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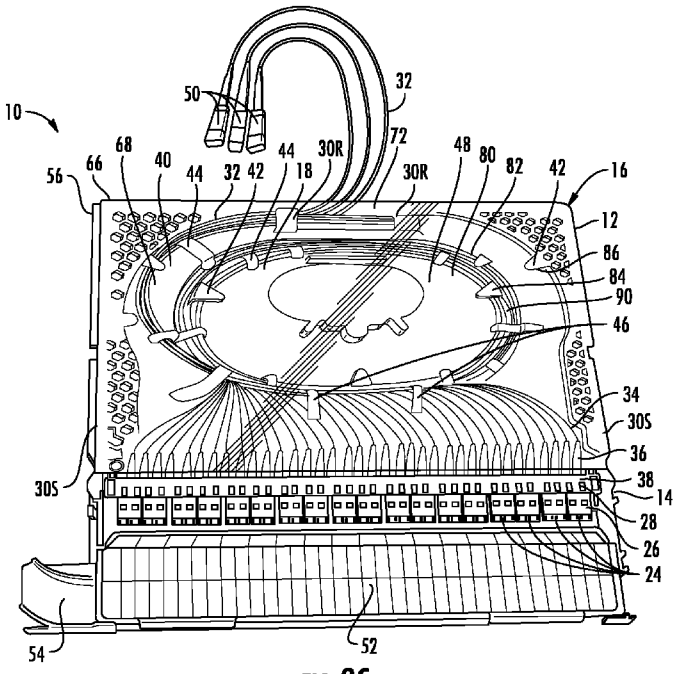

FIG. 2C

(57) **Abstract**: Fiber optic assemblies, including cassettes, with a fiber optic cable movable between cable openings, and related components, systems, and methods, are disclosed. A fiber optic assembly comprises a housing having a front end and a rear end and defining an interior space therein. The fiber optic assembly includes a plurality of cable openings in the housing. Each cable opening is configured to route a fiber optic cable connected to one of a plurality of adapters out of the interior space of the housing. The fiber optic assembly is configured to allow the fiber optic cable to be moved from one of the cable openings to another of the cable openings when one or both panels are moved into the open position.

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FIBER OPTIC ASSEMBLIES WITH A FIBER OPTIC CABLE MOVABLE BETWEEN CABLE OPENINGS

CROSS REFERENCE TO RELATED APPLICATIONS

[0005] This application claims the benefit of priority under U.S.C. 119 of U.S. Provisional Application Serial No. 62/108,246, filed January 27, 2015, the content of which is relied upon and incorporated herein by reference in its entirety.

BACKGROUND

[0001] The technology of the disclosure relates to fiber optic modules provided in fiber optic equipment to support fiber optic connections, and in particular fiber optic assemblies, including cassettes, with a fiber optic cable movable between cable openings, and related components, systems, and methods.

[0002] Benefits of optical fiber use include extremely wide bandwidth and low noise operation. Because of these advantages, optical fiber is increasingly being used for a variety of applications, including but not limited to broadband voice, video, and data transmission. Fiber optic networks employing optical fiber are being developed and used to deliver voice, video, and data transmissions to subscribers over both private and public networks. These fiber optic networks often include separated connection points at which it is necessary to link optical fibers in order to provide "live fiber" from one connection point to another connection point. In this regard, fiber optic equipment is located in data distribution centers or central offices to support interconnections.

[0003] The fiber optic equipment is customized based on the application need. The fiber optic equipment is typically included in housings that are mounted in equipment racks to maximize space. One example of such fiber optic equipment is a fiber optic module. A fiber optic module is designed to provide cable-to-cable fiber optic connections and manage the polarity of fiber optic cable connections. The fiber optic module is typically mounted to a chassis which is then mounted inside an equipment rack or housing. The chassis may be provided in the form of a tray that is extendable from the equipment rack like a drawer. This allows a technician access to fiber optic adapters disposed in the fiber optic module and any fiber optic cables connected to the fiber optic adapters without removing the fiber optic module from the equipment rack.

[0004] Even with advancements in access to fiber optic modules, the labor associated with installing fiber optic modules and making optical connections is significant. For example, for a field technician to install a new fiber optic module, the field technician typically loads trunk cables in the rear section of a fiber optic equipment rack. The field technician then feeds the connectorized fanout legs from the trunk cable to the front of the equipment rack. The field technician then walks around to the front of the equipment rack to connect the fanout legs to a fiber optic module. Because data distribution centers are typically large facilities with significant numbers of equipment racks, walking back and forth from the rear section to the front section of the equipment rack during an installation can take significant time. Alternatively, a second technician may work in tandem with the first technician, where the first technician manages loading of fiber optic cables in the rear section of the equipment rack. The second technician remains in the front of the rack to install the fiber optic modules and establish optical connections between the fiber optic cables and the fiber optic modules. In either scenario, fiber optic cables are installed in the rear section of the equipment rack and the fiber optic modules and connections are installed from the front of the equipment rack thereby requiring extensive labor.

SUMMARY

[0006] Fiber optic assemblies, including cassettes, with a fiber optic cable movable between cable openings, and related components, systems, and methods, are disclosed herein. In an embodiment, a fiber optic assembly comprises a housing having a front end and a rear end. The housing defines an interior space therein, having one or more access openings, with one or more panels connected to the housing and movable between a closed position and an open position. In the closed position, each panel covers a part of the access opening, with the open position permitting access to the interior space of the housing. The fiber optic assembly also includes a plurality of adapters, each having a front and a rear disposed in the front end of the housing. The front of each adapter is accessible from the front end of the housing when the fiber optic assembly is mounted in a fiber optic chassis. The fiber optic assembly also includes a plurality of cable openings in the housing. Each cable opening is configured to route a fiber optic cable connected to the plurality of adapters out of the interior space of the housing. In this embodiment, cable openings may be disposed in the sides of the housing, at the rear end of the housing, or in the front end of the housing. The fiber optic assembly is configured to allow the fiber optic cable to be moved from one of the cable openings to

another of the cable openings when one or both panels are moved into the open position. One benefit of this arrangement is that a portion of a fiber optic cable, such as a pigtail cable, may be moved between a number of differently located cable openings, thereby allowing more versatility in routing fiber optic cables in and out of the housing of the fiber optic assembly.

[0007] In an exemplary embodiment, a fiber optic assembly is disclosed. The fiber optic assembly comprises a housing having a front end and a rear end, the housing defining an interior space therein. The fiber optic assembly further comprises at least one access opening in the housing. The fiber optic assembly further comprises at least one panel connected to the housing and movable between a closed position removably covering at least part of the at least one access opening, and an open position. The fiber optic assembly further comprises a plurality of adapters each having a front end and a rear end disposed in the front end of the housing such that the front end of each of the plurality of adapters is accessible from the front end of the housing when the fiber optic assembly is mounted in a fiber optic chassis. The fiber optic assembly further comprises a plurality of cable openings in the housing configured to route at least one fiber optic cable connected to at least one of the plurality of adapters out of the housing. The fiber optic assembly is configured to allow at least one fiber optic cable connected to at least one of the plurality of adapters to be moved from one of the plurality of cable openings to another of the plurality of cable openings when the panel is moved into the open position.

[0008] In another exemplary embodiment, a fiber optic chassis is disclosed. The fiber optic chassis comprises a housing defining an interior. The fiber optic chassis further comprises at least one fiber optic assembly mounted in the interior of the chassis. Each fiber optic assembly comprises a housing having a front end and a rear end, the housing defining an interior space therein. Each fiber optic assembly further comprises at least one access opening in the housing. Each fiber optic assembly further comprises at least one panel connected to the housing and movable between a closed position removably covering at least part of the at least one access opening, and an open position. Each fiber optic assembly further comprises a plurality of adapters each having a front end and a rear end disposed in the front end of the housing such that the front end of each of the plurality of adapters is accessible from the front end of the housing when the fiber optic assembly is mounted in a fiber optic chassis. Each fiber optic assembly further comprises a plurality of cable openings in the housing configured to route at least one fiber optic cable connected to at least one of the plurality of adapters out of the housing. Each fiber optic assembly is configured to allow

at least one fiber optic cable connected to at least one of the plurality of adapters to be moved from one of the plurality of cable openings to another of the plurality of cable openings when the panel is moved into the open position.

[0009] In another exemplary embodiment, a method of reconfiguring a fiber optic assembly, the fiber optic assembly having a front end and a rear end and defining an interior space therein is disclosed. The method comprises accessing the interior space of the fiber optic assembly via at least one access opening in the housing. The method further comprises removing a fiber optic cable extending from one or more adapters disposed in the front end of the housing to an exterior of the housing through a first cable opening in the housing. The method further comprises disposing the fiber optic cable through a second cable opening in the housing such that the fiber optic cable extends from the one or more adapters disposed in the front end of the housing to an exterior of the housing through the second cable opening in the housing.

[0010] Additional features and advantages will be set forth in the detailed description which follows, and in part will be readily apparent to those skilled in the art from the description or recognized by practicing the embodiments as described in the written description and claims hereof, as well as the appended drawings.

[0011] It is to be understood that both the foregoing general description and the following detailed description are merely exemplary, and are intended to provide an overview or framework to understand the nature and character of the claims.

[0012] The accompanying drawings are included to provide a further understanding, and are incorporated in and constitute a part of this specification. The drawings illustrate one or more embodiment(s), and together with the description serve to explain principles and operation of the various embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] **FIGS. 1A** and **1B** are top and bottom perspective views of a fiber optic assembly having a plurality of cable openings for rerouting a fiber optic cable according to an embodiment;

[0014] **FIGS. 2A-2C** are detailed perspective views of the fiber optic assembly of Figures 1A and 1B illustrating an exemplary method of rerouting the fiber optic cable according to an embodiment;

[0015] **FIGS. 3A** and **3B** are bottom schematic views of the fiber optic assembly of **FIGS. 1A-2C** illustrating strain relief features disposed between the slack storage areas and cable openings of the fiber optic assembly;

[0016] **FIG. 4** is a rear perspective view of an exemplary fiber optic chassis having a plurality of fiber optic assemblies according to **FIGS. 1A-3B** mounted therein, with a rear adapter panel attached thereto;

[0017] **FIG. 5** is a detailed perspective view of the rear adapter panel shown in **FIG. 4** configured to mount to a fiber optic chassis;

[0018] **FIG. 6** is a detailed perspective view of a front adapter panel configured to mount proximate a front end of a fiber optic chassis;

[0019] **FIGS. 7A** and **7B** are front perspective and front schematic views of an exemplary fiber optic rack having the chassis of **FIG. 4** mounted thereon;

[0020] **FIGS. 8A** and **8B** are top schematic and rear perspective views of a fiber optic assembly having a housing with a plurality of multi-fiber connectors mounted in the rear thereof, according to an alternative embodiment; and

[0021] **FIG. 9** is a front perspective view of a fiber optic assembly having a housing with single fiber and multi-fiber connectors mounted in the front thereof, according to an alternative embodiment.

DETAILED DESCRIPTION

[0022] Fiber optic assemblies, including cassettes, with a fiber optic cable movable between cable openings, and related components, systems, and methods, are disclosed herein. In an embodiment, a fiber optic assembly comprises a housing having a front end and a rear end. The housing defines an interior space therein, having one or more access openings, with one or more panels connected to the housing and movable between a closed position and an open position. In the closed position, each panel covers a part of the access opening, with the open position permitting access to the interior space of the housing. The fiber optic assembly also includes a plurality of adapters, each having a front and a rear disposed in the front end of the housing. The front of each adapter is accessible from the front end of the housing when the fiber optic assembly is mounted in a fiber optic chassis. The fiber optic assembly also includes a plurality of cable openings in the housing. Each cable opening is configured to route a fiber optic cable connected to the plurality of adapters out of the interior space of the housing. In this embodiment, cable openings may be disposed in the sides of the housing,

at the rear end of the housing, or in the front end of the housing. The fiber optic assembly is configured to allow the fiber optic cable to be moved from one of the cable openings to another of the cable openings when one or both panels are moved into the open position. One benefit of this arrangement is that a portion of a fiber optic cable, such as a pigtail cable, may be moved between a number of differently located cable openings, thereby allowing more versatility in routing fiber optic cables in and out of the housing of the fiber optic assembly.

[0023] As used herein, it is intended that the terms "fiber optic cable" and "optical cable" include all types of fiber optic cables and optical fibers including single mode and multi-mode light waveguides, and including one or more bare optical fibers, loose-tube optical fibers, tight-buffered optical fibers, ribbonized optical fibers, bend-insensitive optical fibers, or any other expedient of a medium for transmitting light signals, or as otherwise may be relevant to the specific context.

[0024] Embodiments of optical cable assemblies, such as cassettes, and systems and methods employing optical cable assemblies will now be described with reference to the figures. In this regard, **FIGS. 1A** and **1B** illustrate a fiber optic assembly **10**. The fiber optic assembly **10** comprises a housing **12** having a front end **14** and a rear end **16**. The housing **12** defines an interior space **18** therein, having one or more access openings **20** (see **FIG. 1B**). In this embodiment, a pair of panels **22** (see **FIG. 1B**) is connected to the housing **12** and is movable between a closed position and an open position. In the closed position, each panel **22** covers a part of the access opening **20**, with the open position permitting access to the interior space **18** of the housing **12**.

[0025] The fiber optic assembly **10** also includes a plurality of fiber optic adapters **24**, each having a front **26** and a rear **28** disposed in the front end **14** of the housing **12**. The front **26** of each fiber optic adapter **24** is accessible from the front end **14** of the housing **12** when the fiber optic assembly **10** is mounted in a fiber optic chassis (not shown). The fiber optic assembly **10** also includes a plurality of cable openings **30** in the housing **12**. Each cable opening **30** is configured to route a fiber optic cable **32** connected to the plurality of fiber optic adapters **24** out of the interior space **18** of the housing **12**. In this embodiment, cable openings **30** may be disposed in the sides of the housing **12** (see cable opening **30S**), at the rear end **16** of the housing **12** (see cable opening **30R**), or in the front end **14** of the housing **12** (see cable opening **30F''** shown in **FIG. 9**).

[0026] As will be described in detail below, the fiber optic assembly **10** is configured to allow the fiber optic cable **32** to be moved from one of the cable openings **30** to another of

the cable openings **30** when one or both panels **22** are moved into the open position. One benefit of this arrangement is that a portion of a fiber optic cable, such as a pigtail cable, may be moved between a number of differently located cable openings, thereby allowing more versatility in routing fiber optic cables in and out of the housing **12** of fiber optic assembly **10**.

[0027] As shown in **FIG. 1A**, fiber optic cable **32** may include a plurality of optical fibers **34** terminated by a plurality of fiber optic connectors **36**. In this embodiment, the fiber optic connectors **36** are disposed in the rears **28** of a fiber optic adapters **24**, which are in turn retained in an adapters retention structure **38** located at the front end **14** of housing **12**. In addition, excess length of fiber optic cable **32** can be coiled and stored in a slack storage tray 40 disposed in the interior space **18** of housing **12**. In this embodiment, slack storage tray **40** includes a plurality of cable retaining members **42** and retention clips **44** for retaining and guiding the excess length of fiber optic cable **32** in the slack storage tray **40**. In addition, additional guide tabs 46 may also be used to guide individual optical fibers **34** between the slack storage tray 40 and the individual fiber optic adapters **24**.

[0028] In this embodiment as well, a removable cover **48** covers and encloses the top of the housing **12**, thus enclosing the fiber optic connectors **36** within the interior space **18** of the housing **12**. The other end of fiber optic cable **32** is routed through and may be retained by a cable opening **30** (cable opening **30S** in this embodiment) and terminates in a plurality of fiber optic connectors **50** in the opposite ends of the optical fibers **34**. It should be understood that this end of the fiber optic cable may alternatively use one or more multi-fiber connectors in place of or in addition to connectors **50**, or omit connectors **50** and be a non-terminated cable stub, which can then be spliced to another fiber optic cable or cables, as desired.

[0029] As another example of an additional feature, the fiber optic assembly **10** may include a drop handle **52** having a cable guide end **54**. The drop handle **52** may cover the adapter panel 38 when the adapter panel **38** is not in use, and may also protect connectors that are plugged into the adapter panel **40** when the adapter panel **38** is in use. In some embodiments, the drop handle **52** may include a pivot hinge (not shown) that allows the drop handle **52** to swing up or down to provide access to the adapter panel **38**. Cable guide end **54** is also configured to facilitate fiber optic connections at the front end **14** of the housing **12**, for example by guiding fiber optic cables and/or optical fibers towards and away from the adapter panel **38** at the front end **14** of the housing **12**. In addition, the housing **12** may

include one or more guide rails **56** to facilitate guiding and aligning the fiber optic assembly 10 when the fiber optic assembly **10** is inserted into a fiber optic chassis.

[0030] Referring now to **FIG. 1B**, a bottom view of the fiber optic assembly **10** of **FIG. 1A** is illustrated. As discussed above, the bottom of housing **12** may include a pair of transparent movable panels **22**, each covering a portion of the access opening **20** of interior space 18. The interior space **18** includes additional slack storage, with additional guide tabs 58 configured to guide and retain excess length of fiber optic cable **32**. As can be more clearly seen in **FIG. 1B**, fiber optic cable **32** is routed out of one of the cable openings **30** (cable opening 30S in this example) and out of the housing **12**. As will be discussed below with respect to **FIGS. 2A** and **2B**, by moving one or both of the panels **22** into their open position, the fiber optic cables **32** can be removed from cable opening **30S** and placed in any of the other cable openings **30**, such as cable openings **30R**, or a different cable opening **30S**. To avoid undesirable strain and bending on individual optical fibers **34**, in this embodiment, one or more curved cable guides **60** is disposed proximate to one or more of the cable openings **30**. Each curved cable guide **60** has a curved surface **62** having a sufficient radius of curvature to avoid bending one or more optical fibers **34** beyond an acceptable bend radius. In this manner, a fiber optic cable **32** may be coiled within the interior space 18 in either direction, while maintaining the ability to be routed through any of the plurality of cable openings **30**, regardless of the direction of approach to the cable opening **30** by the fiber optic cable **32**.

[0031] Referring now to **FIGS. 2A** and **2B**, an exemplary method of reconfiguring fiber optic assembly **10** is illustrated. In **FIG. 2A**, the pair of panels **22** are moved to an open position to provide access to access opening **20** of interior space **18**. In this embodiment, the panels are rotatably connected to the housing **12** via hinges **64**. Once the interior space **18** is accessed, the fiber optic cable **32** may be removed from cable opening **30S**, and moved to another cable opening **30**, such as cable opening 30R in this example. Referring now to **FIG. 2B**, the fiber optic cable **32** is now disposed through cable opening **30R** in the housing **12** such that the fiber optic cable **32** extends from the adapters disposed in the front end 14 of the housing **12** to the exterior of the housing **12** through the rear cable opening **30R** in the housing **12**.

[0032] Referring now to **FIG. 2C**, a top view of the reconfigured fiber optic assembly **10** is illustrated. In this example, the configuration of fiber optic assembly **10** is similar to the configuration illustrated by **FIG. 1A**, with the exception of fiber optic cable **32** extending

from cable opening **30R** rather than cable opening **30S**, as in **FIG. 1A**. In this manner, fiber optic assembly **10** can be reconfigured to accommodate a number of fiber optic routing schemes.

[0033] The fiber optic assembly **10** in this embodiment is a fiber optic cassette. Exemplary fiber optic cassettes that may include additional features suitable for use with the fiber optic assembly **10** of **FIGS. 2A-2C** are described in commonly-owned United States Patent Application Publication 2014/0348479, which is hereby incorporated by reference for describing similar features of fiber optic cassettes, such as splice cassettes. It should also be understood that other types of fiber optic assemblies may also employ features described herein, such as, without limitation, fiber optic modules or fiber optic adapter panels. As used herein, the term "cassette" refers to a fiber optic assembly having one or more fiber optic adapters disposed therein, and configured to facilitate connection of one or more fiber optic cables therein, for example, by splicing. As used herein, the term "module" refers to a fiber optic assembly having one or more fiber optic adapters disposed therein, and configured to facilitate optical connections between and among the plurality of adapters. It should also be noted that the terms "cassette" and "module" are not mutually exclusive and may refer to similar fiber optic assemblies.

[0034] Referring now to the additional structural details of the fiber optic assembly **10** of **FIGS. 2A-2C**, the fiber optic assembly **10** may include a tray base **66** having a tray top surface **68** and a tray bottom surface **70**. The tray base **66** may include a transition passage **72** through which a slack cable can be routed from the tray top surface **68** to the tray bottom surface **70**. A tray-bottom substructure **74** may protrude from the tray bottom surface **70** and may have a substructure wall **76** between the tray-bottom substructure **74** and the tray bottom surface **70**. A continuous slack passage may be defined outwardly on the tray bottom surface **70** from the substructure wall **76** of the tray-bottom substructure **74**. The continuous slack passage may include a first slack region **78A** and a second slack region **78B** on opposite sides of the tray-bottom substructure **74**, which are covered by respective panels **22**.

[0035] In some embodiments, as shown in **FIG. 2C**, a tray center portion **80** may be defined on the tray top surface 68 inside a center-portion periphery **82**. A plurality of tray cable retaining members **42** such as periphery members **84** and outer members **86** may be arranged around or outside of the center-portion periphery **82** for either or both guiding and retaining optical cables around the center-portion periphery **82**. The tray center portion 80

may be a depression in the tray top surface **68** that corresponds with the tray-bottom substructure **74** on the tray bottom surface **70** (see **FIG. 2B**).

[0036] In some embodiments, the tray cover **48** may be made of a transparent or translucent material that enables a technician to view connections and devices on the tray base **66** through the tray cover **48**. The tray base **66** may be made of a rigid material such as a plastic or polymer and may be made by any suitable technique such as molding or pressing, for example. In some embodiments, the tray center portion **80** of tray base **66** may be a depression in the center of the tray base **66**, such that the center-portion periphery **82** is defined by outer walls of the depression. In other embodiments, the tray top surface **68**, including the tray center portion **80**, may be substantially planar, such that the center-portion periphery **82** may be defined by one or more raised features connected to the tray top surface **68**.

[0037] The tray center portion **80** may be disposed within a plurality of tray cable retaining members **42** such as periphery members **88** arranged around the center-portion periphery **82**. The plurality of tray cable retaining members **42** may secure the fiber optic cable **32** running within the tray center portion **80**, within a cable track **90** outside the tray center portion **80**, or both. Cables running within the cable track **90** may also be secured by outer members **86**. The periphery members **88** and the outer members **86** may be any suitable structure that guides, catches, or secures optical cables, or that facilitates winding or wrapping of the fiber optic cable **32** along a predetermined pathway such as within the cable track **90**.

[0038] The tray base **66** may include a transition passage **72** through which the fiber optic cable **32** can be routed from the tray top surface **68** to the tray bottom surface **70**. The transition passage **72** may be any feature such as a notch or a hole in the tray base **66** configured such that slack cable that may be routed through the cable track **90** can be easily directed from the tray top surface **68** to the tray bottom surface **70**. In this embodiment, the rear cable openings **30R**, in addition to providing access for the fiber optic cable **32** out of the housing **12**, may also facilitate routing the fiber optic cable **32** in and out of the transition passage **72**. The tray bottom surface **70** may also contain features that allow the tray bottom surface **70** to be used to store a significant amount of slack cable that may be used by a technician during installation, repair, or replacement of the fiber optic assembly **10**. Features of the tray bottom surface **70** will now be described in greater detail.

[0039] Referring back to **FIG. 2B**, guidance of optical cables **32** around the continuous slack passage may be facilitated by slack-passage guidance members **98** positioned at bends of the continuous slack passage. Additional guidance and retaining of optical cables may be provided by retaining members **42** such as slack-passage overhead retaining member **100**.

[0040] The panels **22** may include corner securing members **102** that hold the each panel **22** in a closed position, such as during storage of the fiber optic assembly **10**. Each of the corner securing members **102** may be configured as snap hooks having a resilience that enables the snap hooks to lock into the tray base **66** when the panels **22** are closed. The corner securing members **102** may lock into corresponding cover tabs **104** on the tray base **66**.

[0041] Referring now to **FIG. 3**, a detailed view of the cable guide **60** is illustrated. **FIG. 3** illustrates how the fiber optic cable **32** is coiled in a clockwise pattern within slack regions **78A, 78B** of the interior space **18** of the housing **12**. The fiber optic cable **32** can easily be routed out of the left-hand side cable opening **30S(1)** because the bend radius of the cable is not in danger of exceeding its bend radius parameters. However, if the fiber optic cable 32 is routed out of the right-hand cable opening **30S(2)**, as shown by **FIG. 3B**, there is greater risk of excessive bending and damage to the optical fiber because the bend radius of the fiber optic cable **32** is significantly reduced compared to the bend radius of the slack regions **78A, 78B**. To prevent this from occurring, portions of the housing **12** on both sides of the slack regions **78A, 78B** include cable guides **60** having a curved surface **62** that curves toward the respective cable opening **30S**. Thus, even if the fiber optic cable is coiled in a direction that curves away from the respective cable opening **30S**, the fiber optic cable **32** can provide strain relief for the required direction change of the fiber optic cable **32**. When tension is applied to the fiber optic cable **32**, as shown by dashed line representation referred to as fiber optic cable **32'**, the fiber optic cable **32'** is prevented from sharply bent by the curved surface **62** of cable guide **60**.

[0042] This versatility in routing fiber optic cable out of the fiber optic assembly **10** leads to added versatility when the fiber optic assembly **10** is disposed in a fiber optic chassis and/or rack configuration. In this regard, **FIG. 4** illustrates a fiber optic chassis **112** in which a plurality of fiber optic assemblies **10** are disposed. The fiber optic chassis **112** includes a chassis housing **114** having a top **116**, a bottom **118**, and two sides **120**. The sides **120** of chassis housing **114** also have mounting brackets **122** attached thereto. Each mounting

bracket **122** in this embodiment includes a rack mounting flange **124** for mounting the fiber optic chassis **112** to a fiber optic rack (not shown).

[0043] In this embodiment, fiber optic chassis **112** also includes a rear adapter panel 126 attached to chassis housing **114**. The rear adapter panel **126** includes a plurality of openings **128** in which a plurality of fiber optic adapters **130** are disposed. The rear adapter panel **126** also includes a plurality of mounting holes **132** arranged on a pair of chassis mounting flanges **134**, to facilitate connection of the rear adapter panel **126** to the side **120** of chassis housing **114**. It should be understood that while the rear adapter panel **126** in this embodiment uses mounting holes **132**, such as screw holes, other mounting and/or fastening structures may be employed to attach rear adapter panel **126** to the chassis housing **114**.

[0044] Referring now to **FIG. 5**, a detailed view of rear adapter panel **126** is illustrated. As shown in **FIG. 5**, each adapter **130** has a first end **136** on one side of the adapter panel **126** and a second side **138** disposed on the other side of the adapter panel **126**. This arrangement allows fiber optic cables, such as the fiber optic cable **32** extending from the exemplary fiber optic assembly **10**, to be connected to one or more adapters **130** of rear adapter panel **126**. Additional fiber optic cables can then be connected directly to the stationary rear adapter panel **126**, as opposed to connecting to a loose fiber optic pigtail extending from one or more of the fiber optic assemblies **10**.

[0045] In another embodiment shown in **FIG. 6**, a front adapter panel **140** may instead be mounted to or approximate to a front side of chassis **112**. In this embodiment, front adapter panel **140** includes a plurality of angled flanges **142**, each having a plurality of openings **144** for receiving and retaining a plurality of fiber optic adapters **146**. Each fiber optic adapter **146** in this embodiment has a first side **148** angled vertically upward and a second side **150** angled vertically downward. One advantage of this arrangement is that the amount of horizontal space required for connectors connected to either end of a fiber optic adapter **146** is reduced, thereby allowing the connectors connected to the front adapter panel **140** to be fit into a smaller horizontal space.

[0046] Front adapter panel **140** may be configured to be attached to a fiber optic chassis or fiber optic rack via one or more mounting holes **152** disposed in a mounting flange **154**. Referring now to **FIGS. 7A** and **7B**, a fiber optic rack **156** having a fiber optic chassis **112** mounted thereon is illustrated. In this embodiment, the fiber optic chassis **112** has a plurality of fiber optic assemblies **10** mounted therein. Fiber optic chassis **112** is also mounted to the fiber optic rack **156** via the rack mounting flanges **124** of the attached mounting brackets **122**

(see **FIG. 4**). Fiber optic rack **156** comprises a rigid rack frame **158** including a plurality of vertical rack rails **160**. In this embodiment, rack mounting flanges **124** may be removably attached to the vertical rack rails **160**.

[0047] In this embodiment as well, front adapter panel **140** is also attached to one of the vertical rack rails **160** proximate to one of the rack mounting flanges **124** of the chassis **112**. In this embodiment, the rack mounting **124** of fiber optic chassis **112** and the mounting flange **154** of the front adapter panel **140** are sandwiched together and may be attached to vertical rack rail **160** via common mounting holes, or, in other embodiments, may be separately and independently attached to the vertical rack rail **160**.

[0048] It should be understood that the additional configurations for the fiber optic assemblies described above are contemplated. In this regard, **FIGS. 8A** and **8B** are top schematic and rear perspective views of a fiber optic assembly **10'** having a housing **12'** with a plurality of multi-fiber adapters **162** mounted in the rear end **16'** thereof, according to an alternative embodiment. In this embodiment, except where indicated, the fiber optic assembly **10'** may include similar features described above with respect to the embodiment of **FIGS. 1A-2C**. As with the embodiment of **FIGS. 1A-2C**, the housing **12'** of fiber optic assembly has a front end **14'** and a rear end **16'**. The housing **12'** defines an interior space **18'** therein. The fiber optic assembly **10'** also includes a plurality of fiber optic adapters **24'**, each having a front **26'** and a rear **28'** disposed in the front end **14'** of the housing **12'**. The front **26'** of each fiber optic adapter **24'** is accessible from the front end **14'** of the housing **12'** when the fiber optic assembly **10'** is mounted in a fiber optic chassis, such as fiber optic chassis **112** of **FIG. 4**. The fiber optic assembly **10'** also includes a plurality of cable openings **30'** in the housing **12'**.

[0049] In the embodiment of **FIGS. 8A** and **8B**, one or more of the plurality of cable openings **30'** are sized and adapted to receive and support one or more multi-fiber adapters **162** for receiving one or more multifiber connectors (not shown). In this embodiment, multi-fiber adapter **162** are mounted in rear cable opening **30R'**. Each multi-fiber adapter **162** has a front end **164** disposed inside the interior space **18'** and a rear end **164** disposed outside the interior space **18'**. Thus, in this embodiment, connectorized cables (not shown) may be routed between and among the fiber optic adapters **24'** and multi-fiber adapters **162**. Connectorized cables may also be moved and rerouted between and among the fiber optic adapters **24'** and multi-fiber adapters **162**, in order to reconfigure the fiber optic assembly **10'** as desired. In this manner, the fiber optic adapters **24'** and multi-fiber adapters **162** may

provide connection points for one or more fiber optic connectors at different points on the housing **12'** of fiber optic assembly **10'**, in order to provide easier and more efficient access and reconfigurability to the fiber optic cabling therein.

[0050] It should be understood that multi-fiber adapters **162** may be disposed anywhere on the housing **12'**. In this regard, **FIG. 9** is a front perspective view of a fiber optic assembly **10''** having a housing **12''** with single fiber adapters **24''** and multi-fiber adapters **162''** mounted in the front end **14''** thereof, according to an alternative embodiment. In this embodiment, as with the embodiment of **FIGS. 8A** and **8B**, the fiber optic assembly **10''** may include similar features described above with respect to the embodiment of **FIGS. 1A-2C**, except where indicated. As with the embodiment of **FIGS. 1A-2C**, the housing **12''** of fiber optic assembly has a front end **14''** and a rear end **16''**. The housing **12''** defines an interior space **18''** therein. The fiber optic assembly **10''** also includes a plurality of fiber optic adapters **24''**, each having a front **26''** and a rear **28''** disposed in the front end **14''** of the housing **12''**. The front **26''** of each fiber optic adapter **24''** is accessible from the front end **14''** of the housing **12''** when the fiber optic assembly **10''** is mounted in a fiber optic chassis, such as fiber optic chassis **112** of **FIG. 4**. The fiber optic assembly **10'** also includes a plurality of cable openings **30''** in the housing **12''**.

[0051] In this embodiment, one or more multi-fiber adapters **162''** are mounted in a front cable opening **30F''** adjacent to the fiber optic adapters **24''** disposed in the front end **14''** of the housing **12''**. Each multi-fiber adapter **162''** has a front end **164''** disposed inside the interior space **18''** and a rear end **166''** disposed outside the interior space **18'**. Thus, in this embodiment, connectorized cables (not shown) may be routed between and among the fiber optic adapters **24''** and multi-fiber adapters **162**'', similar to the embodiment of **FIGS. 8A** and **8B**.

[0052] Unless otherwise expressly stated, it is in no way intended that any method set forth herein be construed as requiring that its steps be performed in a specific order. Accordingly, where a method claim does not actually recite an order to be followed by its steps or it is not otherwise specifically stated in the claims or descriptions that the steps are to be limited to a specific order, it is no way intended that any particular order be inferred.

[0053] It will be apparent to those skilled in the art that various modifications and variations can be made without departing from the spirit or scope of the disclosure. Since modifications combinations, sub-combinations and variations of the disclosed embodiments incorporating the spirit and substance of the disclosure may occur to persons skilled in the art,

the disclosure should be construed to include everything within the scope of the appended claims and their equivalents.

What is claimed is:

1. A fiber optic assembly comprising:

a housing having a front end and a rear end, the housing defining an interior space therein;

at least one access opening in the housing;

at least one panel connected to the housing and movable between a closed position covering at least part of the at least one access opening, and an open position;

a plurality of adapters each having a front end and a rear end disposed in the front end of the housing such that the front end of each of the plurality of adapters is accessible from the front end of the housing when the fiber optic assembly is mounted in a fiber optic chassis; and

a plurality of cable openings in the housing configured to route at least one fiber optic cable connected to at least one of the plurality of adapters out of the housing;

wherein, when the at least one panel is moved into the open position, at least one fiber optic cable connected to at least one of the plurality of adapters is movable from one of the plurality of cable openings to another of the plurality of cable openings.

2. The fiber optic assembly of claim 1, wherein at least one of the plurality of cable openings is located in a side wall of the housing extending between the front end and the rear end of the housing.

3. The fiber optic assembly of claim 2, wherein the at least one of the plurality of cable openings is located in the rear end of the housing.

4. The fiber optic assembly of claim 2, wherein the at least one of the plurality of cable openings is located in the front end of the housing.

5. The fiber optic assembly of claim 1, wherein at least one of the plurality of cable openings is located in the rear end of the housing.

6. The fiber optic assembly of claim 5, wherein at least one of the plurality of cable openings is located in the front end of the housing.

7. The fiber optic assembly of claim 1, wherein at least one of the plurality of cable openings is located in the front end of the housing.

8. The fiber optic assembly of claim 1, wherein the assembly is a fiber optic cassette.

9. The fiber optic assembly of claim 1, wherein the assembly is a fiber optic module.

10. The fiber optic assembly of claim 1, further comprising at least one cable guide disposed in the housing proximate at least one of the plurality of cable openings, the at least one cable guide having at least one curved surface configured to guide and provide strain relief to the at least one fiber optic cable when the fiber optic cable is disposed in the respective cable opening.

11. The fiber optic assembly of claim 1, wherein the at least one panel is removably connected to the housing.

12. A fiber optic system comprising:

a chassis housing defining an interior;

at least one fiber optic assembly mounted in the interior of the chassis, each fiber optic assembly comprising:

a housing having a front end and a rear end, the housing defining an interior space therein;

at least one access opening in the housing;

at least one panel connected to the housing and movable between a closed position removably covering at least part of the at least one access opening, and an open position;

a plurality of adapters each having a front end and a rear end disposed in the front end of the housing such that the front end of each of the plurality of adapters is accessible from the front end of the housing when the fiber optic assembly is mounted in a fiber optic chassis; and

a plurality of cable openings in the housing configured to route at least one fiber optic cable connected to at least one of the plurality of adapters out of the housing;

wherein, when the at least one panel of the at least one one fiber optic assembly is moved into the open position, at least one fiber optic cable connected to at least one of the plurality of adapters is movable from one of the plurality of cable openings to another of the plurality of cable openings.

13. The fiber optic chassis of claim 12, further comprising at least one adapter panel comprising a plurality of fiber optic adapters mounted therethrough and configured to receive the at least one fiber optic cable extending from at least one of the cable openings therein.

14. The fiber optic assembly of claim 13, wherein the at least one adapter panel is located proximate to the rear end of the housing.

15. The fiber optic assembly of claim 13, wherein the at least one adapter panel is located proximate to the front end of the housing.

16. The fiber optic assembly of claim 13, wherein the plurality of fiber optic adapters is disposed at an oblique angle with respect to the at least one adapter panel.

17. The fiber optic assembly of claim 13, wherein the at least one adapter panel is mounted on the chassis housing.

18. The fiber optic assembly of claim 13, further comprising a fiber optic equipment rack, wherein the chassis housing is mounted on the fiber optic equipment rack, and the at least one adapter panel is mounted on the fiber optic equipment rack.

19. A method of reconfiguring a fiber optic assembly, the fiber optic assembly having a front end and a rear end and defining an interior space therein, the method comprising:

accessing the interior space of the fiber optic assembly via at least one access opening in a housing;

removing a fiber optic cable extending from one or more adapters disposed in a front end of the housing to an exterior of the housing through a first cable opening in the housing;

disposing the fiber optic cable through a second cable opening in the housing such that the fiber optic cable extends from the one or more adapters disposed in the front end of the housing to the exterior of the housing through the second cable opening in the housing.

20. The method of claim 19, further comprising:

connecting the fiber optic cable to one or more fiber optic adapters disposed in an adapter panel disposed outside the fiber optic assembly, such that the fiber optic cable extends from the one or more adapters disposed in the front end of the housing to the one or more fiber optic adapters disposed in the adapter panel through the second cable opening in the housing.

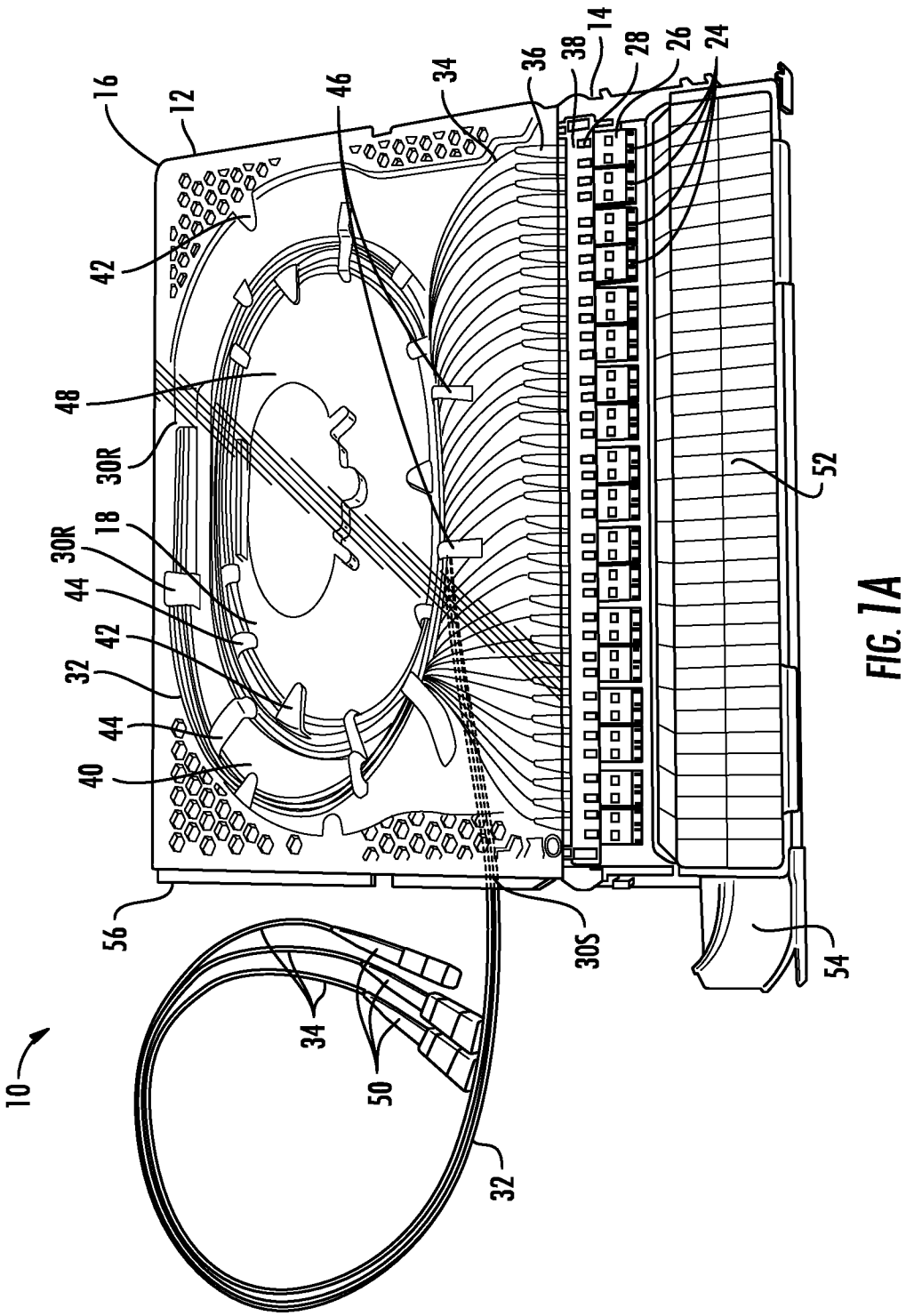

FIG. 1A

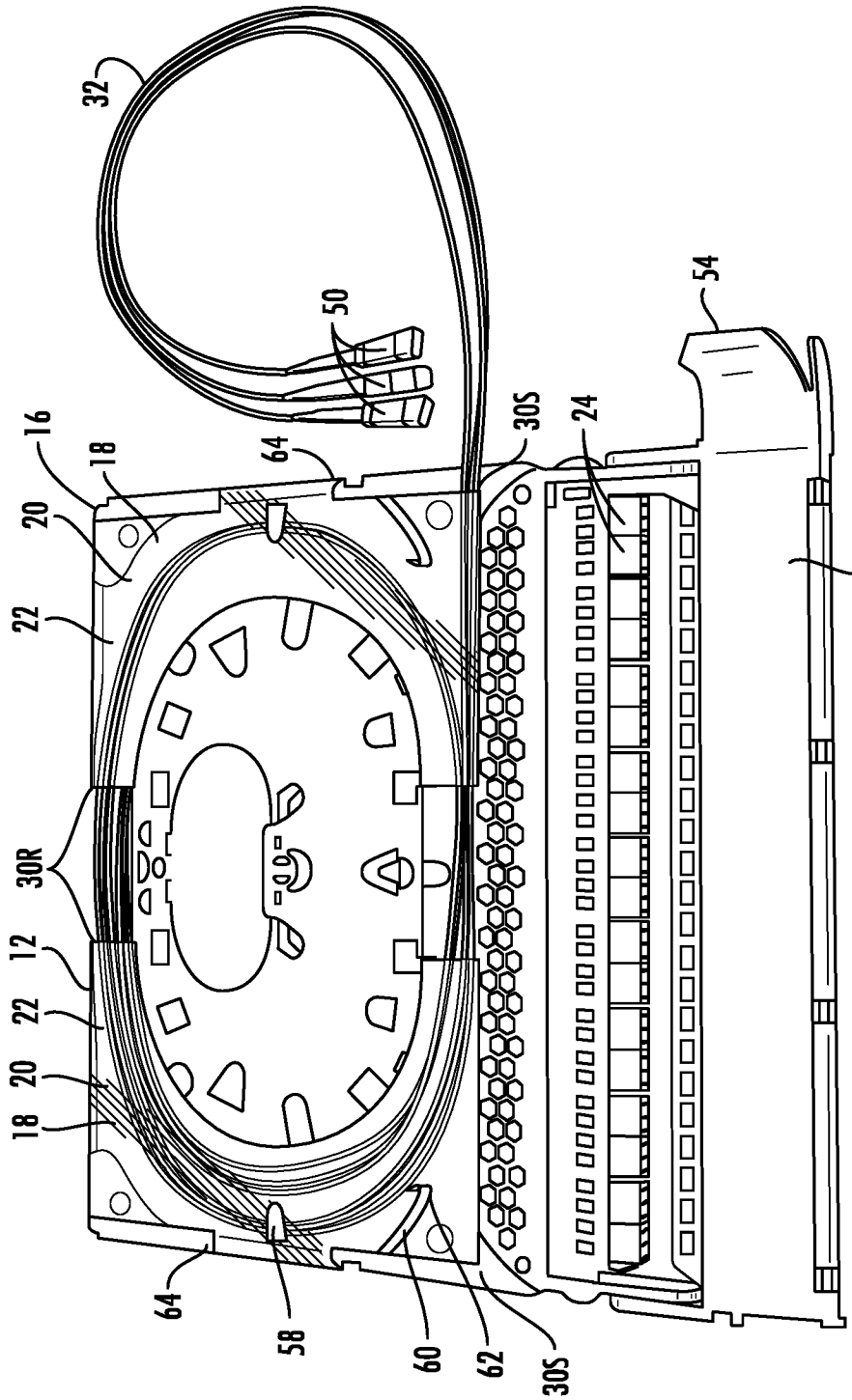

FIG. 1B

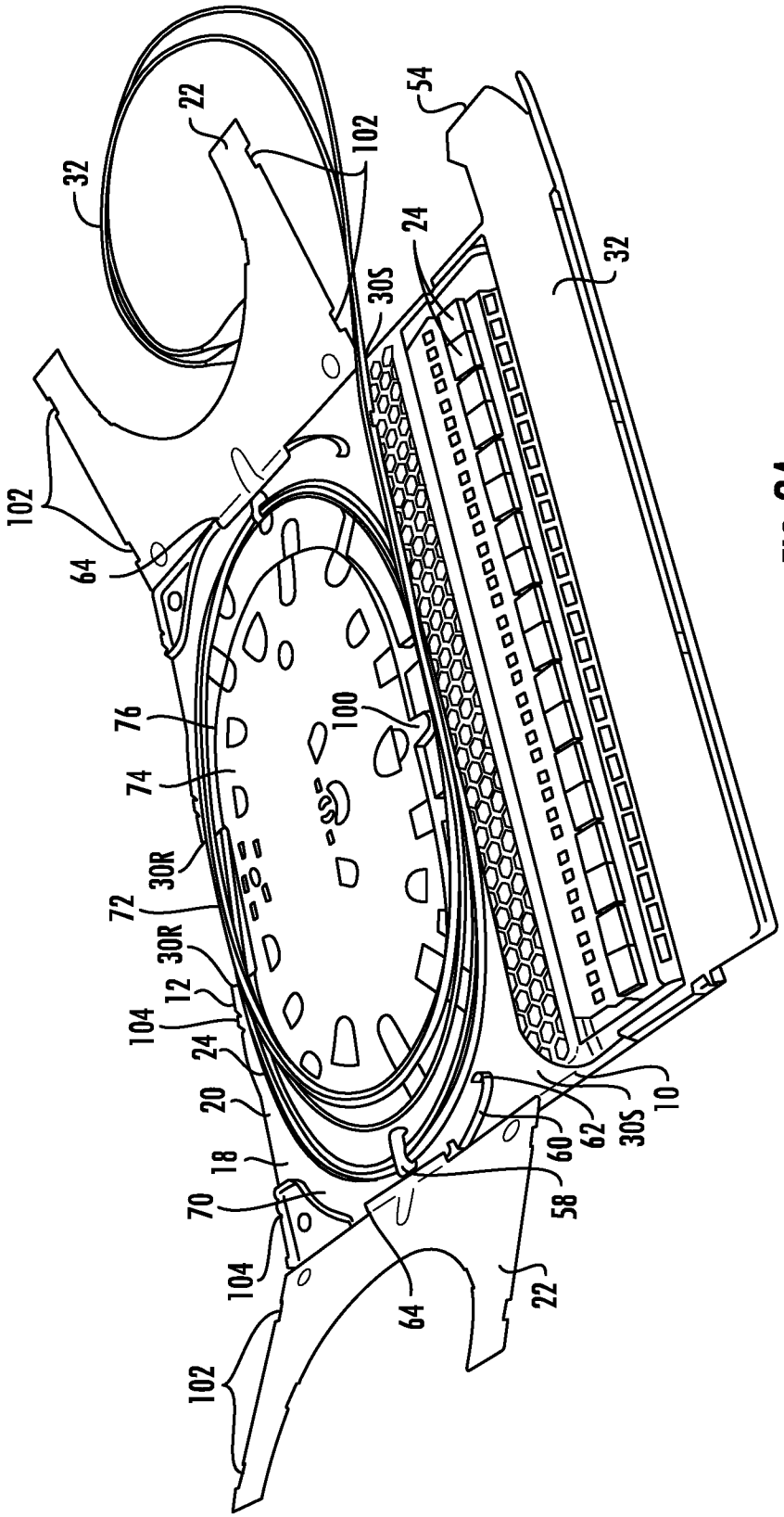
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FIG. 2A

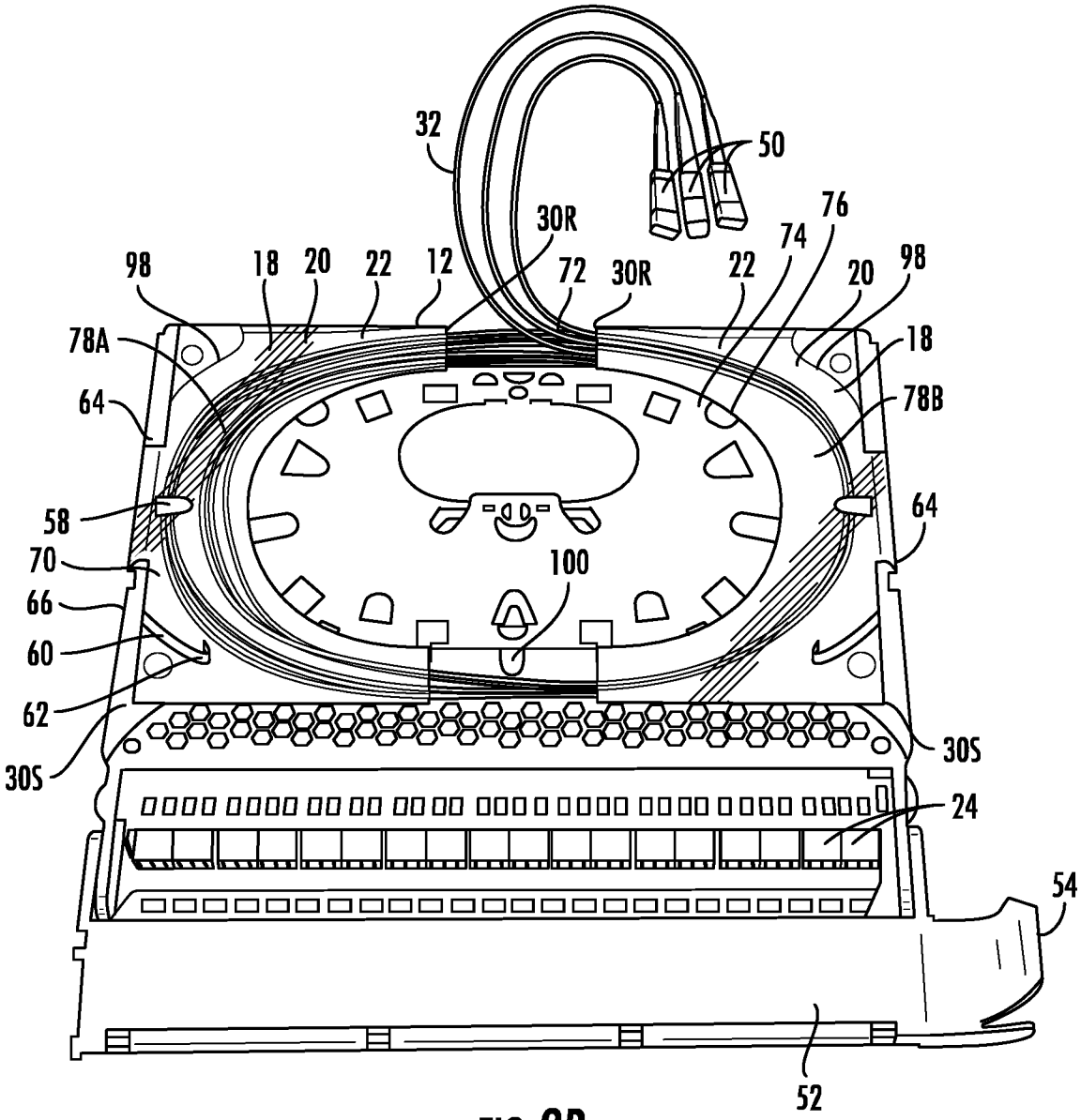
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FIG. 2B

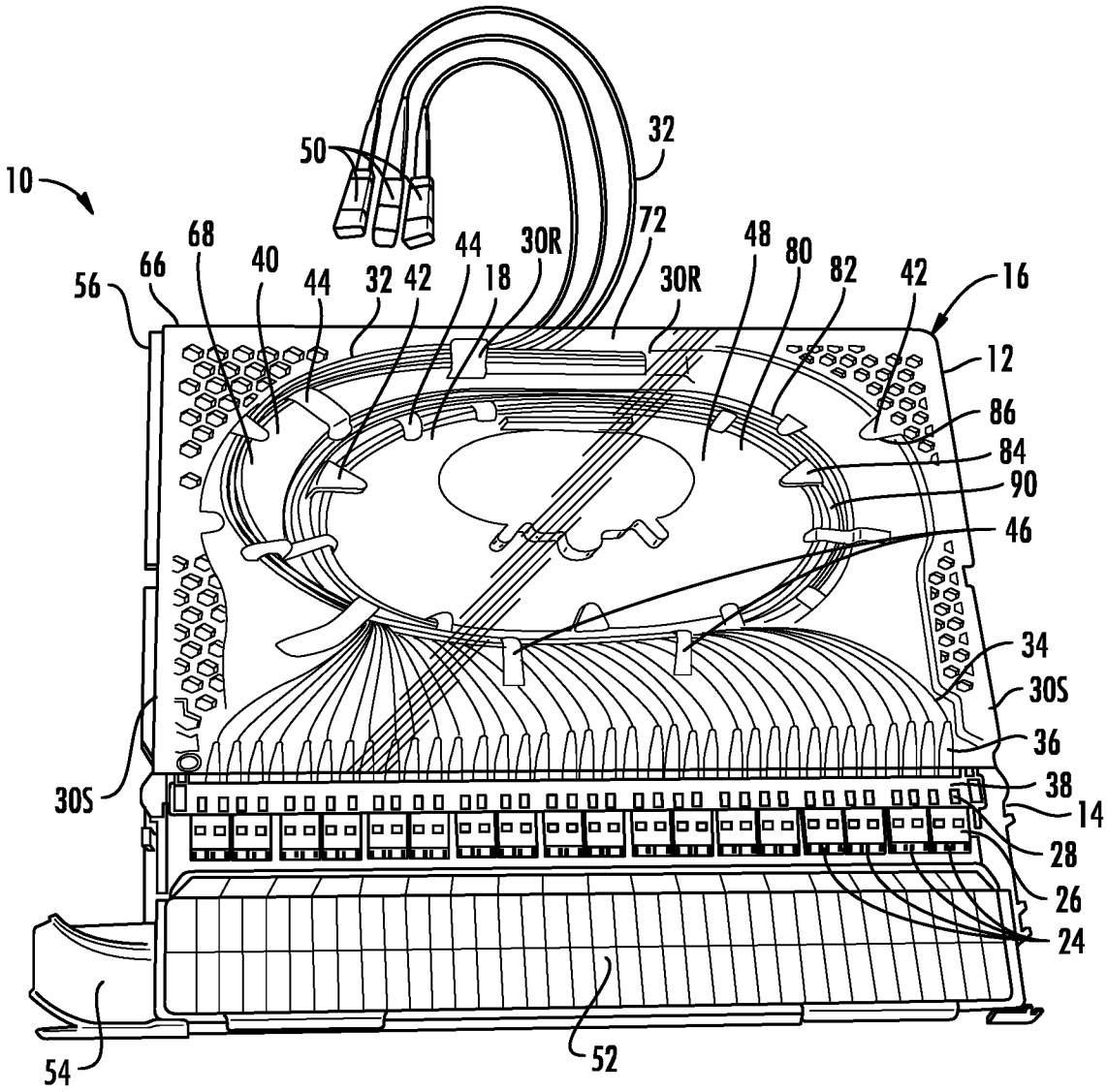
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FIG. 2C

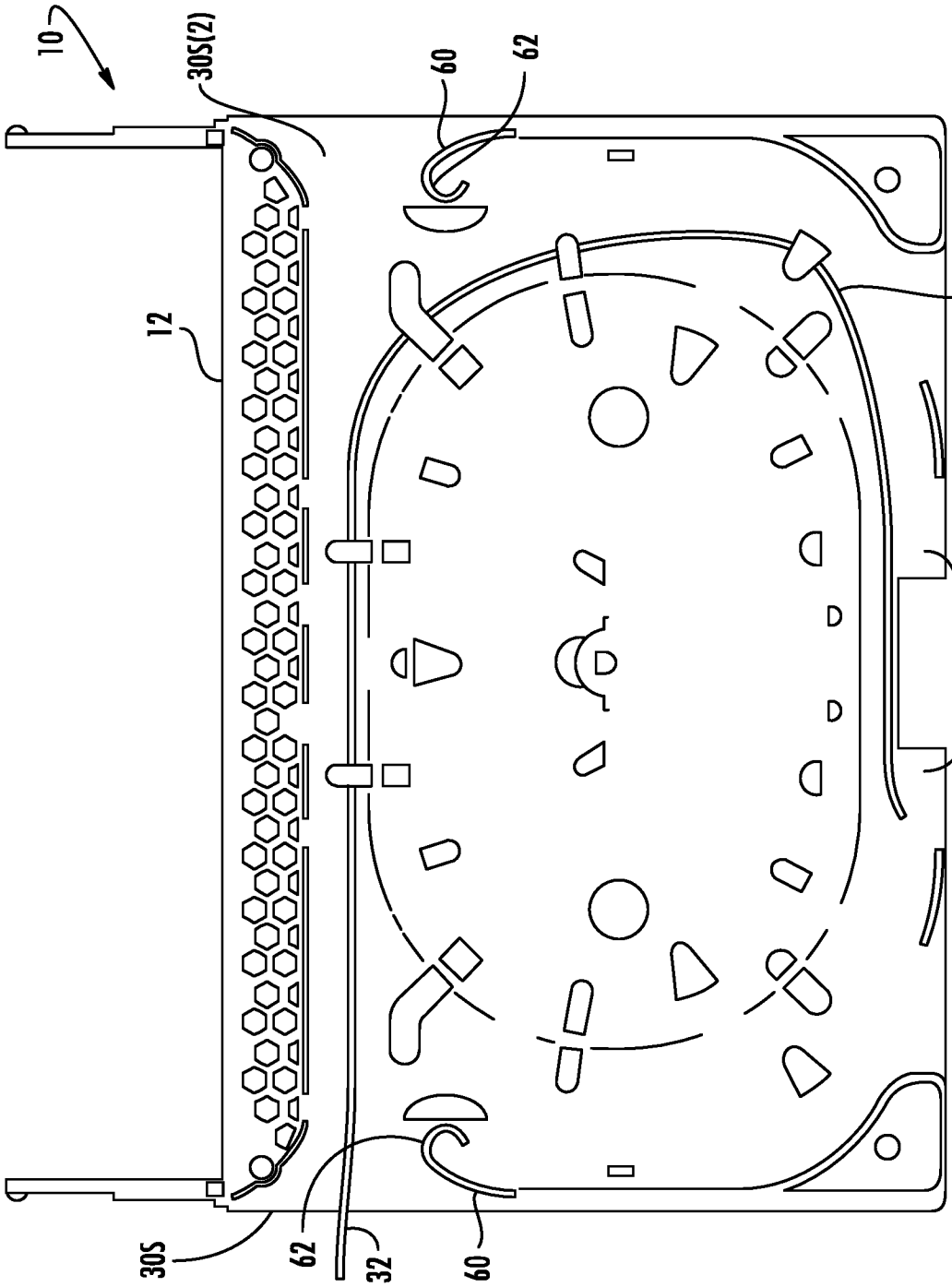

FIG. 3A

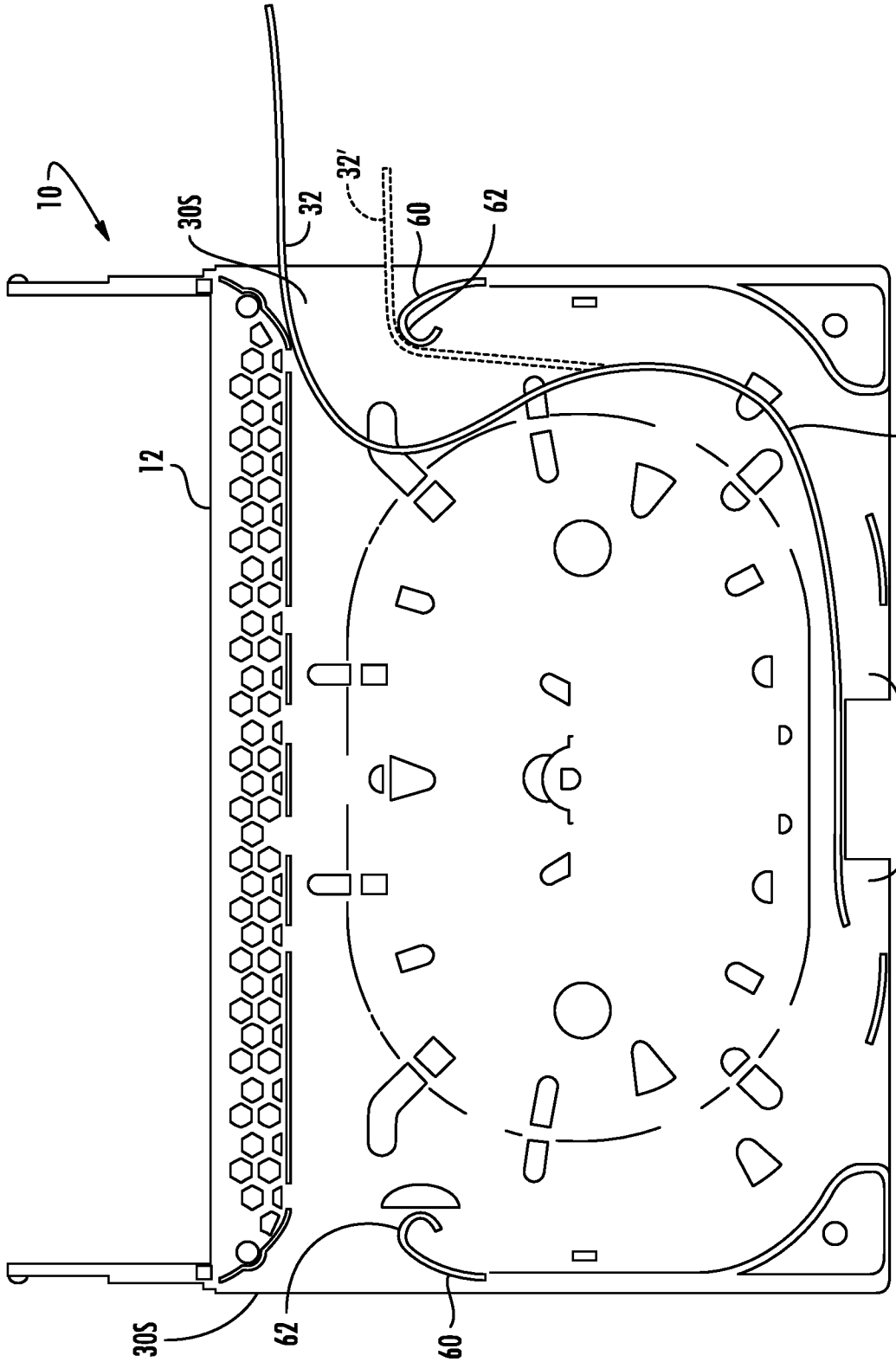

FIG. 3B

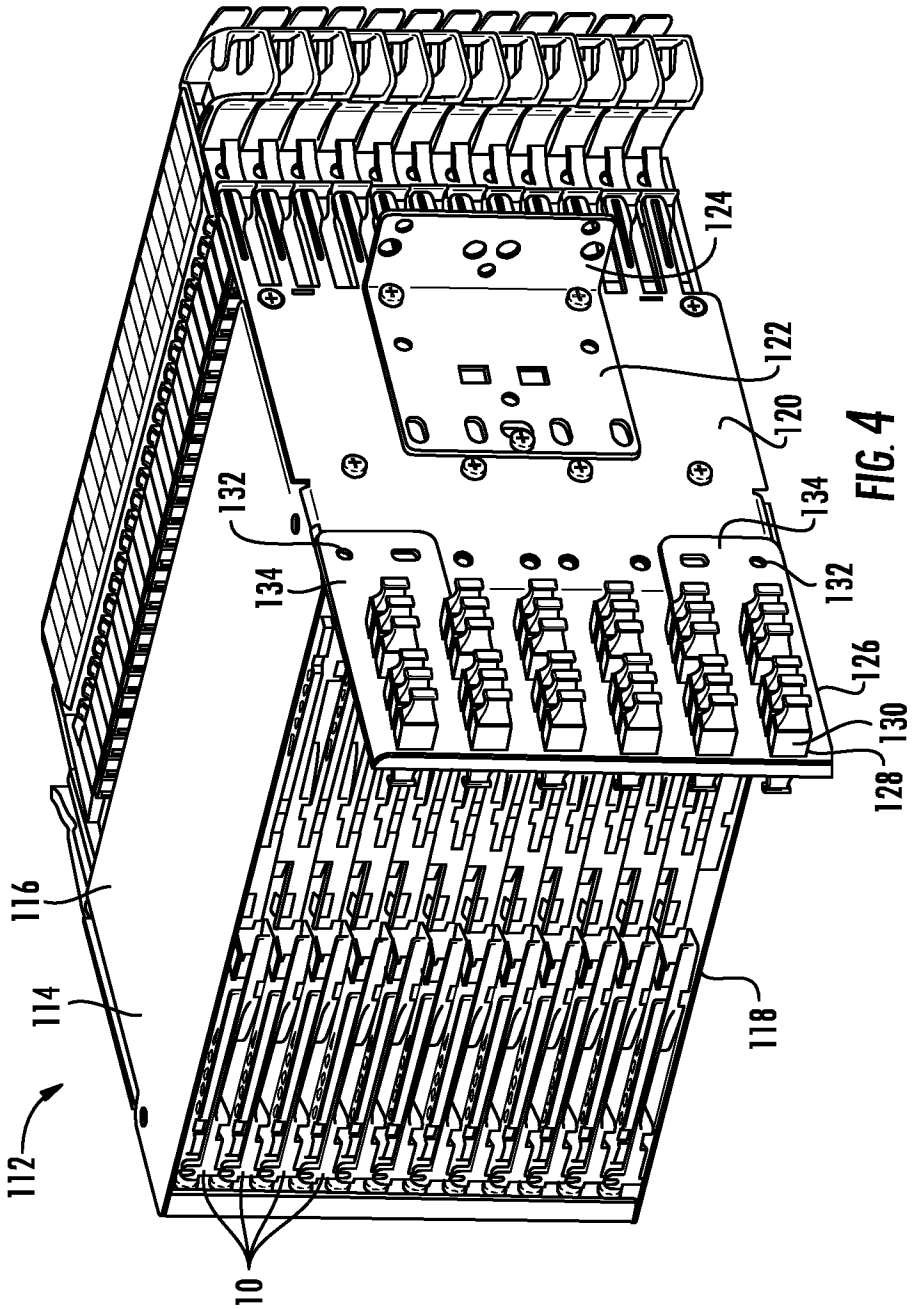

FIG. 4

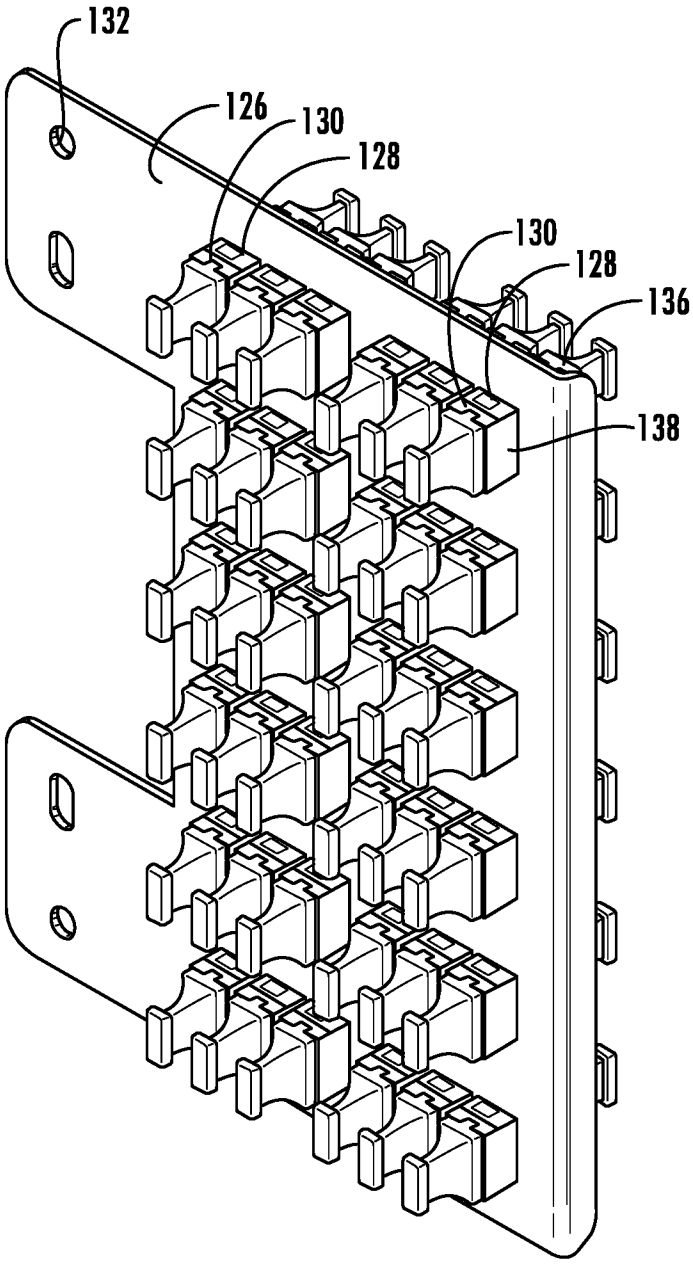

FIG. 5

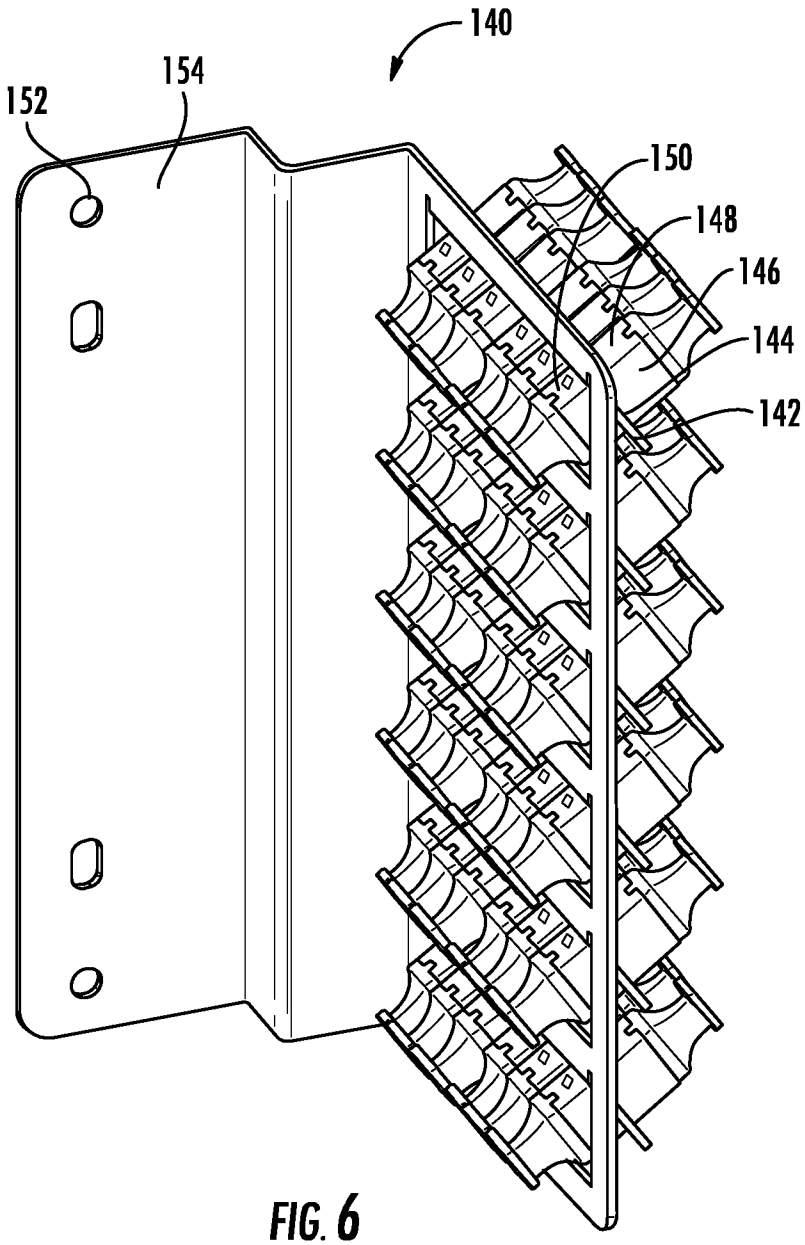

FIG. 6

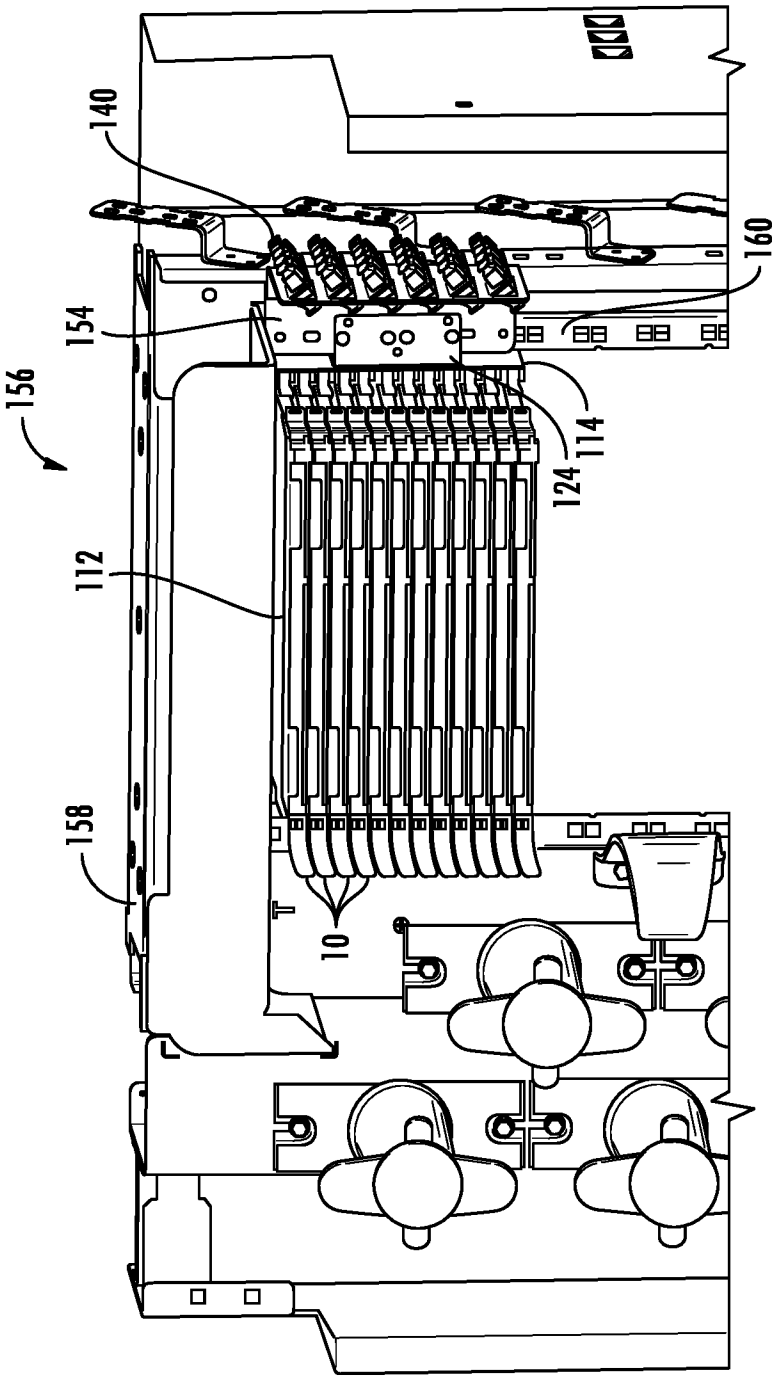

FIG. 7A

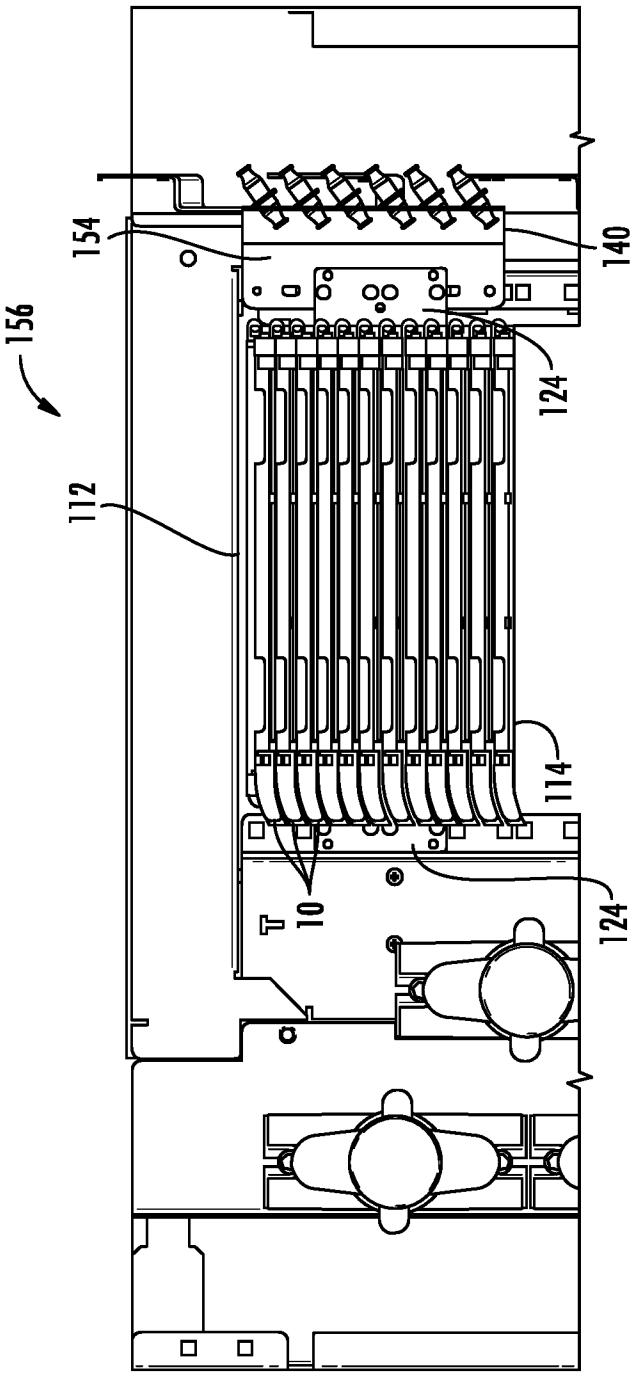

FIG. 7B

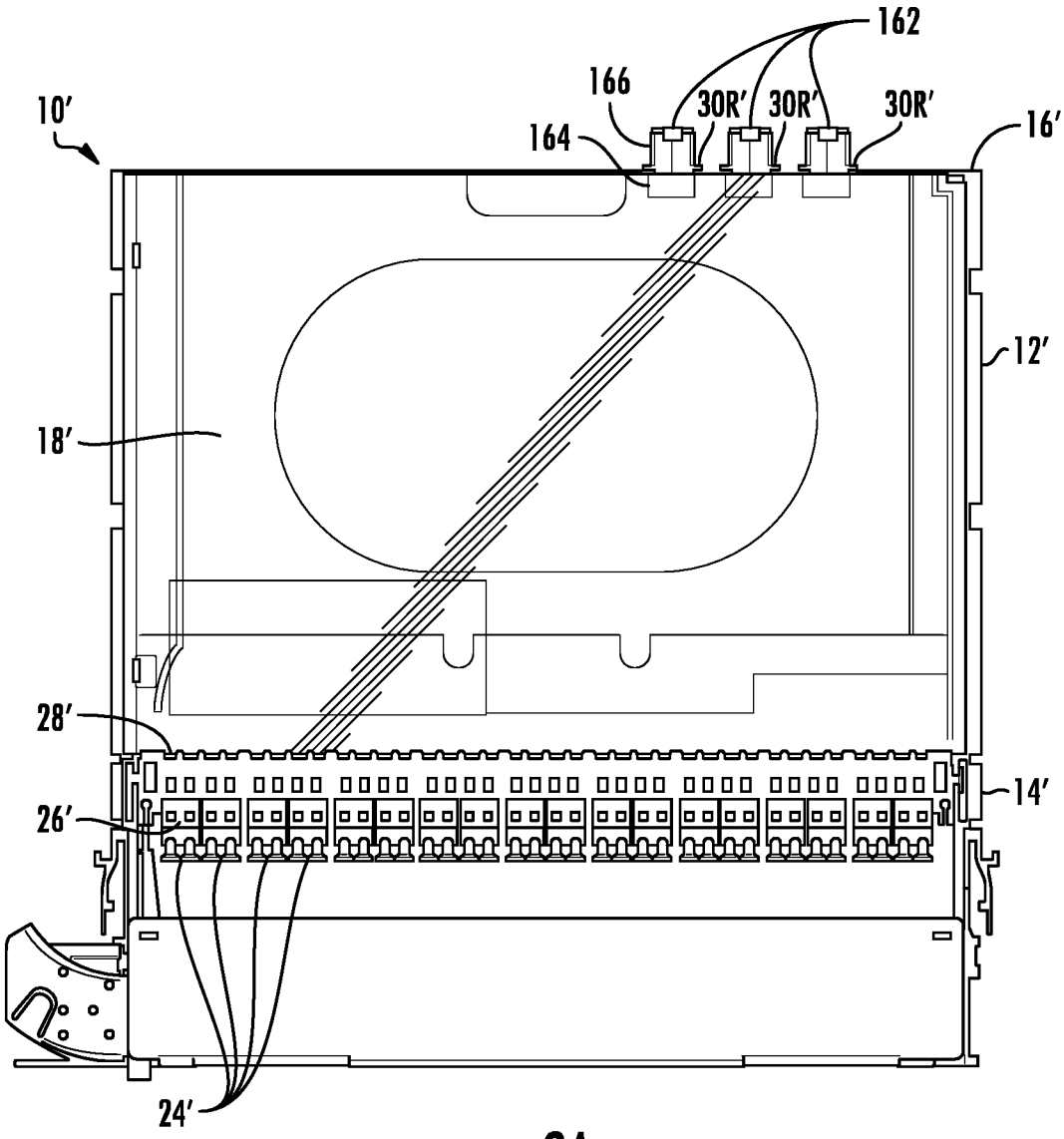

FIG. 8A

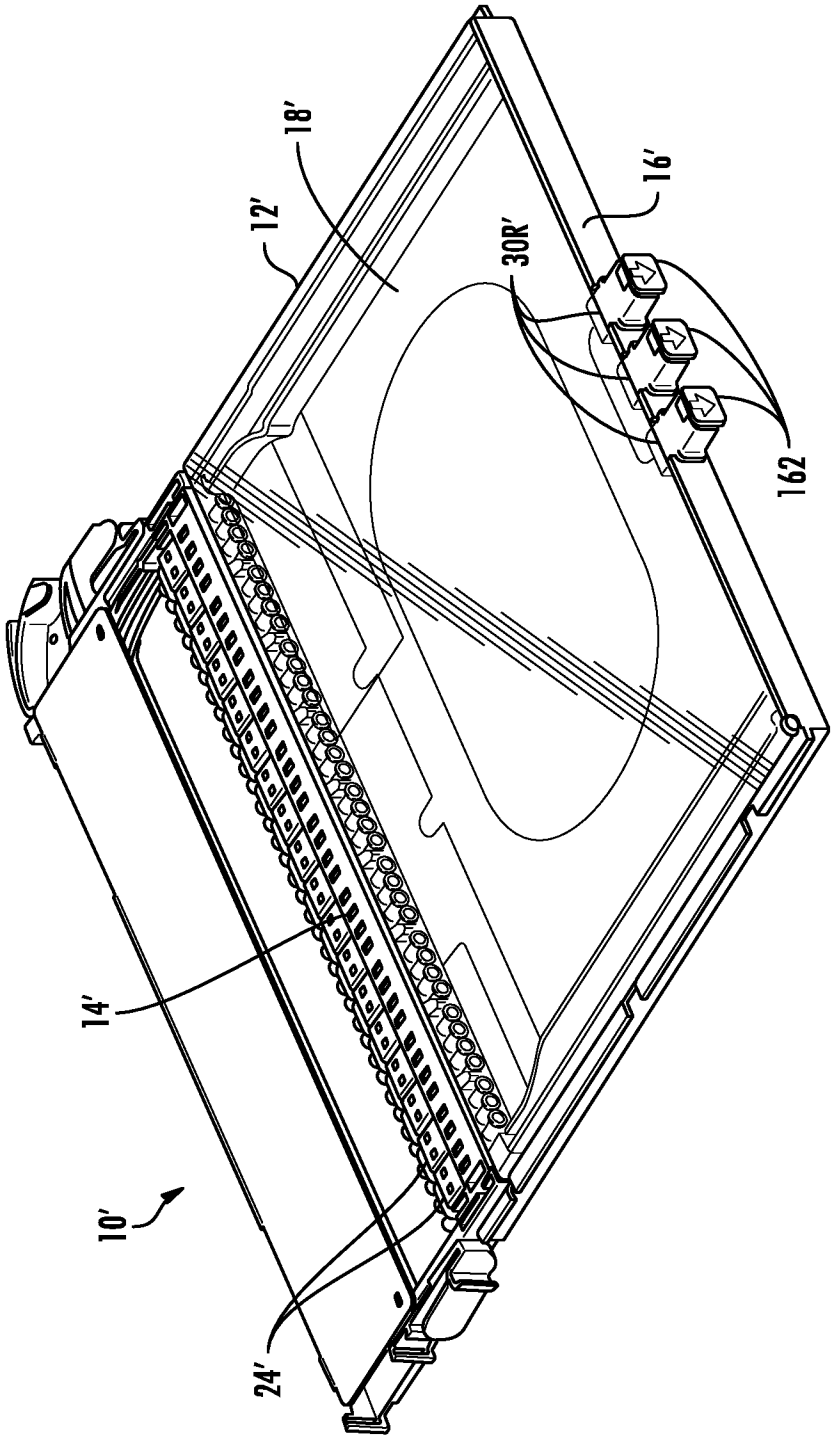

FIG. 8B

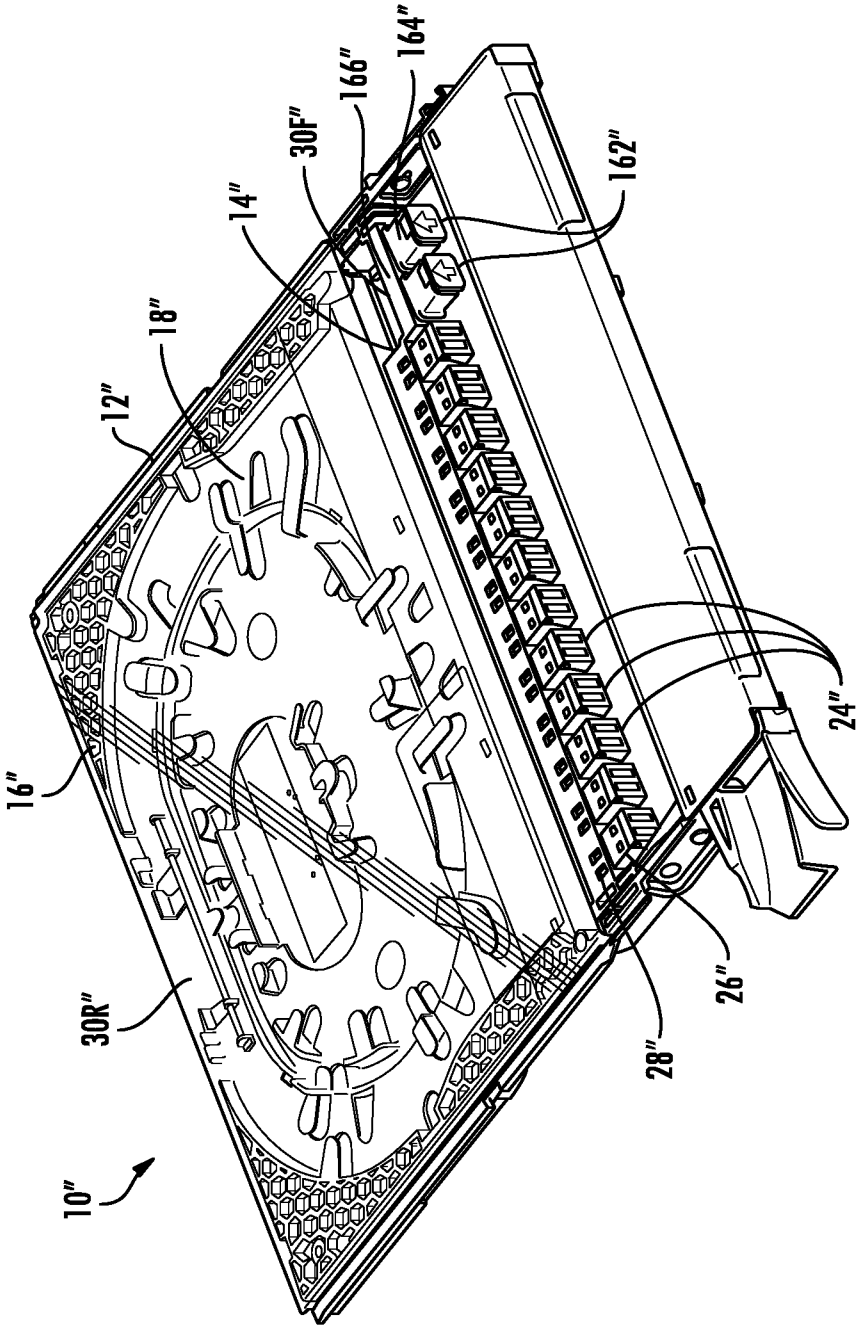

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/015044

A. CLASSIFICATION OF SUBJECT MATTER
INV. G02B6/44
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2014/348480 A1 (GIRAUD WILLIAM JULIUS MCPHIL [US] ET AL) 27 November 2014 (2014-11-27) paragraphs [0003], [0043], [0045], [0048] figure 12	1-8, 10-20
X	US 2014/056568 A1 (KOWALCZYK SCOTT C [US] ET AL) 27 February 2014 (2014-02-27) paragraphs [0098], [0126] figure 14	1-20
X	US 2010/142910 A1 (HILL JOHN P [US] ET AL) 10 June 2010 (2010-06-10) paragraphs [0049], [0055], [0059] figure 1	1-20

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 April 2016	19/04/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Hohmann, Leander

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/015044

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 2008/031585 A1 (SOLHEID JAMES J [US] ET AL) 7 February 2008 (2008-02-07) paragraph [0064] figure 18	13-15, 17,18,20
A	US 2006/217004 A1 (ADOMEIT JORG [DE] ET AL) 28 September 2006 (2006-09-28) figure 1	16

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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