Filed: September 10, 2018 GTRC Reference No.: 7398, Allowed December 28, 2020.

17. US Continuation Patent “Application Systems and Methods for Improved Data Transmission in Short-Reach Links” App. No.: 17/209,111, Filing Date: 22 March 2021, GTRC Ref. No.: 7398

18. “Devices, Systems and Methods for Processing Optical Components,” PCT Patent Application, International Filing Date: 5 November 2020 GTRC ID No.: 8286.

Patents 11 to 14 licensed to Harris Corp.

G.2 Recent Invention Disclosures

1. "Raised Cosine Pulses for Multimode Fiber Links," S. Varghese and S. E. Ralph, GTRC ID #7398. Allowed, Patent application US 2019/0081826, Systems and Methods for Improved Data Transmission in Short Reach Links, TroutmanSanders

2. "Blind Classification of OFDM Modulation Parameters," J. Langston and S. E. Ralph, GTRC ID #7444, November 2016, Provisional 62/415,644

3. "Digital-to-Analog Converter model for high-speed optical link simulations," S. Varghese and S. E. Ralph, GTRC ID #7593, June 2017. Full Patent in process TroutmanSanders, 62/537,164

4. "High Power Waveform Generation Using Integrated Photonics," A. Thomas and S. E. Ralph, GTRC ID #7736, November 2017, Provisional 62/583,663

5. "Blind Cyclostationarity-based Format Classification," J. Langston, and S. E. Ralph, GTRC ID #8037 October 2018.

6. "Quasicoherent Receivers for High-Speed Optical Links," A. Thomas and S. E. Ralph, GTRC ID #8051 Nov. 2018.

7. "Optical Anomaly Detection and Impairment Identification Using Adaptive Filter Weights," S. Varghese and S. E. Ralph, GTRC ID #8090, January 2019.

8. "Linearized optical modulators by DC Kerr effect," C. Bottenfield and S. E. Ralph, GTRC ID# 8230, June 2019.

V. Education

A. Individual Student Guidance

A.1 PhD Students

A.1.a PhD Students graduated

1) Yue Chen, Fall 2000
"THz Spectroscopy"
Current Employer, Startup focused on integrated laser systems

2) Paul Juodawlkis, Fall 2001
"Low temperature grown InGaAs quantum wells waveguides for optical device applications"
Current Employer: Division Leader of the Quantum and Electro-Optic Materials and Devices Groups at the MIT Lincoln Laboratory, Lexington, MA 02420

3) Todd Ulmer, Fall 2002
"Surface emitting second harmonic from quasi phase-matched nonlinear waveguides for all-optical demultiplexing"
Current Employer: MIT Lincoln Laboratories, Lexington, MA 02420

4) Brian Washburn, Spring 2002
"Dispersion and nonlinearities associated with supercontinuum generation in microstructured fibers"
Current Employer: NIST, Boulder Colorado

5) J. Scott Rodgers, Fall 2002
"Nonlinear optical switching in multimode interference structures"
Past Employer: DARPA MTO Arlington VA
Current Employer: Lockheed Martin, Arlington VA

6) Michael Gross, Fall 2003
"High repetition rate short pulse laser sources for high data rate optical links"
Current Employer: Applied Physics Laboratory, Johns Hopkins University, Laurel, MD, 20723

7) Pierre A. Lacourt, Summer 2003
"Optical Code division multiple access fiber links"
Thesis defense completed and approved, needs one class to confer degree
Joint Georgia Tech, Metz-Atlanta Ph.D. program
Current Employer: CNRS, Besancon, FR

8) Ketan M. Patel, Fall 2004
"Spatially Resolved Equalization: A New Device Concept in Intermodal Dispersion Compensation for Multimode Fiber"
Current Employer: Princeton Lightwave, Cranbury, NJ 08512

9) Jeffrey Lillie, Spring 2005
"Highly Sensitive, Integrable, Multimode, Interferometric, Evanescent-Wave Chemical Sensor"
Current Employer: Milliken & Company, Spartanburg, SC 29304

10) Kasyapa Balemarthy, Summer 2008
"Electronic equalization of high-speed multimode fiber links"
Current Employer: Optical Fiber Solutions, Norcross, GA 30071

11) Arup Polley, Fall 2008
"Electronic and Optical signal processing for optical fiber links"
University India

12) Joong Kim, Fall 2008
"THz sources for sensing and communications"
Current Employer: Intelligent Sensing Branch, Code T12
Naval Surface Warfare Center, Panama City Division
110 Vernon Avenue Panama City, FL 32407-7001

13) Tom Detwiler, Fall 2011
"Continuous phase and related formats for optical communications"
Current Employer: Microsoft, Huntsville AL

14) Yu-Ting Hsueh (GK Chang primary advisor), Fall 2012
"DQPSK deployments in hybrid fiber networks"
Current Employer: JDSU, Santa Clara, CA

15) Cheng Liu (GK Chang primary advisor), Fall 2013
"Advanced system design and simulation for WDM optical fiber optic networks"
Current Employer: AT&T Wireless, Atlanta, GA, 30308

16) Andrew Stark, Fall 2012
"QAM modulation for coherent WDM optical networks"
Current Employer: Georgia Tech Research Institute, Atlanta GA

17) Jie Pan, Spring 2015
"Signal processing strategies for mitigation of impairments due to fiber and components in DWDM coherent optical networks"
Current Employer: Nokia Bell Labs, Murray Hill, NJ

18) Sriharsha Kota Pavan, Spring 2015
"Simulation tools for VCSEL based high speed optical links"
Current employer: Ayer Labs, Sunnyvale CA

19) Pierre Isautier, Fall 2015
"Autonomous receivers for next generation of high-speed optical communications networks"
Current employer: McKinsey and Company, Atlanta, GA 30308

20) Jerrod Langston, Summer 2019
"Autonomous receivers for next generation of high-speed optical communications networks"
Current employer: L3Harris Corporation, Melbourne FL, 32901

21) Joseph Lavrencik, Spring 2020
"100G VCSEL based optical interconnects"
Current employer: Infinera Corp., Sunnyvale, CA 94089

22) Siddharth Varughese, Fall 2020
"Performance analysis and impairment identification in optical communication systems"
Current employer: Infinera Corp., Savage, MD 20763

23) Alirio Melgar, Spring 2021
"VCSEL based high-capacity links"
Current employer: Lumentum, Sunnyvale CA

24) Christian Bottenfield, Fall 2021
"Integrated microwave photonics"
Current employer: GTRI, Atlanta GA

25) Hyung Joon Cho, Summer 2022
"*Machine learning and performance estimation"*
Current employer: Korea

26) Gareeyasee Saha, Fall 2022
"Silicon Photonics for high-capacity optical systems"
Current employer: AMD, Sunnyvale CA

27) Alec Hammond, Fall 2022
"Topology Optimization"
Current employer: META Reality Labs, Seattle WA

28) Daniel Lippiatt, Fall 2023
"Machine learning and fault detection in high-capacity fiber networks"
Current employer: ADVA, Norcross, GA

A.1.b Current PhD Students (Spring 2023)

1) Michael Hoff
Began advisement, Fall 2019
Project Title: *Integrated photonic systems for analog RF applications*

2) Arjun Khurana
Began advisement, Summer 2021
Project Title: *High-capacity fiber optic interconnects*

3) Jakob Krzyston
Began advisement, Summer 2021
Project Title: *Machine Learning for Fiber Networks*

4) Joel Slaby
Began advisement, Summer 2021
Project Title: *Topology Optimization for Silicon Photonics*

5) Alex Kaylor
Began advisement, Fall 2021
Project Title: *Integrated Microwave Photonics*

6) Michael Probst
Began advisement, Summer 2022
Project Title: *Thin Film Lithium Niobate and Silicon Photonics*

7) Prankush
Began advisement, Summer 2022
Project Title: *DWDM fiber Networks*

8) Jacob Hiesener
Began advisement, Fall 2022
Project Title: *Integrated Microwave Photonics*

9) Meredith Caveney
Began advisement, Spring 2024
Project Title: *Signal Processing and ML for Fiber Com Systems*

A.2 Masters Students

Past M.S. Students Supervised

1) Efrain Figueroa, M.S.E.E., December 1999
Project Title: "Submicron resolution photoluminescence of quantum structures"

2) Bill Astar, [Co-Advisor Prof. C. Verber and R. Kenan], June 2000
Project Title: “Spot size converters for integrated electro-absorption modulators”
Current Employer: Laboratory for Physical Sciences, Univ. of Maryland, College Park, MD.

3) Julaine Taylor Simmons, M.S.E.E., June 2000, Presidential Scholar
Project Title: “Polarization mode distortion in optical links”
Current Employer: M.C. Dean, Inc., Washington D.C.

4) Shannon Madison, M.S.E.E., June 2006
Project Title: “Dense integrated optical switching platform technology”
Past Employer: Lincoln Laboratories, Lexington, MA 02420
Current Employer: National Institute for Standards and Technology, Boulder, CO

5) Rohan Gandhi, M.S.E.E. June 2007
Project Title: “VCSEL signal processing for high-speed multimode fiber links
Current Employer: Applied Micro, Inc., Redwood City, CA

6) Ben Clarke, M.S.E.E., June 2009
Project Title: “OFDM for 40G and 100G fiber networks”
Current Employer: Cox Communications, Atlanta GA

7) Robert Fleming, M.S.E.E., June 2009
Project Title: “Monolithic CMOS photonic receivers for access networks”

8) Steven Searcy, M.S.E.E., December 2010
Project Title: “Simulations for optical networks; impact of component impairments”
Current Employer: ADVA Optical Networks, Norcross, GA

9) Patrick Decker, M.S.E.E., December 2010
Project Title: “Multimode transceivers for short reach and access networks”
Current Employer: Qualcomm, Santa Clara, CA

10) Patrick Caputo, M.S.E.E., June 2012
Project Title: “High-speed optical receivers”
Current Employer: Thorlabs, Ann Arbor, MI

11) Kedar Mehta, M.S.E.E., May 2012
Project Title: “Blind Algorithms for Optical Coherent Receivers”
Current Employer: Qualcomm, India

12) Evan Atwood, M.S.E.E., August 2013
Project Title: “Mixing in high speed photodiodes”
Current employer: Sandia National Labs, Dublin, CA

13) Stuart Hughes, M.S.E.E., August 2015
Project Title: “Photonic devices for In-Phase/Quadrature-Phase Vector Modulation”
Current employer: United States Air Force, Long Island, NY

14) Michael Pratt, M.S.E.E., December 2015
Project Title: *DSP and impairment mitigation in Terabit links*
Current employer: Boeing Satellite Development Center, El Segundo, CA

15) Edward Tan, M.S.E.E., May 2016
Thesis Title: “Hyper-Wideband OFDM System”
Current employer: DoD, MD

16) Stephen Hurst, (December 2018)
Began advisement, Spring 2018
Current employer, GTRI, Spring 2019

17) Daniel Garon, (Spring 2020)
Began advisement, Fall 2018
Current employer: ADVA, Norcross GA

18) Chris Conrey
Began advisement, Fall 2018
Current employer: L3Harris, Palm Bay FL

Undergraduate Students Supervised

1) Stewart Jenkins, B.S. Physics, Georgia Tech, 2001
Georgia Tech SURE program, summer 1999 and Undergraduate research, Fall 1999
Topic: “Temporal analysis of optical microcavities”

2) Mahesh Pai
Undergraduate research, Summer 2000, Indian Institute of Technology
Topic: “Receivers for high-speed optical links”

3) Tushar Thrivikramen, B.S. ECE, Georgia Tech, 2002
Undergraduate research, Summer 2001
Topic: “Multimode Chem/Bio sensors”

4) Rajiv Khosla
Undergraduate research at Georgia Tech, Summer 2001, Indian Institute of Technology
Topic: “Electronic equalization of multimode fiber links,” Summer 2003

5) Kishitz Kumar
Undergraduate research at Georgia Tech, Summer 2001, Indian Institute of Technology
Topic: “Electronic equalization of multimode fiber links,” Summer 2003

6) Mark King, B.S.E.E, Georgia Tech, 2004
Undergraduate research, Summer 2004
Topic: “Nonlinear optical response of nano-metal particles”

7) Chu Meh Chu, B.S.E.E., Georgia Tech
Undergraduate research, Summer 2005, SURE program, NJIT
Topic: “Electronic equalization of multimode fiber links”

8) Kim Wise, B.S.E.E., Georgia Tech
Undergraduate research, Summer 2005
Topic: “Nonlinear optical response of nano-metal particles embedded in glass host”

9) David Fink, B.S.E.E., Georgia Tech
Undergraduate research, Summer 2008
Topic: “Evaluation of 10GbE VCSELs and VCSEL drivers for short reach links”

10) Patrick Caputo, B.S.E.E., Georgia Tech, 2011
Undergraduate research, Fall 2008 and Spring 2009, Spring 2010
Topic: “Optical receivers for access networks”

11) Kevin Anzalone, B.S.E.E., Georgia Tech, 2013
Fall 2012, Spring 2013
Topic: “Signal Processing for coherent optical receivers; efficiency and version control”

12) Clark Kerr, B.S.E.E. Georgia Tech, 2013
Fall 2012, Spring 2013
Topic: “Simulations of optical components for WDM optical fiber networks”

13) Angel Sanchez, B.S.E.E., Georgia Tech 2018
Spring 2017, Fall 2017
Topic: “Graphical interfaces for control of the Terabit Optical Testbed”

14) Kunal Mitra, ECE undergrad, Fall 2017 to present
Topic: “Laboratory Instrumentation for DWDM Networks”

15) Julian Rosker, ECE undergrad, January 2018
Topic: “Packaging of photonic integrated circuits”

16) Chris Conrey, January 2018
Topic: “Numerical investigations of photonic integrated circuits”

17) Joel Slaby, ECE undergrad Fall and Spring 2021, B.S.E.E., Georgia Tech 2021
Topic: “Topology Optimization for silicon photonics”

18) Michael Probst, ECE undergrad Fall and Spring 2022, B.S.E.E., Georgia Tech 2022
Topic: “Topology Optimization for silicon photonics”

19) Joshua Wong, ECE undergrad Fall and Spring 2023, B.S.E.E., Georgia Tech 2023
Topic: High capacity fiber interconnects

Former Post-Doctoral Research Associates Supervised

1) Sriganesh S. Prabhu, 1996-1998
Project: Free carrier dynamics of III-V semiconductors via THz spectroscopy
Current Employer: Tata Institute for Fundamental Research, Mumbai 400 005, India

2) Debasis Dawn, 2011 to 2012
Project: Broadband high-frequency circuits and measurement techniques

3) Kyutae Lim, 2011 to 2014
Project: GEDC Research Associate

4) Cagri Ulusoy, 2012 to 2015
Project: Wideband mixed signal circuits and systems

5) Saeed Zeinolabedinzadeh, Fall 2017 to Spring 2018
Project: Wideband mixed signal circuits and systems

6) Moon-Kyu Cho, Fall 2014 to 2021
Project: Wideband mixed signal circuits and systems

7) Varghese A. Thomas, Fall 2015 to present
Project: High capacity optically amplified optical systems

8) Goker Ariyak, Spring 2022 to present
Projects: Wideband mixed signal circuits and systems

Current Post-Doctoral Research Associates Supervised

1) Varghese A. Thomas, Fall 2015 to present
Project: High capacity optically amplified optical systems

2) Goker Ariyak, Spring 2022 to present
Projects: Wideband mixed signal circuits and systems

Visiting Interns Supervised

1) Visiting PhD Intern, Summer and Fall 2016
Jhon James Granada Torres
Project Title: "Nonlinear signal processing for coherent digital receivers"
Current University: Universidad de Antioquia, Medellin, Columbia

High School Students

1) Kunal Mitra, Summer 2016 to Summer 2017
"Control and interface for ITLA lasers"
High School: The Gwinnett School of Mathematics, Science, and Technology
Began attending, GaTech Fall 2017, major in ECE

B. Educational Innovations and Other Contributions

Revised and updated undergraduate Fiber Optic Communications 4502
The undergraduate fiber lab has undergone a dramatic modernization. This includes a curriculum update to ECE 4502 "Optical Fiber Communications". Major equipment upgrades have been implemented, 5 new experiments for ECE4502 were created and 3 companies agreed to supply free or heavily discounted equipment. The lab was entirely reorganized from "first paint in decades" to surplusing old equipment to organizing existing and installing new equipment. *Six completely new communication link test benches capable of 10 Gbps data rates with real-time waveform capture to enable offline DSP were created*. The curriculum update is mostly complete although course content is constantly evolving to keep up with modern fiber communications systems.

- Dr. Ralph designed new test benches/required equipment, and successfully applied for "Tech Fee" modernization: $40,650.00 for FY19 and $100,394.84 for FY20 enabling a complete lab overhaul
- Tektronix 4GHz (upgradable to 10GHz) real time sampling scope; Tektronix donated 2 new scopes and heavily discounted four others. The lab now has 6 new modern real-time scopes for the price of 2.
- Multiple Keysight 12Gbps pattern generators supplemented with shared signal sources from the undergrad RF lab
- OFS fiber solutions: obtained optical fiber from OFS Solutions (fiber manufacturer located in Norcross.
- Dr. Ralph has also obtained commitments from ADVA Optical Networks (located in Norcross) for addition Optical networking equipment to create a realistic optical networking environment.
- Dr. Ralph also donated equipment and fiber from his research lab to the fiber lab

New lab/equipment enables nearly doubling of allowed enrollment per semester.

New course in Fiber Optic Networks, ECE 6543

Created new course in optical networks spanning optical fiber and component technologies communication theory and signal processing. Topics include: Raman Amplification, EDFAs, nonlinear propagation in fiber, laser fundamentals, modulation, network switches, coherent digital receivers, high spectral efficiency and Nyquist WDM systems, crosstalk, signal processing.

Industrial Issues in Fiber Optics Networks, ECE 8503

Industrial collaborations and special topics in collaboration with BellSouth Telecommunications investigate impact of polarization mode dispersion (PMD) and optical amplification on existing installed fiber plant.

Integrated Optics ECE 4505 and Fiber Optics Communications, ECE 4051

Developed new computer-based numerical investigations of integrated devices and optical channels

Senior Design Undergraduate Class, ECE 4006

Multiple semesters as advisor for our capstone senior design course focusing on optical communications. Example projects include: 10Gbps Optical Links and Raman amplification in multimode fiber, LED based aircraft beacon and ambient lighting communications system.

VI. Service

A. Professional Contributions

Recent:

Panel reviewer for NSF 2021

Panel reviewer for AFOSR MURI 2021

Journal reviewer Journal of Lightwave Technology (IEEE) and Optics Express 2020 thru 2023

Organizing Committee, NASA/JPL 2021 NEPP Electronics Technology Workshop

Organizing Committee: Sixth Workshop on Scalable Information Processing with Quantum Nano-Photonics (SIPQNP), Snowbird Utah, March 16-17, 2020

Elected to Board of Governors, IEEE Photonics Society term January 2019 thru December 2021

Member of Technical Advisory Board, IEEE Photonics Society January 2016 thru Dec 2018

Member *Optical Fiber Conference* Committee, 2018 thru 2023

Member of IEEE Photonics Society Emerging Technologies Committee, 2021 thru 2023

IEEE Photonics Society Treasurer, 2022 - present

IEEE Associate Editor IEEE Transaction on Electron Devices, Optoelectronic devices, 2011 to 2014.
Conference Chair: POF 2012, Plastic Optical Fiber Conference, Atlanta, GA
Member of Organizing Committee, IEEE Summer Topicals: Terabit Optical Ethernet, Montreal Canada, July 2011.
Reviewer for: *Optics Letters, Physical Review B, IEEE Journal of Quantum Electronics, Journal of the Optical Society of America,*
Applied Physics Letters, Journal of Applied Physics,
Photonics Technology Letters, Optics Express,
Journal of Lightwave Technology, IEE Proc. Optoelectronics

Panel Reviewer for National Science Foundation, NSF-Engineering-EPDT-**Panel Reviewer** for National Science Foundation SBIR Engineering

A.1 Campus Contributions:

Managed GT Foundry Services: Continued multiple efforts to sustain and improve Georgia Tech partnership for campus wide access to Global Foundries courtesy fabrication services (value to GT community ~$6-$10M/yr.) 2020 to present

Search committee GTRI EOSL Lab Director 2023
Search committee for GTRI Deputy Director of Research
– Electronics, Optics, and Systems Directorate (EOSD) 2023
Member of GT Chips Coordinating Committee 2023

Member of Search Committee for Packaging Research Center	2023
Member of TSRB Space Committee (organized by EVPR office, Rob Butera)	2021-present
Search committee for GTRI EOSL RFPAM Division Chief	2022
Member of Search Committee for Packaging Research Center	Spring 2018-Spring 2019
Director of the Georgia Electronic Design Center	April 2011 to present
Member of Space Planning Shepherds Committee	September 2015 to September 2016
Member of IRI Research Faculty Promotions Committee	Fall 2012 to 2019
Associate Director GEDC	June 2010-April 2011
Chaired the Optics and Photonics Technical Interest Group	August 2001- July 2004

Standing School Committees

Faculty Recruitment Committee 2005-2009
Faculty RPT Committee 2010- 2013
ECE Graduate Committee 2013- present
ECE External Communications Committee 2022 - present