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(54) **Title**: FIBER OPTIC HOUSINGS CONFIGURED FOR TOOL-LESS ASSEMBLY, AND RELATED COMPONENTS AND METHODS

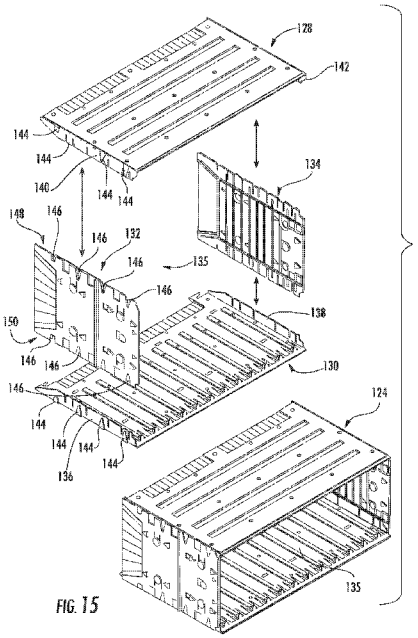

FIG. 15

(57) **Abstract**: Fiber optic housings configured for tool-less assembly, and related components and methods are disclosed. A fiber optic housing is provided having a top, a bottom, a right side, and a left side which removably attach to each other tool-lessly, and by other than external fastening means, thereby defining at least one interior chamber configured to support fiber optic equipment. The top, bottom, right side, and left side may be removably attached to each other by using a snap attachment integral to at least one of the bottom, the right side, and the left side. One or more mounting brackets and/or strain relief brackets may be attached to the fiber optic housing by other than external fastening means, which may be done by using a quick snap attachment integral to at least one of the sides of the fiber optic housing and the mounting brackets and/or strain relief brackets.

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FIBER OPTIC HOUSINGS CONFIGURED FOR TOOL-LESS ASSEMBLY, AND RELATED COMPONENTS AND METHODS

RELATED APPLICATIONS

[0001] The present application claims priority to U.S. Provisional Patent Application Serial No. 61/332,572, filed May 7, 2010, entitled "Fiber Optic Housing," the disclosure of which is relied upon and incorporated herein by reference in its entirety.

[0002] The present application claims priority to U.S. Patent Application Serial No. 12/953,134, filed November 23, 2010, entitled "Fiber Optic Housings Configured for Tool-Less Assembly, And Related Components and Methods," the disclosure of which is relied upon and incorporated herein by reference in its entirety.

[0003] The present application is also related to U.S. Patent Application Serial No. 12/953,164, filed November 23, 2010, entitled "Fiber Optic Housings Having a Removable Top, and Related Components and Methods," the disclosure of which is relied upon and incorporated herein by reference in its entirety.

[0004] The present application is also related to U.S. Patent Application Serial No. 12/953,118, filed November 23, 2010, entitled "Removable Fiber Management Sections for Fiber Optic Housings, and Related Components and Methods," the disclosure of which is relied upon and incorporated herein by reference in its entirety.

BACKGROUND

Field of the Disclosure

[0005] The technology of the disclosure relates to fiber optic housings for supporting fiber optic equipment, including but not limited to fiber optic equipment that provides interconnect and/or cross-connect capabilities between optical components and opto-electrical components using fiber optic cables, and more particularly to fiber optic housings configured to be assembled without using tools.

Technical Background

[0006] Benefits of optical fiber 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 linking optical fibers to

provide a contiguous fiber optic link 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.

[0007] The fiber optic equipment is customized based on the application need. The fiber optic equipment is typically included in housings designed to support the fiber optic equipment, which are mounted in equipment racks to optimize use of space. One example of such fiber optic equipment is a fiber optic module/cassette. A fiber optic module/cassette is designed to provide cable-to-cable fiber optic connections and manage the polarity of fiber optic cable connections. A fiber optic module or cassette is mounted to a chassis or housing that is specifically designed to support fiber optic modules and cassettes. Another example of such fiber optic equipment is a fiber optic panel (also referred to as a "patch panel"). A fiber optic panel is designed to provide connection or termination points for optical fiber. A fiber optic panel typically includes fiber optic adapters that are configured to receive fiber optic connectors connected to the optical fiber to be connected or terminated. A fiber optic panel is typically mounted to a chassis or housing that is specifically designed to support fiber optic panels.

[0008] A fiber optic housing is typically assembled from various parts by a technician using tools. Fiber optic equipment, such as fiber optic modules/cassettes and fiber optic panels as examples, may be loaded into and supported by a fiber optic housing prior to shipment to the installation site. Alternatively, the fiber optic equipment may be loaded into a fiber optic housing after shipment at the installation site. Whether loaded or unloaded, an assembled fiber optic housing consumes a given volume during shipping. It may be desirable and more cost efficient in terms of shipping costs to ship the components of the fiber optic housing unassembled to the installation site and assemble the components of the fiber optic housing on site.

SUMMARY OF THE DETAILED DESCRIPTION

[0009] Embodiments disclosed in the detailed description include fiber optic housings configured for tool-less assembly, and related components and methods. In one embodiment, a fiber optic housing is provided having a top, a bottom, a right side, and a left side which removably attach to each other tool-lessly, and by other than external fastening means, thereby defining at least one interior chamber configured to support fiber optic equipment.

The top, bottom, right side, and left side of the fiber optic housing may be removably attached to each other by using a snap attachment integral to at least one of the bottom, the right side, and the left side. In an embodiment, the fiber optic housing further has one or more mounting brackets and/or strain relief brackets, which may be attached to the fiber optic housing by other than external fastening means. In another embodiment, the mounting brackets and/or strain relief brackets may be attached to a side of the fiber optic housing by using a quick snap attachment integral to at least one of the side of the fiber optic housing and the mounting brackets and/or strain relief brackets.

[0010] In another embodiment, a method of assembling a fiber optic housing without tools is disclosed. A top, a bottom, a right side, and a left side of a fiber optic housing are provided and attached to each other tool-lessly, by other than external fastening means, thereby defining at least one interior chamber configured to support fiber optic equipment. The top, bottom, right side, and left side of the fiber optic housing can also be detached tool-lessly. In one embodiment, the top, bottom, right side, and left side are removably attached to each other by using snap attachments integral to at least one of the top, the bottom, the right side, and the left side. In an embodiment, the method further comprises removably mounting a side mounting bracket and/or a strain relief bracket to the fiber optic housing. In one embodiment, the side mounting bracket or the strain relief bracket is attached to the fiber optic housing by using snap attachments on a side of the fiber optic housing. In another embodiment, the method further comprises removably mounting the fiber optic housing to an equipment rack tool-lessly, and by other than external fastening means, using a side mounting bracket.

[0011] In this disclosure, "tool-less" assembly of any set of components is used to refer to the assembly of that set of components being done without the use of tools or external fastening means. One non-limiting example of "tool-less" assembly is when a set of components is assembled using fastening means, such as snap attachments, that are integral to one or more of the components in the set of components. Once the set of components is assembled tool-lessly, then the assembled set of components may be attached to another component or device using external fasteners and tools, and even with this use of external fasteners and tools, the assembly of the original set of components is still considered to be "tool-less."

[0012] 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 that

description or recognized by practicing the invention as described herein, including the detailed description that follows, the claims, as well as the appended drawings.

[0013] It is to be understood that both the foregoing general description and the following detailed description present embodiments, and are intended to provide an overview or framework for understanding the nature and character of the disclosure. The accompanying drawings are included to provide a further understanding, and are incorporated into and constitute a part of this specification. The drawings illustrate various embodiments, and together with the description serve to explain the principles and operation of the concepts disclosed.

BRIEF DESCRIPTION OF THE FIGURES

[0014] **FIG. 1A** is a front perspective view of an exemplary fiber optic housing being mounted to an exemplary equipment rack from the front of the equipment rack;

[0015] **FIG. 1B** is a front perspective view of the fiber optic housing in **FIG. 1A** after being mounted to the equipment rack in **FIG. 1A** from the front of the equipment rack;

[0016] **FIG. 1C** is a front perspective view of the fiber optic housing of **FIG. 1A** being mounted to the equipment rack in **FIG. 1A** from the rear of the equipment rack;

[0017] **FIG. 1D** is a front perspective view of the fiber optic housing in **FIG. 1A** after being mounted to the equipment rack in **FIG. 1A** from the rear of the equipment rack;

[0018] **FIG. 1E** is a front perspective view of an alternate exemplary fiber optic housing being mounted to an exemplary equipment rack from the front of the equipment rack;

[0019] **FIG. 1F** is a front perspective view of the fiber optic housing in **FIG. 1E** after being mounted to the equipment rack in **FIG. 1E**;

[0020] **FIG. 1G** is a rear perspective view of the fiber optic housing in **FIG. 1E** being removed from the equipment rack in **FIG. 1E**;

[0021] **FIG. 2** is a rear view of the fiber optic housing in **FIG. 1E** mounted in the equipment rack in **FIG. 1E** with a close-up view of exemplary snap features disposed on a side of the fiber optic housing;

[0022] **FIG. 3A** is a front perspective view of another exemplary fiber optic housing mounted in an exemplary equipment rack;

[0023] **FIG. 3B** is a rear perspective view of the fiber optic housing in **FIG. 3A** illustrating an exemplary release tab for removing the fiber optic housing from the equipment rack in **FIG. 3A**;

[0024] **FIG. 3C** is a rear perspective view of the fiber optic housing of **FIG. 3A** being removed from the equipment rack in **FIG. 3A**;

[0025] **FIG. 4** is a detail view of an exemplary mounting bracket configured to be removably attached to a side of the fiber optic housing in **FIGS. 3A-3C**;

[0026] **FIG. 5** is a front perspective view of the fiber optic housing in **FIGS. 3A-3C** being reinstalled into an equipment rack;

[0027] **FIG. 6** is a front perspective view of the fiber optic housing in **FIGS. 1A-1D** including an exemplary mounting bracket snap attachment feature;

[0028] **FIG. 7** is a front perspective view of an exemplary mounting bracket configured to be removably attached to a side of an exemplary fiber optic housing;

[0029] **FIG. 8** is a cut section of the mounting bracket and side of the fiber optic housing illustrated in **FIG. 7**;

[0030] **FIG. 9** is a rear perspective view of an exemplary fiber optic housing including an exemplary strain relief bracket;

[0031] **FIG. 10** is a side perspective view of an exemplary fiber optic housing including an exemplary strain relief bracket;

[0032] **FIGS. 11A** and **11B** are a side view of the strain relief bracket in **FIG. 10** mounted to the fiber optic housing in **FIG. 10** and a close-up view of the fiber optic housing and strain relief bracket illustrated in **FIG. 10**, respectively;

[0033] **FIG. 12** is a cut section of the external strain relief bracket and a side of the fiber optic housing in **FIGS. 10, 11A,** and **11B**;

[0034] **FIG. 13** is a partial, rear perspective view of the fiber optic housing in **FIG. 9** illustrating exemplary strain relief brackets with exemplary fiber optic cables tied to the strain relief brackets;

[0035] **FIG. 14** is a front perspective view of an exemplary fiber optic housing with a front door closed;

[0036] **FIG. 15** illustrates exploded and assembled front perspective views of exemplary components of an exemplary fiber optic housing;

[0037] **FIG. 16** illustrates an exploded front perspective view of exemplary components of an exemplary fiber optic housing;

[0038] **FIG. 17A** is an assembled front perspective view of the fiber optic housing in **FIG. 16**;

[0039] **FIG. 17B** is an assembled front perspective view of the fiber optic housing in **FIG. 17A** with a cover plate;

[0040] **FIG. 18** is a close-up front perspective view illustrating details of how an inside top panel of the fiber optic housing in **FIGS. 17A** and **17B** is connected to a side panel of the fiber optic housing;

[0041] **FIG. 19A** is a rear perspective view of an exemplary fiber optic housing having an exemplary removable top;

[0042] **FIG. 19B** is a rear perspective view of the fiber optic housing of **FIG. 19A** after the removable top is removed;

[0043] **FIG. 19C** illustrates an exemplary release tab in the fiber optic housing in **FIGS. 19A** and **19B**;

[0044] **FIG. 20A** illustrates an exploded front perspective view of an exemplary removable top;

[0045] **FIG. 20B** illustrates an assembled front perspective view of the fiber optic housing in **FIG. 17B** as the removable top in **FIG. 20A** is being installed into the fiber optic housing;

[0046] **FIG. 21A** is a side view section cut of an exemplary side panel of an exemplary fiber optic housing with the removable top in **FIGS. 19A, 20A,** and **20B** installed;

[0047] **FIG. 21B** is a side view of an exemplary gap in the removable top in **FIGS. 19A, 20A,** and **20B** configured to receive the side panel of the fiber optic housing;

[0048] **FIG. 22** is a front perspective view of an exemplary fiber optic housing including exemplary openings disposed in the sides of the fiber optic housing and rubber entry grommets disposed in the fiber optic housing, both for fiber management;

[0049] **FIG. 23** is a partial, front perspective view of an exemplary fiber optic housing in **FIG. 22**, illustrating exemplary molded in flexible edge protection disposed in the fiber optic housing;

[0050] **FIG. 24** illustrates a front perspective view of an exemplary fiber optic housing and perspective views of exemplary removable front section versions attached to the fiber optic housing to provide additional capacity for fiber management devices;

[0051] **FIG. 25** illustrates an exploded, front perspective view of an exemplary removable front section in **FIG. 24** configured to be attached to the fiber optic housing in **FIG. 24**;

[0052] **FIG. 26A** illustrates a front perspective view of the removable front section in **FIG. 25** with a door closed against the removable front section;

[0053] **FIG. 26B** illustrates a front perspective view of the removable front section in **FIGS. 25** and **26A** with the door in **FIG. 26A** opened;

[0054] **FIG. 26C** illustrates a top perspective view of the removable front section in **FIGS. 25, 26A,** and **26B** with the door removed;

[0055] **FIG. 26D** illustrates a front perspective view of the removable front section in **FIGS. 25** and **26A-C** with the door removed;

[0056] **FIG. 27** illustrates a front perspective view of an exemplary removable front section being attached to an exemplary fiber optic housing;

[0057] **FIG. 28** illustrates a front perspective view of an exemplary removable front section in **FIGS. 25** and **26A-C** attached to an exemplary fiber optic housing with exemplary fiber optic jumpers being routed out of sides of the removable front section;

[0058] **FIG. 29** is a front perspective view of an exemplary fiber optic housing illustrating an exemplary removable front section having a plurality of exemplary removable front jumper management devices with grommets;

[0059] **FIG. 30** is a front perspective view of the fiber optic housing in **FIG. 29** illustrating exemplary fiber management of exemplary optical fiber jumpers using the front jumper management device with pass-through grommets in **FIG. 29**;

[0060] **FIG. 31** is a front perspective view of the front jumper management device with the pass-through grommets in **FIGS. 29** and **30**;

[0061] **FIG. 32** illustrates how exemplary front jumper management devices with pass-through grommets may be mounted on their sides to create horizontal fiber management outside an exemplary fiber optic housing;

[0062] **FIG. 33** illustrates how an exemplary front jumper management device with pass-through grommets may be mounted in an exemplary fiber optic housing in place of a fiber optic panel to allow for fiber management;

[0063] **FIG. 34** is a perspective view of an exemplary fiber optic housing configured to support exemplary fiber optic modules;

[0064] **FIG. 35A** is a front perspective view illustrating where and how an exemplary removable panel clip is attached to a bottom panel of an exemplary fiber optic housing;

[0065] **FIG. 35B** is a close-up view of the removable panel clip in **FIG. 35A** being attached to the bottom panel of the fiber optic housing;

[0066] **FIG. 35C** is a cut section of the removable panel clip in **FIGS. 35A** and **35B** being attached to the bottom panel of the fiber optic housing;

[0067] **FIG. 36A** is a front perspective view of exemplary fiber optic panels being mounted in the fiber optic housing in **FIGS. 35A-C** by being attached to the removable panel clips illustrated in **FIGS. 35A-C**;

[0068] **FIG. 36B** is a front perspective view of the fiber optic housing in **FIG. 36A** fully loaded with fiber optic panels attached to removable panel clips;

[0069] **FIGS. 37A-37G** are top perspective, bottom perspective, rotated perspective, right side, left side, top, and front views, respectively, of a removable panel clip to be used with the fiber optic housing in **FIGS. 34, 35A, 36A,** and **36B**;

[0070] **FIG. 38** is a perspective view of an alternate exemplary removable panel clip installed in an exemplary fiber optic housing to enable the fiber optic housing to interchangeably support exemplary fiber optic panels and fiber optic modules;

[0071] **FIGS. 39A-39D** are bottom, side, front, and back views, respectively, of the removable panel clip in **FIG. 38;**

[0072] **FIGS. 40A-40D** illustrate various views of exemplary rails to be used in mounting exemplary fiber optic splice cassettes in an exemplary fiber optic housing;

[0073] **FIGS. 41A** and **41B** are front perspective and side views, respectively, of an exemplary fiber optic splice cassette that may be mounted on an exemplary rail in an exemplary fiber optic housing;

[0074] **FIG. 42** is a rear view of an exemplary fiber optic housing with the rear door opened that is fully loaded with exemplary fiber optic splice cassettes attached to rails;

[0075] **FIG. 43A** is a rear perspective view of an exemplary fiber optic housing mounted in an exemplary equipment rack illustrating exemplary fiber slack storage and fiber management on a rear door of the fiber optic housing;

[0076] **FIG. 43B** is a rear perspective view of an exemplary fiber optic housing mounted in an exemplary equipment rack illustrating an alternate exemplary fiber slack storage and management scheme on a rear door of the fiber optic housing having exemplary fiber optic splice cassettes;

[0077] **FIG. 43C** is a rear perspective view of an exemplary fiber optic housing mounted in an exemplary equipment rack illustrating an alternate exemplary fiber slack storage and management scheme on a rear door of the fiber optic housing having exemplary fiber optic panels;

[0078] **FIG. 44** is a rear perspective view of an exemplary fiber optic housing mounted in an exemplary equipment rack with an exemplary removable fiber management device mounted in the fiber optic housing;

[0079] **FIG. 45** is a rear perspective view of the fiber optic housing mounted in the equipment rack in **FIG. 44** with the removable fiber management device in **FIG. 44** removed from the fiber optic housing;

[0080] **FIG. 46A** is a front perspective view of the removable fiber management device in **FIG. 44** with exemplary routing clips;

[0081] **FIG. 46B** is a front perspective view of the removable fiber management device in **FIG. 46A** illustrating an exemplary fiber optic cable routing with an exemplary buffer tube and optical fiber;

[0082] **FIG. 46C** is a top front perspective view of the removable fiber management device in **FIG. 44** with exemplary optical fiber splice trays;

[0083] **FIG. 46D** is a front perspective view of an alternate exemplary removable fiber management device;

[0084] **FIG. 47** is a rear perspective view of an exemplary fiber optic housing illustrating optical fiber storage using the removable fiber management devices in **FIGS. 44-46D**;

[0085] **FIG. 48** is a front perspective view of an exemplary fiber optic housing illustrating an expandable attachment housing separated from the fiber optic housing;

[0086] **FIG. 49** is a front perspective view of the fiber optic housing in **FIG. 48** illustrating the expandable attachment housing in **FIG. 48** attached to the fiber optic housing;

[0087] **FIG. 50A** is a rear, perspective view of the expandable attachment housing in **FIGS. 48** and **49** with exemplary jumper slack storage;

[0088] **FIG. 50B** is a rear, perspective view of the expandable attachment housing in **FIGS. 48** and **49** with exemplary strain relief brackets;

[0089] **FIG. 51** is a rear view of an exemplary fiber optic housing illustrating how an exemplary door can be easily attached or removed; and

[0090] **FIG. 52** is a close-up view of how the door in **FIG. 51** can be easily attached to or removed from the fiber optic housing;

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0091] Reference will now be made in detail to certain embodiments, examples of which are illustrated in the accompanying drawings, in which some, but not all features are illustrated. Indeed, embodiments disclosed herein may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Whenever possible, like reference numbers will be used to refer to like components or parts.

[0092] Embodiments disclosed in the detailed description include apparatuses, and related components and methods for attachment and release of fiber optic housings to and from equipment racks. The fiber optic housings may be attached to equipment racks such that the fiber optic housings may be easily and quickly removed from the equipment rack. In one embodiment, a fiber optic apparatus is disclosed that comprises a fiber optic housing and at

least one mounting bracket. The fiber optic housing may have a top, a bottom, a right side, and a left side defining at least one interior chamber configured to support fiber optic equipment. The at least one mounting bracket is configured to removably attach to at least one of the right side or the left side of the fiber optic housing. The at least one mounting bracket is also configured to attach the fiber optic housing to an equipment rack. In one embodiment, the at least one mounting bracket is configured to removably attach to the at least one of the right side or the left side of the fiber optic housing tool-lessly, and by other than external fastening means. In an embodiment, the at least one mounting bracket is removably attached to the at least one of the right side or the left side of the fiber optic housing by a snap attachment integral to at least one of the right side or the left side.

[0093] In this regard, **FIGS. 1A-1G** illustrate a first embodiment of a fiber optic housing **10** that may be attached to and removed from an equipment rack **11** easily and quickly. The fiber optic housing **10** is configured to support fiber optic equipment for establishing fiber optic connections. As non-limiting examples, the fiber optic equipment may include fiber optic modules and/or fiber optic panels. As described in more detail below, the fiber optic housing **10** may be removably attached to the equipment rack **11** from the front or the rear of the equipment rack **11**, as is illustrated in **FIGS. 1A-1G**.

[0094] **FIG. 1A** is a front perspective view of the fiber optic housing **10** being mounted to the equipment rack **11** from the front of the equipment rack **11**. **FIG. 1B** is a front perspective view of the fiber optic housing **10** after it has been mounted to the equipment rack **11** from the front. Referring to **FIG. 1A**, the equipment rack **11** may comprise a pair of vertical supports **12A, 12B** in one embodiment. Mounting brackets **14A**, **14B** may be attached to the vertical supports **12A, 12B** to support the fiber optic housing **10** in the equipment rack **11**. The mounting brackets **14A**, **14B** may be mounted on the equipment rack **11** before sliding the fiber optic housing **10** into the equipment rack **11**. However, in other embodiments, the mounting brackets **14A**, **14B** may be snapped onto the side of the fiber optic housing **10** first. In one embodiment, each of the pair of vertical supports **12A, 12B** of the equipment rack **11** includes a plurality of openings or holes **16** disposed along the length of the vertical supports **12A, 12B** of the equipment rack **11** configured to receive a fastener to attach the mounting brackets **14A, 14B** to the vertical supports **12A, 12B**.

[0095] In one embodiment, the mounting brackets **14A, 14B** are mounted to the vertical supports **12A, 12B** before the fiber optic housing **10** is installed in the equipment rack **11**. The fiber optic housing **10** is then slid into place in the equipment rack **11** and removably attached to the mounting brackets **14A, 14B** using features disclosed herein. This process of

supporting the fiber optic housing **10** in the equipment rack **11** may be easier for a technician than securing the mounting brackets **14A, 14B** to the fiber optic housing **10** first before securing the mounting brackets **14A, 14B** to the vertical supports **12A, 12B**. The mounting brackets **14A, 14B** are typically smaller, lighter, and easier for a technician to align to the holes **16** and evenly in the vertical supports **12A, 12B** without having to support the additional weight of the fiber optic housing **10**. Therefore, it may be safer for the technician to slide the fiber optic housing **10** into place in the mounting brackets **14A, 14B** after the mounting brackets **14A,14B** are mounted to the equipment rack **11** than to use screws or other fasteners to try to attach the fiber optic housing **10** to the equipment rack **11**.

[0096] Once the mounting brackets **14A, 14B** are mounted to the equipment rack **11**, the fiber optic housing **10** may be placed and secured into the equipment rack **11** by snapping the fiber optic housing **10** into place in the mounting brackets **14A, 14B**. In one embodiment, the mounting brackets **14A, 14B** may include a plurality of receivers **18, 20,** and **22**. Although the receivers **18, 20,** and **22** may be seen only on the mounting bracket **14B** in **FIG. 1A**, the mounting bracket **14A** may have similar receivers **18, 20**, and **22**. In one embodiment as illustrated in **FIG. 1A**, there may be a pair of receivers **18**, one at or near the top rear part of the mounting bracket **14B**, and a corresponding receiver **18** at or near the bottom rear part of the mounting bracket **14B**. The mounting bracket **14B** may also include a pair of receivers **20**, one at or near the top middle part of the mounting bracket **14B**, and a corresponding receiver **20** at or near the bottom middle part of the mounting bracket **14B**. The mounting bracket **14B** may also include a pair of receivers **22**, one at or near the top front part of the mounting bracket **14B**, and a corresponding receiver **22** at or near the bottom front part of the mounting bracket **14B**. Although the embodiment of **FIG. 1A** illustrates three (3) pairs of receivers **18, 20,** and **22**, any number of receivers sufficient to attach the fiber optic housing **10** to the mounting brackets **14A, 14B** may be used.

[0097] In one embodiment, the fiber optic housing **10** may include a plurality of snap features **24, 26,** and **28** disposed on a side **30** of the fiber optic housing **10**. The snap features **24, 26,** and **28** may also be referred to as snap attachments or snap attachment features. Although the snap features **24, 26,** and **28** may be seen only on one side **30** of the fiber optic housing **10** in **FIG. 1A**, the fiber optic housing **10** may have similar snap features **24, 26,** and **28** on the other side as well. In one embodiment, as seen in **FIG. 1A**, there may be a pair of snap features **24**, one at or near the top rear part of a rear portion **32** of the side **30** of the fiber optic housing **10**, and a corresponding snap feature **24** at or near the bottom rear part of the rear portion **32** of the side **30**. The side **30** may also include a pair of snap features **26**, one at

or near the top middle part of the rear portion **32** of the side **30,** and a corresponding snap feature **26** at or near the bottom middle part of the rear portion **32** of the side **30**. The side **30** may also include a pair of snap features **28**, one at or near the top front part of the rear portion **32** of the side **30**, and a corresponding snap feature **28** at or near the bottom front part of the rear portion **32** of the side **30**. Although the embodiment of **FIG. 1A** illustrates three (3) pairs of snap features **24, 26,** and **28**, any number of snap features **24, 26,** and **28** sufficient to attach the fiber optic housing **10** to the mounting brackets **14A, 14B** may be used.

[0098] The receivers **18, 20,** and **22** of the mounting brackets **14A, 14B** are configured to receive the snap features **24, 26,** and **28** disposed on the sides **30** of the fiber optic housing **10**. As the fiber optic housing **10** is slid into the equipment rack **12**, the snap features **24, 26,** and **28** disposed on the sides **30** of the fiber optic housing **10** selectably engage with the receivers **18, 20,** and **22** of the mounting brackets **14A, 14B** and are locked into place, thereby allowing the fiber optic housing **10** to be quickly and easily snapped into place in the equipment rack **11**.

[0099] The receivers **18, 20,** and **22** of the mounting brackets **14A, 14B** may take a variety of shapes and sizes, as may the snap features **24, 26,** and **28** disposed on the sides **30** of the fiber optic housing **10**. The receivers **18, 20,** and **22** may be of any shape and size that correspond to the shape and size of the snap features **24, 26,** and **28** such that the snap features **24, 26,** and **28** selectably engage with the receivers **18, 20,** and **22** of the mounting brackets **14A, 14B** and are locked into place to hold the fiber optic housing **10** in the equipment rack **11**.

[00100] The fiber optic housing **10** may also be loaded into the equipment rack **11** from the rear of the equipment rack **11**. **FIG. 1C** is a front perspective view of the fiber optic housing **10** as it is being mounted to the equipment rack **11** from the rear. **FIG. 1D** is a front perspective view of a fiber optic housing **10** after it has been mounted to the equipment rack **11** from the rear. The fiber optic housing **10** is snapped into place in a similar fashion as described above with respect to **FIGS. 1A** and **1B**. The snap features **24, 26,** and **28** on the side **30** of the fiber optic housing **10** selectably engage the receivers **18, 20,** and **22** of the mounting brackets **14A, 14B** as the fiber optic housing **10** is slid into the equipment rack **11**. In this manner, the fiber optic housing **10** may be quickly and easily attached to the mounting brackets **14A, 14B**, thereby installing the fiber optic housing **10** into the equipment rack **11**.

[00101] Any type of fiber optic housing having the above described snap features may be quickly and easily mounted in an equipment rack having mounting brackets with receivers of the type described above. **FIG. 1E** is a front perspective view of an alternate embodiment of

a fiber optic housing **34** being mounted to the equipment rack **11** from the front. **FIG. 1F** is a front perspective view of the alternate embodiment of the fiber optic housing **34** illustrated in **FIG. 1E** after being mounted to the equipment rack **11**. The fiber optic housing **34** in **FIG. 1E** has fiber optic modules **36** vertically mounted in the fiber optic housing **34**. The fiber optic housings **10** and **34** illustrated in **FIGS. 1A-1F** are 4U in this embodiment, but any size fiber optic housing may be mounted in an equipment rack having mounting brackets with the receivers disclosed above to selectably engage snap features disposed on the side of the fiber optic housing as disclosed above.

[00102] The designation "U" refers to a standard equipment shelf size of a fiber optic equipment rack or a cabinet. This may also be referred to as "RU." For example, an equipment rack may support 42 1U-sized shelves, with "U" equal to a standard 1.75 inches in height and nineteen (19) inches in width. In certain applications, the width of "U" may be twenty-three (23) inches. Other heights and widths may be designated as "U." Typically, the more rack space (the more "U's") a fiber optic housing takes up, the higher the fiber capacity in the fiber optic housing.

[00103] **FIG. 1G** is a rear perspective view of the fiber optic housing **34** being removed from the equipment rack **11**. When the fiber optic housing **34** is removed from the equipment rack **11**, as will be discussed in more detail below with respect to **FIGS. 3A-3C** and **4**, mounting brackets **38A, 38B** remain attached to the equipment rack **11**. In this manner, the fiber optic housing **34** can be easily re-mounted into the equipment rack **11** at a later time if desired. As mentioned above, the mounting brackets **38A, 38B** may have any number of receivers configured to receive snap features on a side of the fiber optic housing **34**. In the embodiment seen in **FIG. 1G**, the mounting brackets **38A, 38B** each have a single circular receiver **40**.

[00104] **FIG. 2** is a rear view of the fiber optic housing **34** mounted in the equipment rack **11** with a close-up view of snap features disposed on the side **30** of the fiber optic housing **34**. The fiber optic housing **34** in this embodiment has a plurality of snap features **42** disposed on the side **30** of the fiber optic housing **34**. The snap features **42** in **FIG. 2** are of a half-circle shape and are configured to selectably engage with corresponding receivers on the mounting brackets attached to the equipment rack **11**.

[00105] **FIGS. 3A-3C** illustrate how a fiber optic housing can be easily removed from an equipment rack. In this regard, **FIG. 3A** is a front perspective view of the fiber optic housing **34** mounted in the equipment rack **11**. Although the fiber optic housing **34** in **FIG. 3A** has the fiber optic modules **36** vertically mounted in the fiber optic housing **34**, any type of fiber

optic housing, including but not limited to the fiber optic housing **10** illustrated in **FIGS. 1A-1D**, or the fiber optic housing **10** illustrated in **FIG. 2**, may be mounted into the equipment rack **11** and then removed.

[00106] **FIG. 3B** is a rear perspective view of the fiber optic housing **34** of **FIG. 3A** illustrating a release tab **44** for removing the fiber optic housing **34** from the equipment rack **11**. **FIG. 3C** is a rear perspective view of the fiber optic housing **34** of **FIG. 3A** being removed from the equipment rack **11**. Referring to **FIGS. 3B** and **3C**, the release tab **44** is selectably engaged with an opening **46** in a mounting bracket **48B** attached to the equipment rack **11**. Although only a single release tab **44** and a single opening **46** on the mounting bracket **48B** are illustrated in **FIG. 3C**, in one embodiment, there may be a similar opening on a mounting bracket **48A** to receive a release tab similar to the release tab **44** on the other side of the fiber optic housing **34**. In another embodiment, there may be multiple release tabs **44** for each of the mounting brackets **48A, 48B**.

[00107] To remove the fiber optic housing **34** from the equipment rack **11**, the release tab **44** is pressed inward by a user in one embodiment, which causes the release tab **44** to disengage from the opening **46** on the mounting bracket **48B**, allowing the fiber optic housing **34** to be removed from the equipment rack **11**. In one embodiment, the release tab **44** is flexible and resilient, such that it is biased to move from a first position to a second position when a force is exerted on the release tab **44**, and then returns to the first position by itself when the force is no longer exerted. In another embodiment, the release tab **44** may be spring loaded. In the embodiment having two (2) release tabs **44**, one on each side of the fiber optic housing **34**, both release tabs **44** may be pressed inward by the user at approximately the same time to remove the fiber optic housing **34** from the equipment rack **11**. Although the release tab **44** is pressed inward in the above embodiments, in other embodiments, the release tab **44** may be lifted up, pulled outward, pressed downward, or manipulated in other ways and/or directions to cause the release tab **44** to disengage from the opening **46** on the mounting bracket **48B**, allowing the fiber optic housing **34** to be removed from the equipment rack **11**.

[00108] **FIG. 4** is a detail view of a mounting bracket configured to be removably attached to a side of a fiber optic housing according to an exemplary embodiment. The mounting bracket **48B** in the embodiment illustrated in **FIG. 4** has the opening **46** and slot features **50, 52** on a top surface **53** of the mounting bracket **48B**. The slot features **50, 52** on the mounting bracket **48B** engage with tongue features **54, 55,** and **56** on a top surface **58** of a side plate **60** of the fiber optic housing **34**. The slot features **50, 52** on the mounting bracket **48B** may be a slot **50** and a tab **52** in one embodiment, as seen in **FIG. 4**. The tongue features **54, 55,** and

56 may be a protrusion **54** at one end of a raised guide member **55** and a tongue **56** at the opposite end of the raised guide member **55** in one embodiment, as seen in **FIG. 4**. As the fiber optic housing **34** is moved into contact with the mounting bracket **48B**, the top surface **53** of the mounting bracket **48B** slides along the side of the raised guide member **55** until the slot **50** mates with the tongue **56** and the tab **52** mates with the protrusion **54**. As this occurs, the opening **46** of the mounting bracket **48B** selectively engages with the release tab **44** on the side plate **60** of the fiber optic housing **34**. The release tab **44** extends outwards from the side plate **60** of the fiber optic housing **34** a sufficient distance to extend out of the opening **46** when the opening **46** selectively engages with the release tab **44**. If the fiber optic housing **34** is mounted to an equipment rack **11**, and a user wishes to remove the fiber optic housing **34** from the equipment rack **11**, the release tab **44** may be pressed inward by a user, which causes the release tab **44** to disengage from the opening **46** on the mounting bracket **48B**, allowing the fiber optic housing **34** to be removed from the equipment rack **11**.

[00109] When the fiber optic housing **34** is removed from the equipment rack **11** (as illustrated in **FIG. 3C**), the mounting brackets **48A**, **48B** remain attached to the equipment rack **11**. Then, if the user wishes to re-install the fiber optic housing **34** in the equipment rack **11**, such can be done quickly and easily. **FIG. 5** is a front perspective view of the fiber optic housing **34** of **FIGS. 3A-3C** being re-installed into the equipment rack **11** from the rear of the equipment rack **11**. As the fiber optic housing **34** is slid forward by the user toward the mounting brackets **48A**, **48B** attached to the equipment rack **11**, the raised guide member **55** on each side of the top surface **58** of the side plate **60** slides along the side of the top surface **53** of the respective mounting brackets **48A**, **48B** until the protrusion **54** on each side plate **60** mates with the tab **52** on the respective mounting bracket **48A** or **48B** and the tongue **56** mates with the slot **50** of the respective mounting bracket **48A** or **48B**. As this occurs, the release tab **44** on each side plate **60** selectively engages with the opening **46** of the respective mounting bracket **48A** or **48B**, thereby locking the fiber optic housing **34** into place in the equipment rack **11**. The mounting brackets **48A**, **48B** may be mounted on the equipment rack **11** before sliding the fiber optic housing **34** into the equipment rack **11**, as seen in **FIG. 5**.

[00110] However, in other embodiments, the mounting brackets may be snapped onto the side of the fiber optic housing first. **FIG. 6** is a front perspective view of a fiber optic housing **62** including a mounting bracket snap attachment feature **66**. In this regard, the fiber optic housing **62** has a left side **64**. In one embodiment, the left side **64** of the fiber optic housing **62** has a plurality of mounting bracket snap attachment features **66**. Although only

the left side **64** of the fiber optic housing **62** is illustrated in **FIG. 6**, the opposite side may also have similar mounting bracket snap attachment features **66**. In addition, although the embodiment of **FIG. 6** illustrates two (2) mounting bracket snap attachment features **66**, any number of mounting bracket snap attachment features **66** may be used.

[00111] With continuing reference to **FIG. 6**, a mounting bracket **68** has a plurality of openings **70** which are configured to fit together with the mounting bracket snap attachment features **66** integral to the fiber optic housing **62** to attach the mounting bracket **68** to the fiber optic housing **62**. The mounting bracket **68** can be removably attached to the fiber optic housing **62** such that the mounting bracket **68** can be removed from the fiber optic housing **62**, or the fiber optic housing **62** can be removed from the mounting bracket **68**, such as when the mounting bracket **68** is mounted to an equipment rack. The number of openings **70** may correspond to the number of mounting bracket snap attachment features **66**. The openings **70** of the mounting bracket **68** are placed over the mounting bracket snap attachment features **66** and slid toward the back of the fiber optic housing **62** until the mounting bracket snap attachment features **66** lock, or snap, into place against an edge of the openings **70**. In one embodiment, the mounting bracket snap attachment features **66** fit tightly enough in the openings **70** that there is sufficient friction between the mounting bracket snap attachment features **66** and the mounting bracket **68** to form a friction fit. The mounting bracket snap attachment features **66** in **FIG. 6** are triangular in shape and the openings **70** are square in shape, but any shape of mounting bracket snap attachment features **66** and openings **70** can be used that will allow the mounting bracket snap attachment features **66** to lock, or snap, into the openings **70**. The mounting bracket **68** can then be easily removed from the fiber optic housing **62** by sliding the mounting bracket **68** back toward the front of the fiber optic housing **62** until the mounting bracket snap attachment features **66** are within the openings **70**, and the mounting bracket **68** can be lifted away from the left side **64** such that the mounting bracket snap attachment features **66** pass through the openings **70**. In another embodiment, the fiber optic housing **62** can be removed from the mounting bracket **68** in a similar fashion, such as when the mounting bracket **68** is mounted to an equipment rack.

[00112] As also illustrated in **FIG. 6**, the mounting brackets **68** may be one or more snap-on, removable mounting brackets **68** that are removably attachable to the side of the fiber optic housing without the use of screws or other hardware. In one embodiment, the mounting brackets **68** are removably attached to the fiber optic housing **62** using the mounting bracket snap attachment features **66.** These mounting bracket snap attachment features **66** can save time during installation. No tools may be needed for installation of the fiber optic housing **62**

to an equipment rack for tool-less installation, and no additional hardware may be needed. Thus, a technician need not worry about tools or hardware that may be lost or missing. The mounting brackets may be easily changed out with different designs for different types of equipment racks and for different positions in the equipment racks.

[00113] In this manner, the mounting brackets may be removably attached to at least one of the right side and the left side of the fiber optic housing tool-lessly, and by other than external fastening means. As described above, "tool-lessly" as used here means that the set of components is assembled using fastening means, such as snap attachments, that are integral to one or more of the components in the set of components, rather than external fastening means. Once the set of components is assembled tool-lessly, then the assembled set of components may be attached to another component or device using external fasteners and tools, and even with this use of external fasteners and tools, the assembly of the original set of components is still considered to be "tool-less." For example, the mounting brackets may be attached to an equipment rack using tools and external fastening means, but the mounting brackets may be tool-lessly attached to the fiber optic housing.

[00114] **FIG. 6** also illustrates rubber entry grommets **72** on the top and bottom rear and front, and left and right sides rear and front of the fiber optic housing **62**. Rubber provides better protection than solid materials, especially on the edges, and provides a better seal to keep dust, insects, and rodents out of the housings. The rubber entry grommets **72** provide entry and exit points for fiber optic cables or optical fibers to be routed in and out of the fiber optic housing **62** to the appropriate locations.

[00115] **FIG. 7** is a front perspective view of a mounting bracket **74** configured to be removably attached to a side **78** of a fiber optic housing **80** according to another exemplary embodiment. **FIG. 8** is a cut section of the mounting bracket **74** and side **78** of the fiber optic housing **80** illustrated in **FIG. 7**. The mounting bracket **74** in **FIGS. 7** and **8** is of a different type than the mounting bracket **68** of **FIG. 6**. In the embodiment of **FIGS. 7** and **8**, the mounting bracket **74** has a single circular opening **76**. The mounting bracket **74** may also have a plurality of recesses **75**, which allow a space for other apparatuses to be attached to the fiber optic housing **80**. The side **78** of the fiber optic housing **80** has a groove **82** configured to receive the mounting bracket **74**. The groove **82** extends a distance down the side **78** that corresponds to a length of the mounting bracket **74**. The side **78** has an interior wall with a release tab disposed thereon (similar to an interior wall **84** with a release tab **86** illustrated on the opposite side from the side **78**). When the mounting bracket **74** is slid into the groove **82** toward the rear of the fiber optic housing **80**, the opening **76** will selectively engage with the

release tab **86** to lock the mounting bracket **74** into place. If it is desired to remove the mounting bracket **74**, the release tab **86** can be pressed and the mounting bracket **74** can be pulled out of the groove **82**.

[00116] **FIG. 9** is a rear perspective view of a fiber optic housing **81** including one or more strain relief brackets **85**. One or more snap-on removable strain relief brackets **85** may be attached to the fiber optic housing **81** as illustrated in **FIG. 9**. In one embodiment, the strain relief brackets **85** may be L-shaped, with a flange **83** at one end having a plurality of holes **87**. The holes **87** are for ties such as tyrap or Velcro ties to help secure fiber optic cables or optical fibers to the strain relief brackets **85**. The snap-on removable strain relief brackets **85** can be easily snapped on to a left side **92** of the fiber optic housing **81** using a plurality of strain relief bracket snap attachment features **88** disposed on the left side **92** of the fiber optic housing **81**. In one embodiment, the plurality of strain relief bracket snap attachment features **88** are similar to the plurality of mounting bracket snap attachment features **66** used to removably attach the mounting bracket **68** to the fiber optic housing **62** in **FIG. 6**.

[00117] In one embodiment as illustrated in **FIG. 9**, the left side **92** of the fiber optic housing **81** has a plurality of strain relief bracket snap attachment features **88**. Although only the left side **92** of the fiber optic housing **81** is illustrated in **FIG. 9**, the opposite side, the right side, may also have similar strain relief bracket snap attachment features **88**. In addition, although the embodiment of **FIG. 9** illustrates two (2) strain relief bracket snap attachment features **88**, any number of strain relief mounting bracket snap attachment features **88** may be used.

[00118] With continuing reference to **FIG. 9**, each strain relief bracket **85** has at least one opening **90** which is configured to fit together with one of the strain relief bracket snap attachment features **88**. The opening **90** of each strain relief bracket **85** is placed over one of the strain relief bracket snap attachment features **88** and slid toward the back of the fiber optic housing **81** until the strain relief bracket snap attachment feature **88** locks, or snaps, into place against an edge of the opening **90**. In one embodiment, the strain relief bracket snap attachment features **88** fit tightly enough in the openings **90** that there is sufficient friction between the strain relief bracket snap attachment features **88** and the strain relief bracket **85** to form a friction fit. The strain relief bracket snap attachment features **88** in **FIG. 9** are triangular in shape and the openings **90** are square in shape, but any shape of strain relief bracket snap attachment features **88** and openings **90** can be used that will allow the strain relief bracket snap attachment features **88** to lock, or snap, into the openings **90**. The strain relief bracket **85** can then be easily removed by sliding the strain relief bracket **85** back

toward the front of the fiber optic housing **81** until the strain relief bracket snap attachment feature **88** is within the opening **90**, and the strain relief bracket **85** can be lifted away from the left side **92** such that the strain relief bracket snap attachment feature **88** passes through the opening **90**.

[00119] As illustrated in **FIG. 9**, the snap-on cable strain relief brackets do not require the use of screws or other hardware to be attached to the fiber optic housing **81**. The snap attachment feature saves time during installation. No tools or hardware may be needed. Thus, a technician need not worry about tools or hardware that may be lost or missing. In addition, the strain relief brackets may be easily changed out for different strain relief applications. In this manner, the strain relief brackets may be removably attached to at least one of the right side and the left side of the fiber optic housing tool-lessly, and by other than external fastening means. As described above, "tool-lessly" as used here means that the strain relief brackets are attached to the fiber optic housing using fastening means, such as snap attachments, that are integral to one or more of the components in the set of components, rather than by using external fastening means.

[00120] **FIG. 10** is a side perspective view of a fiber optic housing **94** and a strain relief bracket **96**. In **FIG. 10**, an alternate type of strain relief bracket and an alternate type of strain relief bracket snap attachment feature are illustrated. **FIGS. 11A** and **11B** illustrate a close-up view of the fiber optic housing **94** and strain relief bracket **96** illustrated in **FIG. 10**. In one embodiment, the strain relief bracket **96** may be attached to the fiber optic housing **94** as illustrated in **FIGS. 10, 11A,** and **11B**. In one embodiment, the strain relief bracket **96** may be L-shaped, with a flange **98** at one end having a plurality of holes **100**. The holes **100** may be of any shape and are configured to receive ties such as tyrap or Velcro ties to help secure fiber optic cables or optical fibers to the strain relief bracket **96**. The snap-on removable strain relief brackets **96** may also comprise a plurality of openings **102** and **104**. In the embodiments seen in **FIGS. 10, 11A,** and **11B**, there are a pair of keyhole-shaped openings **102** and a pair of U-shaped openings **104**. However, there may be any number and any shape of openings in other embodiments.

[00121] The strain relief bracket **96** can be easily snapped onto a right side **95** of the fiber optic housing **94** using a plurality of strain relief bracket snap attachment features **106, 108,** and **110** disposed on the right side **95** of the fiber optic housing **94**. In one embodiment, as seen in **FIG. 11B**, the plurality of strain relief bracket snap attachment features **106, 108,** and **110** comprise a pair of half-moon-shaped snap attachment features **106** with a lip **107**, a U-shaped snap attachment feature **108** with raised edges **109**, and a release button **110**. The

plurality of strain relief bracket snap attachment features **106, 108,** and **110** may be used to removably attach the strain relief bracket **96** to the fiber optic housing **94** in **FIGS. 10, 11A,** and **11B**.

[00122] In one embodiment as illustrated in **FIG. 10**, the right side **95** of the fiber optic housing **94** has the plurality of strain relief bracket snap attachment features **106, 108,** and **110**. Although only the right side **95** of the fiber optic housing **94** is illustrated in **FIG. 10**, the opposite side may also have similar strain relief bracket snap attachment features. In addition, any number of strain relief mounting bracket snap attachment features may be used. The strain relief bracket **96** in **FIG. 10** may be easily snapped onto the right side **95** of the fiber optic housing **94** by placing the pair of keyhole-shaped openings **102** over the pair of half-moon-shaped snap attachment features **106** and the pair of U-shaped openings **104** over the U-shaped snap attachment feature **108** and the release button **110** and then sliding the strain relief bracket **96** toward the front of the fiber optic housing **94** (to the left in **FIG. 10**). The lip **107** on each of the half-moon-shaped snap attachment features **106** will help lock the half-moon-shaped snap attachment features **106** into the keyhole-shaped openings **102**, as seen in **FIG. 11B**. The U-shaped snap attachment feature **108** with raised edges **109** will selectably engage with one of the U-shaped openings **104** and the release button **110** will selectably engage with the other one of the U-shaped openings **104**.

[00123] **FIG. 11A** illustrates the strain relief bracket **96** snapped into place on the right side **95** of the fiber optic housing **94**. Referring to **FIG. 11B**, in one embodiment, the strain relief bracket **96** can then be easily removed by pressing the release button **110**. The release button **110** is coupled to the U-shaped snap attachment feature **108** with raised edges **109** such that when the release button **110** is pressed, the raised edges **109** of the U-shaped attachment feature **108** are disengaged with the U-shaped opening **104**. A user may then slide the strain relief bracket **96** back toward the rear of the fiber optic housing **94** (to the right in **FIG. 10** or **FIG. 11A**) to remove the strain relief bracket **96**. **FIG. 12** is a cut section of the strain relief bracket **96** and the back of a left side **97** of the fiber optic housing **94** in **FIGS. 10, 11A,** and **11B**, illustrating how the strain relief bracket **96** is mounted to the fiber optic housing **94** using the snap attachment features disclosed above.

[00124] **FIG. 13** is a partial, rear, perspective view of a fiber optic housing **112** illustrating a strain relief bracket **114** with fiber optic cables according to one embodiment. The fiber optic housing **112** may be any type of fiber optic housing. The strain relief brackets **114** having a plurality of openings **116** may be mounted to the fiber optic housing **112** using the snap attachment features disclosed above in **FIGS. 9, 10, 11A,** and **11B**. **FIG. 13** illustrates how

the removable strain relief brackets **114** allow fiber optic cables to enter at any angle. In the embodiment of **FIG. 13**, buffer tubes **118A** and **118B** each containing one or more optical fibers **120A** and **120B**, respectively, may be tied to the strain relief brackets **114** by means of a fastener **122** that is routed through the openings **116** of the strain relief brackets **114** to tie the buffer tubes **118A** and **118B** to the strain relief brackets **114**. Although buffer tubes **118A** and **118B** are illustrated in **FIG. 13**, any sort of fiber optic cable or optical fiber can be fastened to the strain relief brackets **114**. The fastener **122** may be any suitable fastener, including but not limited to a tywrap, a Velcro tie, or a plastic fastener, that will tie the buffer tubes **118A** and **118B**, or other fiber optic cable or optical fiber, to the strain relief brackets **114**. With traditional strain relief brackets, fiber optic cables can enter the fiber optic housing **112** at only a single angle, but with the snap-on removable strain relief brackets **114** disclosed above, the fiber optic cables may enter at any angle, and different fiber optic cables may enter at multiple angles, as illustrated in **FIG. 13**.

[00125] Embodiments disclosed below include fiber optic housings configured for tool-less assembly, and related components and methods. In one embodiment, a fiber optic housing is provided having a top, a bottom, a right side, and a left side which removably attach to each other tool-lessly, and by other than external fastening means, thereby defining at least one interior chamber configured to support fiber optic equipment. The top, bottom, right side, and left side of the fiber optic housing may be removably attached to each other by using a snap attachment integral to at least one of the bottom, the right side, and the left side. In an embodiment, the fiber optic housing further has one or more mounting brackets and/or strain relief brackets, which may be attached to the fiber optic housing by other than external fastening means. In another embodiment, the mounting brackets and/or strain relief brackets may be attached to a side of the fiber optic housing by using a quick snap attachment integral to at least one of the side of the fiber optic housing and the mounting brackets and/or strain relief brackets.

[00126] In this regard, **FIG. 14** is a front perspective view of a fiber optic housing **124** with a front door **126** closed. The fiber optic housing **124** in **FIG. 14** may be a seven inch fiber optic housing for the local area network (LAN) and data center environment. The fiber optic housing **124** in **FIG. 14** may be mountable in 19- or 23-inch equipment racks or cabinets. The fiber optic housing **124** in **FIG. 14** may provide interconnect or cross-connect capabilities between the outside plant, riser, or distribution cables and the opto-electronics.

[00127] **FIG. 15** illustrates exploded and assembled front perspective views of an exemplary embodiment of the fiber optic housing **124**. **FIG. 15** illustrates a quick fit assembly of the

components of the fiber optic housing **124**, particularly, a top panel **128**, a bottom panel **130**, a left side panel **132**, and a right side panel **134**, which are configured to be quickly and easily assembled with little or no tools. The top panel **128**, the bottom panel **130**, the left side panel **132**, and the right side panel **134** may also be referred to as the top, the bottom, the left side, and the right side, respectively. The top panel **128**, the bottom panel **130**, the left side panel **132**, and the right side panel **134** together define at least one interior chamber **135** of the fiber optic housing **124** configured to support fiber optic equipment. In this embodiment, each of the top panel **128**, the bottom panel **130**, the left side panel **132**, and the right side panel **134** of the fiber optic housing **124** further includes snap attachment features configured to snap the components together, as described more fully below.

[00128] In the embodiment of **FIG. 15**, the bottom panel **130** has side extensions **136**, **138** that extend upward in a direction approximately perpendicular to the bottom panel **130**. Likewise, the top panel **128** has side extensions **140**, **142** that extend downward in a direction approximately perpendicular to the top panel **128**. The side extensions **136, 138** of the bottom panel **130** and the side extensions **140**, **142** of the top panel **128** each have a plurality of snap attachments **144** disposed thereon (though only the snap attachments **144** disposed on the side extension **136** of the bottom panel **130** and the snap attachments **144** disposed on the side extension **140** of the top panel **128** can be seen in **FIG. 15**). These snap attachments **144** may be raised from a surface of the side extensions **136, 138, 140,** and **142**. The left side panel **132** may have a plurality of snap attachment receivers **146** at a top edge **148** and a bottom edge **150** of the left side panel **132**. Although not seen in **FIG. 15**, the right side panel **134** may have similar snap attachment receivers **146** at a top edge and at a bottom edge.

[00129] The snap attachment receivers **146** at the top edge **148** of the left side panel **132** are configured to receive the snap attachments **144** disposed on the side extension **140** of the top panel **128**. The snap attachment receivers **146** at the bottom edge **150** of the left side panel **132** are configured to receive the snap attachments **144** disposed on the side extension **136** of the bottom panel **130**. In this manner, the left side panel **132** may be tool-lessly attached to the top panel **128** and the bottom panel **130**. The right side panel **134** may be similarly attached to the top panel **128** and the bottom panel **130** using snap attachment receivers on a top edge and a bottom edge to receive snap attachments on the side extension **142** of the top panel **128** and the side extension **138** of the bottom panel **130**, respectively. In this manner, the top panel **128**, the bottom panel **130**, the left side panel **132**, and the right side panel **134** may be assembled together into the fiber optic housing **124** quickly and easily with little or no tools.

[00130] The snap attachments **144** and the snap attachment receivers **146** may be any size and shape as long as the snap attachment receivers **146** are of a size and shape that allows the snap attachments **144** to fit and snap into the snap attachment receivers **146** in a manner that the components of the fiber optic housing **124** are assembled together in a sturdy fashion.

[00131] The assembled fiber optic housing **124** can be quickly and easily unassembled by detaching the top panel **128**, the bottom panel **130**, the left side panel **132** and the right side panel **134** from each other tool-lessly.

[00132] The quick fit assembly allows the components of the fiber optic housing **124** to be shipped in smaller packaging, saving shipping cost and storage space. In one embodiment, an end user can assemble the fiber optic housing **124** at the time of use, such as at the installation location. In one embodiment, an end user can assemble the fiber optic housing **124** with little or no tools. Additionally, the quick fit assembly makes field repairs a possibility with the purchase of repair kits, and allows the fiber optic housing **124** to be transformed in the field by replacing components with ones that provide a different function.

[00133] **FIG. 16** illustrates an exploded front perspective view of an exemplary embodiment of a fiber optic housing **152**. **FIG. 16** illustrates an alternate embodiment of the fiber optic housing **152** that can be assembled easily and quickly with little or no tools. **FIG. 16** illustrates a quick fit assembly of the components of the fiber optic housing **152**, particularly, an inside top panel **154**, a bottom panel **156**, a left side panel **158**, and a right side panel **160**, which are configured to be quickly and easily assembled with little or no tools. The inside top panel **154**, the bottom panel **156**, the left side panel **132**, and the right side panel **160** together define at least one interior chamber **161** of the fiber optic housing **152** configured to support fiber optic equipment. In this regard, each of the inside top panel **154**, the bottom panel **156**, the left side panel **158**, and the right side panel **160** includes snap attachment features configured to snap the components together. In one embodiment, the fiber optic housing **152** may also include a cover plate **162** for the inside top panel **154**.

[00134] In one embodiment, as seen in **FIG. 16**, the bottom panel **156** has side flanges **164, 166** on each side of the bottom panel **156** that extend upward in a direction approximately perpendicular to the bottom panel **156**. The side flanges **164**, **166** of the bottom panel **156** each have one or more receivers **168A, 168B** disposed on the side flanges **164**, **166**. The inside top panel **154** has side flanges **170**, **172** on each side of the inside top panel **154** that extend downward in a direction approximately perpendicular to the inside top panel **154**. The side flanges **170**, **172** of the inside top panel **154** each have one or more receivers **174** disposed on the side flanges **170**, **172**. Although **FIG. 16** illustrates the side flanges **164**, **166**

of the bottom panel **156** each having two (2) receivers **168A, 168B**, and the side flanges **170**, **172** of the inside top panel **154** each having one receiver **174**, any number of receivers like the receivers **168A, 168B** may be disposed on the side flanges **164**, **166** of the bottom panel **156** and any number of receivers **174** may be disposed on the side flanges **170**, **172** of the inside top panel **154**. The inside top panel **154** also has a plurality of standoffs **176** on its top surface. In the embodiment of **FIG. 16**, the inside top panel **154** has two (2) standoffs **176** on a left edge **178** of the inside top panel **154**, one toward a front edge **180** of the inside top panel **154**, and one toward a back edge **182** of the inside top panel **154**. The inside top panel **154** of **FIG. 16** also has two standoffs **176** on a right edge **184** of the inside top panel **154**, one toward the front edge **180** of the inside top panel **154** and one toward the back edge **182** of the inside top panel **154**. The standoffs **176** are also used together with the receivers **168A**, **168B**, **174** to attach the inside top panel **154** to the left side panel **158** and to the right side panel **160**.

[00135] The left side panel **158** may include a plurality of snap attachments **186A, 186B,** and **186C**. In the embodiment of **FIG. 16**, the left side panel **158** has two (2) snap attachments **186A, 186B** on a bottom portion **188** of an interior side **190** of the left side panel **158**, one toward a front portion **192** of the left side panel **158** and one toward a rear portion **194** of the left side panel **158**. The left side panel **158** also has at least one snap attachment **186C** on a top portion **196** of the interior side **190** of the left side panel **158** toward the front portion **192** of the left side panel **158**. The snap attachments **186A, 186B,** and **186C** in the embodiment of **FIG. 16** are half-moon-shaped with a lip. In other embodiments, the number, location, and shape of the snap attachments **186A, 186B,** and **186C** may vary in order to correspond to the receivers **168A, 168B** on the side flanges **164** and **166** of the bottom panel **156** and the receivers **174** on the side flanges **170**, **172** of the inside top panel **154**. The left side panel **158** also may include a top flange **198** and a bottom flange **200**. The top flange **198** may have a plurality of grooves **202** disposed thereon. In the embodiment of **FIG. 16**, the top flange **198** has two (2) grooves **202** toward a front portion **204** of the top flange **198**. In one embodiment, as illustrated in **FIG. 16**, the grooves **202** are L-shaped, but other shapes may also be used.

[00136] With continued reference to **FIG. 16**, the right side panel **160** is symmetrical to the left side panel **158** and may also include a plurality of snap attachments **186A** and **186B**, a top flange **205** having a plurality of grooves **206**, and a bottom flange **208**. The left side panel **158** and the right side panel **160** may be tool-lessly attached to the bottom panel **156** quickly and easily. The left side panel **158** may be attached to the side flange **164** of the

bottom panel **156** by positioning the snap attachments **186A, 186B** on the left side panel **158** within the receivers **168A, 168B** on the side flange **164** of the bottom panel **156** and sliding the left side panel **158** toward the back of the bottom panel **156** until the snap attachments **186A, 186B** snap, or lock, into place within the receivers **168A**, **168B**. The bottom flange **200** will be positioned under the bottom panel **156** as the left side panel **158** is attached to the bottom panel **156**. In the embodiment seen in **FIG. 16**, the receivers **168A**, **168B** are keyhole-shaped and correspond to the half-moon shaped snap attachments **186A, 186B**. However, the snap attachments **186A, 186B** and the receivers **168A**, **168B** may be any shape as long as the receivers **168A**, **168B** correspond to the snap attachments **186A, 186B** such that the snap attachments **186A**, **186B** snap, or lock, into place within the receivers **168A**, **168B**. In one embodiment, the receivers **168A**, **168B** are slightly larger at one end than the snap attachments **186A, 186B** so that the snap attachments **186A**, **186B** may fit into the receivers **168A**, **168B**, respectively.

[00137] The right side panel **160** may be attached to the side flange **166** of the bottom panel **156** in a fashion similar to that disclosed above for attaching the left side panel **158** to the side flange **164** of the bottom panel **156.**

[00138] Still referring to **FIG. 16,** as well as to **FIG. 18,** the inside top panel **154** may be tool-lessly attached to the left side panel **158** and the right side panel **160** quickly and easily. **FIG. 18** is a close up front perspective view illustrating details of how the inside top panel **154** of the fiber optic housing **152** of **FIGS. 16, 17A** and **17B** is connected to a side panel **158**, **160** of the fiber optic housing **152**. To do so, a user will slide the inside top panel **154** from the front of the left side panel **158** and the right side panel **160** toward the back of the left side panel **158** and the right side panel **160** such that the inside top panel **154** slides under the top flange **198** of the left side panel **158** and under the top flange **205** of the right side panel **160**. The inside top panel **154** is positioned such that the receiver **174** on the side flange **170** of the inside top panel **154** is aligned with the snap attachment **186C** located at the top portion **196** of the left side panel **158**, which will also align the standoffs **176** on the left edge **178** of the inside top panel **154** with the grooves **202** on the top flange **198** of the left side panel **158**. The inside top panel **154** should also be positioned such that the receiver **174** on the side flange **172** of the inside top panel **154** is aligned with the snap attachment **186C** located at the top portion of the right side panel **160**, which will also align the standoffs **176** on the right edge **184** of the inside top panel **154** with the grooves **206** on the top flange **205** of the right side panel **160**. Once the inside top panel is aligned, the inside top panel **154** can be snapped onto the left side panel **158** and the right side panel **160** by snapping, or locking,

the snap attachments **186C** into the receivers **174** and the standoffs **176** into the grooves **202** and **206** (as seen in the close-up insets of **FIG. 18**).

[00139] In the embodiment as illustrated in **FIGS. 16** and **18**, the receivers **174** are keyhole-shaped in order to correspond to the half-moon shaped snap attachments **186C**. However, the snap attachments **186C** and the receivers **174** may be any shape as long as the receivers **174** correspond to the snap attachments **186C** such that the snap attachments **186C** snap, or lock, into place within the receivers **174**. In one embodiment, the receivers **174** are slightly larger at one end than the snap attachments **186C** so that the snap attachments **186C** may fit into the receivers **174**. Likewise, the standoffs **176** and the grooves **202** and **206** may be any size and shape as long as the standoffs **176** will lock into place in the grooves **202** and **206.**

[00140] In the embodiment as illustrated in **FIG. 18**, the side flanges **170** and **172** of the inside top panel **154** may also include one or more cut out sections **209**, sometimes known as crenels. The left side panel **158** may also include one or more protrusions **210**, sometimes known as merlons, on the interior side **190** of the left side panel **158** toward the front portion **192** of the left side panel **158**. In one embodiment, the merlons **210** are located directly beneath the snap attachment **186C**. The right side panel **160** may have similar merlons **210** on its interior side. In the embodiment illustrated in **FIG. 18**, when the inside top panel **154** is positioned such that the receiver **174** on the side flange **170** of the inside top panel **154** is aligned with the snap attachment **186C** located at the top portion **196** of the left side panel **158**, the crenels **209** of the side flange **170** of the inside top panel **154** are also aligned with the merlons **210** of the left side panel **158**. Then, when the inside top panel **154** is locked into place (such as by sliding the inside top panel **154** toward the front portion **192** of the left side panel **158**, as indicated by the arrow in **FIG. 18**), the snap attachment **186C** is locked into the receiver **174** and the merlons **210** interlock with the crenels **209** to provide additional stability for the attachment between the inside top panel **154** and the left side panel **158** and the right side panel **160**.

[00141] **FIG. 17A** is an assembled front perspective view of the fiber optic housing **152** of **FIG. 16**. Once the left side panel **158** and the right side panel **160** have been tool-lessly attached to the bottom panel **156** and the inside top panel **154** has been tool-lessly attached to the left side panel **158** and the right side panel **160**, the fiber optic housing **152** has been tool-lessly assembled, as illustrated in **FIG. 17A**.

[00142] The assembled fiber optic housing **152** can be quickly and easily unassembled by detaching the inside top panel **154**, the bottom panel **156**, the left side panel **158**, and the right side panel **160** from each other tool-lessly.

[00143] In one embodiment, the fiber optic housing **152** may also include the cover plate **162** (as seen in **FIG. 16**) for the inside top panel **154**. As seen in **FIG. 16**, the cover plate **162** may have a plurality of openings **212** configured such that when the cover plate **162** is positioned over the inside top panel **154**, the openings **212** fit over the standoffs **176** on the inside top panel **154** in order to provide a gap between the inside top panel **154** and the cover plate **162**. **FIG. 17B** is an assembled front perspective view of the fiber optic housing **152** of **FIG. 17A** with the cover plate **162** attached. In one embodiment, the cover plate **162** may be attached to the assembled fiber optic housing **152** by means of fasteners, with screws being one non-limiting example. In one embodiment, the fasteners extend through the grooves **202**, **206** to attach the cover plate **162** to the right and left side panels **158**, **160**.

[00144] Embodiments disclosed below include fiber optic housings having a removable top, and related components and methods. In one embodiment, a fiber optic housing is provided having a removable top. In one embodiment, the fiber optic housing comprises a top, a bottom, a right side, and a left side defining at least one interior chamber configured to support fiber optic equipment. The top comprises a base and a cover in one embodiment. The top is configured to provide a gap between the base and the cover such that at least one of the right side and the left side of the fiber optic housing is configured to be slidably engaged into and out of the gap. In this manner, the top can be easily removed to provide access to the interior of the fiber optic housing.

[00145] In this regard, **FIGS. 19A-21B** disclose another embodiment, in which a removable top for a fiber optic housing is disclosed. The removable top allows easy access to internal features of the fiber optic housing at initial installation or afterwards. The removable top thus may provide an advantage over current fiber optic housing designs which are not removable since the removable top allows the technician or user easy access and a clear view of the working area inside the fiber optic housing. **FIG. 19A** illustrates the removable top as it slides out of the fiber optic housing. **FIG. 19B** illustrates the fiber optic housing after the removable top has been removed.

[00146] In one embodiment, the removable top on the fiber optic housing consists of a base and a cover plate capable of being fastened with pop-rivets or screws. In one embodiment, the removable top may be shaped in a way to provide a gap between the base and cover into which the side panel on the housing can slide. The side panel of the fiber optic housing has a release tab that engages and locks the removable top in place. In one embodiment, the removable top is made from any satisfactory metal. In other embodiments, the removable top can be one piece made out of plastic. In the embodiment illustrated in **FIGS. 19A-21B**, the

release tab is round, but the release tab can be different shapes in other embodiments. In one embodiment, the release tab may be located on a top side of the removable top, or on an underside of the removable top.

[00147] **FIG. 19A** is a rear perspective view of a fiber optic housing **214** having a removable top **222** according to one embodiment. The fiber optic housing **214** has a bottom **216**, a right side **218**, and a left side **220**. The bottom **216**, the right side **218**, and the left side **220** together define at least one interior chamber **221** of the fiber optic housing **214** configured to support fiber optic equipment. The fiber optic housing **214** also comprises the removable top **222** in this embodiment. In one embodiment, the fiber optic housing **214** may be assembled by attaching the bottom **216**, the right side **218**, the left side **220**, and the removable top **222**. In one embodiment, the fiber optic housing **214** may be assembled tool-lessly as disclosed above with respect to **FIGS. 14-18**. However, in other embodiments, the fiber optic housing **214** need not be assembled tool-lessly to have the removable top **222** as described herein.

[00148] The removable top **222** comprises a base **224** and a cover plate **226**. The cover plate **226** is attached to the base **224** such that a gap **228** exists between the base **224** and the cover plate **226**. The right side **218** may comprise a top flange **229**. The left side **220** may comprise a top flange **230**. The gap **228** between the base **224** and the cover plate **226** may be of a size that corresponds to the thickness of the top flanges **229** and **230**. In this manner, the removable top **222** may slide on and off the right side **218** and the left side **220**, where the gap **228** between the base **224** and the cover plate **226** allows the cover plate **226** of the removable top **222** to pass over the top flanges **229**, **230** and the base **224** of the removable top **222** to pass under the top flanges **229, 230**. One or both of the top flanges **229, 230** may have a release tab **232**. The cover plate **226** may have one or more holes **234** configured to receive the release tab(s) **232** when the removable top **222** is slid onto the right side **218** and the left side **220.** As the removable top **222** is slid onto the right side **218** and the left side **220**, the release tab(s) **232** selectably engages with the hole(s) **234** to hold the removable top **222** in place in the fiber optic housing **214**. If it is desired to remove the removable top **222,** the user will press the release tab(s) **232** down, allowing the release tab(s) **232** to be disengaged from the hole(s) **234** and allowing the removable top **222** to be slid out from the fiber optic housing **214**. In one embodiment, the release tab **232** is flexible and resilient, such that it is biased to move from a first position to a second position when a force is exerted on the release tab **232**, and then returns to the first position by itself when the force is no longer exerted. In another embodiment, the release tab **232** may be spring loaded. In one

embodiment, as seen in **FIG. 19A**, the release tab **232** is accessible from the top of the removable top **222**. Although the release tab **232** is pressed downward in the above embodiments, in other embodiments, the release tab **232** may be lifted up, pulled outward, pressed inward, or manipulated in other ways and/or directions to cause the release tab **232** to disengage from the hole(s) **234** and allow the removable top **222** to be slid out from the fiber optic housing **214**.

[00149] **FIG. 19A** illustrates the removable top **222** sliding out of the fiber optic housing **214**. **FIG. 19B** is a rear perspective view of the fiber optic housing **214** of **FIG. 19A** after the removable top **222** is removed. This allows the user or technician access to the fiber optic cables, modules, cassettes, optical fibers, or other fiber optic apparatuses inside the fiber optic housing **214**. **FIG. 19C** illustrates an alternate embodiment of the release tab **232**. In this embodiment, the release tab **232** is accessible from an underside **235** of the removable top **222**. In another embodiment, the release tab **232** may be located on a top side of the removable top **222**.

[00150] **FIG. 20A** illustrates an exploded front perspective view of an exemplary embodiment of the removable top **222**. **FIG. 20A** illustrates how the removable top **222** of **FIG. 19A** is assembled according to one embodiment. The removable top **222** is assembled using the base **224** and the cover plate **226**. The base **224** may have a plurality of standoffs **236** disposed on its top surface. In the embodiment of **FIG. 20A**, the base **224** has a plurality of standoffs **236** arranged along a front edge **238** of the base **224**, a plurality of standoffs **236** arranged in a middle portion **240** of the base **224**, and a plurality of standoffs along a back edge **242** of the base **224**. The cover plate **226** has a plurality of openings **244** that correspond to the plurality of standoffs **236** in one embodiment. In the embodiment of **FIG. 20A**, the cover plate **226** has a plurality of openings **244** arranged along a front edge **246** of the cover plate **226**, a plurality of openings **244** arranged in a middle portion **248** of the cover plate **226**, and a plurality of openings **244** along a back edge **374** of the cover plate **226**. The number of standoffs **236** and openings **244** may vary.

[00151] The standoffs **236** may be a predetermined height in one embodiment. In one embodiment, the standoffs **236** may be between approximately one eighth (1/8) of an inch tall and approximately one half (1/2) of an inch tall. In one embodiment, the standoffs **236** may be approximately one quarter (1/4) of an inch tall. The cover plate **226** is attached to the base **224** by placing the openings **244** over the corresponding standoffs **236** in order to form the removable top **222** of **FIGS. 19A** and **20B** (discussed below). In one embodiment, the standoffs **236** are configured to receive screws or other fasteners that will affix the cover

plate **226** to the base **224.** In one embodiment, the base **224** may also have cutout sections **376** that are configured to receive rubber grommets **378**. The rubber grommets **378** can be used for access for fiber optic cables or optical fibers to be routed into and out of the fiber optic housing **214**.

[00152] When the cover plate **226** is attached to the base **224** to form the removable top **222**, the standoffs **236** help form the gap **228** between the base **224** and the cover plate **226** as seen in **FIGS. 19A** and **20A**. The gap **228** allows the removable top **222** to be slid on and off of the fiber optic housing **214**.

[00153] **FIG. 20B** illustrates an assembled front perspective view of an exemplary embodiment of the fiber optic housing **214** of **FIG. 19A** as the removable top **222** is being reinstalled into the fiber optic housing **214.** As seen in **FIG. 20B**, the removable top **222** can be slid back onto the fiber optic housing **214** such that the gap **228** allows the cover plate **226** of the removable top **222** to pass over the top flanges **229** and **230** of the right side **218** and left side **220** of the fiber optic housing **214** and the base **224** of the removable top **222** to pass under the top flanges **229, 230**.

[00154] **FIG. 21A** is a side view section cut of a side panel (such as the right side **218** or the left side **220** of the fiber optic housing **214** of **FIGS. 19A** and **20A)** of a fiber optic housing configured to receive the removable top **222** of **FIGS. 19A, 20A,** and **20B**. **FIG. 21B** is a side view of the gap **228** in the removable top **222** of **FIGS. 19A, 20A,** and **20B** configured to receive the side panel of the fiber optic housing. As discussed above, the right side **218** in **FIG. 21A** has a top flange **229** of a thickness that corresponds to the gap **228** between the base **224** and the cover plate **226** of the removable top **222**. As illustrated in **FIG. 21B**, the gap **228** is configured to correspond to the thickness of the top flange **229** such that the removable top **222** can slide along the top flange **229**, with the gap **228** receiving the top flange **229**. In this manner, the removable top **222** can be reinstalled into the fiber optic housing **214**.

[00155] **FIG. 22** is a front perspective view of a fiber optic housing **256** illustrating rubber entry grommets **264, 266**. The fiber optic housing **256** may be of any type and can be assembled in any manner. In one embodiment, the fiber optic housing **256** has a bottom (not illustrated in **FIG. 22**), a left side **258**, a right side (not illustrated in **FIG. 22**), and a top **260**. The fiber optic housing **256** also comprises a front door **262** in this embodiment. In one embodiment, the fiber optic housing **256** may be assembled by attaching the bottom, the left side **258**, the right side, and the top **260**. In one embodiment, the fiber optic housing **256** may be assembled tool-lessly as disclosed above with respect to **FIGS. 14-18**. However, in other

embodiments, the fiber optic housing **256** need not be assembled tool-lessly. The top **260** may or may not comprise a removable top as disclosed above with respect to **FIGS. 19A-21B**. The fiber optic housing **256** has a plurality of rubber grommets **264** and **266**. In one embodiment, the fiber optic housing **256** may have rubber grommets **264** or **266** on the top and bottom rear and front, and left and right sides rear and front of the fiber optic housing **256**. The rubber grommets **264**, **266** may be in the form of a single piece of rubber, like the rubber grommets **264**, or they may be part of a jumper management device, like the rubber grommets **266**, which are disclosed in more detail below with respect to **FIGS. 29** and **31-34**. The rubber grommets may be of any shape, including but not limited to rectangles, like the rubber grommets **264**, or circles, like the rubber grommets **266**. Rubber provides better protection than solid materials, especially on the edges, and provides a better seal to keep dust, insects, and rodents out of the housings. In one embodiment, the rubber grommets **264, 266** may be easily removed to provide entry and exit points for fiber optic cables or optical fibers to be routed in and out of the fiber optic housing **256** to the appropriate locations.

[00156] **FIG. 23** is a partial, front perspective view of the fiber optic housing **256** of **FIG. 22**. The fiber optic housing **256** may include molded in flexible edge protection. A molded in flexible edge protection piece **268** is located around an opening **270** on one or more sides **272** of the fiber optic housing **256**, as illustrated in **FIG. 23**. Fiber optic jumper cables or other fiber optic cables or optical fibers (not illustrated in **FIG. 23**) may be routed out of the fiber optic housing **256** through the opening **270**, and the molded in flexible edge protection piece **268** offers protection for the fiber optic jumper cables. In addition, one or more side grommets **274** are molded onto the solid material of the side **272** for a strong bond with the lowest profile possible. The side grommets **274** also offer access points for fiber optic jumper cables or other fiber optic cables or optical fibers to be routed into or out of the fiber optic housing **256**.

[00157] The rubber grommets disclosed above with respect to **FIGS. 22** and **23** allow for the routing of various fiber optic cables and optical fibers in and out of fiber optic housings. The fiber optic housings may also include various features to help better route and manage the fiber optic cables and optical fibers in and around the fiber optic housings. In one embodiment, the fiber optic housing may have a removable front section. The removable front section allows the fiber optic housing to be used for different applications and/or designs, as examples, where no jumper management is needed, or where a sealed version may be required. Further, the removable front section may comprise a removable front jumper management device with pass-through grommets. Fiber optic cables may be allowed

to pass through using the pass-through grommets while keeping the fiber management within the housing envelope. When removed, it allows for a greater volume of fiber jumpers to exit from the top and bottom, without sacrificing the space above the unit. Additionally, it allows pass-through of fiber optic cables or optical fibers on the top and bottom, instead of the top only like previous designs.

[00158] In this regard, embodiments disclosed below include removable fiber management sections for fiber optic housings, and related components and methods. In one embodiment, a fiber optic system is provided. The fiber optic system comprises a fiber optic housing defining at least one interior chamber configured to support fiber optic equipment. The fiber optic system also comprises a removable front section connected to the fiber optic housing and defining at least one front section interior chamber coupled to the at least one interior chamber of the fiber optic housing. The removable front section is configured to support at least one fiber management device to manage one or more optical fibers connected to fiber optic equipment disposed in the fiber optic housing.

[00159] In this regard, **FIG. 24** illustrates a front perspective view of a fiber optic housing **276** with a removable front section **278** and perspective views of two (2) removable front section versions. The fiber optic housing **276** defines an interior chamber **279** configured to support fiber optic equipment. The removable front section **278** also defines a front section interior chamber **281** to support fiber management components for managing one or more optical fibers connected to the fiber optic equipment supported by the fiber optic housing **276**, as will be discussed in more detail below. In this embodiment, the removable front section **278** is attached to the fiber optic housing **276**. The removable front section **278** can also be removed from the fiber optic housing **276** when no longer needed or desired. Optical fibers can be managed in fiber management components disposed in the removable front section **278** before or after the removable front section **278** is attached to the fiber optic housing **276**. Further, optical fibers routed in fiber management devices disposed in the removable front section **278** can be unrouted or removed before or after the removable front section **278** is detached from the fiber optic housing **276**.

[00160] The removable front section **278** may come in different versions. In one embodiment, the removable front section **278** may include fiber management components in the form of a plurality of front jumper management devices **280** and an opening **270** disposed on both sides of the removable front section **278**. The front jumper management devices **280** allow optical fibers that are connected to fiber optic equipment supported in the fiber optic housing **276** to be routed and maintained. The removable front section **278** can be employed

to provide capacity for employing such a fiber management component when the fiber optic housing **276** is either not able or is not configured to provide sufficient additional room for fiber management components. The openings **270** are both configured to provide fiber management by being configured to route one or more optical fibers connected to fiber optic equipment in the fiber optic housing **276** outside of the fiber optic housing **276** and to the sides of the removable front section **278**. When optical fibers are not routed through the openings **270**, a rubber seal **286** can be disposed in the openings **270**, as exemplified by the removable front section **278B**. The rubber seal **286** can fit in the place of the openings **270** in the removable front section **278A** to provide protection for the inside of the fiber optic housing **276** and to keep dust, insects, rodents, and other things out of the fiber optic housing **276**.

[00161] In this embodiment, the opening **270** includes a molded in flexible edge protection piece **268**, as exemplified by the removable front section **278A**. The flexible edge protection piece **268** protects optical fibers routed or otherwise disposed through the openings **270** from being damaged by kinking or bending against the edges of the openings **270** which may be sharp, especially if the fiber optic housing **276** is constructed from sheet metal as an example. The flexible edge protection piece **268** may be made from any type of material desired, including any type of polymer, rubber, plastic, etc. The flexible edge protection piece **268** may also be removable.

[00162] Fiber optic jumper cables or other fiber optic cables or optical fibers (not illustrated in **FIG. 24**) may be routed out of the fiber optic housing **276** through the opening **270**, and the molded in flexible edge protection piece **268** offers protection for the fiber optic jumper cables. The front jumper management devices **280** aid in fiber management and routing, as will be described in more detail below, with respect to **FIGS. 29-34**. The front jumper management devices **280** may be easily removable in one embodiment. The front jumper management devices **280** may be located on a top portion **282** and/or on a bottom portion **284** of the removable front section **278**.

[00163] In another embodiment, the removable front section **278** may also include a fiber management component in the form of a plurality of front jumper management devices **280** to route optical fibers along and through the bottom and top panels **298, 290** of the removable front section **278**. As will also be discussed in more detail below with regard to **FIGS. 31-33**, the front jumper management devices **280** may include a plurality of fiber routing guides in the form of routing clips **356** (see also **FIG. 31**) configured to route optical fibers connected to fiber optic equipment supported in the fiber optic housing **276**. As will also be discussed

in more detail below with regard to **FIGS. 31-33**, the front jumper management devices **280** may also include openings to allow optical fibers to be routed through bottom and top sections **290, 298** away from the removable front section **278**. Although in the embodiment of **FIG. 24**, the removable front section **278A** also has front jumper management devices **280**, in other embodiments, the removable front section **278A** or **278B** may not have any front jumper management devices **280**, or may have less front jumper management devices **280**.

[00164] **FIG. 25** illustrates an exploded, front perspective view of the removable front section **278** of a fiber optic housing. The removable front section **278** has a base **288** which is attached to a bottom panel **290**. A plurality of clips **292** for routing optical fibers may be configured to be attached to the bottom panel **290** of the base **288**. A left side panel **294** with an opening **270** having a molded in flexible edge protection piece **268** is configured to be attached to the bottom panel **290**. A symmetrical right side panel **296** with an opening **270** having a molded in flexible edge protection piece **268** is also configured to be attached to the bottom panel **290**. In one embodiment, the left side panel **294** and the right side panel **296** may be attached to the bottom panel **290** tool-lessly in a manner as described above with respect to **FIGS. 14-18**.

[00165] With continued reference to **FIG. 25**, a top panel **298** having a plurality of standoffs **300** disposed on its top surface is configured to be attached to the left side panel **294** and to the right side panel **296**. In one embodiment, the top panel **298** may be attached to the left side panel **294** and to the right side panel **296** tool-lessly in a manner as described above with respect to **FIGS. 14-18**. Alternative fiber management components in the form of a plurality of clips **292** for routing optical fibers may be configured to be attached to the top panel **298** for routing optical fibers. A cover plate **302** having openings **304** disposed thereon is configured to be attached to the top panel **298**. The openings **304** on the cover plate **302** are configured to fit over the standoffs **300** on the top panel **298**. In one embodiment, a fastener (not illustrated), including but not limited to a screw or pop rivet, will pass through the openings **304** into the standoffs **300** in order to attach the cover plate **302** to the top panel **298**. In one embodiment, the top panel **298** and the cover plate **302** have corresponding cutout sections **306**. The cutout sections **306** are configured to receive rubber grommets **308**, as illustrated in the embodiment of **FIG. 25**, or front jumper management devices **280** in another embodiment.

[00166] Still referring to **FIG. 25**, L-shaped brackets **310** are configured to be attached to each of the left side panel **294** and the right side panel **296**. The L-shaped brackets **310** may

be attached to the left and right side panels **294**, **296** by any means, including by screws or pop rivets. The L-shaped brackets **310** may have openings **311A** on one flange of the L-shaped brackets **310** to attach the L-shaped brackets **310** to the left and right side panels **294**, **296**. The L-shaped brackets **310** may also have openings **311B** and **311C** on another flange of the L-shaped brackets **310** to attach the removable front section **278** to a fiber optic housing, as described more fully below in connection with **FIG. 27**. In one embodiment, the L-shaped brackets **310** may take a form similar to the mounting brackets disclosed above (see, e.g., **FIG. 6**) and the left side panel **294** and the right side panel **296** may have snap attachment features as disclosed above (see, e.g., **FIG. 6**), and the L-shaped brackets **310** may be tool-lessly attached to the left side panel **294** and the right side panel **296**. The removable front section **278** may also have a door **312**. The door **312** is configured to attach to the base **288** and may be opened and closed.

[00167] Once the various components of the removable front section **278** of **FIG. 25** are assembled, the removable front section **278** will look like the removable front section **278** of **FIG. 26A**. **FIG. 26A** illustrates a front perspective view of the removable front section **278** of a fiber optic housing with the door **312** closed. The door **312** may have one or more latches **314** for opening and closing the door **312**.

[00168] **FIG. 26B** illustrates a front perspective view of the removable front section **278** with the door **312** open. With the door **312** open, the plurality of clips **292** are visible. The plurality of clips **292** are used for routing control and management of fiber optic cables and optical fibers, including but not limited to fiber optic jumper cables. The fiber optic jumper cables, or other fiber optic cables and optical fibers, may be routed through one or more of the plurality of clips **292** and in or out of the openings **270** on either side of the removable front section **278**. In addition, the rubber grommets **308** may be removed to another access point for the fiber optic jumper cables, or other fiber optic cables and optical fibers, to be routed in and out of the removable front section **278**. In one embodiment, the door **312** may also comprise one or more lips **315**. The lips **315** are configured to allow flip cards (not illustrated) to be removably attached to the lips **315**.

[00169] **FIG. 26C** illustrates a top front perspective view of the removable front section **278** with the door **312** removed. **FIG. 26D** illustrates another front perspective view of the removable front section **278** with the door **312** removed. Referring to **FIG. 26C**, the top panel **298** has a plurality of receivers **316** disposed thereon. The plurality of receivers **316** are configured to receive the plurality of clips **292**. In one embodiment, each of the plurality of clips **292** has a hook **318** that is configured to selectively fit into one of the plurality of

receivers **316**, thereby attaching the clip **292** to the top panel **298**. Each of the plurality of clips **292** is inserted from underneath the top panel **298** such that the hook **318** on each respective clip **292** fits into one of the plurality of receivers **316**, locking the respective clip **292** into the respective receiver **316**. The bottom panel **290** may also have a plurality of receivers like the receivers **316** that are configured to receive a plurality of clips **292** such that a plurality of clips **292** may also be attached to the bottom panel **290**.

[00170] **FIG. 27** illustrates a front perspective view of the removable front section **278** being attached to a fiber optic housing **320**. The fiber optic housing **320** may be of any type and may be assembled in any manner. In one embodiment, the fiber optic housing **320** may be assembled tool-lessly as disclosed above with respect to **FIGS. 14-18**. The fiber optic housing **320** may have mounting brackets **322** attached to each side of the fiber optic housing **320**. In one embodiment, the mounting brackets **322** may be like any of the mounting brackets disclosed above in **FIGS. 4-8** and may be attached to the fiber optic housing **320** as disclosed therein. The mounting brackets **322** may have a plurality of keyhole-shaped openings **324**. In one embodiment, there may be one keyhole-shaped opening **324** at a top **326** of each of the mounting brackets **322** and one keyhole-shaped opening **324** at a bottom **328** of each of the mounting brackets **322**. In one embodiment, the mounting brackets **322** may also include a plurality of oval-shaped openings **330** and a plurality of circular holes **332**. In one embodiment, the plurality of circular holes **332** may be located at or near a center **334** of the each of the mounting brackets **322**. In other embodiments, the keyhole-shaped openings **324**, the oval-shaped openings **330** and the circular holes **332** may be different shapes. The mounting brackets **322** may also have a plurality of recesses **336**, which allow a space for other apparatuses, such as the removable front section **278**, to be attached to the fiber optic housing **320**, as described more fully below.

[00171] With continued reference to **FIG. 27**, including the inset view, the removable front section **278** has a plurality of tabs **338** at a top **340** and a bottom **342** of each of the left side panel **294** and the right side panel **296** (although only the tabs **338** on the right side panel **296** are visible in **FIG. 27**). In order to attach the removable front section **278** to the fiber optic housing **320**, the removable front section **278** is positioned such that the tabs **338** fit into the recesses **336** of the mounting brackets **322**. This will align the openings **311B** of the L-shaped bracket **310** of the removable front section **278** with the circular holes **332** of the mounting bracket **322**, and will align the openings **311C** of the L-shaped bracket **310** with the oval-shaped openings **330** of the mounting bracket **322**. A fastener, such as a screw or pop rivet, may then be placed through one or more of the openings **311B** of the L-shaped bracket

310 of the removable front section **278** and through the circular holes **332** of the mounting bracket **322** to securely attach the removable front section **278** to the fiber optic housing **320**.

[00172] **FIG. 28** illustrates a front perspective view of the removable front section **278** attached to a fiber optic housing **344** with fiber optic jumpers being routed out of sides of the removable front section **278**. The door **312** is open, allowing access to the inside of the removable front section **278**. The fiber optic housing **344** in the embodiment of **FIG. 28** has fiber optic panels **346** loaded in the removable front section **278**, although any sort of fiber optic apparatuses, including but not limited to fiber optic modules and cassettes, may be loaded into the removable front section **278**. Fiber optic jumpers **348** are connected to the fiber optic panels **346** and may be routed through the clips **292** and then out of the openings **270** on either side of the removable front section **278**.

[00173] **FIGS. 29-34** illustrate various embodiments of a front jumper management device for use with a fiber optic housing or a removable front section attached to a fiber optic housing.

[00174] **FIG. 29** is a front perspective view of a fiber optic housing **350** illustrating a removable front section **278** having a plurality of removable front jumper management devices **280** with grommets **352**, as previously mentioned in **FIG. 24**. The front jumper management devices **280** aid in fiber management and routing. The front jumper management devices **280** may be easily removable in one embodiment. The front jumper management devices **280** may be located on the top portion **282** and/or on the bottom portion **284** of the removable front section **278**.

[00175] In one embodiment, the front jumper management devices **280** comprise a plurality of grommet/clip assemblies **354** for use with the fiber optic housing **350** or the removable front section **278**. Each of the grommet/clip assemblies **354** may include a clip **356** and a grommet **352**. The grommet **352** may be made of rubber in one embodiment. In one embodiment, the grommet/clip assembly **354** may be removably mounted in openings **355** on the front of the fiber optic housing **350** on both the top and the bottom. The grommet/clip assembly **354** may be removably mounted to the fiber optic housing **350** by sliding it into the opening **355** in the fiber optic housing **350**.

[00176] The front jumper management devices **280** may be removably mounted on the inside of the fiber optic housing **350** to aid in fiber management, or on the outside of the fiber optic housing **350** to serve as an external fiber management device or component, as seen in **FIG. 30**.

[00177] **FIG. 30** is a front perspective view of the fiber optic housing **350** of **FIG. 29** illustrating fiber management of optical fiber jumpers **358** using the front jumper management devices **280**. The door **312** is open, allowing access to the inside of the removable front section **278**. The fiber optic housing **350** in the embodiment of **FIG. 30** has fiber optic panels **346** loaded in the removable front section **278**, although any sort of fiber optic apparatuses, including but not limited to fiber optic modules and cassettes, may be loaded into the removable front section **278**. Although the embodiment of **FIG. 30** illustrates a removable front section **278**, in other embodiments, the fiber optic housing **350** may not have a removable front section **278**, and the fiber optic panels **346** may be loaded into the fiber optic housing **350** itself.

[00178] The optical fiber jumpers **358** are connected to the fiber optic panels **346** and, in one embodiment, may be routed out of the fiber optic housing **350** through the openings **270** on either side of the removable front section **278**. In one embodiment, certain of the optical fiber jumpers **358** may be routed out of the fiber optic housing **350** through the grommets **352** of the front jumper management devices **280**. For example, in **FIG. 30**, some of the optical fiber jumpers **358** are routed from the fiber optic panels **346** directly through the grommets **352** of one of the front jumper management devices **280**. In one embodiment, the optical fiber jumpers **358** may be first passed through the grommet/clip assemblies **354** of the front jumper management devices **280** and then through the openings **270** on either side of the removable front section **278**. For example, some of the optical fiber jumpers **358** are routed through the clip **356B** of one of the front jumper management devices **280** and through the openings **270** on the left side of the removable front section **278**.

[00179] By locating front jumper management devices **280** on both the top portion **282** and/or on the bottom portion **284** of the removable front section **278**, a variety of options for optical fiber routing and management are provided. For example, in **FIG. 30**, some of the optical fiber jumpers **358** are routed through the clip **356B** and then through the clip **356C** of one of the front jumper management devices **280** at the top portion **282** and then through the openings **270** on the right side of the removable front section **278.** Some of the optical fiber jumpers **358** are routed through only one of the clips (clip **356C**) of the one of the front jumper management devices **280** at the top portion **282** before being routed through the openings **270** on the right side of the removable front section **278**. Finally, some of the optical fiber jumpers **358** are routed through one or more of the clips (clips **356D** and **356E**) of the one of the front jumper management devices **280** at the bottom portion **284** before being routed through the openings **270** on the right side of the removable front section **278.**

Although not illustrated in **FIG. 30**, certain of the optical fiber jumpers **358** could be routed through one or more of the grommets **352** on the front jumper management devices **280** at the bottom section **284** without being routed through the openings **270**.

[00180] **FIG. 31** is a front perspective view of the front jumper management device **280** to illustrate more detail for this particular embodiment of a fiber management component with the pass-through grommets of **FIGS. 29** and **30**. In one embodiment, as illustrated in **FIG. 31**, the front jumper management device **280** may comprise the grommet/clip assembly **354**. The grommet/clip assembly **354** may include the routing clips or clips **356** and the grommets **352** mounted in openings or ports **360** to allow optical fibers to be routed through the grommet/clip assembly **354**. The ports **360** are provided to allow optical fibers to be routed therethrough as previously discussed. If optical fibers are routed through the ports **360**, the appropriate grommets **352** are removed. The grommets **352** are removable and close off the ports **360** to prevent dust or debris from entering into the fiber optic housing or removable front section, as examples, when the ports **360** are not used to route optical fibers. The grommets **352** may be made from any type of material, including a flexible material. The grommets **352** may be made from any type of polymer or rubber, as additional non-limiting examples. In one embodiment, the clips **356** may be routing clips/fiber holders.

[00181] In this embodiment, as illustrated in **FIG. 31**, a plurality of clips **356** may be disposed in a base **362**, with one clip **356** disposed on a first end **365** of the base **362** and another clip **356** disposed on a second end **367** of the base **362**. Also in this embodiment, the clip **356** is comprised of a first arcuate member **369** having a first end **371** attached to the base **362** and a second end **373** adjacent a second end **375** of a second member **377** having a first end **379** attached to the base **362**. The first arcuate member **369** and the second member **377** may be flexible. In this embodiment, the second end **373** of the first arcuate member **369** abuts against the second end **375** of the second member **377** when a compression force **F1** is not applied inward to the first arcuate member **369** towards the second member **377**. The second end **373** of the first arcuate member **369** is configured to separate from the second end **375** of the second member **377** when the compression force **F1** is applied inward to the first arcuate member **369** towards the second member **377**.

[00182] The grommet/clip assembly **354** may also comprise the base **362** with one or more mounting holes **364**, as illustrated in **FIG. 31**, to allow the grommet/clip assembly **354** to be mounted to a fiber optic housing. In this embodiment, the clips **356** are attached to the base **362**. The mounting holes **364** may be used for fasteners (not illustrated), such as a screw, pop rivet, or a plunger fastener, to removably attach the grommet/clip assembly **354** to a fiber

optic housing. The grommet/clip assembly **354** retains optical fiber jumpers (like the optical fiber jumpers **358** in **FIG. 30**) while creating a pathway to routing fibers that are terminated in optical connectors. In one embodiment, the grommet/clip assembly **354** may be removably attached to a fiber optic management panel, and may be installed in the same location as a connector panel. In another embodiment, as illustrated in **FIG. 29**, the grommet/clip assembly **354** may be removably mounted in the openings **355** on the front of the fiber optic housing **350** on both the top and the bottom. The grommet/clip assembly **354** may be removably mounted to the housing by sliding it into the opening **355** in the fiber optic housing **350**.

[00183] The grommet/clip assembly **354** may also have features that allow it to be installed in different orientations and in different locations. **FIG. 32** illustrates how front jumper management devices with grommets can be mounted on their sides to create horizontal fiber management outside the fiber optic housing. In the embodiment of **FIG. 32**, the grommet/clip assembly **354** at the top of the fiber optic housing **350** is removably mounted on its side to create horizontal fiber management outside the fiber optic housing **350**. This will use a 1U rack unit space of 1.75 inches. However, the grommet/clip assembly **354** may be removed to allow fiber optic housings to be stacked directly on top of each other and still maintain the pass-through feature.

[00184] Further, the grommet/clip assembly **354** may be mounted in the same location as a connector panel using the same mounting hardware as the connector panels. **FIG. 33** illustrates how a front jumper management device with grommets may be mounted in a fiber optic housing in place of a fiber optic panel to allow for fiber management. In the embodiment of **FIG. 33**, a 1U fiber optic housing **366** has a plurality of openings **368**. A fiber optic panel **370** may be placed in one of the plurality of openings **368**. In the other opening **368**, a front jumper management device **280** comprising one or more grommet/clip assemblies **354** is positioned horizontally. The grommet/clip assembly **354** may also comprise a base **362** with one or more mounting holes **364**, as illustrated in **FIG. 31**, to allow the grommet/clip assembly **354** to be mounted to the fiber optic housing **366**. A fastener, such as a plunger fastener **372** as illustrated in **FIG. 33**, may be used to removably attach the grommet/clip assembly **354** to the fiber optic housing **366**. In other embodiments, different fasteners, such as a screw or pop rivet, may be used in place of the plunger fastener **372**.

[00185] The front jumper management device **280** with the grommet/clip assembly **354** disclosed above may be removably attached to a fiber optic housing. The end user may configure the front jumper management device **280** in multiple ways or remove it when it is

not needed. Various other ways of mounting the front jumper management device **280** are possible, including but not limited to sliding the front jumper management device **280** into a cutout in a wall of a fiber optic housing, installing the front jumper management device **280** on its side using snaps that latch into a cutout in a wall of a fiber optic housing, or installing the front jumper management device **280** using plungers in the same location as a fiber adapter panel or module. Additionally, the grommets **352** in the grommet/clip assembly **354** allow fiber to transition in any direction (including, but not limited to, the rear, up, or down) depending on the orientation of the grommet/clip assembly **354**, as seen in **FIG. 30** above.

[00186] **FIG. 34** is a perspective view of an alternative fiber optic housing **374** configured to support fiber optic modules **376**. In one embodiment, the fiber optic housing **374** may also support fiber optic panels (like fiber optic panels **378** illustrated in **FIG. 36A**) interchangeably by employing a removable panel clip (which is disclosed more fully in **FIGS. 37A-37G**). The fiber optic housing **374** is configured to support fiber optic equipment in a vertical orientation. **FIG. 34** illustrates the fiber optic housing **374** supporting the fiber optic modules **376**. If it desired to provide fiber optic panels **378** in the fiber optic housing **374**, removable panel clips **380** (see **FIGS. 37A-37G**) can be installed in a base **382** and a top **384** of the fiber optic housing **374**, as illustrated in **FIGS. 35A-35C**.

[00187] **FIGS. 35A-35C** are perspective, perspective close-up, and perspective close-up cut section views, respectively, of the removable panel clip **380** installed in the fiber optic housing **374** to enable the fiber optic housing **374** to support fiber optic panels **378** and fiber optic modules **376** interchangeably. The removable panel clips **380** may be installed in a front **374A** of the fiber optic housing **374**, or may be installed in a rear **374B** of the fiber optic housing **374**. The base **382** contains receivers **386** in the form of openings to receive and secure a flange **388** of the removable panel clip **380** (see **FIGS. 37A-37G**). The removable panel clip **380** is secured to the receiver **386** in the base **382**, as described more fully below.

[00188] **FIG. 36A** is a perspective view of the fiber optic housing **374** in **FIG. 35A** with removable panel clips **380** installed in the base **382** and the top **384** to be able to support the fiber optic panels **378**. **FIG. 36B** is a perspective view of the fiber optic housing **374** in **FIG. 35A** with removable panel clips **380** installed and inserts **390** provided in the form of push pins of the fiber optic panels **378** inserted into receptacles **392** of the removable panel clips **380** to support the fiber optic panels **378** in the fiber optic housing **374**. In another embodiment, the inserts **390** may be provided in the form of plungers

[00189] As illustrated in **FIGS. 37A-37G**, the removable panel clip **380** includes the flange **388**. The flange **388** is configured to be inserted into the receiver **386** of the base **382** (**FIGS.**

35A-35C) to attach the removable panel clip **380** to the base **382**. The flange **388** in this embodiment is circular-shaped, but other shapes can be provided. The flange **388** is disposed in a first side **394** of the removable panel clip **380**. A receptacle **392** disposed in a second side **396** of the removable panel clip **380** is configured to receive the insert **390** of a fiber optic panel **378**, as illustrated in **FIGS. 36A-36B**. The first side **394** may be generally at a right angle to the second side **396** in this embodiment.

[00190] Referring to **FIGS. 35B** and **35C** as well as **FIGS. 37A-37G**, the flange **388** of the removable panel clip **380** is configured to be inserted into a first area **398** of the receiver **386** of the base **382** and slid into a second area **400** of the receiver **386** to attach the removable panel clip **380** to the base **382**. A standoff or extender **402** is disposed between the flange **388** and the first side **394** to extend the flange **388** a distance away from the first side **394** so the flange **388** can be inserted into the receiver **386** in the base **382**. The flange **388** can then be slid behind the second area **400** of the receiver **386**, which has an opening size less than the size of the flange **388**.

[00191] The flange **388** cannot be removed from the receiver **386** unless and until the flange **388** is slid back to the first area **398** of the receiver **386**, which has an opening size that will allow the flange **388** to be removed from the receiver **386**. A protrusion **404** is also disposed in the first side **394** of the removable panel clip **380** to be disposed into the second area **400** of the receiver **386** to further secure the removable panel clip **380** to the base **382**. In one embodiment, in order to remove the flange **388** from the receiver **386**, the removable panel clip **380** is slightly lifted in a vertical direction until the protrusion **404** overcomes the base **382**. In one embodiment, the removable panel clip **380** can also be installed in the base **382** in a position one hundred eighty (180) degrees from the orientation discussed above and shown in **FIGS. 35B** and **35C** to allow the fiber optic panel or fiber optic module/cassette disposed therein to move independently.

[00192] **FIG. 38** is a perspective view of another removable panel clip **406** installed in a fiber optic housing **408** to enable the fiber optic housing **408** to interchangeably support fiber optic panels and fiber optic modules. **FIG. 39A-39D** illustrate bottom, side, front, and back views, respectively, of the removable panel clip **406** in **FIG. 38**. The removable panel clips **406** are configured to be attached to a rail system **410** disposed in the fiber optic housing **408** to attach the removable panel clips **406** to the fiber optic housing **408** to support fiber optic panels. The rail system **410** is configured to support fiber optic modules in the fiber optic housing **408** when the removable panel clip **406** is not attached to the rail system **410**. In this regard, the removable panel clips **406** each comprise a groove **409** configured to receive a rail

412 disposed in the fiber optic housing **408** to attach the removable panel clips **406** to the fiber optic housing **408**. Like the removable panel clip **380**, the removable panel clip **406** contains a receptacle **413** disposed therein that is configured to receive an insert in the form of a push pin or plunger from a fiber optic panel to secure the fiber optic panel to the removable panel clip **406** and thus the fiber optic housing **408**. Protrusions **414** are disposed in the removable panel clip **406**, as illustrated in **FIG. 38**, and are configured to engage with receivers **416** to further secure the removable panel clips **406** to the fiber optic housing **408**. A support member **418** is disposed or provided as part of the removable panel clip **406** to provide structural support, as illustrated in **FIGS. 39A** and **39B**.

[00193] The base of the fiber optic housing (such as the base **382** of the fiber optic housing **374** in **FIGS. 35A** and **36A,** or the base of the fiber optic housing **408** in **FIG. 38**) may be configured to support either fiber optic panels or fiber optic modules/cassettes. To support fiber optic panels, a receiver (like the receiver **416** in **FIG. 38**) is disposed in the fiber optic housing **374** or **408** to receive the removable panel clips **406**. If a fiber optic module(s) is desired to be supported, the removable panel clips **406** are not employed. Instead, the fiber optic module(s) includes a rail guide that is configured to receive a rail disposed in the fiber optic housing **374** of **FIGS. 35A** and **36A** or the fiber optic housing **408** in **FIG. 38**.

[00194] **FIGS. 40A-40D** illustrate various views of exemplary rails **412** to be used in the fiber optic housing **408** of **FIG. 38**. In one embodiment, the rail **412** has three sections **412-1, 412-2, 412-3** formed by two notches **415-1, 415-2**. The notches **415-1, 415-2** are used to lock fiber optic modules or cassettes onto the rail **412**, as will be discussed in more detail below. The rail **412** may also have a pair of latches **419-1**, which may extend from the section **412-2** in one embodiment, as illustrated in **FIGS. 40A-40D**. The rail **412** may have a groove **417** at one end of the section **412-1**. The rail **412** may also have a latch **419-2** at one end of the rail **412**, such as at the end of portion **412-3**, as illustrated **FIGS. 40A-40D**. The latches **419-1, 419-2** may be used to attach the rail **412** to the fiber optic housing **374** of **FIGS. 35A** and **36B**, or the fiber optic housing **408** of **FIG. 38**. In one embodiment, the latches **419-1, 419-2** may fit into receivers **383** disposed in the base **382** of the fiber optic housing **374** of **FIGS. 35A** and **36B** and be used to attach the rail **412** to the fiber optic housing **374**. The latches **419-1, 419-2** may be flexible and resilient such that they provide biasing to allow the latches **419-1, 419-2** to extend into the receivers **383** to secure the rail **412** to the base **382** of the fiber optic housing **374** of **FIGS. 35A** and **36B**.**FIGS. 41A** and **41B** are front perspective and side views, respectively, of an exemplary fiber optic module or cassette **422** that may be mounted on a rail in the fiber optic housing **408** of **FIG. 38**. As

illustrated in the front perspective and top views of the fiber optic module/cassette **422** in **FIGS. 41A** and **41B**, respectively, the fiber optic module/cassette **422** includes a housing **422H** that includes a first end **422-1** and a second end **422-2**. Rails guide**s 421A, 421B** are disposed in the housing **422H** on the first end **422-1** and the second end **422-2** of the housing **422H**, respectively. Thus, when a rear portion **422R** of the fiber optic module/cassette **422** is inserted onto a rail or rails **412** disposed on the fiber optic housing **408**, the rail guide**s 421A, 421B** of the fiber optic module/cassette **422** are aligned with the rails **412**. The rail guides **421A, 421B** receive the rail**s 412**. The fiber optic module/cassette **422** can be slid back from a front **408F** of the fiber optic housing **408** to a rear **408R** of the fiber optic housing **408** (**FIG. 38**), until a front side **422F** of the fiber optic module/cassette **422** locks into place in one of the notches **415-1** or **415-2** on the rail **412**.

[00195] The fiber optic module/cassette **422** can be locked into place on the rails **412** by protrusions **401A, 401B** provided in a latching system **403A, 403B** disposed in the rail guides **421A, 421B**, respectively. As illustrated in **FIGS. 41A** and **41B**, the protrusions **401A, 401B** are each configured to be secured into notches **415-2** disposed in the rails **412** to lock the fiber optic module/cassette **422** into place. When it is desired to release the fiber optic module/cassette **422** from the rail **412**, latches **405A, 405B** can be pushed inward toward the fiber optic module/cassette **422** to release the protrusions **401A, 401B** from the notches **415-2** to allow the rail guides **421A, 421B** of the fiber optic module/cassette **422** to be moved about the rails **412** of the fiber optic housing **408**. In one embodiment, the fiber optic module/cassette **422** might be slid onto the rail **412** such that the protrusions **401A, 401B** lock into place in the notch **415-1** instead of notches **415-2.**

[00196] The fiber optic housing **408** illustrated in **FIG. 38** thus provides integrated tracks or rails to house large splice modules, with removable panel clips to hold fiber optic panels or smaller fiber optic modules. The integrated tracks or rails allow the fiber optic housing to work with any panel designed for the housing, for example a 4U housing, simply by changing the adapter to match the desired panel. The rails allow larger fiber optic modules to slide in place for maximum use of the available space inside the fiber optic housing. The removable panel clips also allow for multiple mounting locations in the front to back orientation, allowing the user to move the fiber optic panel to a more recessed position when needed for the use of components which may require additional space, including, as one non-limiting example, in-line attenuators or other apparatuses.

[00197] Embodiments disclosed below also include door fiber management for fiber optic housings, and related components and methods. In one embodiment, a fiber optic housing is

provided. The fiber optic housing comprises an enclosure defining at least one interior chamber configured to support fiber optic equipment. The fiber optic housing also comprises at least one door attached to the enclosure and configured to seal off at least a portion of the at least one interior chamber when the door is closed. The fiber optic housing also comprises at least one fiber management component disposed in the at least one door. The door can be a front door, a rear door, both a front and rear door, or any other door attached or provided as part of the fiber optic housing. The fiber management component can be any type of fiber management device or component, including but not limited to a slack storage device or component, a routing guide, and a fan-out body holder.

[00198] In this regard, **FIG. 42** is a rear view of a fiber optic housing **420** with a rear door **424** opened that is fully loaded with fiber optic modules/cassettes **422** attached to rails. In one embodiment, the fiber optic modules/cassettes **422** may be fiber optic splice cassettes. The fiber optic housing **420** is fully loaded with fiber optic modules/cassettes **422**. In other embodiments, the fiber optic housing **420** may be loaded with fiber optic panels, fiber optic connectors, or fiber optic modules. The fiber optic housing **420** has the rear door **424** that is opened to allow access to the fiber optic modules/cassettes **422**. The fiber optic housing **420** in this embodiment defines an enclosure **423** defining an interior chamber **425** configured to support fiber optic equipment **427** disposed therein. The rear door **424** is attached to the enclosure **423** and configured to seal off at least a portion of the interior chamber **425** when the rear door **424** is closed against the enclosure **423**.

[00199] In fiber optic housings, fiber cable management is commonly done inside the rear on the bottom of the fiber optic housing. Optical fiber slack storage is located on the bottom and top in the back section of the fiber optic housing **420**. Sometimes that space becomes very limited, resulting in poor fiber management. In one embodiment as disclosed herein, the rear door **424** may be adapted to be used in fiber optic housings to store slack fiber optic cables and to provide locations for strain relief. In addition, the rear door **424** may also be used to hold fiber transition boxes. Having additional storage on the rear door **424** frees up space on the inside of the fiber optic housing for better access to the fiber optic modules. This is especially true when large splice modules are used, as there is less room for slack storage of optical fibers on the bottom or top, so storage on the rear door provides the storage space that otherwise would have been located in the bottom or the top of the fiber optic housing. When the rear door **424** is opened, the optical fiber bundle is rotated out of the way of the user providing safer access to the rear of the fiber optic modules.

[00200] With continuing reference to **FIG. 42** and **43B-43C**, a fiber management component in the form of a slack storage component **429** is disposed in an inside surface **431** of the rear door **424**. The slack storage component **429** is designed to store slack of optical fibers **442** connected to the fiber optic equipment **427** disposed in the fiber optic housing **420**, as illustrated in **FIGS. 43B** and **43C**. In this embodiment, the slack storage component **429** is comprised of two (2) retainers **444**, each comprised of two (2) flanges **433A, 433B**. The retainers **444** are disposed in a perimeter of the rear door **424** in this embodiment. The flanges **433A, 443B** are each comprised of a first member **435A, 435B** disposed in a first plane and attached to the interior surface **431** of the rear door **424**, which serves as a base, and a second member **437A, 437B** attached to the first member **435A, 435B**, in a second plane intersecting with the first plane to form a slack storage area **439A, 439B** within the flanges **433A, 433B**. Other fiber management components, including routing guides, could also be disposed in or on the rear door **424**, including the interior surface **431**, or an external surface of the rear door **424**. Further, the fiber management components could be disposed on any door of the fiber optic housing **420**, including the rear door **424**, or a front door, as examples.

[00201] **FIG. 43A** is a rear perspective view of a fiber optic housing **428** mounted in an equipment rack illustrating an exemplary embodiment of fiber management components in the form of fiber slack storage and fiber management on a rear door **426** of the fiber optic housing **428**. **FIG. 43A** illustrates optical fiber slack storage and management on a rear door **426** of the fiber optic housing **428**. The rear door **426** may pivot downward about a pivot point **430** between the rear door **426** and the fiber optic housing **428** when the rear door **426** is opened. In one embodiment, the pivot point **430** may be a hinge. The rear door **426** may have a plurality of routing clips **432** disposed thereon. The rear door **426** may also have a plurality of lips **434** disposed thereon in one embodiment. In one embodiment, one or more transition boxes **436** may be attached to the rear door **426** via a respective one of the lips **434**. In another embodiment, a flip card (not illustrated) may be attached to the rear door **426** via the lips **434**. The rear door **426** may also have one or more strain relief locations **438** located near the pivot point **430** in one embodiment.

[00202] An optical fiber or fiber optic cable may be routed to the rear of the fiber optic housing **428**. In the embodiment of **FIG. 43A**, the fiber optic cable is a buffer tube with one or more optical fibers **442** connected to one or more of the fiber optic modules/cassettes **422**. The optical fibers **442** may be strain-relieved at the strain relief location **438** near the pivot point **430** of the rear door **426** to minimize fiber movement as the rear door **426** is opened.

The optical fibers **442** will be routed near the pivot point **430**. The routing clips **432** may hold the optical fibers **442** in a loop greater than the minimum bend radius of the optical fibers **442**. When ribbon fiber is used, the transition boxes **436** may be used to fan out the ribbon into individual fibers when connectorized. The rear door **426** also has provisions (the lips **434**) to hold these fan-out or transition boxes **436**.

[00203] The fiber optic housing **428** may be any size. Additionally, the fiber optic housing **428** does not need to be an equipment rack-mounted fiber optic housing. For example, the fiber optic housing **428** may be a wall mount fiber optic housing. The rear door **426** may be made out of metal or plastic.

[00204] With continuing reference to **FIG. 43A**, the fiber management components, including the routing clips **432** are disposed in a pedestal or base **445** attached to an interior surface **447** of the rear door **426**. In this manner, the routing clips **432** are disposed above the rear door **426** in a raised manner. The base **445** may include one or more recesses **449** to allow the base **445** to be disposed around and not interfere with any other components in the rear door **426**. The base **445** can be removed if additional fiber management components are not needed or desired to be disposed on the rear door **426**. The base **445** may be of any shape desired, including but not limited to rectangular and circular or elliptical shaped. The base **445** may be attached using one or more fasteners to the rear door **426**. Although not illustrated, the base **445** and the fiber management components disposed therein may also be disposed in the front door.

[00205] **FIG. 43B** is a rear perspective view of the fiber optic housing **428** mounted in an equipment rack illustrating an alternate embodiment of fiber slack storage and management on the rear door **426** of the fiber optic housing **428** having fiber optic splice cassettes. In the embodiment of **FIG. 43B**, the fiber optic cable being routed to the rear of the fiber optic housing **428** is a buffer tube **440** with one or more optical fibers **442** is connected to one or more of the fiber optic modules/cassettes **422**. In the embodiment of **FIG. 43B**, the optical fibers **442** will be routed near the pivot point **430**. The optical fibers **442** are held in a loop greater than the minimum bend radius of the optical fibers **442** in the retainers **444** located at the bottom of the rear door **426**.

[00206] **FIG. 43C** is a rear perspective view of the fiber optic housing **428** mounted in an equipment rack illustrating an alternate embodiment of fiber slack storage and management on the rear door **426** of the fiber optic housing **428** having fiber optic panels. In the embodiment of **FIG. 43C**, the fiber optic cable being routed to the rear of the fiber optic housing **428** is the buffer tube **440** with one or more optical fibers **442**. The optical fibers

442 transition to a 900 micron optical fiber **446** which is connected to one or more of the fiber optic modules/cassettes **422**. In the embodiment of **FIG. 43C**, the optical fibers **442** will be routed near the pivot point **430**. The optical fibers **442** are held in a loop greater than the minimum bend radius of the optical fibers **442** in the retainers **444** located at the bottom of the rear door **426**. In the embodiment of **FIG. 43C**, the 900 micron optical fiber **446** may also be routed through one or more routing clips **448** in the rear of the fiber optic housing **428**.

[00207] Embodiments disclosed below also include fiber management sections for fiber optic housings, and related components and methods. In one embodiment, a fiber management device is provided. The fiber management device comprises a base and at least one fiber management component attached to the base and configured to manage one or more optical fibers. At least one opening is disposed in the base and configured to route one or more optical fibers from the base. The fiber management component may be a routing guide configured to route the one or more optical fibers as a non-limiting example.

[00208] In this regard, **FIG. 44** is a rear perspective view of a fiber optic housing **450** mounted in an equipment rack with a fiber management device **452** mounted in the fiber optic housing **450**. The fiber optic housing **450** has the fiber management device **452** located in a rear portion of the fiber optic housing **450** that can be removed from the fiber optic housing **450**. The fiber management device **452** can be used for fiber slack storage and fiber management in a fiber optic housing for the LAN and data center environment. The fiber management device **452** can store incoming buffer tube or fiber optic cable slack and can also manage 900 micron optical fiber separately from other fiber optic cables or optical fibers.

[00209] The fiber management device **452** has the ability to strain-relieve incoming fiber optic cable, store fiber optic cable slack on a base level of the fiber management device **452**, and store 900 micron optical fiber on a raised level using routing clips. The fiber management device **452** may also be removable, allowing a technician to install, route, and configure fiber optic cable and slack outside the fiber optic housing **450**. In particular, a technician can remove the fiber management device **452** and place it on a work bench or table to freely install, route, and configure the fiber optic cable, as well as provide strain-relief and route the optical fiber per standard practices. After routing, the technician can easily install the fiber management device **452** into the fiber optic housing **450** without the use of tools.

[00210] Looking at **FIGS. 44** and **45**, the fiber optic housing **450** is installed in a typical equipment rack **454** with the rear door **456** down. The fiber management device **452** can be mounted inside a rear door **456** on a bottom panel **457** of the fiber optic housing **450**. In this

embodiment, the fiber management device **452** includes a base **460** configured to support at least one fiber management component. The base **460** includes at least one attachment device in the form of a mounting clip or tab **466** disposed in the base **460** and configured to be received by at least one receiver **467** disposed in the fiber optic housing **450** to secure the base **460** in the fiber optic housing **450**. The tabs **466** could be provided on each side or ends of the base **460**, if desired. The base **460** is configured so that the tab **466** can be removed from the receiver **467** to remove the base **460** from the fiber optic housing **450**. Alternatively, other fasteners could be used to secure the base **460** inside the fiber optic housing **450**. For example, the fastener could be a thumb screw. One or more recesses **473** can also be disposed in the base **460** to provide for the base **460** to not interfere with other components disposed in the fiber optic housing

[00211] **FIG. 45** is a rear perspective view of the fiber optic housing **450** mounted in the equipment rack with the fiber management device **452** of **FIG. 44** removed from the fiber optic housing **450**.

[00212] **FIG. 46A** is a front perspective view of the fiber management device **452** of **FIG. 45**. The fiber management device **452** has a plurality of routing clips **458** disposed on a base **460** of the fiber management device **452**. The fiber management device **452** may be a rectangular shape in one embodiment. In one embodiment, the fiber management device **452** also comprises slack storage components in the form of retainers **459** around a perimeter **461** of the fiber management device **452**. The retainers **459** are configured to store and/or retain slack storage of optical fibers. The retainers **459** may comprise a first member **481** extending upward from the base **460** and then angled inward to provide a second member **483** to retain the slack optical fiber inside the fiber management device **452**. The plurality of routing clips **458** each has a pedestal **462** and a top portion **464** that allows the routing clips **458** to be raised to a level above the base **460** of the fiber management device **452**. Pedestals **462** are disposed in the base **460** to support fiber management components above the base **460**, in this example, the routing clips **458**. The pedestals **462** may allow the routing clips **458** to be rotated about the base **460** if desired, as illustrated in **FIGS. 46A** and **46B**. The fiber management device **452** may also have a plurality of tabs **466** for fastening the fiber management device **452** to the bottom panel **457** of the fiber optic housing **450**. The base **460** may also have one or more thumb screws **468** for fastening the fiber management device **452** to the bottom panel **457** of the fiber optic housing **450**.

[00213] **FIG. 46B** is a front perspective view of the fiber management device **452** of **FIG. 46A** illustrating an exemplary fiber optic cable routing with a buffer tube and 900 micron

optical fiber. A buffer tube **470** may be routed along the base **460** of the fiber management device **452**, while a 900 micron optical fiber **472** may be routed through one or more of the top portions **464** of the routing clips **458** such that the 900 micron optical fiber **472** is routed and stored on a raised level from the base level of the buffer tube **470**. In this manner, slack storage, routing, and management is provided for both the buffer tube **470** and the 900 micron optical fiber **472** at the same time using a single device. In one embodiment, the fiber management device **452** may also comprise lances **474** near one or more corners **476** of the fiber management device **452** to provide strain relief for the incoming buffer tube **470**.

[00214] **FIG. 46C** is a top front perspective view of the fiber management device **452** of **FIG. 45** with exemplary optical fiber splice trays. The fiber management device **452** in this embodiment is similar to the embodiment of **FIG. 46B**, except the routing clips **458** have been removed and a optical fiber splice tray **478** has been provided on the base **460** of the fiber management device **452.** **FIG. 46D** is a front perspective view of an alternate fiber management device **480**. In this example, the fiber management device **480** also includes a base **493** configured to support one or more fiber management components. The fiber management device **480** can be disposed on any surface of a fiber optic housing, including interior surfaces in the enclosure of a fiber optic housing and/or a door of a fiber optic housing. The fiber management device **480** has a plurality of routing clips **482** for routing and storing a buffer tube as fiber management components for routing optical fibers disposed therethrough. The routing clips **482** may be like routing clips **356** in **FIG. 31** and contain the same features, as previously described. Also in this embodiment, the routing clips **482** may be disposed on a common pedestal **495** disposed in the base **493** to raise the routing clips **482** above the base **493** and to provide flexibility in attaching other types of fiber management components that may or may not be compatible to be directly attached to the base **493**.

[00215] The fiber management device **480** also has a fan-out holder **484** for routing and storing one or more 900 micron optical fibers. The fan-out holder **484** is configured to retain and support fan-out bodies for optical fibers as another example of fiber management. The fiber management device **480** may also have a plurality of lances **486** for providing strain relief. In one embodiment, the lances **486** are positioned on an edge **488** of the fiber management device **480**. The fiber management device **480** may also have a plurality of attachment devices in the form of a plurality of integrated mounting clips **490** that are configured to attach the fiber management device **480** to a fiber optic housing or door of a fiber optic housing, as examples of surfaces in which the fiber management device **480** can be attached.

[00216] The fiber management devices described herein may be made out of metal or plastic. Instead of a single fiber management device, two or more smaller fiber management devices could be used such that fiber management devices are provided in different portions of a fiber optic housing, as illustrated in **FIG. 47**. **FIG. 47** is a rear perspective view of the fiber optic housing illustrating optical fiber storage using two (2) fiber management devices similar to the fiber management devices **480** of **FIG. 46D**. **FIG. 47** illustrates optical fiber management and storage in the rear of the housing on both the top and bottom. The optical fiber management and storage at the top is provided by routing clips and the optical fiber management and storage on the bottom is provided using the fiber management devices **480**.

[00217] An attachment housing (also known as a caboose, or an expandable caboose) provides additional features and may be used to expand the depth of the fiber optic housing, as illustrated in **FIGS. 48-50B**. In one embodiment, the attachment housing is designed to be attached to a seven-inch fiber optic housing for use in the LAN and data center environment which may be mountable in the 19-inch or 23-inch equipment racks or cabinets. The attachment housing removably attaches to the side of the fiber optic housing in the strain relief bracket location, without the need for any extra hardware. The attachment housing allows the user to add splicing, more slack storage, and even more strain relief capability. In this way, the attachment housing allows an equipment rack-mounted fiber optic housing to be upgraded in the equipment rack from a connector housing to a splice housing, slack storage housing, or to increase the strain relief capacity of the housing to store plug and play cable assemblies. The attachment housing increases the depth of the fiber optic housing without using any more equipment rack space.

[00218] The attachment housing may involve simple tool-less installation to the fiber optic housing using the attachment features provided on the fiber optic housing. The attachment housing may use the existing rear door of the fiber optic housing, and may save rack space by only increasing the depth of the fiber optic housing but not the height. Additionally, the attachment housing gives the user more flexibility due to the fact that the attachment housing can be added at any time, even after the fiber optic housing is in service.

[00219] In this regard, embodiments disclosed herein also include apparatuses and related components and methods for expanding the capacity of fiber optic housings. In one embodiment, a fiber optic apparatus comprising an attachment housing comprising a side, a top, and a bottom defining an attachment interior chamber configured to support at least a portion of fiber optic equipment is provided. The attachment housing is tool-lessly, and by other than external fasteners, configured to removably attach to a fiber optic housing

comprising a housing interior chamber configured to support fiber optic equipment to couple the attachment interior chamber and the housing interior chamber and expand the capacity of the fiber optic housing.

[00220] In an embodiment, the attachment housing is removably attached to the fiber optic housing by means of snap attachments integral to at least one of the attachment housing and the fiber optic housing. In another embodiment, one or more optical components mount within the attachment housing. In another embodiment, the optical components may include, without limitation, one or more splitter trays, fiber optic jumper slack storage, and one or more strain relief devices.

[00221] In this regard, the term "capacity" is used to refer to any or all of the following non-limiting examples: additional fiber optic housings in a data distribution center; increased internal volume of a fiber optic housing; increased space in an equipment rack for adding additional fiber optic housings; increased space for making additional connections of fiber optic cables or optical fibers to fiber optic equipment; and increased space for supporting additional fiber optic equipment such as fiber optic modules, fiber optic panels, splitter trays, fiber optic jumper storage, and/or strain relief devices. As one non-limiting example, a data distribution center may have space for a certain number of equipment racks, each of which can hold a certain number of fiber optic housings, each of which can hold a certain number of optical components. By adding the attachment housing to the fiber optic housing, additional fiber optic components may be added to the data distribution center without adding additional equipment racks or fiber optic housings. This would be one non-limiting example of expanding "capacity."

[00222] In this regard, **FIG. 48** is a front perspective view of the fiber optic housing illustrating an expandable attachment housing separated from the fiber optic housing. **FIG. 48** illustrates a fiber optic housing **492**, an attachment housing **494**, and a rear door **496** separated from each other. The attachment housing **494** has a top **493**, a bottom **495**, and one or more sides **497** which define an attachment interior chamber **499** configured to support fiber optic equipment. The fiber optic housing **492** may be of any type, including but not limited to, any of the fiber optic housings disclosed herein. The fiber optic housing **492** has a housing interior chamber **501** (illustrated in **FIGS. 51** and **52**) configured to support fiber optic equipment. In one embodiment, the housing interior chamber **501** may be similar to any one or more of the interior chamber **135** in **FIG. 15**, the interior chamber **161** in **FIGS. 16, 17A,** and **17B**, or the interior chamber **221** in **FIGS. 19A, 19B,** and **20B**. The rear door **496** is removed from the fiber optic housing **492** and the attachment housing **494** is attached

to the rear of the fiber optic housing **492**. The rear door **496** is then reinstalled on the rear of the attachment housing **494**. In **FIG. 48**, the attachment housing **494** is illustrated with splice trays **498**.

[00223] In one embodiment, the attachment housing **494** is attached to the fiber optic housing **492** by means of snap attachment features like those disclosed herein. In one embodiment, the attachment housing **494** has a plurality of receivers **500, 502** located on sides **504, 506** of the attachment housing **494.** In one embodiment, the receivers **500** may be square shaped and the receivers **502** may be arcuate-shaped, but in other embodiments, the receivers **500, 502** may be any shape, including but not limited to circular, semi-circular, oval, or keyhole-shaped. The fiber optic housing **492** may have a plurality of snap attachments **508, 510** located on a left side **512** of the fiber optic housing **492** (and on a right side as well, though not illustrated in **FIG. 48**). The snap attachments **508, 510** may be of any shape that corresponds to the shape of the receivers **500, 502.** The receivers **500** are configured to receive the snap attachments **508** and the receivers **502** are configured to receive the snap attachments **510** in order to removably attach the attachment housing **494** to the fiber optic housing **492**. In one embodiment, one or more of the snap attachments **510** may be in the form of release buttons configured to allow the attachment housing **494** to be easily and quickly removed, or detached, from the fiber optic housing **492**.

[00224] **FIG. 49** is a front perspective view of the fiber optic housing **492** illustrating the expandable attachment housing **494** assembled to the fiber optic housing **492**. **FIG. 49** illustrates the attachment housing **494** after it has been attached to the fiber optic housing **492**. The attachment housing **494** is removably attached to the fiber optic housing **492** using the snap attachments **508**, **510** on the sides of the fiber optic housing **492**. Once the attachment housing **494** is removably attached to the fiber optic housing **492**, additional capacity for adding fiber optic equipment is provided. In this manner, the fiber optic housing **492** is configured to support at least a portion of fiber optic equipment, and the attachment housing **494** is also configured to support at least a portion of fiber optic equipment.

[00225] **FIGS. 50A** and **50B** show various versions of an attachment housing that can be used as the attachment housing **494** of **FIGS. 48** and **49**. **FIG. 50A** is a rear, perspective view of the expandable attachment housing **494** with jumper slack storage **514**. **FIG. 50B** is a rear, perspective view of the expandable attachment housing **494** with internal strain relief brackets **516**.

[00226] The attachment housings disclosed herein may be removably attached to any size housing. Additionally, the attachment housings may provide for other functions, including, but not limited to, cooling fans and panels to provide additional connection capacity.

[00227] **FIG. 51** is a rear view of an exemplary fiber optic housing illustrating how a rear door can be easily attached or removed. In one embodiment, a rear door needs to be removed in order to attach an attachment housing to a fiber optic housing, as seen in **FIG. 48**. **FIG. 51** illustrates a fiber optic housing **518** having a top **520**, a left side **522**, a right side **524**, and a bottom **526**. The top **520**, the left side **522**, the right side **524**, and the bottom **526** together define the housing interior chamber **501** configured to support at least a portion of fiber optic equipment. The bottom **526** has an edge **528** with corners **530A**, **530B**. Male hinge portions **532A, 532B** are located at or near the corners **530A, 530B**, respectively. Rods **534A, 534B** extend from the male hinge portions **532A, 532B**. A rear door **536** has a pair of female hinge portions **538A**, **538B** with channels **540A**, **540B** configured to receive the rods **534A**, **534B**. A tab **542** is provided on the edge **528** of the bottom **526** of the fiber optic housing **518** near the male hinge portions **532A**, **532B**.

[00228] **FIG. 52** is a close-up view of how the rear door **536** of **FIG. 51** can be easily attached to or removed from the fiber optic housing **518**.

[00229] Referring to **FIGS. 51** and **52**, the tab **542** on the edge **528** of the bottom **526** of the fiber optic housing **518** may be raised up to allow the channel **540B** of the female hinge portion **538B** to be positioned under the tab **542** so that the channel **540B** can be slid onto the rod **534B** to attach the rear door **536** to the fiber optic housing **518.** If the rear door **536** is attached and it is desired to remove the rear door **536**, the tab **542** may be raised in order to allow the rear door **536** to be slid such that the channel **540B** is disengaged with the rod **534B,** thereby allowing the rear door **536** to be removed.

[00230] Once the door is removed, an attachment housing may be attached to the fiber optic housing **518**. The attachment housing may also have the tab **542** and the other features illustrated in **FIGS. 51** and **52** so that the door is easily attached and removed, or detached, from the attachment housing as well. The features illustrated in **FIGS. 51** and **52** also allow a door to be interchangeable for the front and rear of the fiber optic housing. The doors can be removed from the fiber optic housing and attachable to either the front or rear of the fiber optic housing.

[00231] As discussed above, the fiber optic housings disclosed herein can provide one or more features and options for fiber optic housings. Some non-limiting and non-exhaustive features disclosed herein include quick snap to rack capability for the fiber optic housing,

snap-on mounting brackets, snap-on strain relief brackets, quick fit assembly housing, with no hardware or tools needed, removable top for fiber optic housings, removable front section for low profile rack installation, removable front jumper management device with pass-through grommets, integrated rails to house large splice modules, clips to hold fiber optic panels or smaller fiber optic modules, optical fiber slack storage and management on rear door, rubber entry grommets on all sides, molded in flexible edge protection for the fiber jumpers, and expandable housing using additional caboose housing.

[00232] As used in this disclosure, the terms "fiber optic module" and "fiber optic cassette" are used interchangeably to refer to either a fiber optic module or a fiber optic cassette, including but not limited to a splice cassette.

[00233] Many modifications and other embodiments of the invention set forth herein will come to mind to one skilled in the art to which the invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings.

[00234] Further, as used herein, it is intended that terms "fiber optic cables" and/or "optical fibers" include all types of single mode and multi-mode light waveguides, including one or more optical fibers that may be bare, upcoated, colored, buffered, tight-buffered, loose-tube, ribbonized and/or have other organizing or protective structure in a cable such as one or more tubes, strength members, jackets or the like. Likewise, other types of suitable optical fibers include bend-insensitive optical fibers, or any other expedient of a medium for transmitting light signals. An example of a bend-insensitive, or bend resistant, optical fiber is ClearCurve® Multimode fiber commercially available from Corning Incorporated. Suitable fibers of this type are disclosed, for example, in U.S. Patent Application Publication Nos. 2008/0166094 and 2009/0169163.

[00235] Therefore, it is to be understood that the embodiments are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. It is intended that the embodiments cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

What is claimed is:

1. A fiber optic housing, comprising:

a top, a bottom, a right side, and a left side defining at least one interior chamber configured to support fiber optic equipment,

wherein the top, the bottom, the right side, and the left side are configured to removably attach to each other tool-lessly, and by other than external fastening means.

2. The fiber optic housing of claim 1, wherein the top, the bottom, the right side, and the left side removably attach to each other by at least one snap attachment integral to at least one of the top, the bottom, the right side, and the left side.

3. The fiber optic housing of claim 1, further comprising a side mounting bracket, wherein the side mounting bracket is configured to removably mount the fiber optic housing to an equipment rack tool-lessly, and by other than external fastening means.

4. The fiber optic housing of claim 3, further comprising snap attachments on a side of the fiber optic housing to removably mount the side mounting bracket to the fiber optic housing.

5. The fiber optic housing of claim 1, further comprising a strain relief bracket, wherein the strain relief bracket removably mounts to the fiber optic housing tool-lessly, and by other than external fastening means.

6. The fiber optic housing of claim 5, further comprising snap attachments on a side of the fiber optic housing to removably mount the strain relief bracket to the fiber optic housing.

7. The fiber optic housing of claim 6, wherein the strain relief bracket is configured to allow fiber optic cables to enter the fiber optic housing at any angle.

8. The fiber optic housing of claim 1, further comprising an interchangeable front section, wherein the interchangeable front section removably mounts to the fiber optic housing tool-lessly, and by other than external fastening means.

9. The fiber optic housing of claim 8, further comprising snap attachments on a side of the fiber optic housing to removably mount the interchangeable front section to the fiber optic housing.

10. The fiber optic housing of claim 1, further comprising one or more rubber grommets disposed on at least one of the top, bottom, right side, and left side.

11. The fiber optic housing of claim 1, further comprising an opening on at least one of the top, bottom, right side, and left side, where the opening is configured to allow optical fibers in and out of the fiber optic housing, and wherein a molded flexible edge protection piece is located around a portion of the opening.

12. The fiber optic housing of claim 1, further comprising fiber optic equipment disposed in the at least one interior chamber.

13. The fiber optic housing of claim 12, wherein the fiber optic equipment is comprised of at least one of a fiber optic module and a fiber optic panel.

14. The fiber optic housing of claim 2, wherein at least one snap attachment is located on at least one of the left side and the right side, and the bottom has at least one receiver disposed on at least one side flange of the bottom, the at least one receiver configured to receive the at least one snap attachment.

15. The fiber optic housing of claim 2, wherein the top has at least one receiver disposed on at least one side flange on the top, the at least one receiver configured to receive snap attachments disposed on the left side and the right side.

16. The fiber optic housing of claim 2, wherein at least one of the left side and the right side has a top flange with at least one groove, the at least one groove configured to receive at least one standoff disposed on the top.

17. The fiber optic housing of claim 15, wherein the side flange on the top further comprises a merlon configured to interlock with a crenel disposed on at least one of the left side and the right side.

18. A method of assembling a fiber optic housing, comprising:

attaching a top, a bottom, a right side, and a left side to each other tool-lessly and by other than external fastening means, defining at least one interior chamber configured to support fiber optic equipment.

19. The method of claim 18, further comprising detaching the top, the bottom, the right side, and the left side from each other tool-lessly.

20. The method of claim 18, wherein the attaching further comprises using a snap attachment integral to at least one of the top, the bottom, the right side, and the left side to removably attach the top, the bottom, the right side, and the left side to each other.

21. The method of claim 18, further comprising removably mounting a side mounting bracket to the fiber optic housing, wherein the side mounting bracket is configured to removably mount the fiber optic housing to an equipment rack tool-lessly, and by other than external fastening means.

22. The method of claim 18, further comprising using snap attachments on a side of the fiber optic housing to removably mount a side mounting bracket to the fiber optic housing.

23. The method of claim 18, further comprising removably mounting a strain relief bracket to the fiber optic housing, wherein the strain relief bracket removably mounts to the fiber optic housing tool-lessly, and by other than external fastening means.

24. The method of claim 23, further comprising using snap attachments on a side of the fiber optic housing to removably mount the strain relief bracket to the fiber optic housing.

25. The method of claim 18, further comprising removably mounting an interchangeable front section, wherein the interchangeable front section removably mounts to the fiber optic housing tool-lessly, and by other than by external fastening means.

26. The method of claim 25, further comprising using snap attachments on a side of the fiber optic housing to removably mount the interchangeable front section to the fiber optic housing.

27. The method of claim 18, further comprising disposing fiber optic equipment in the at least one interior chamber of the fiber optic housing.

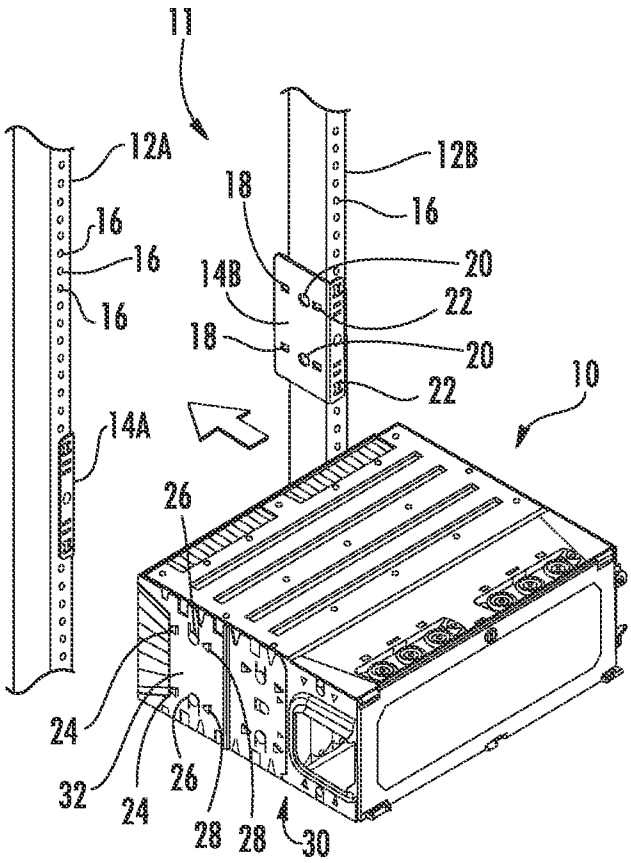
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FIG. 1A

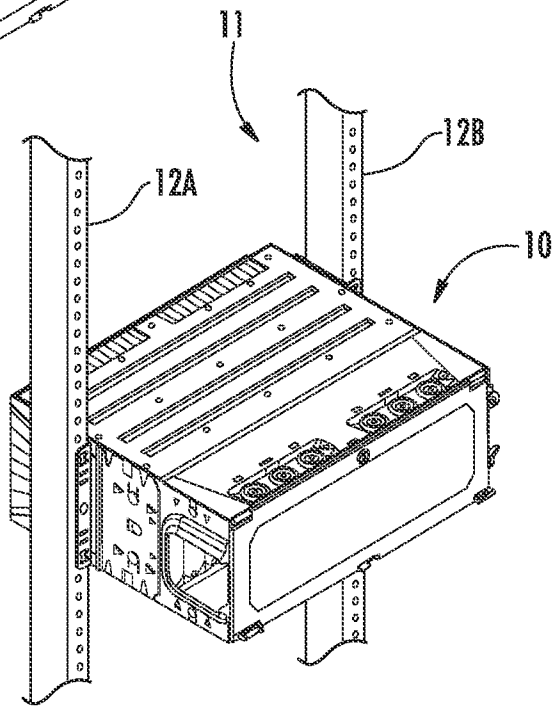
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FIG. 1B

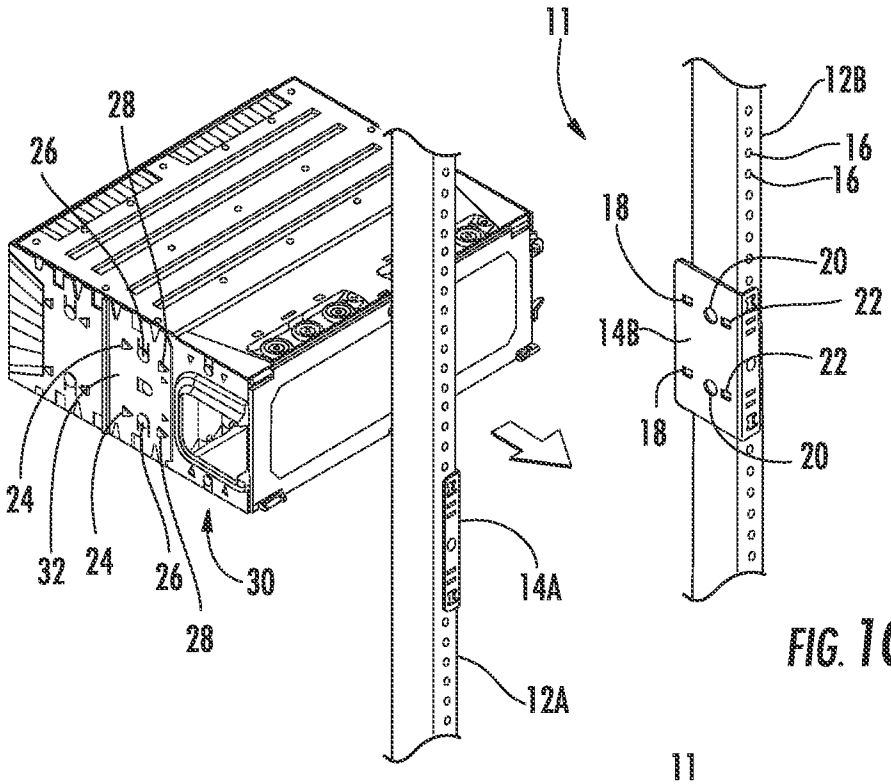
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FIG. 1C

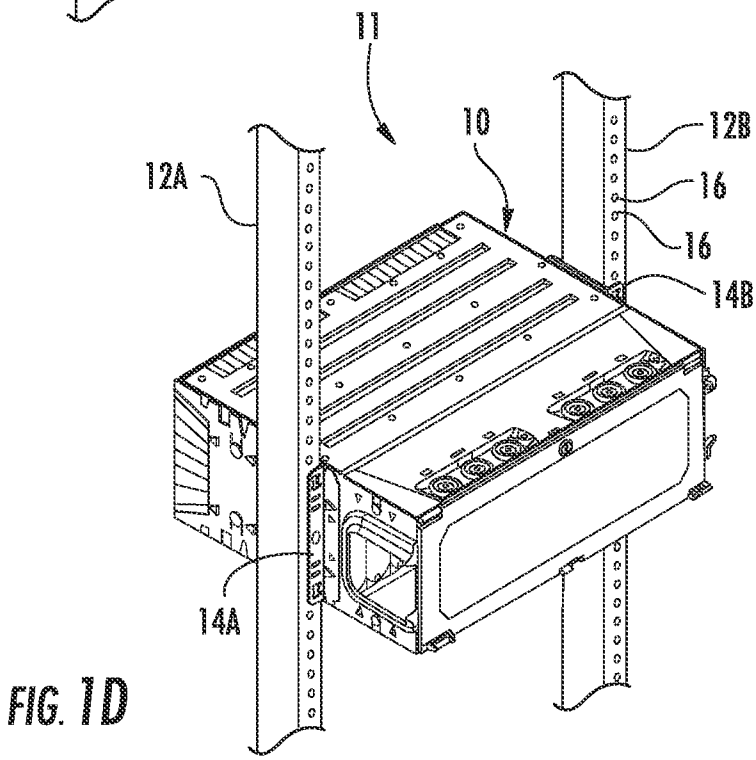
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FIG. 1D

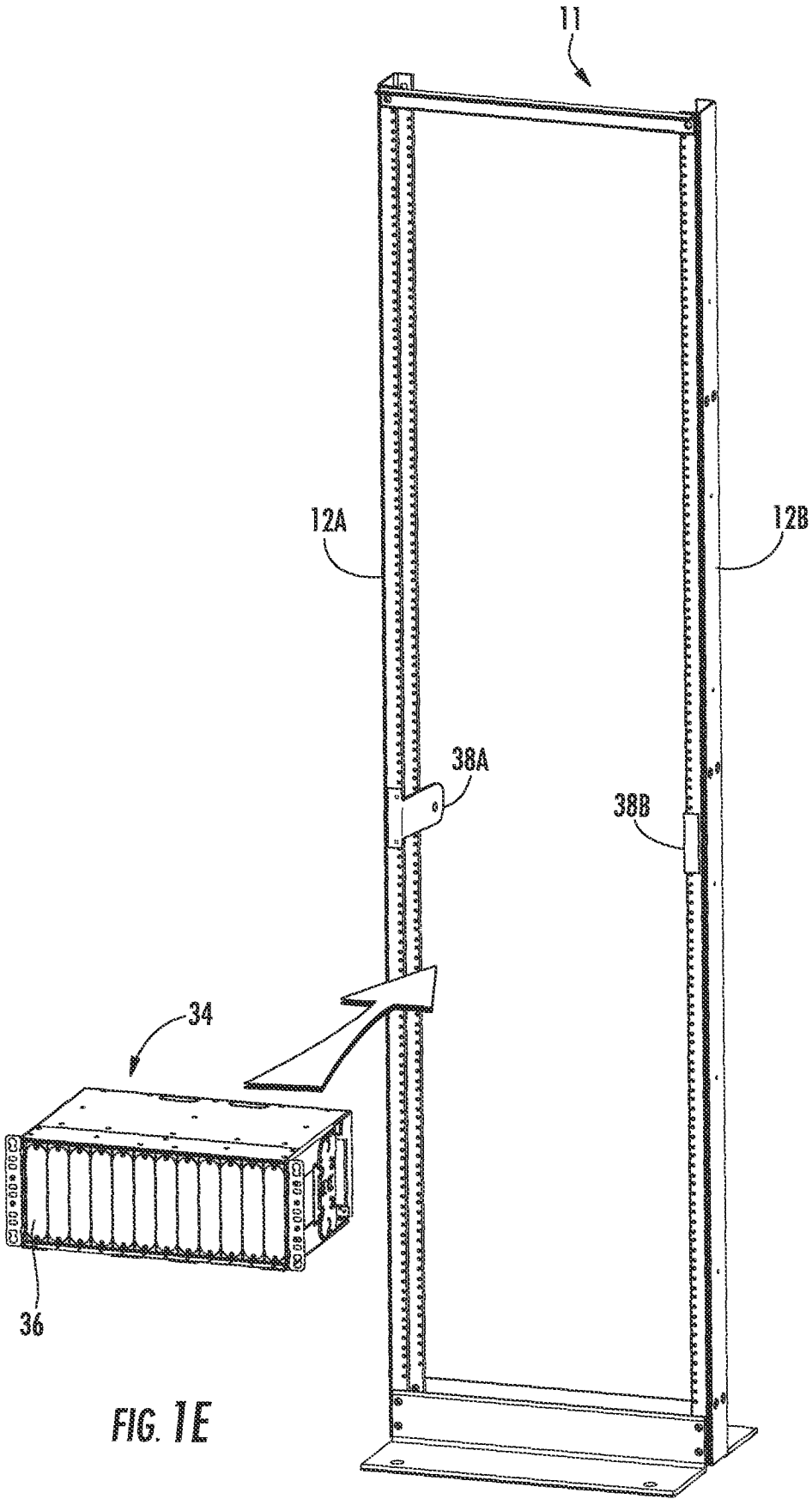

FIG. 1E

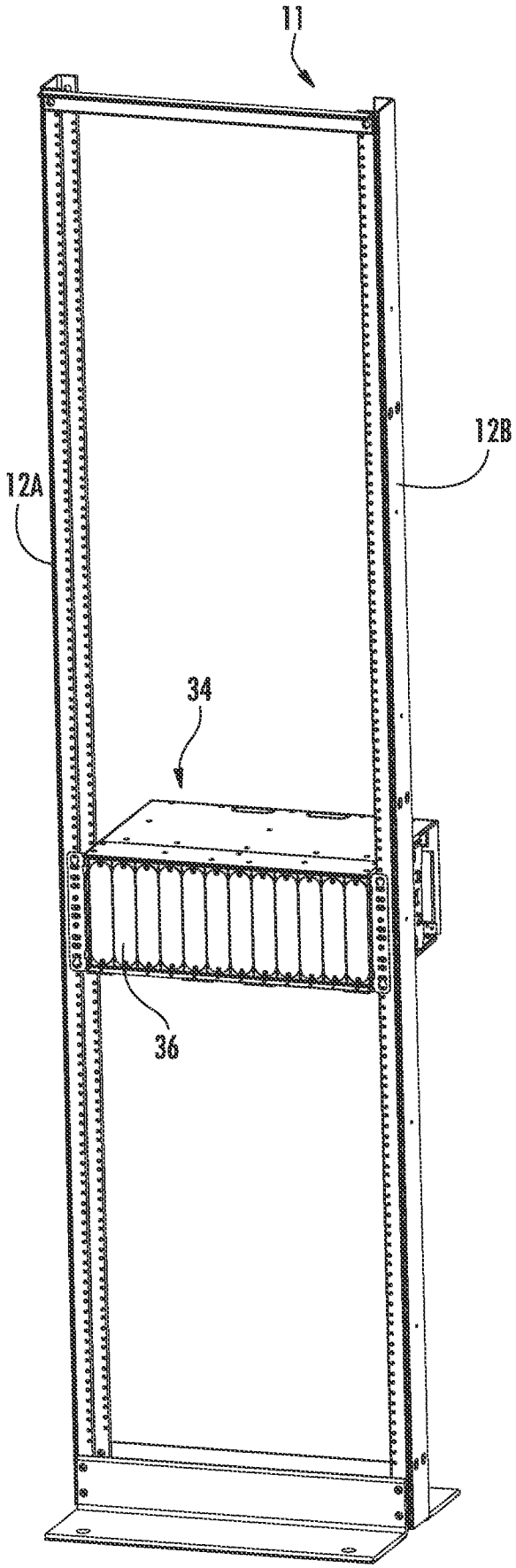

FIG. 1F

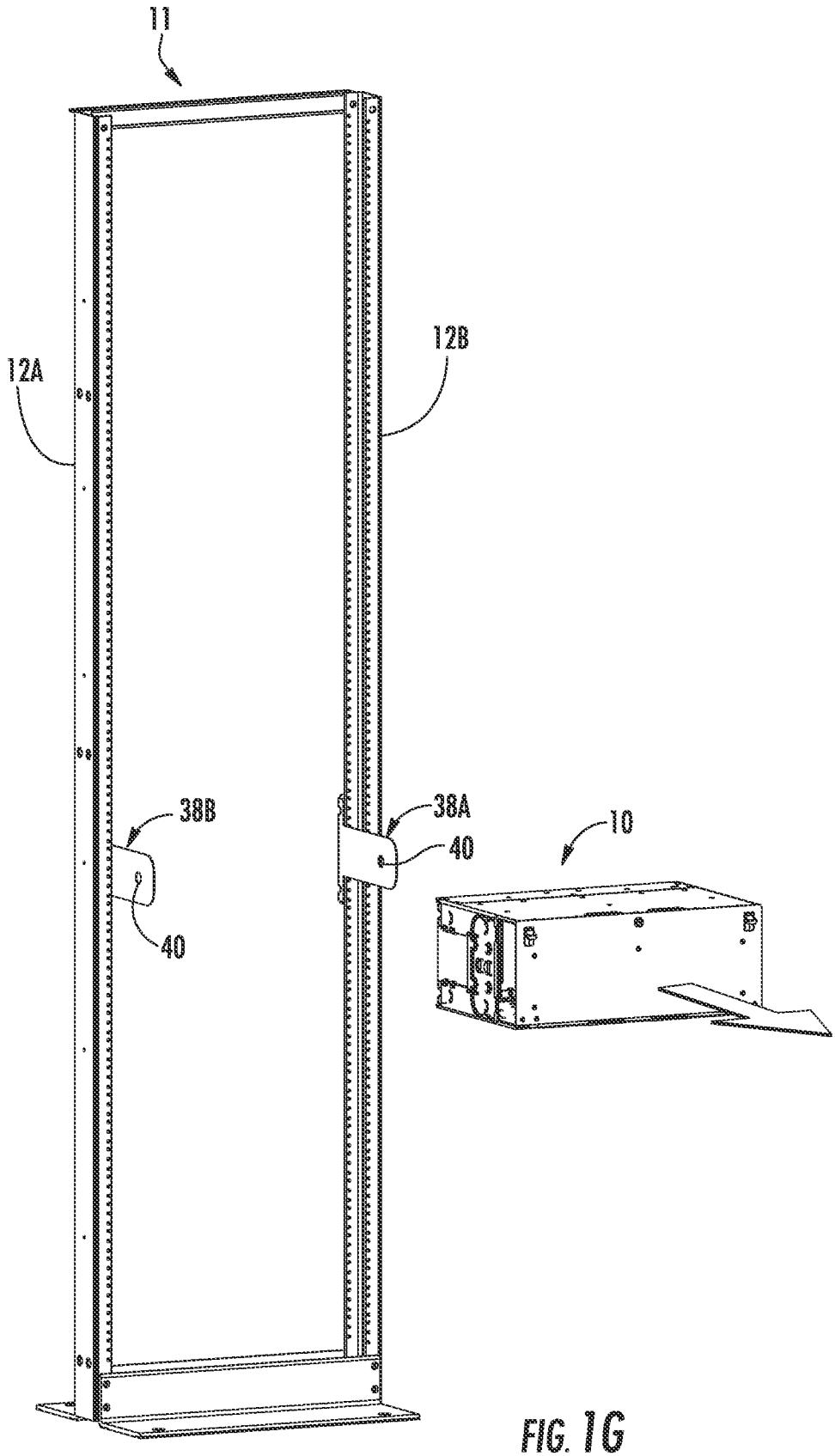

FIG. 1G

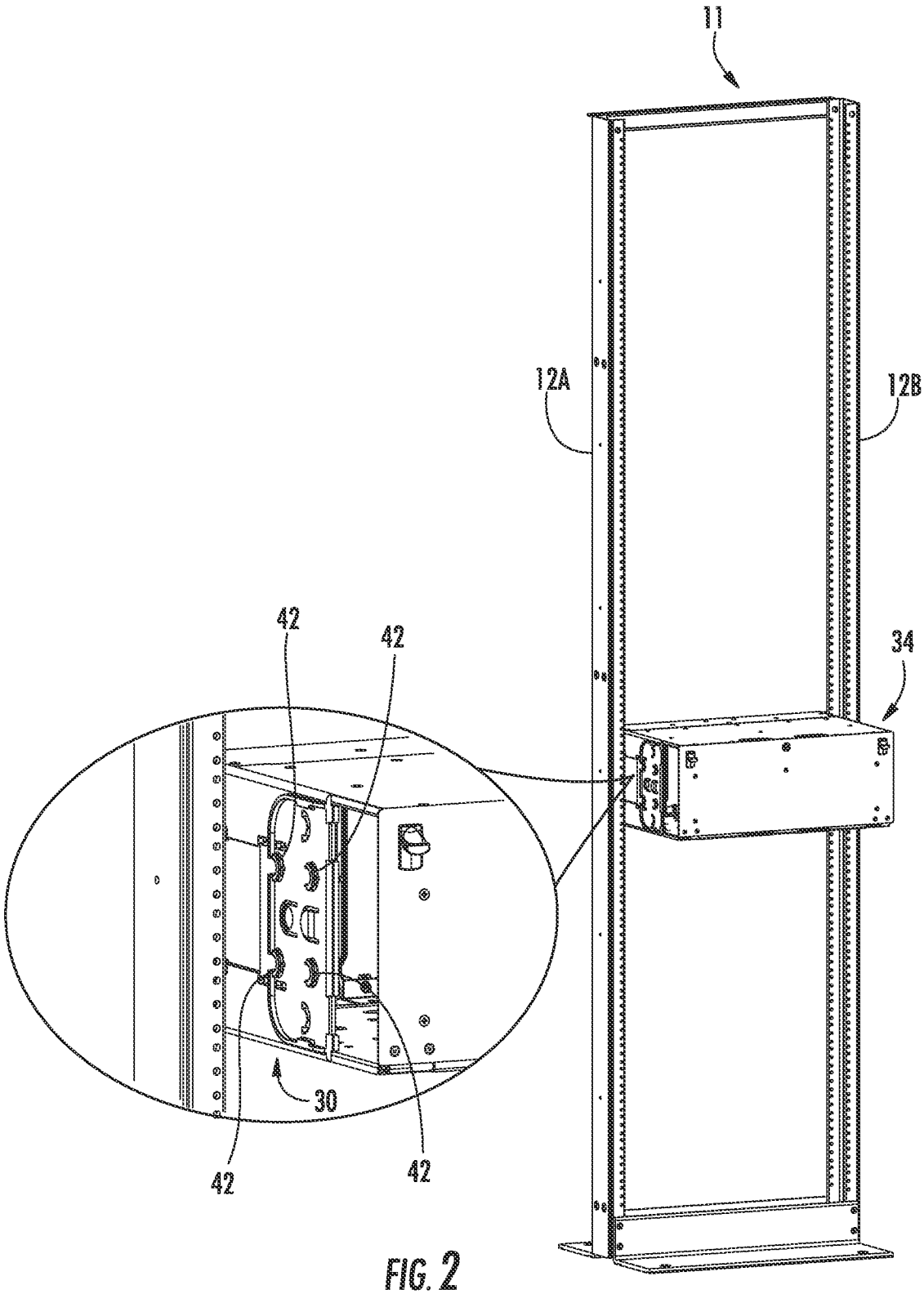

FIG. 2

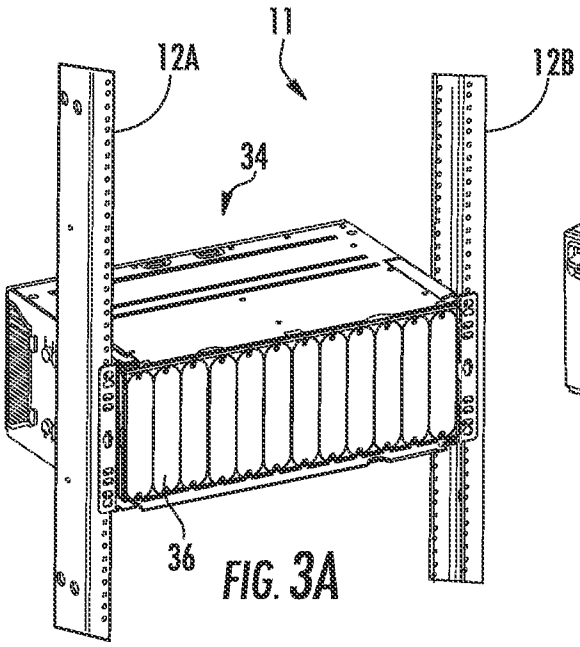

FIG. 3A

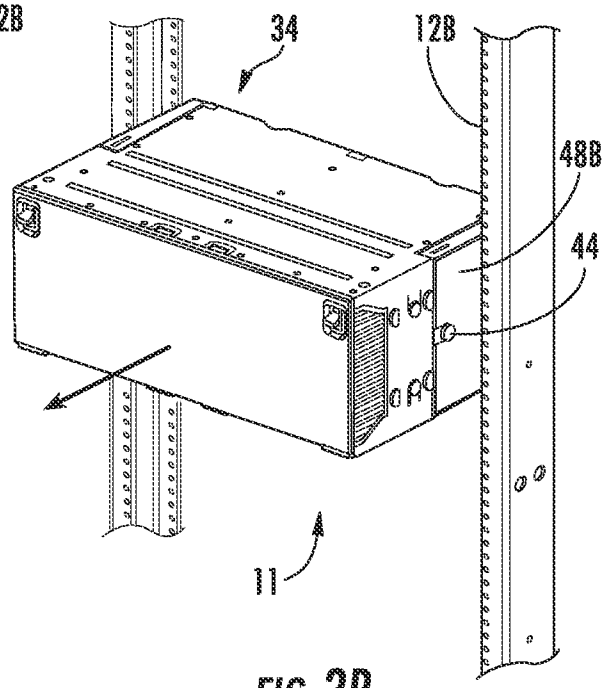

FIG. 3B

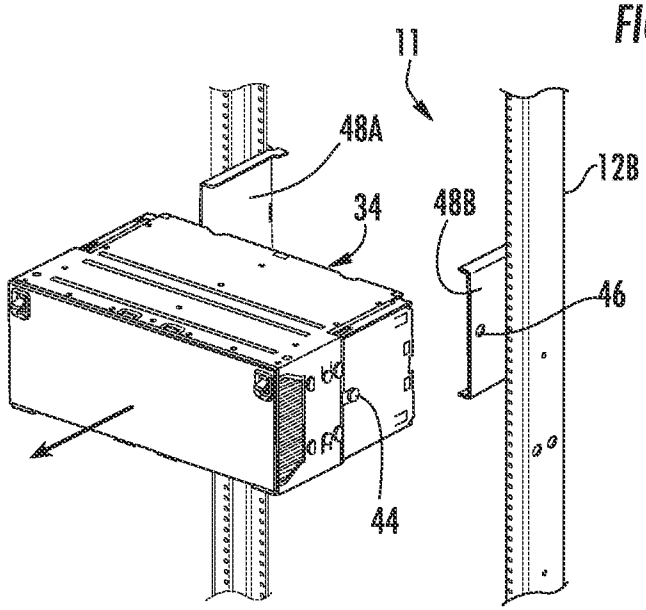

FIG. 3C

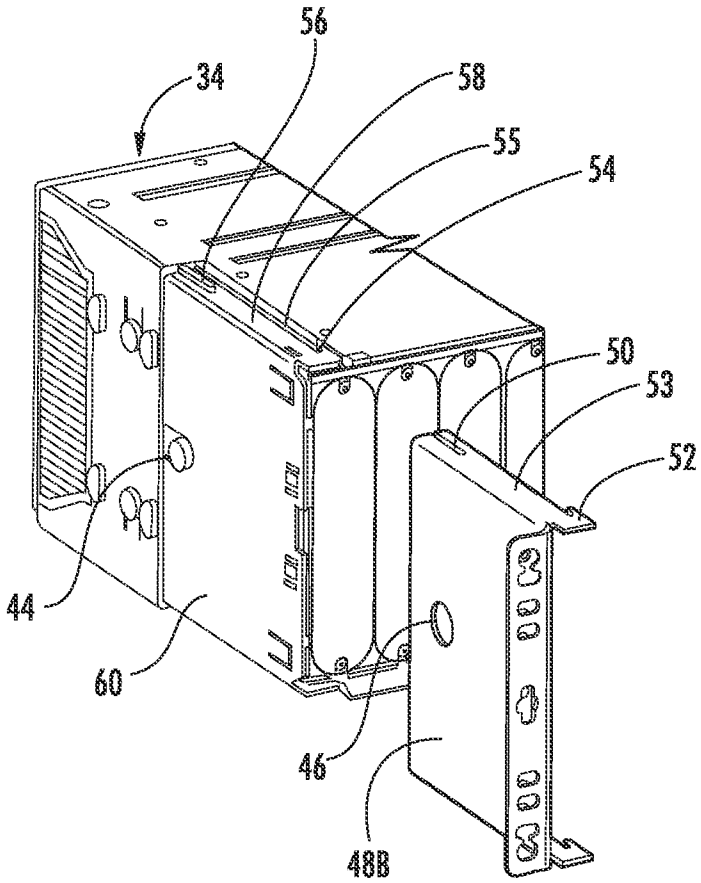

FIG. 4

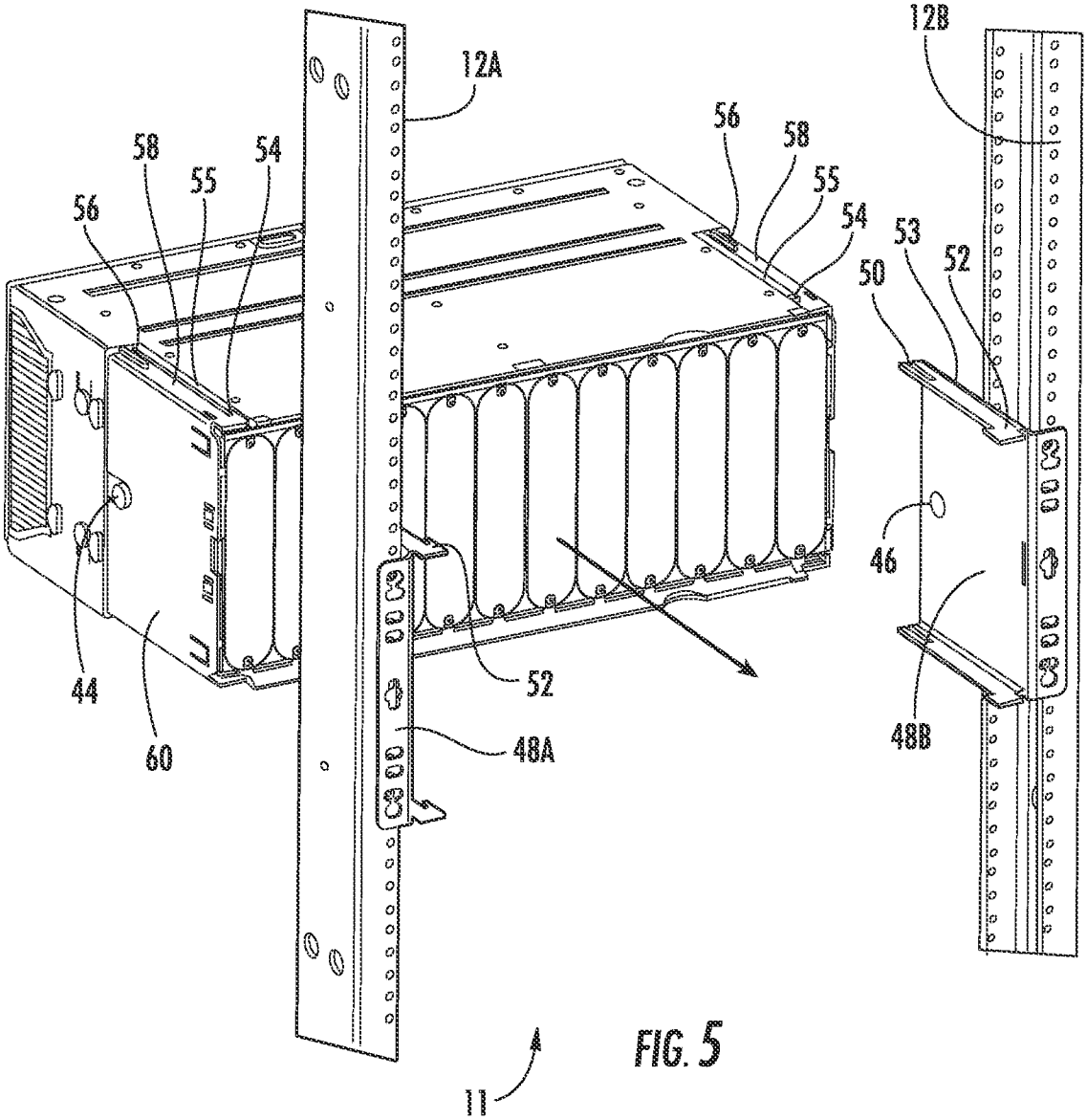

FIG. 5

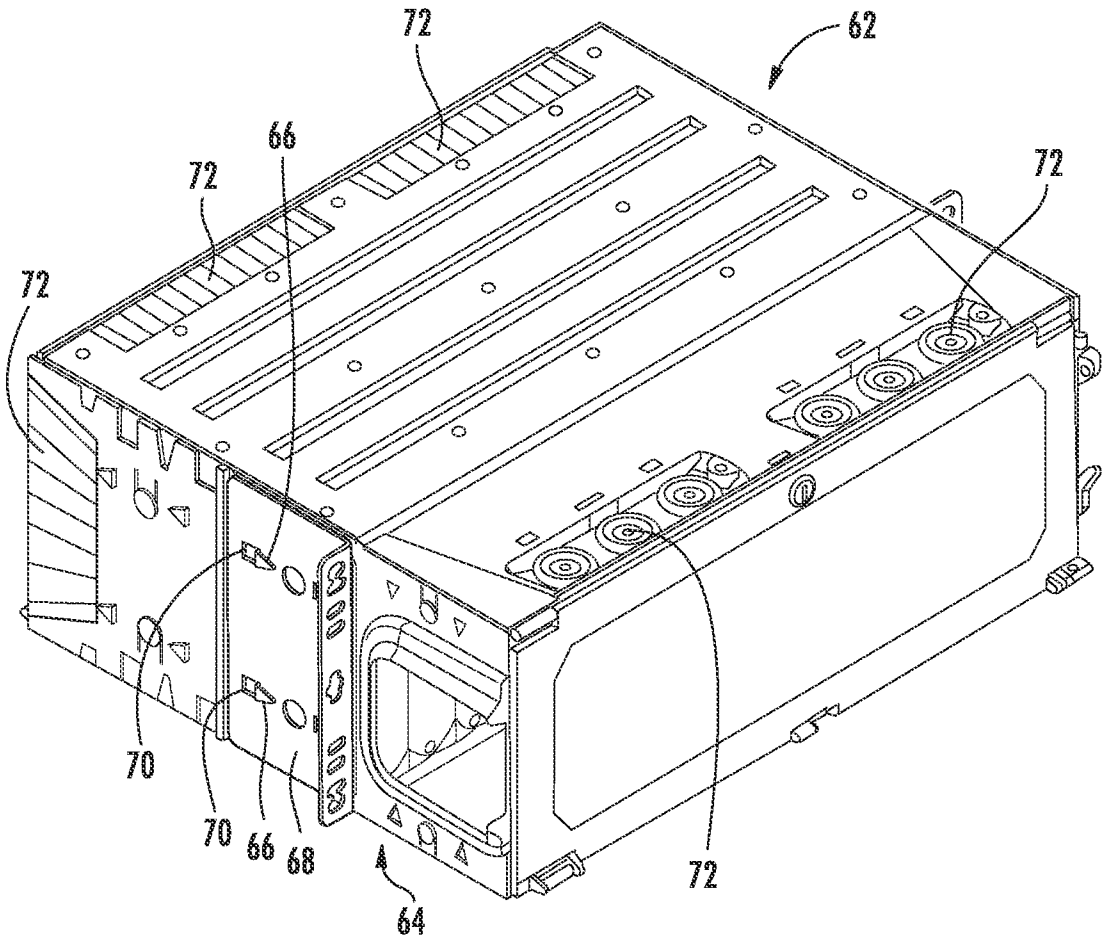

FIG. 6

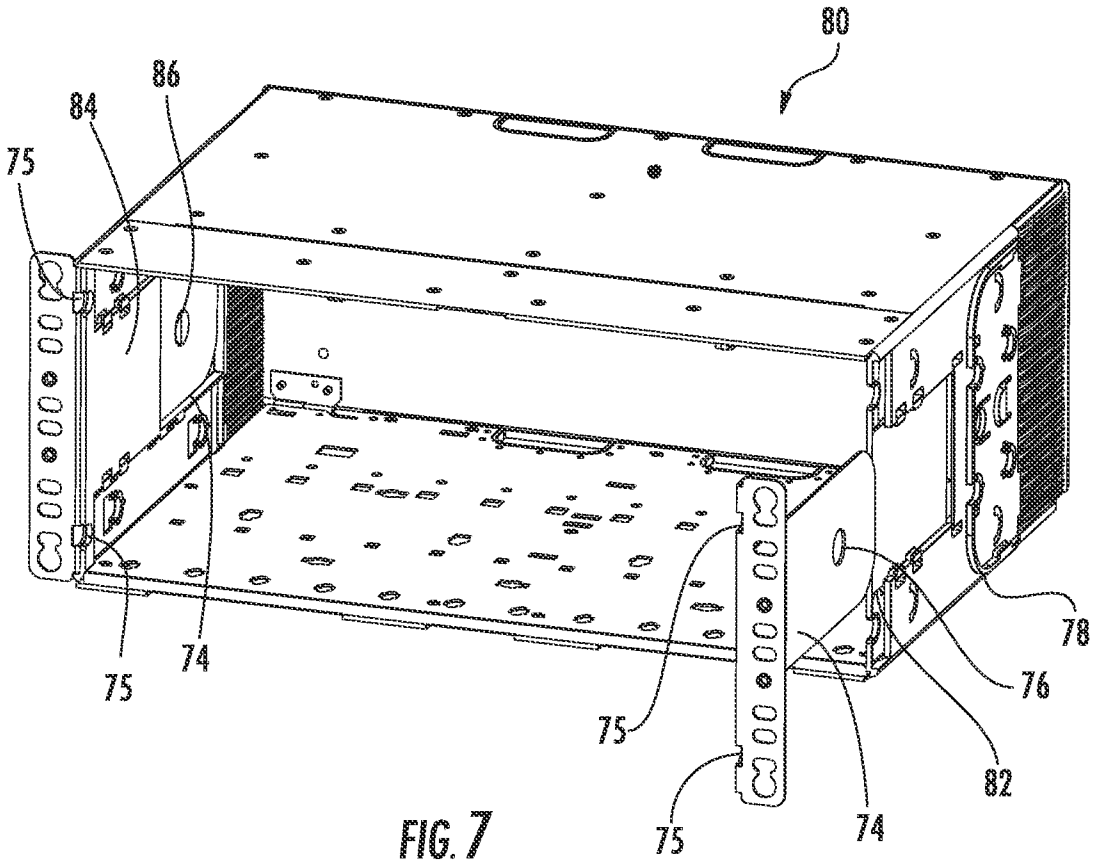

FIG. 7

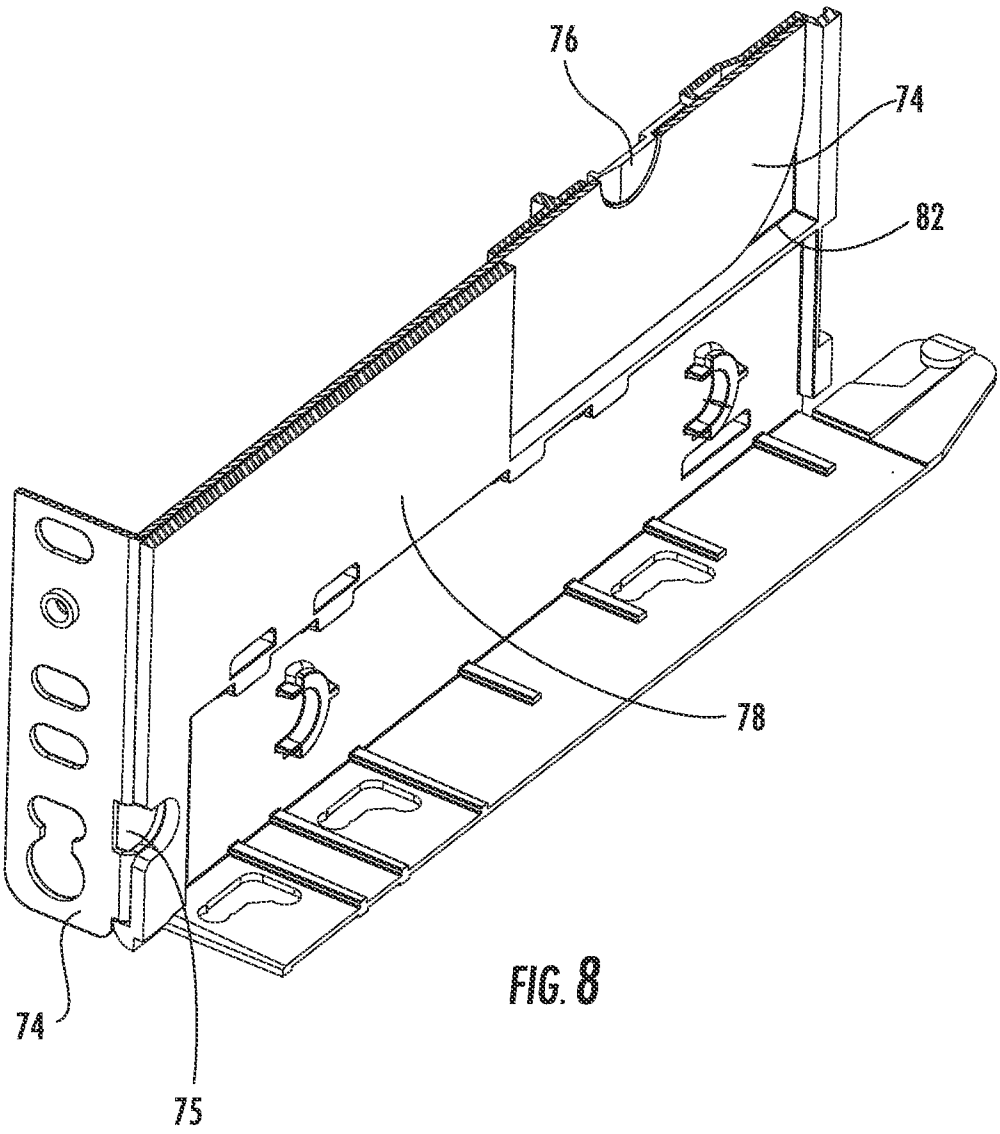

FIG. 8

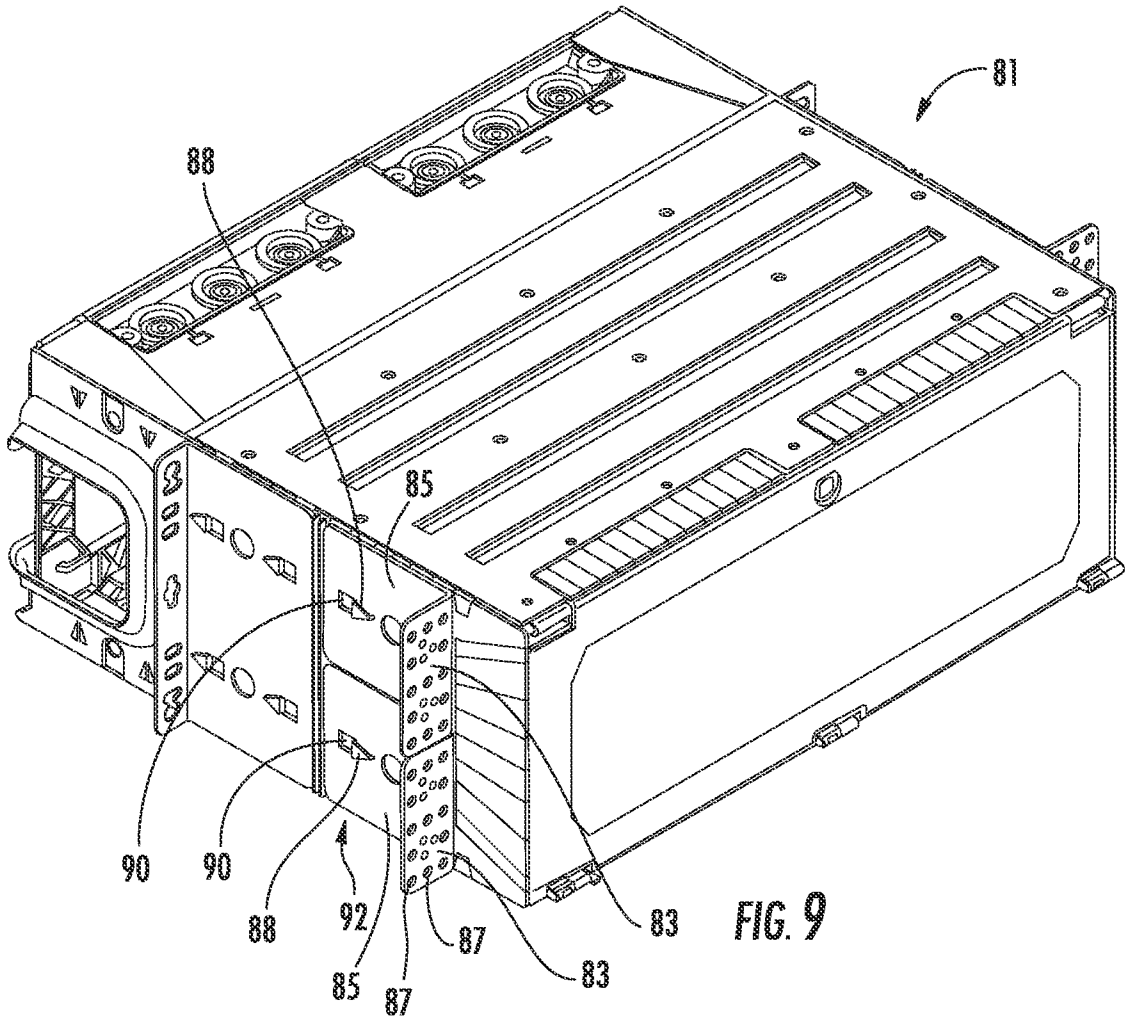

FIG. 9

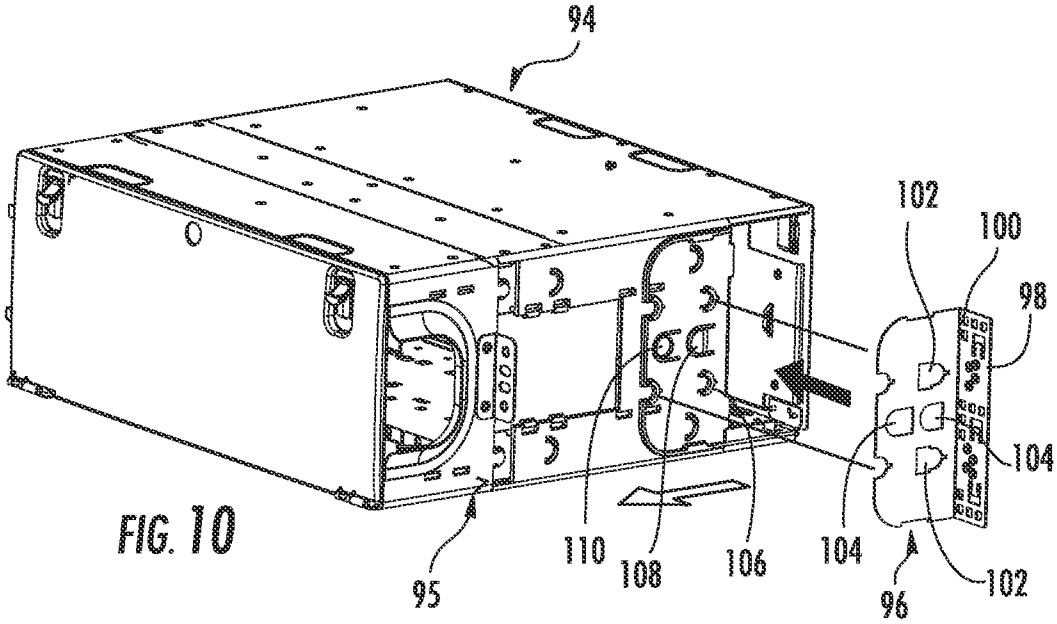

FIG. 10

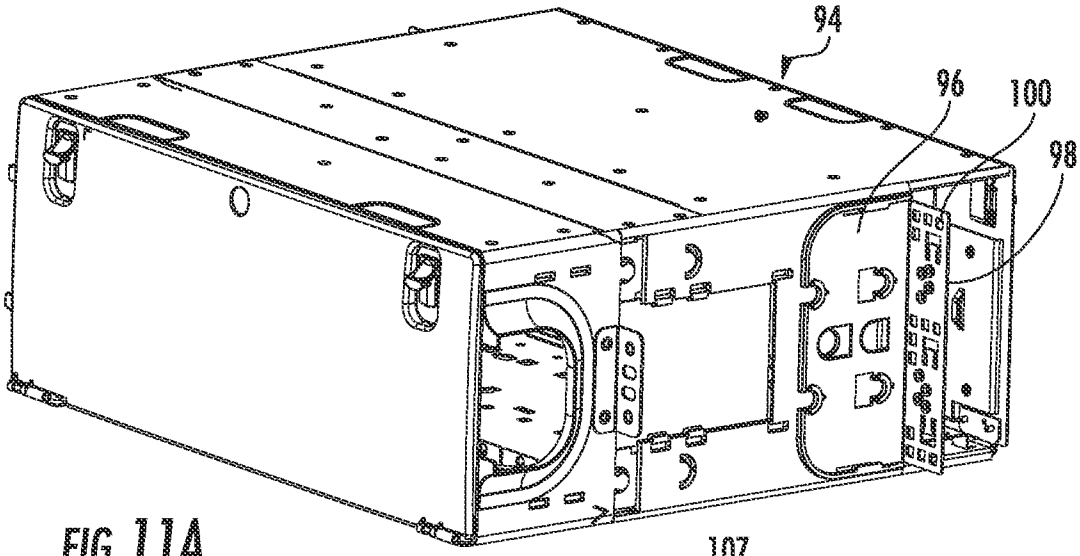

FIG. 11A

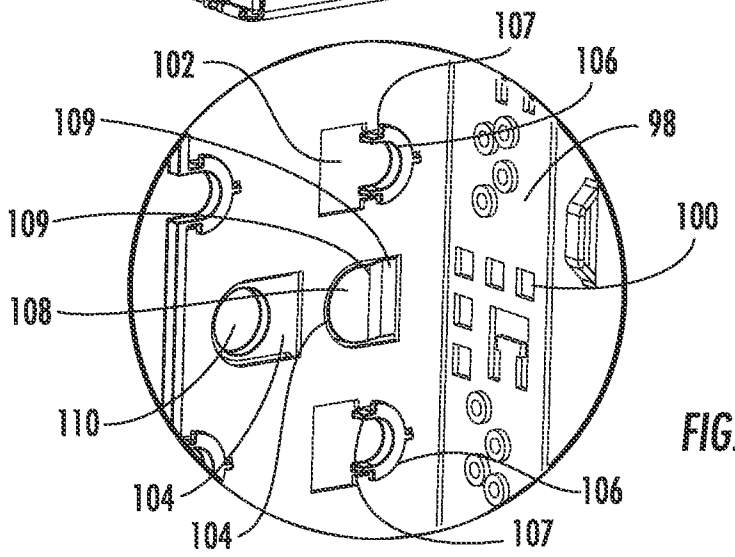

FIG. 11B

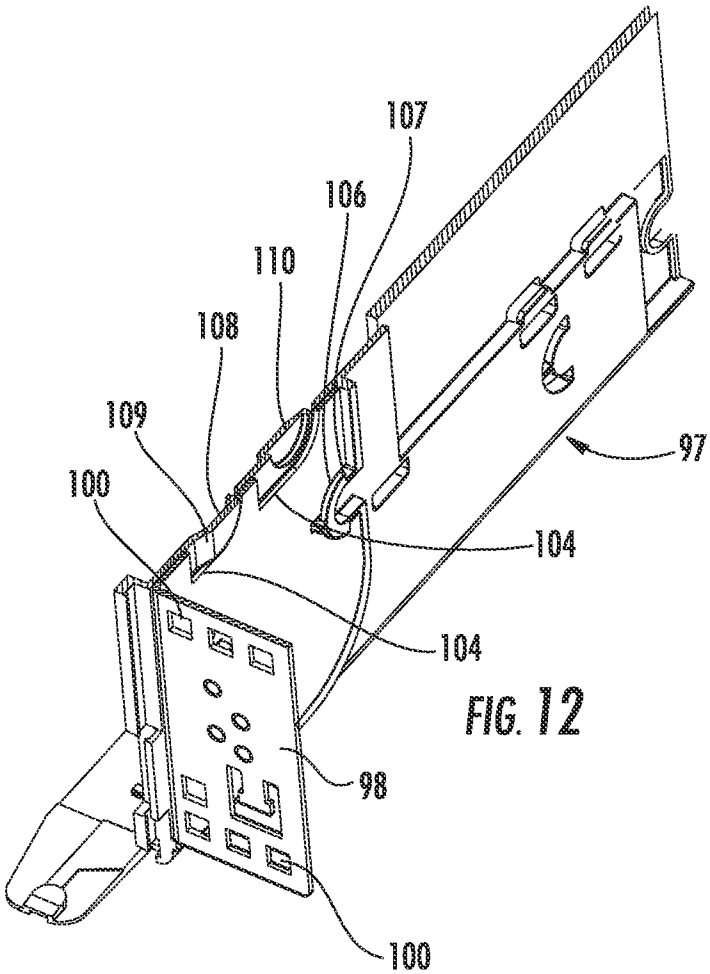

FIG. 12

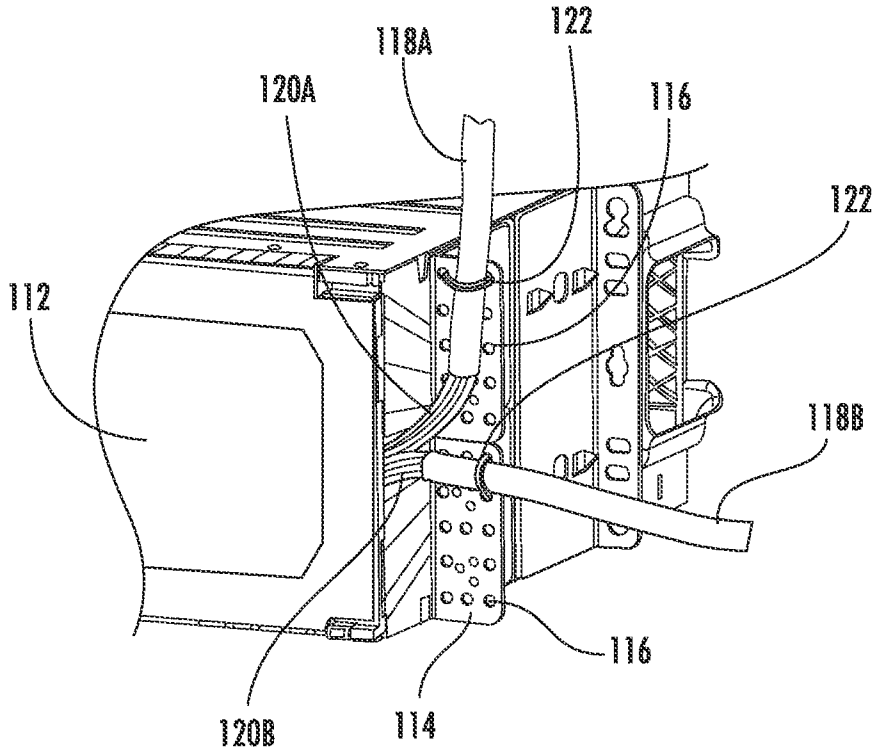

FIG. 13

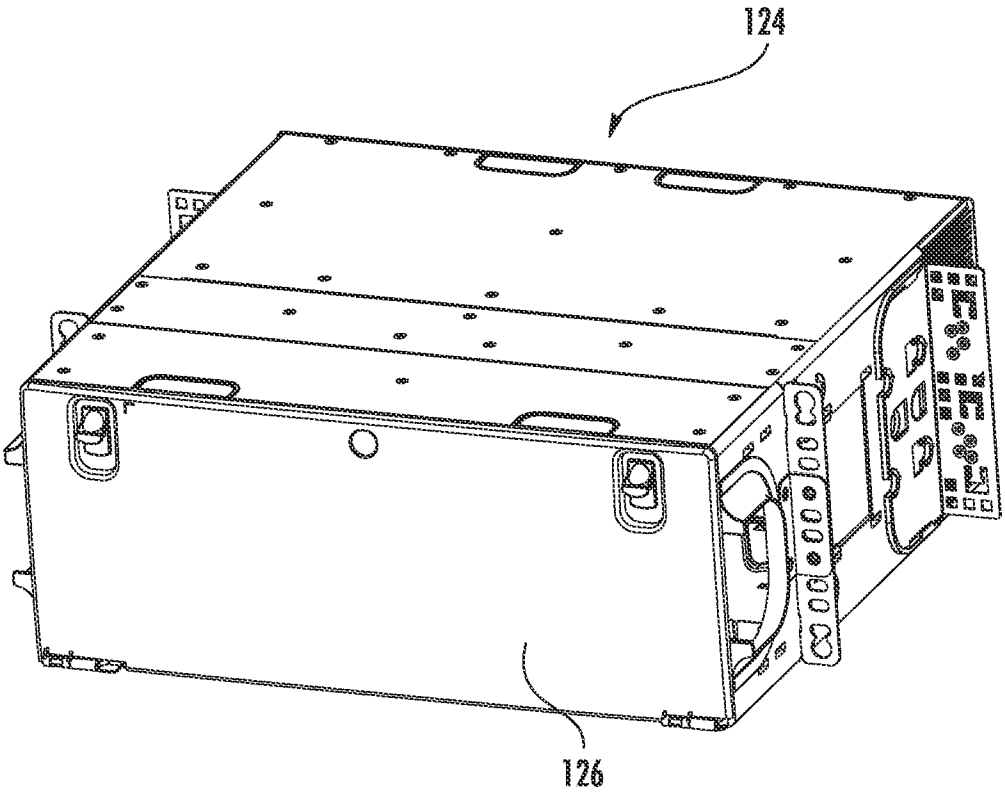

FIG. 14

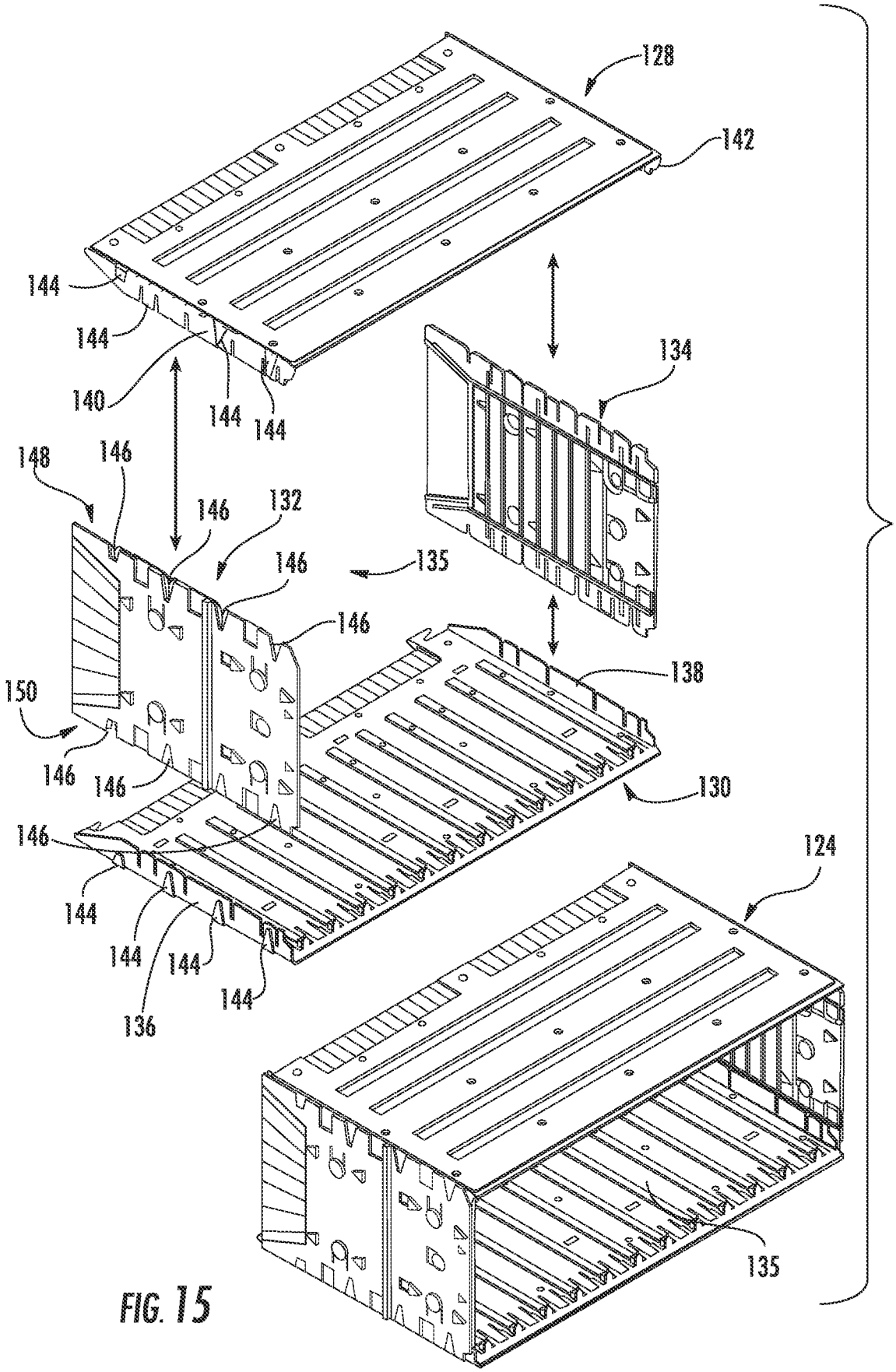
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FIG. 15

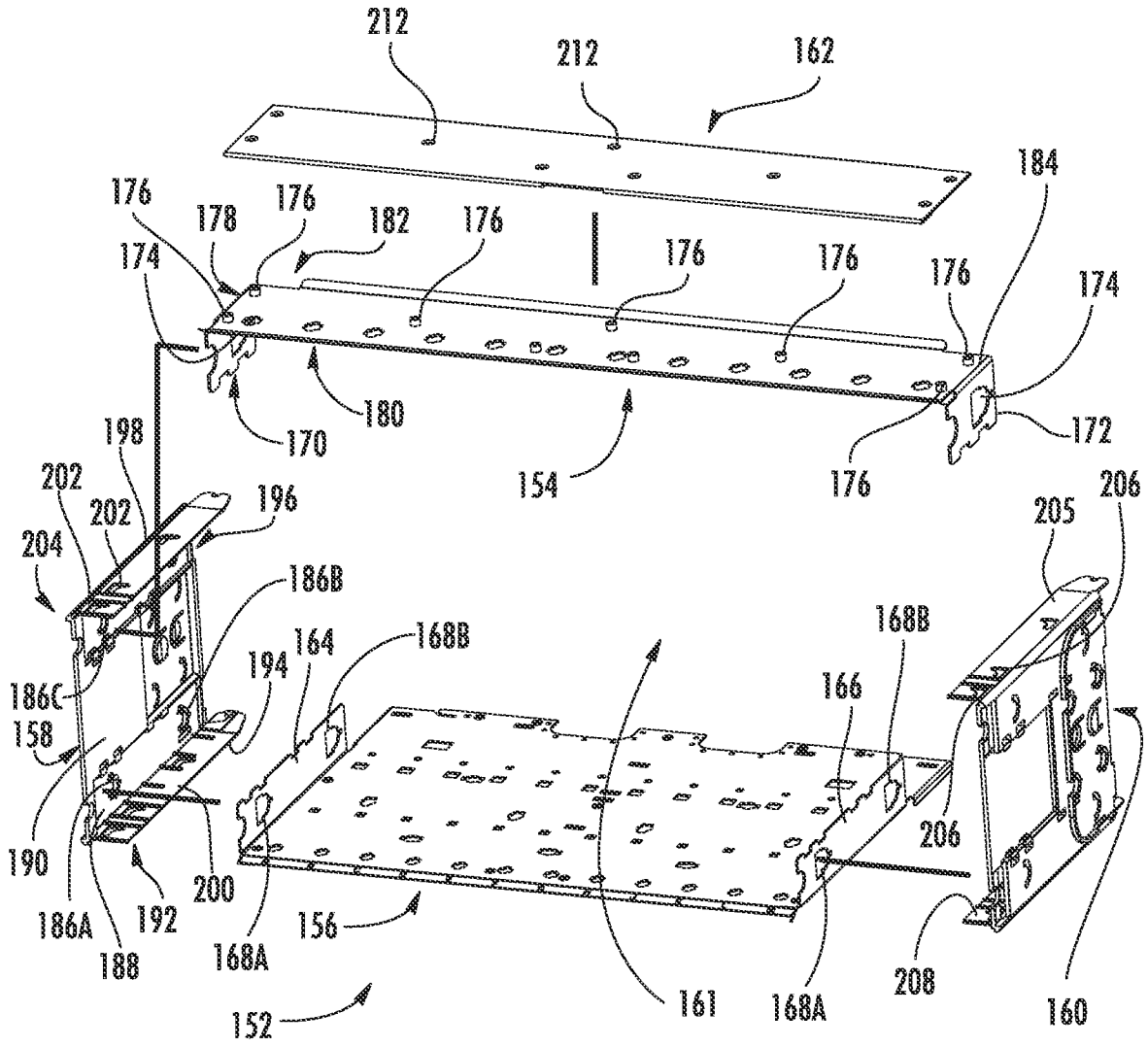
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FIG. 16

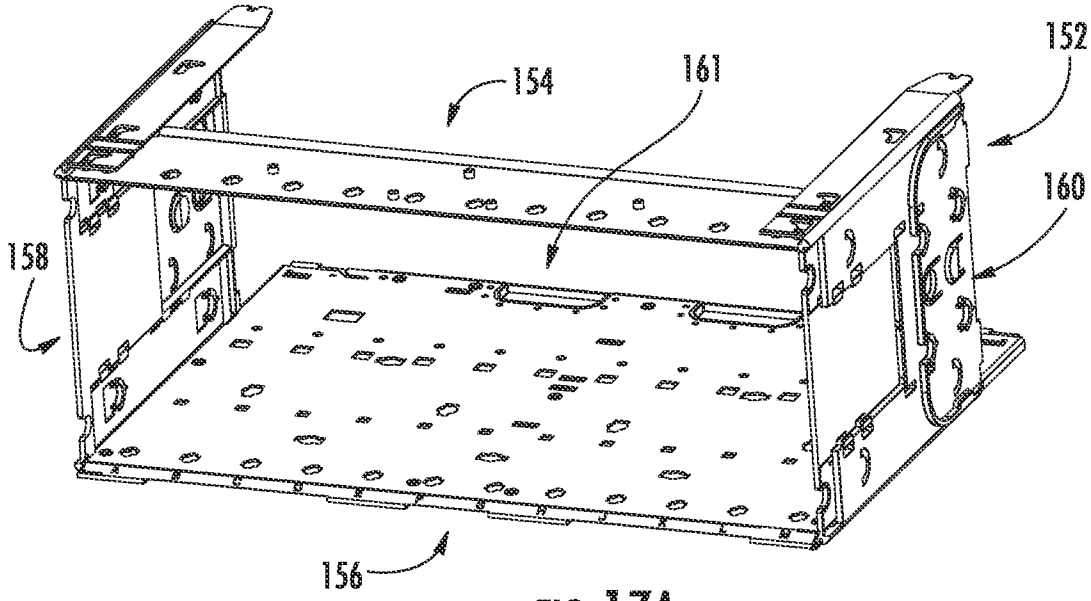

FIG. 17A

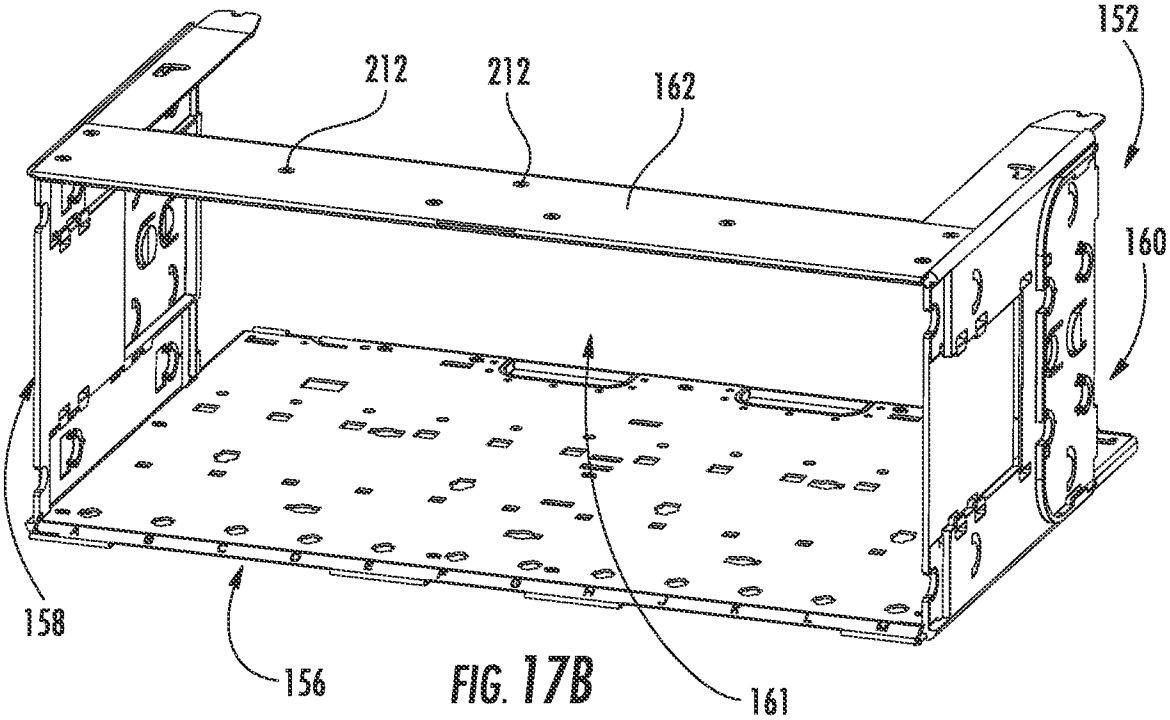

FIG. 17B

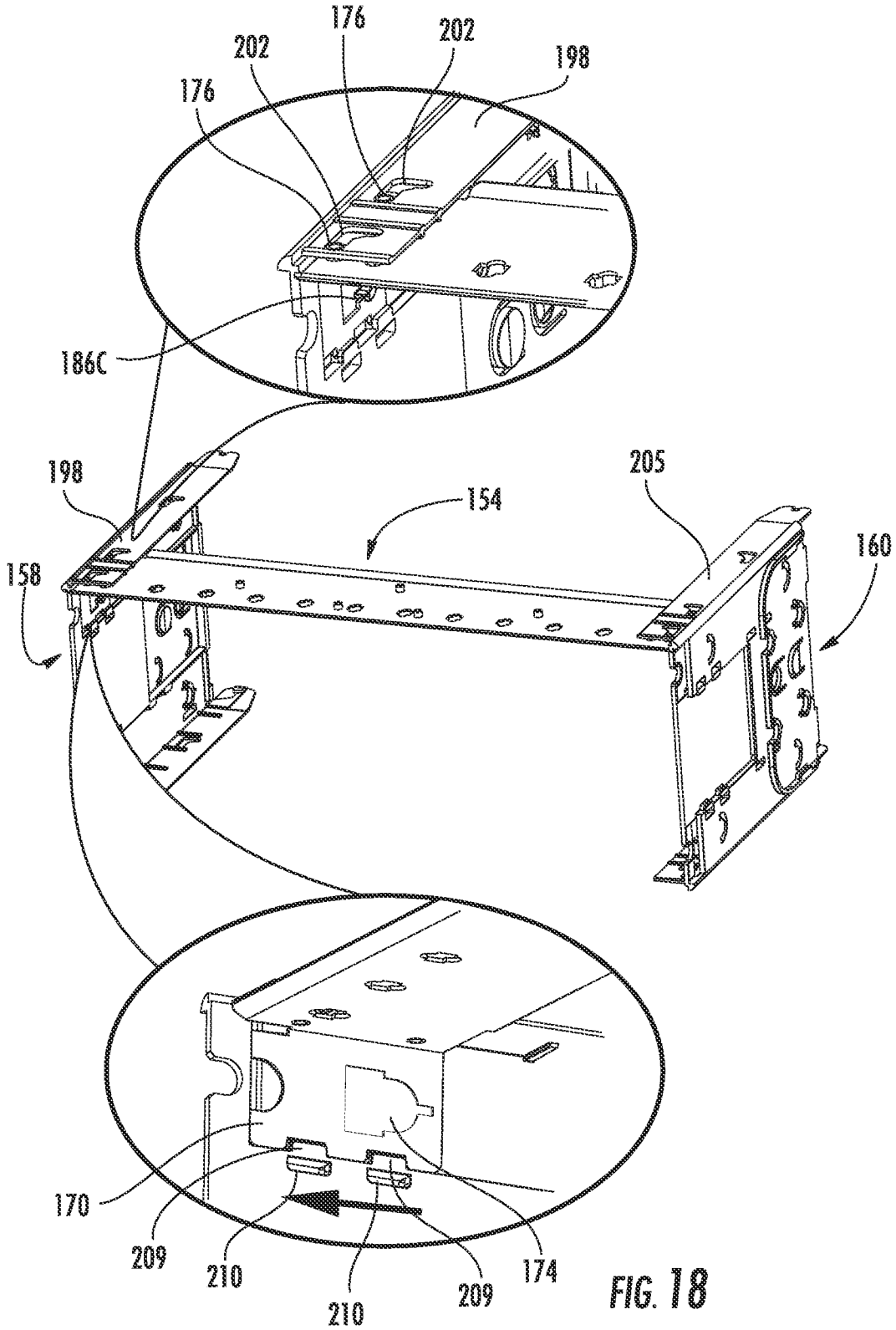
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FIG. 18

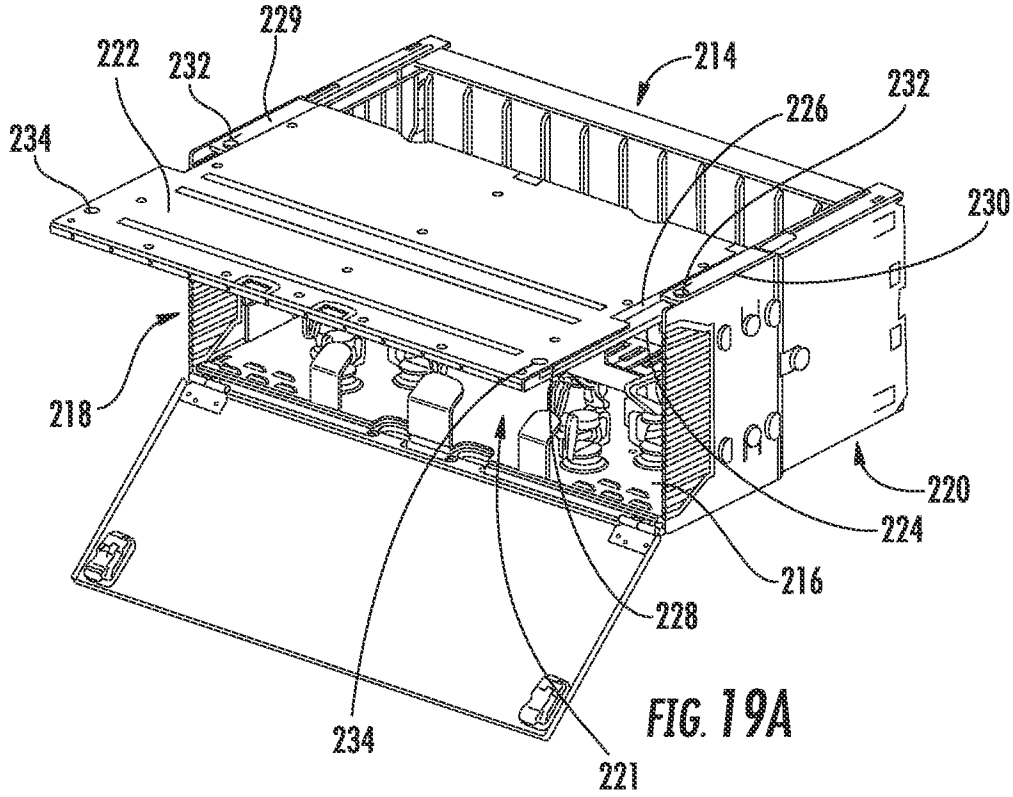

FIG. 19A

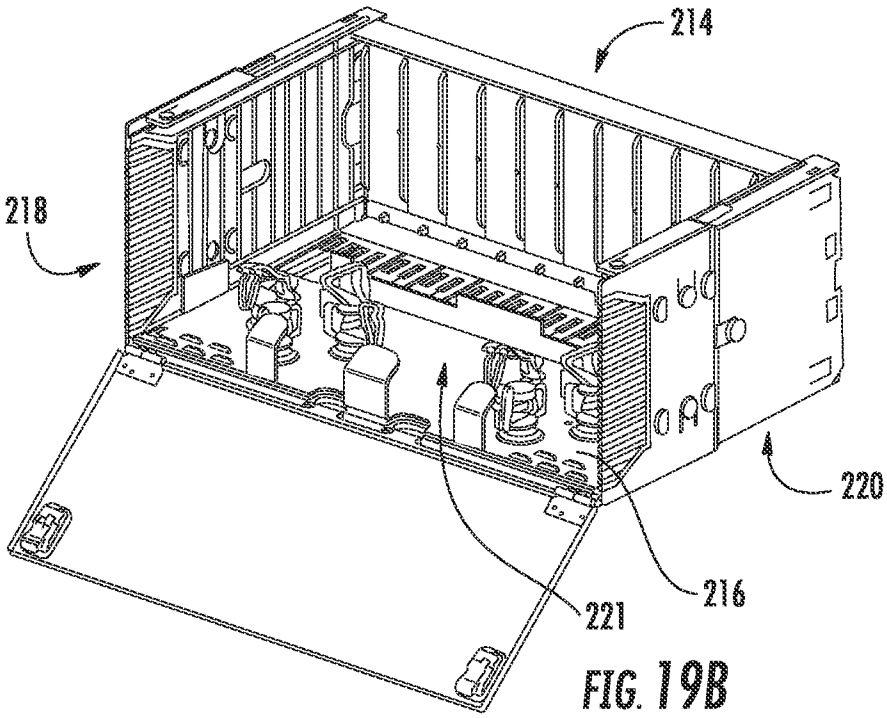

FIG. 19B

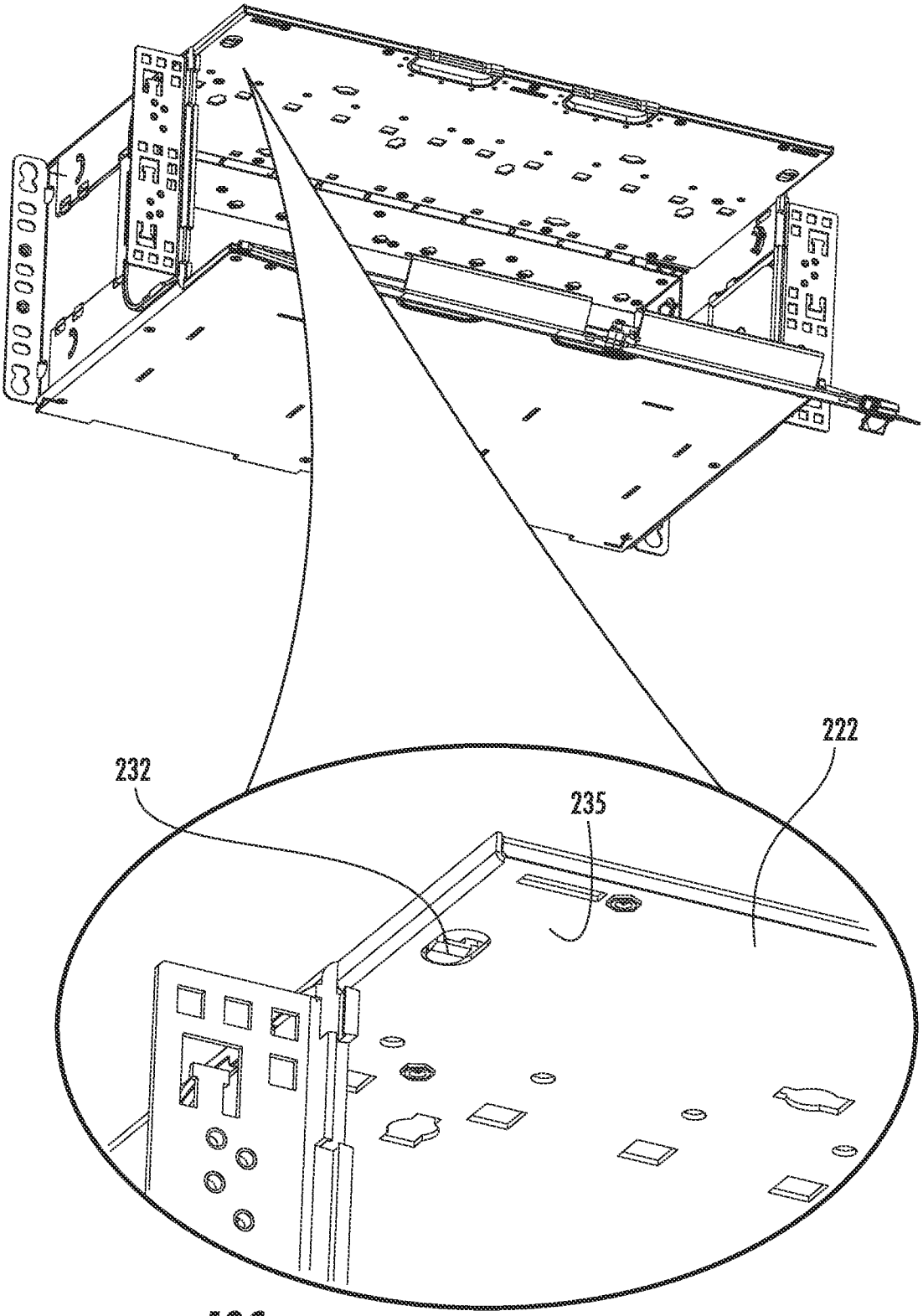

FIG. 19C

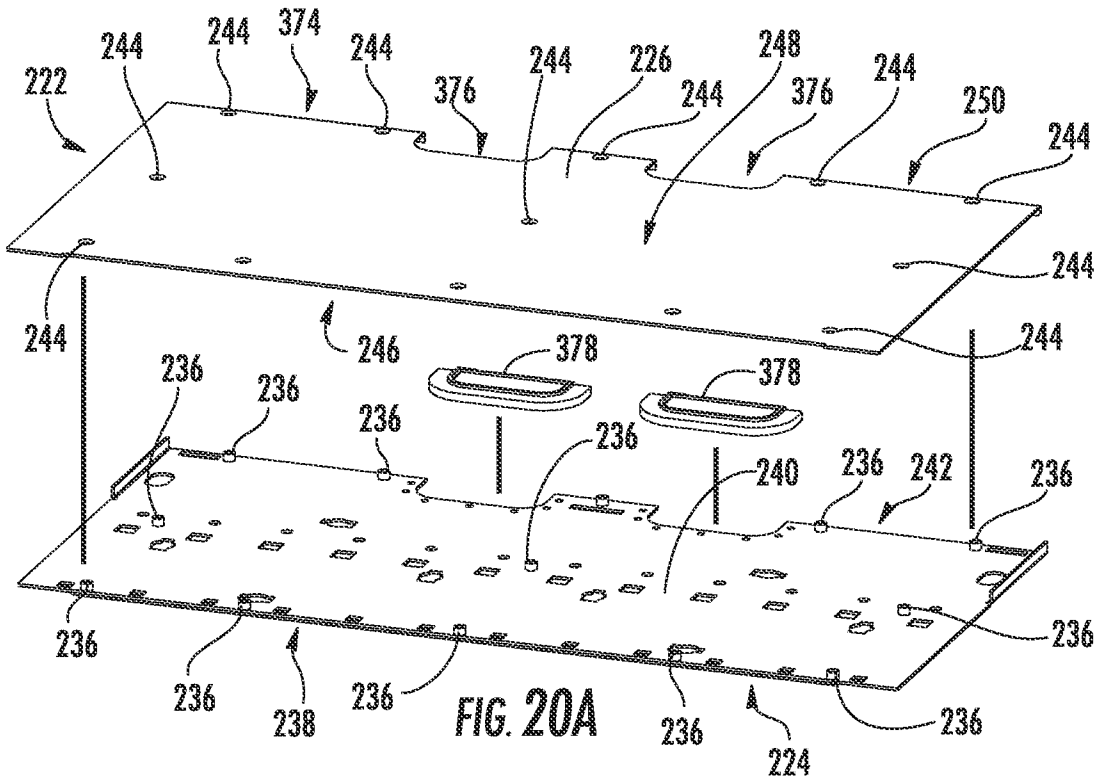

FIG. 20A

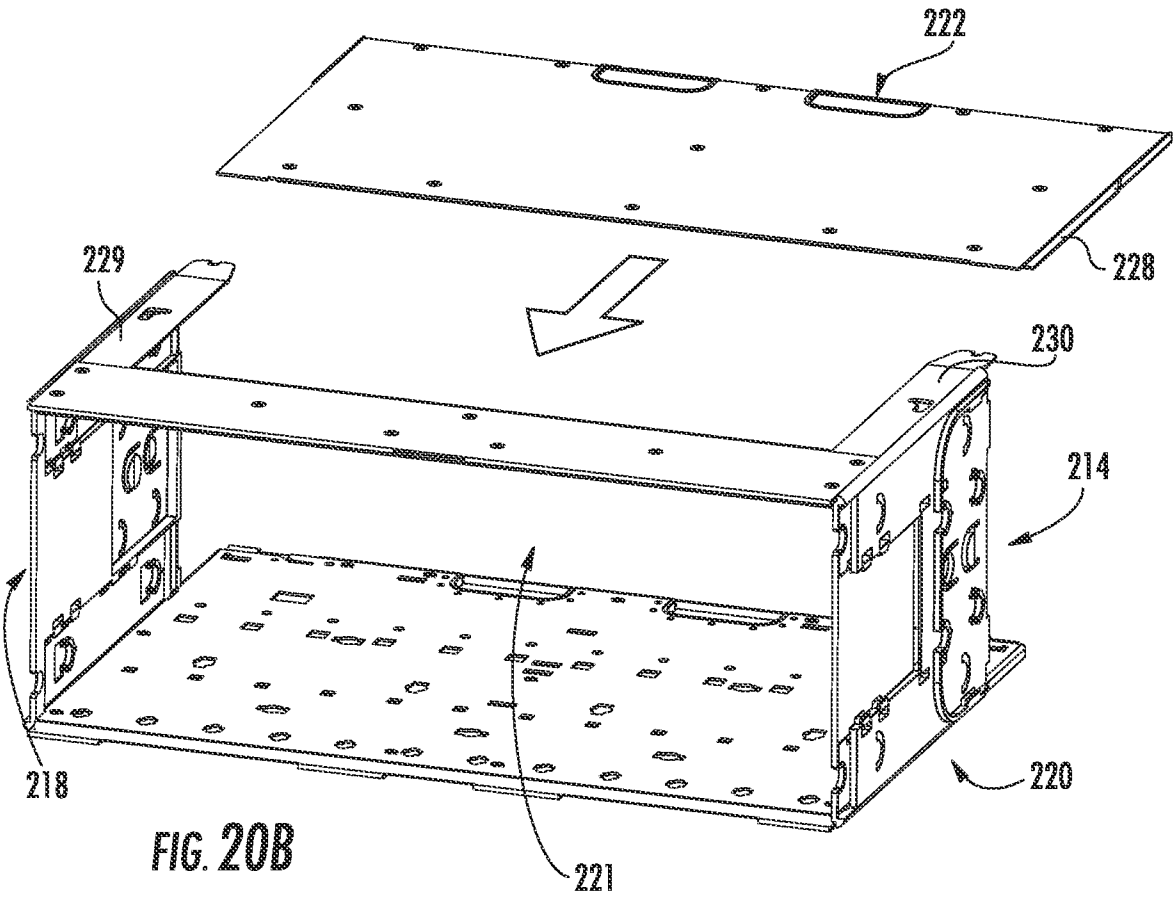

FIG. 20B

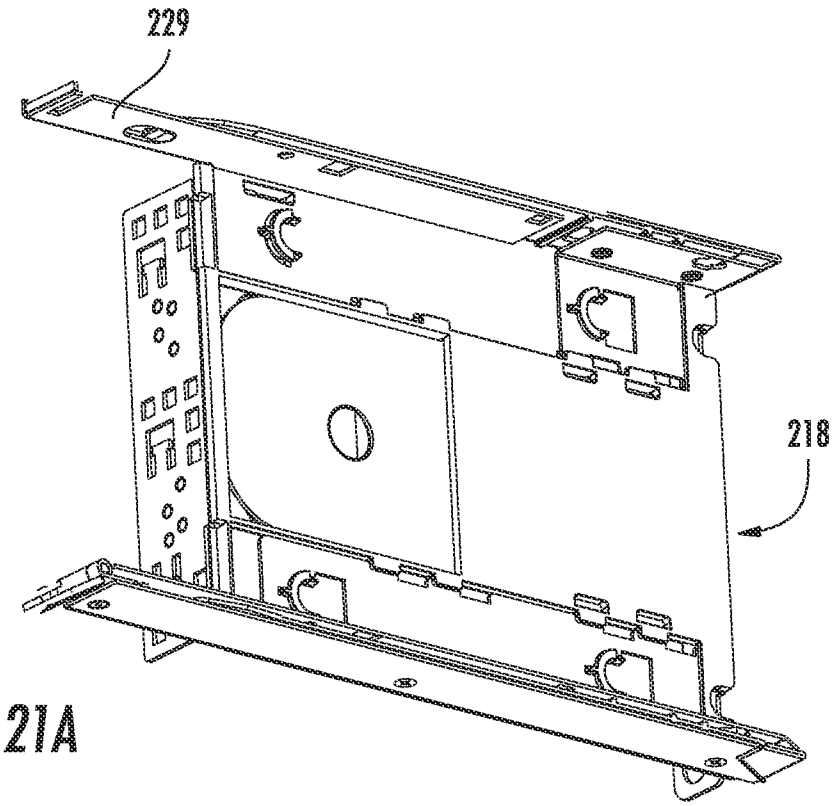

FIG. 21A

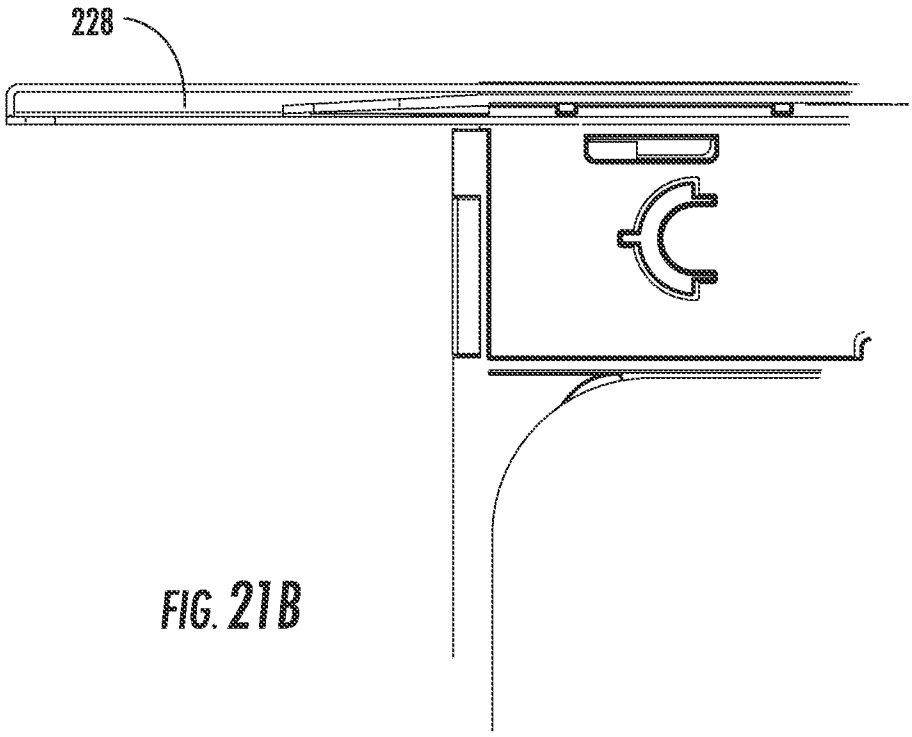

FIG. 21B

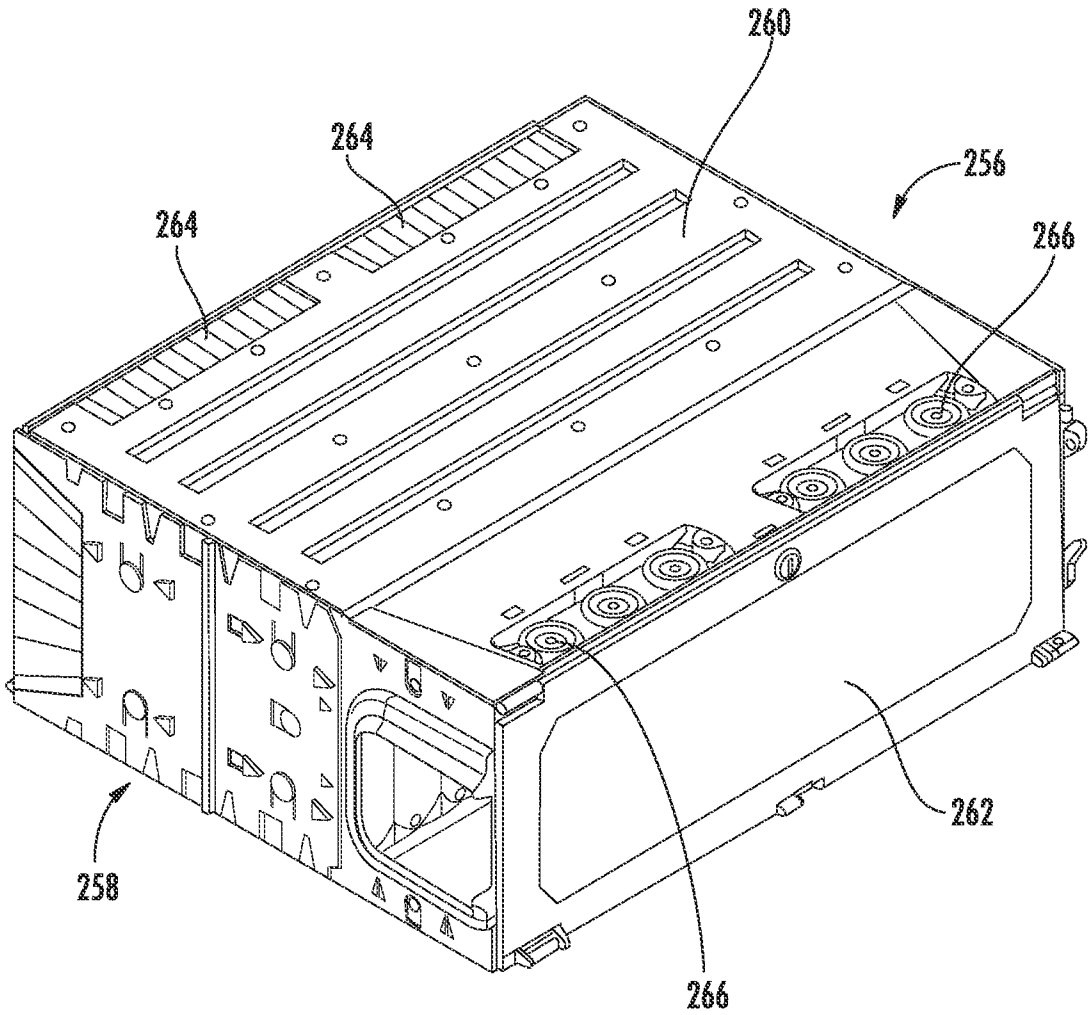

FIG. 22

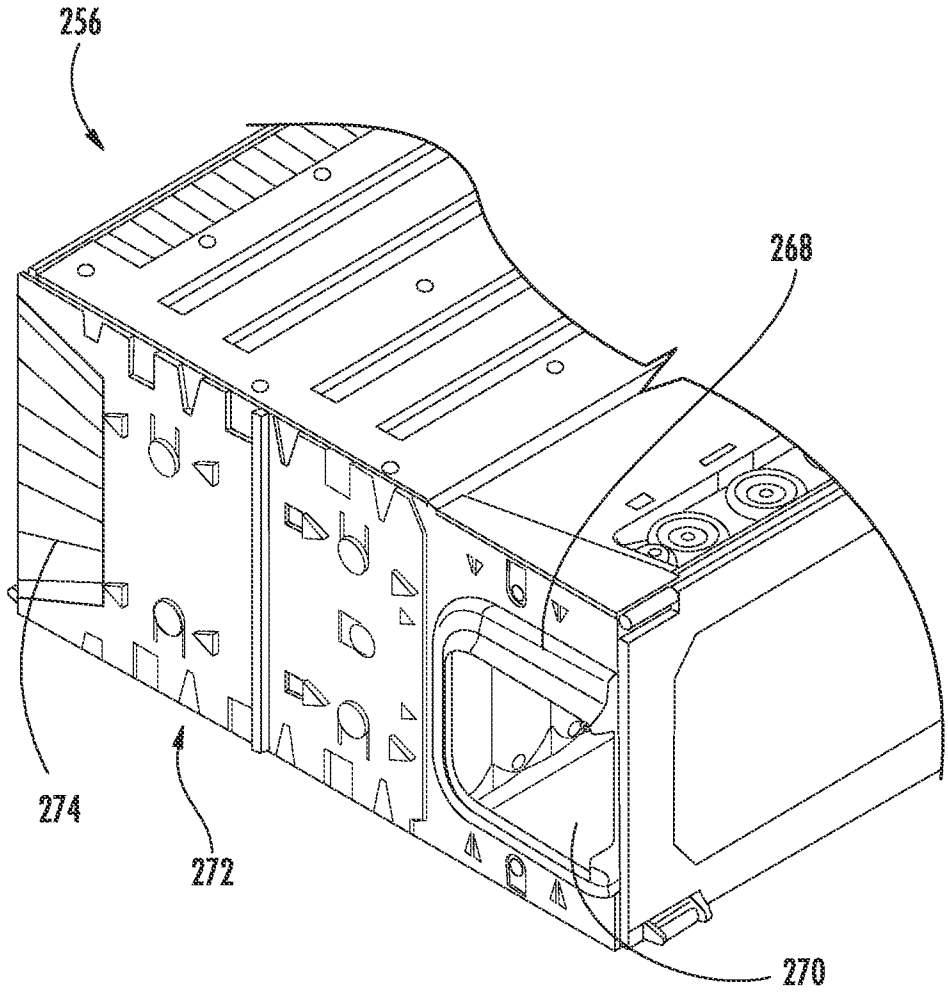

FIG. 23

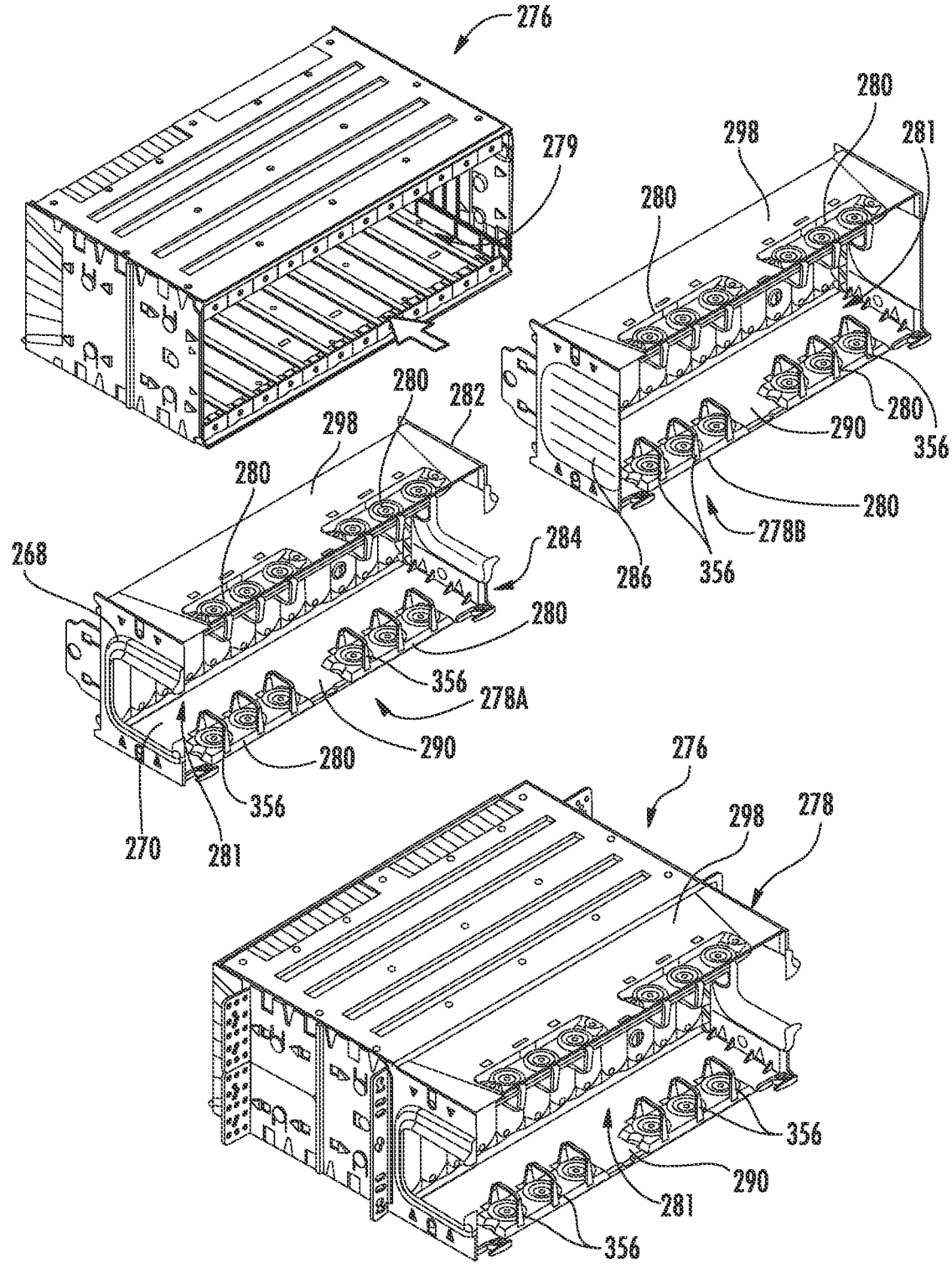
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FIG. 24

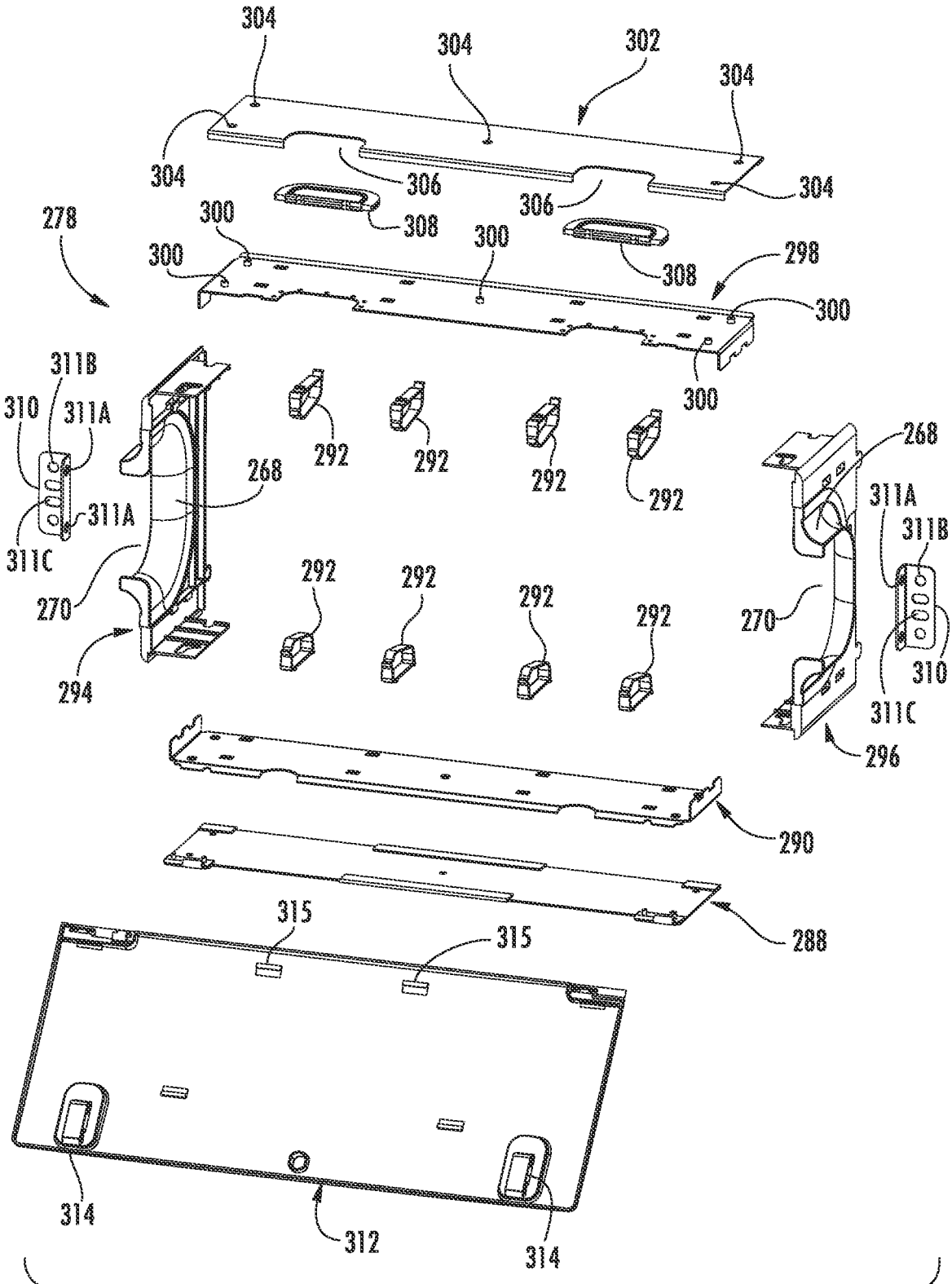
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FIG. 25

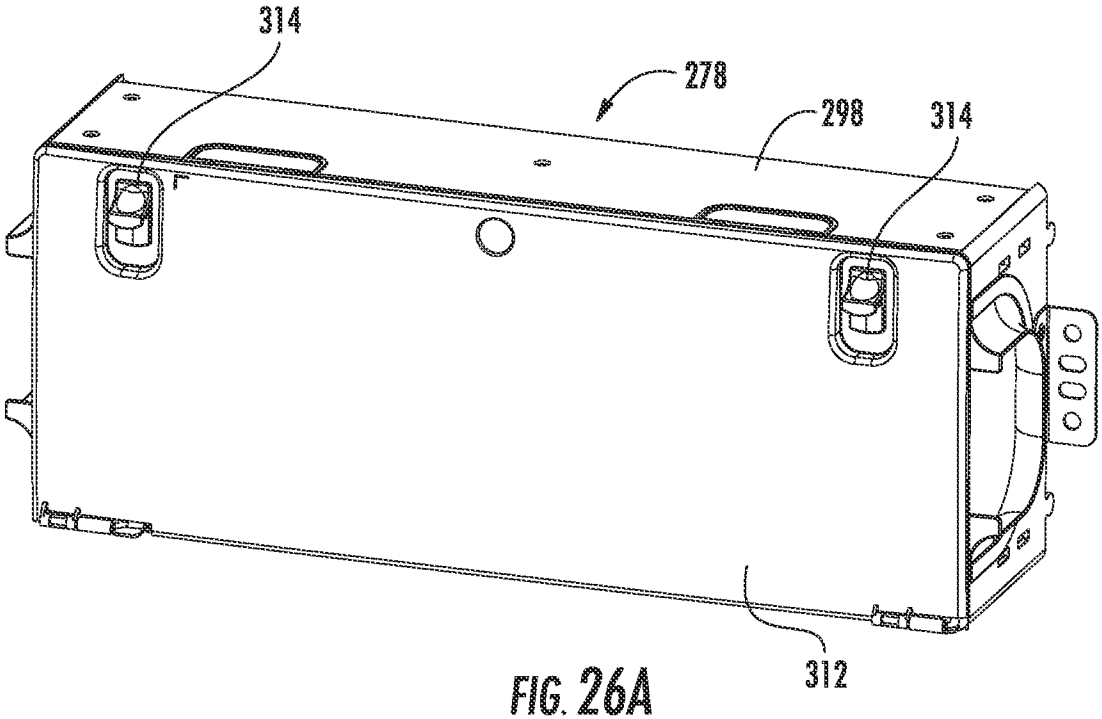

FIG. 26A

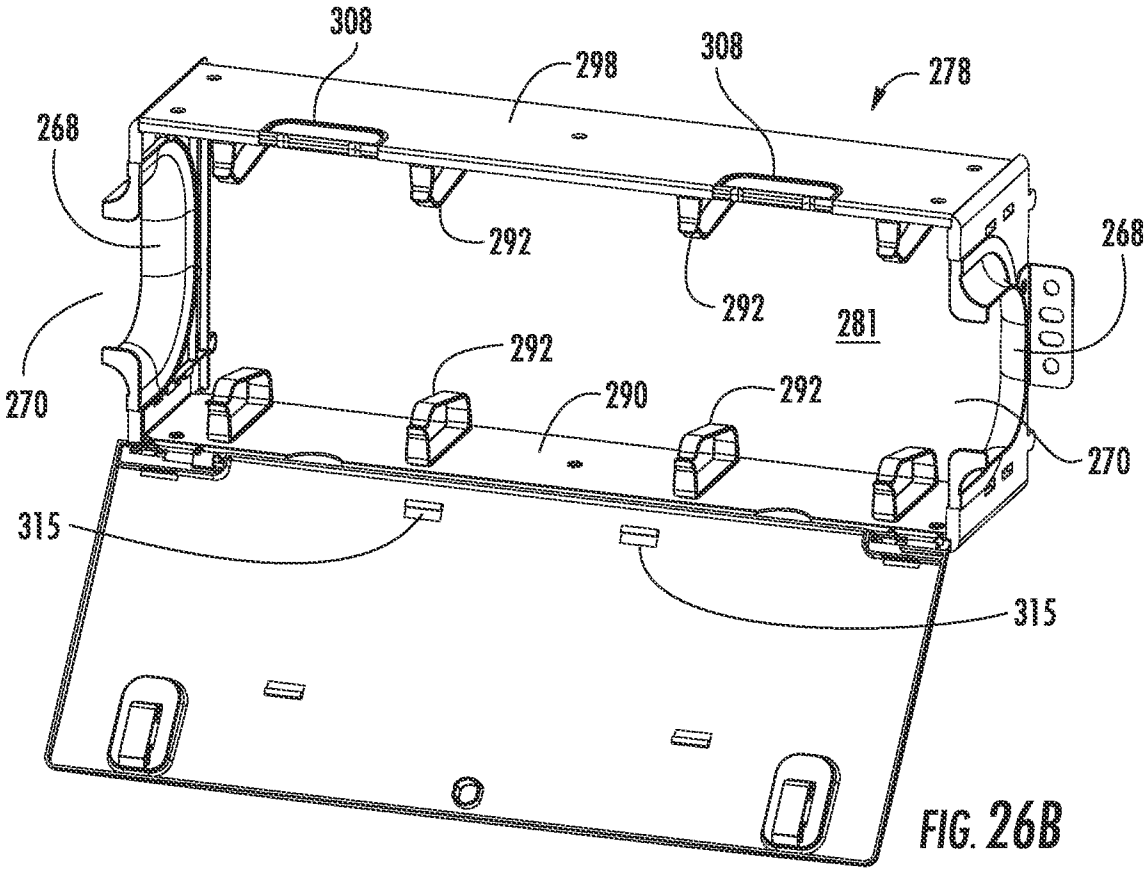

FIG. 26B

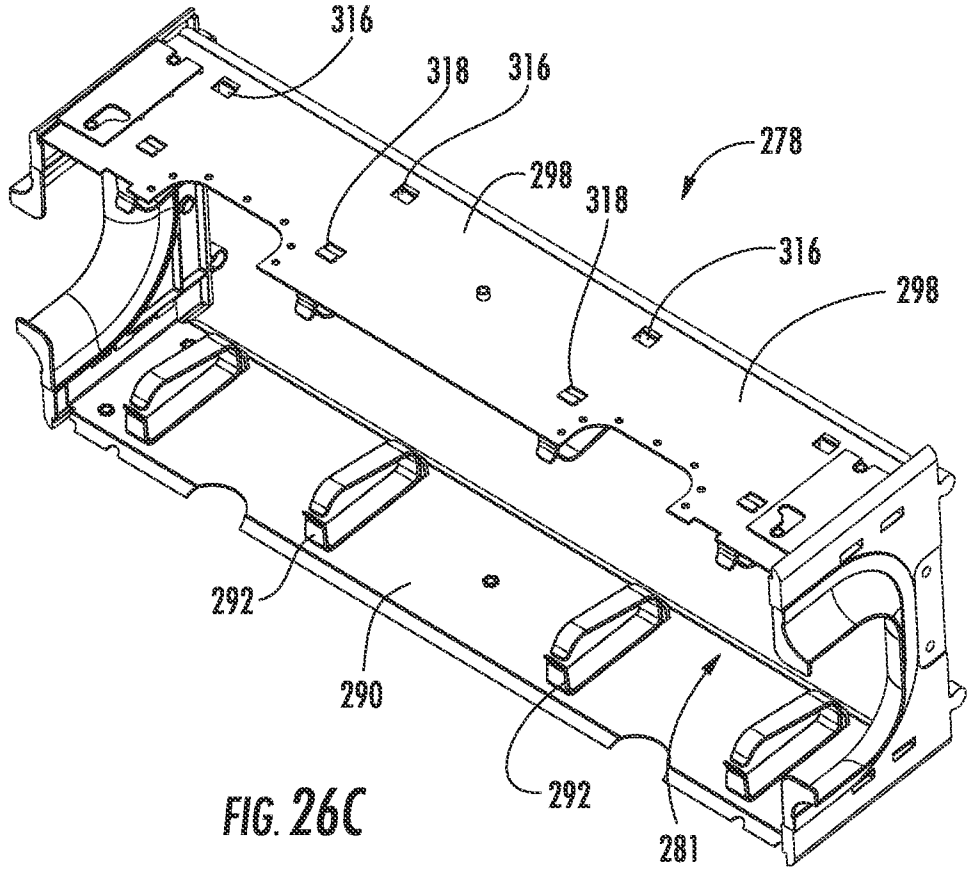

FIG. 26C

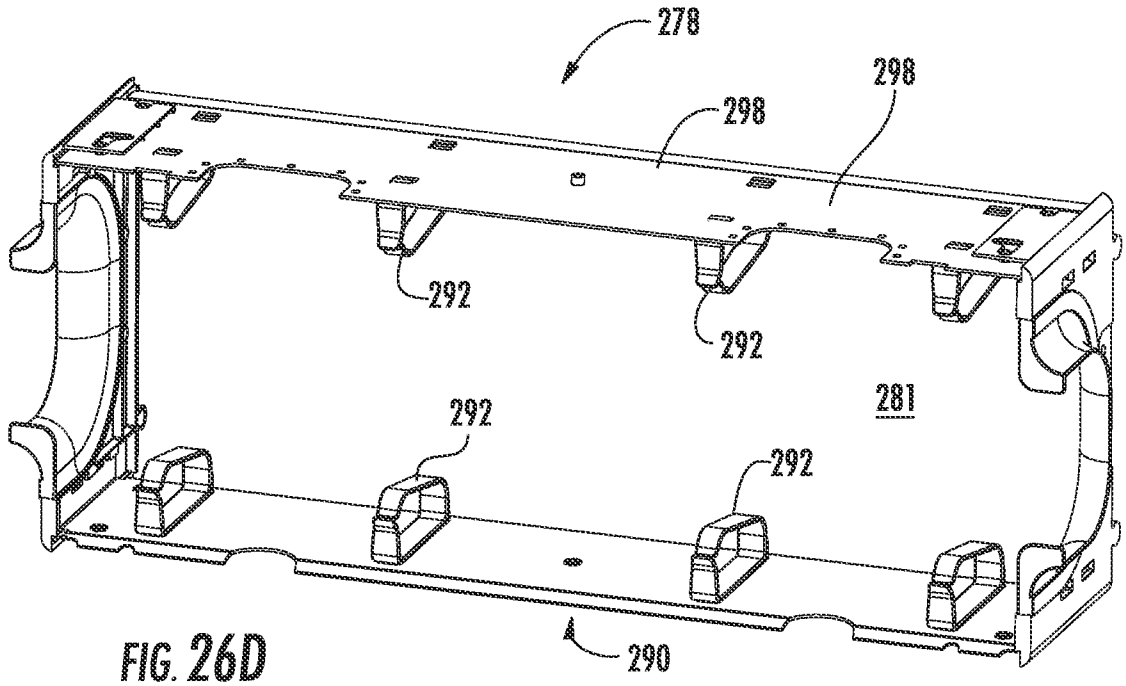

FIG. 26D

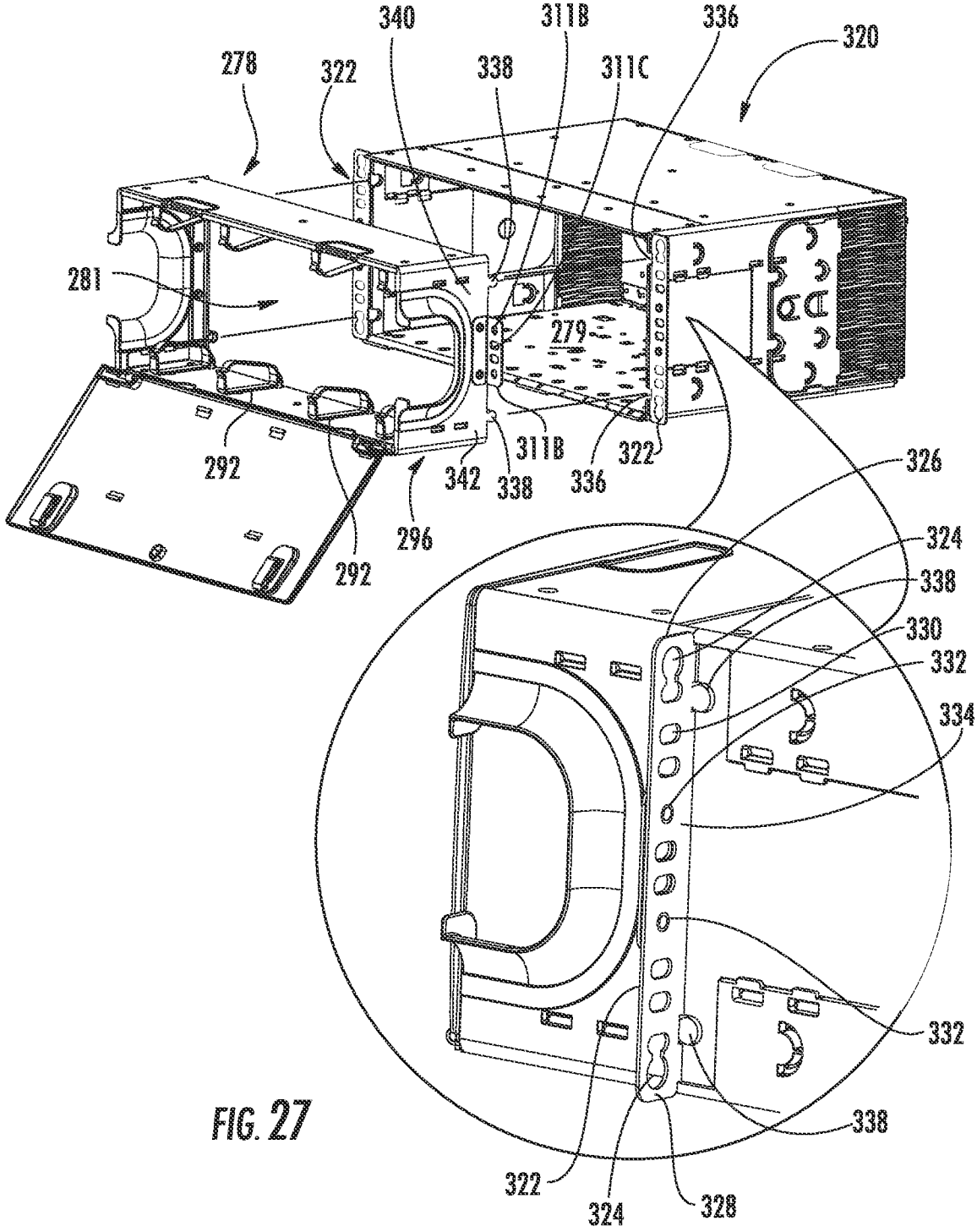
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FIG. 27

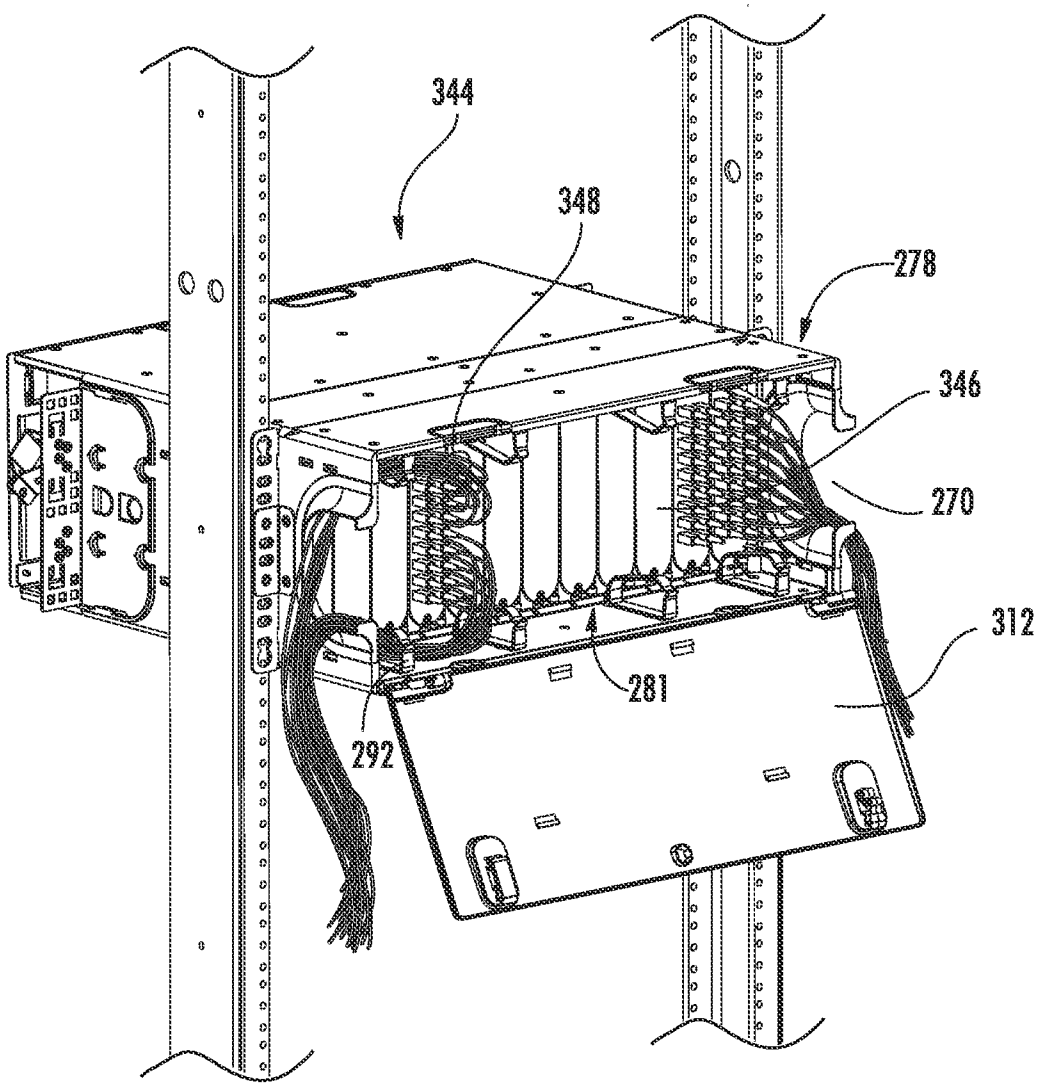

FIG. 28

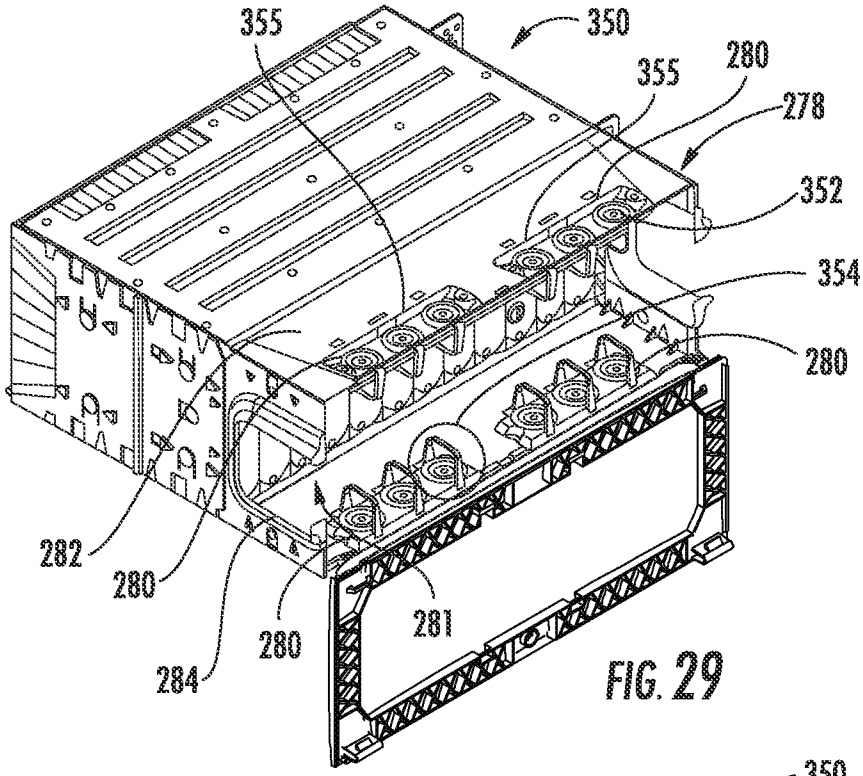
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FIG. 29

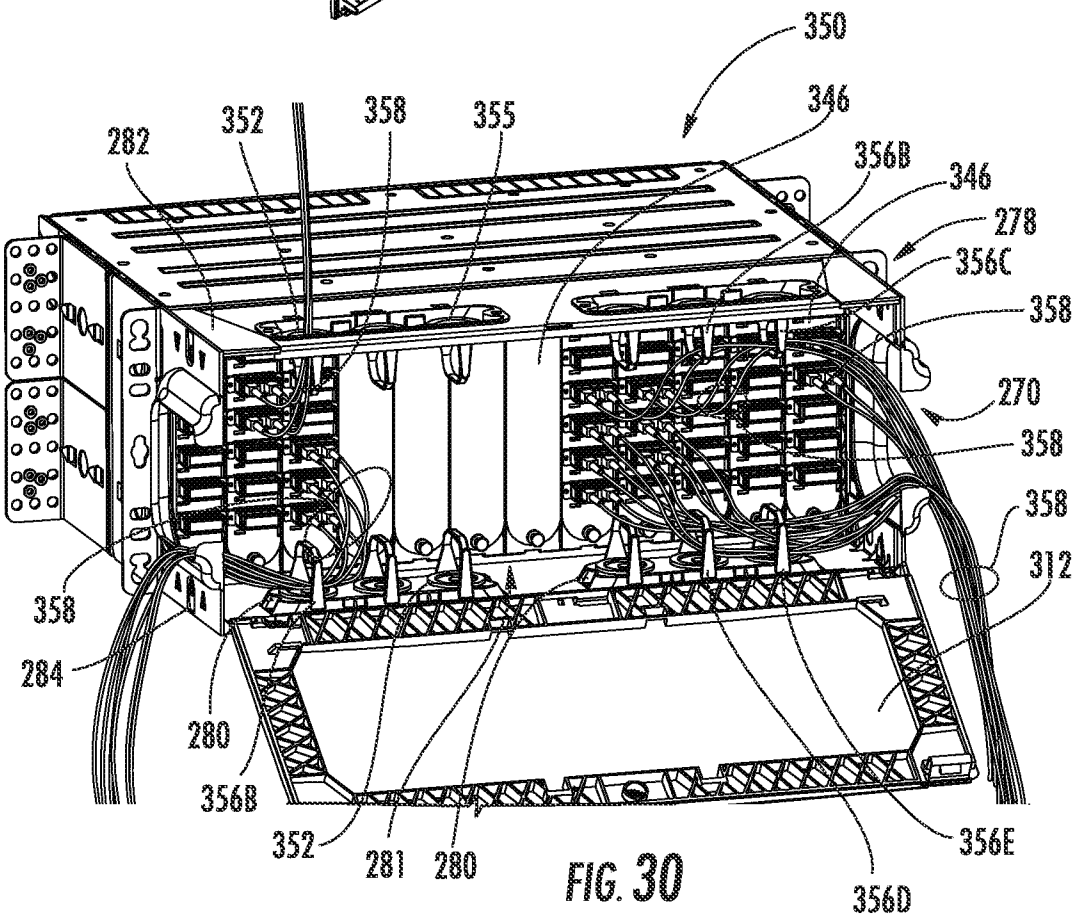
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FIG. 30

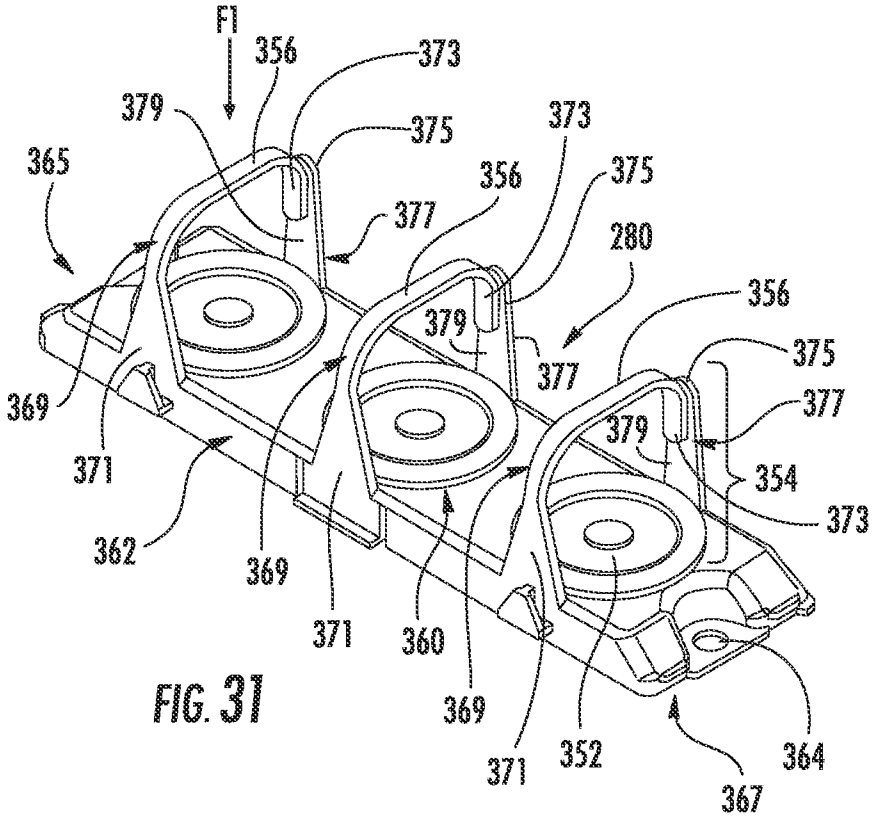
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FIG. 31

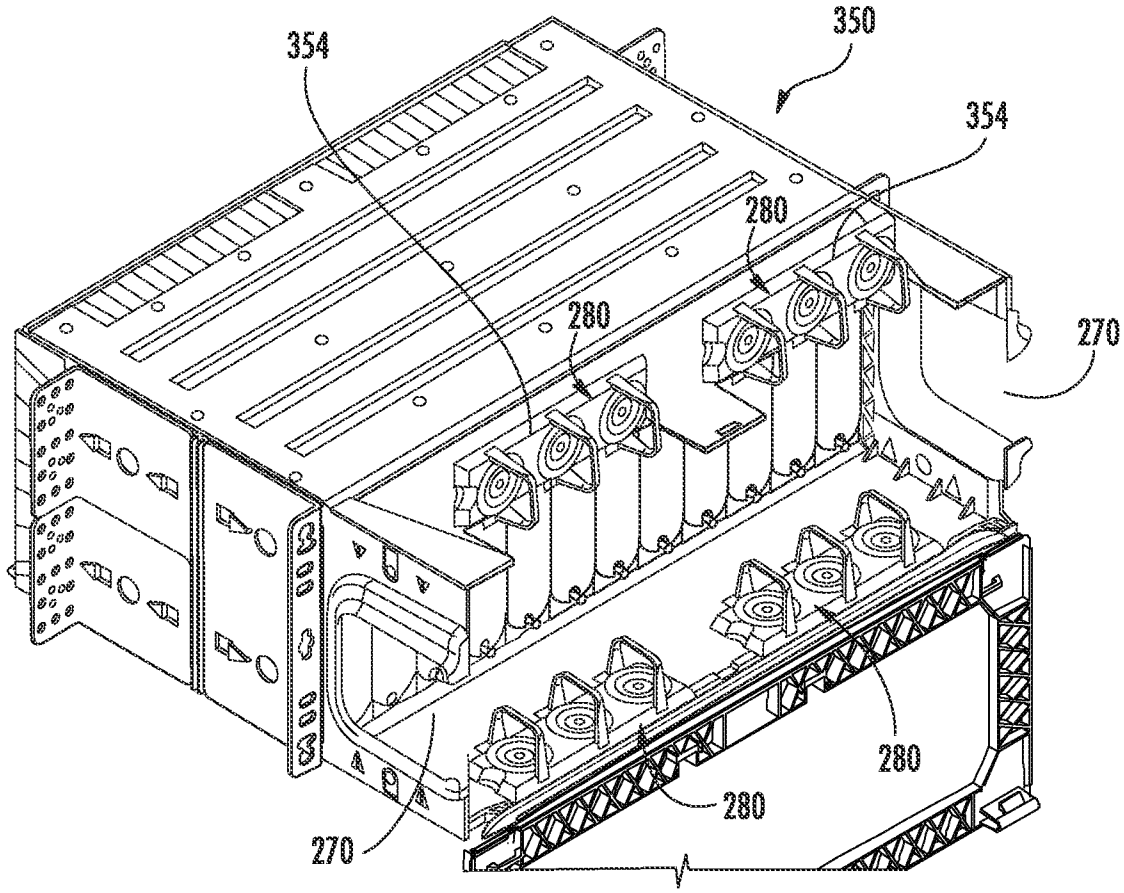

FIG. 32

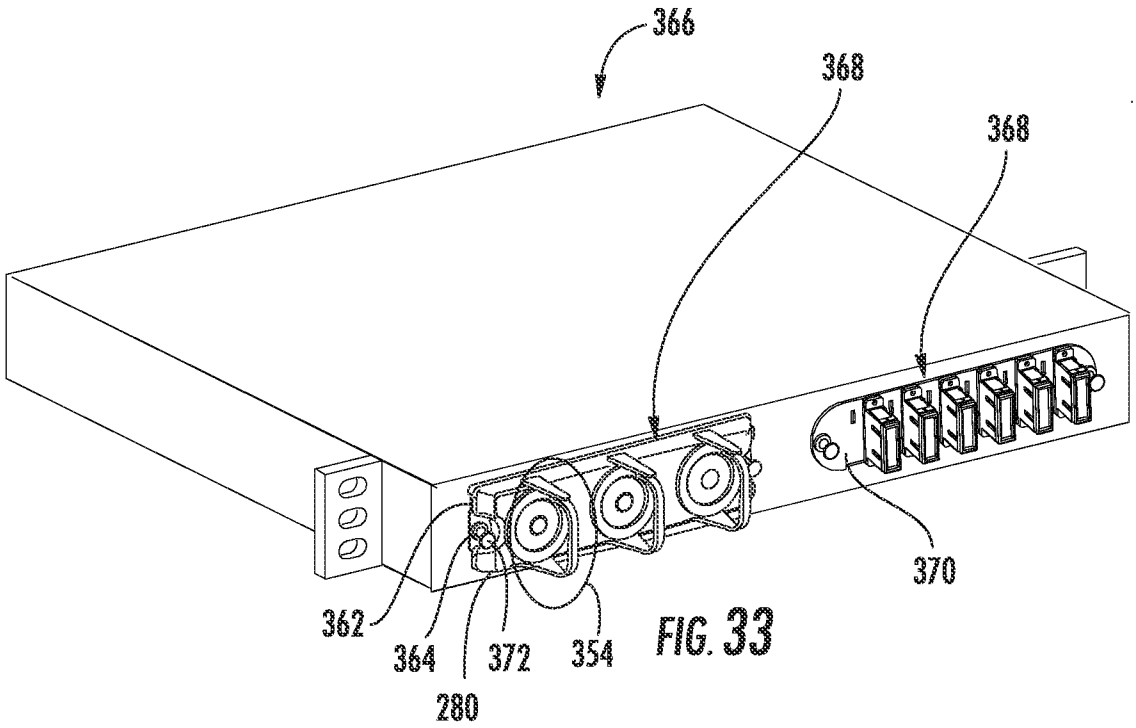

FIG. 33

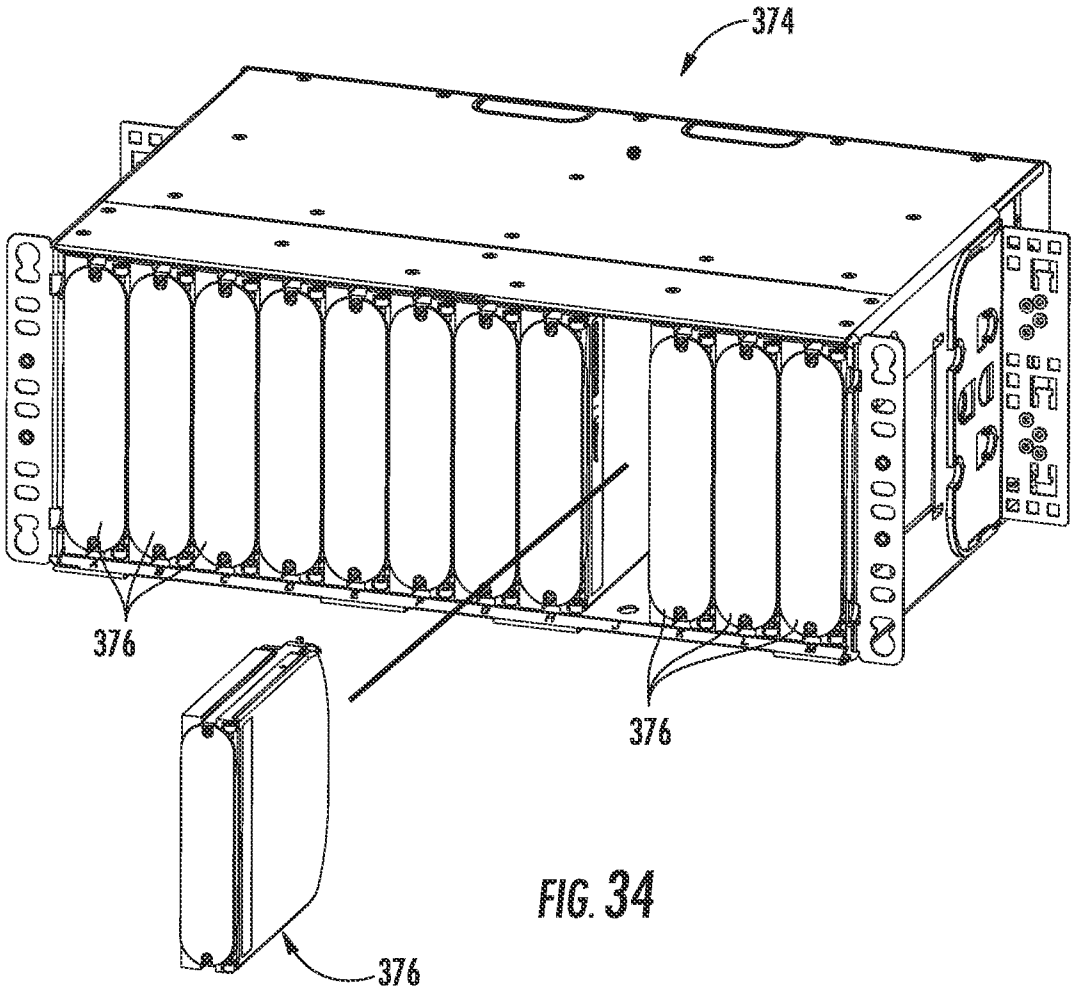

FIG. 34

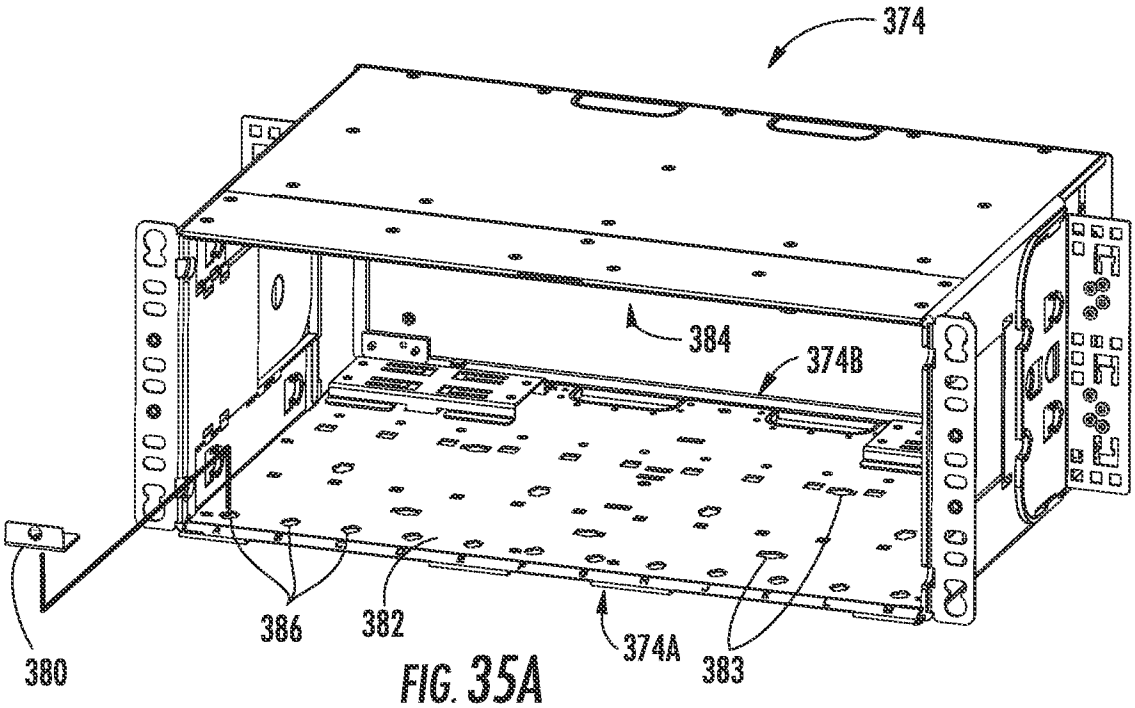

FIG. 35A

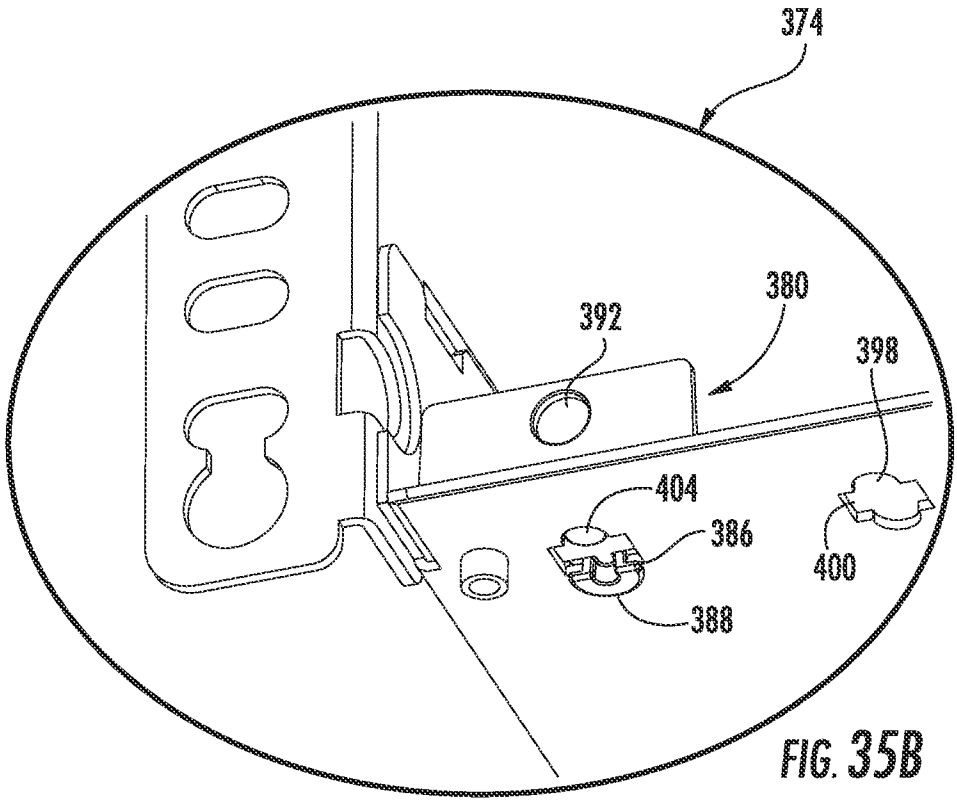

FIG. 35B

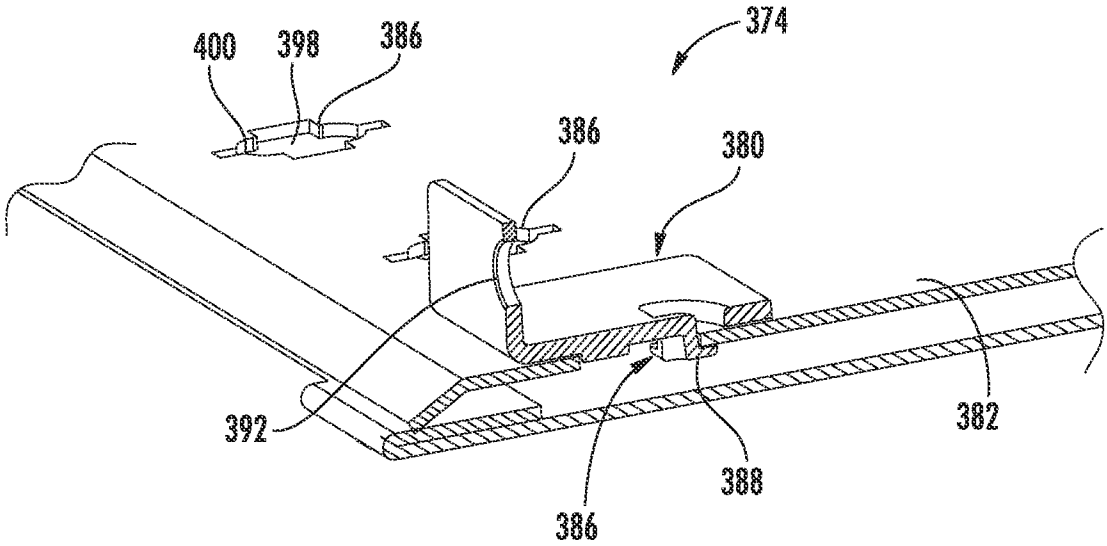

FIG. 35C

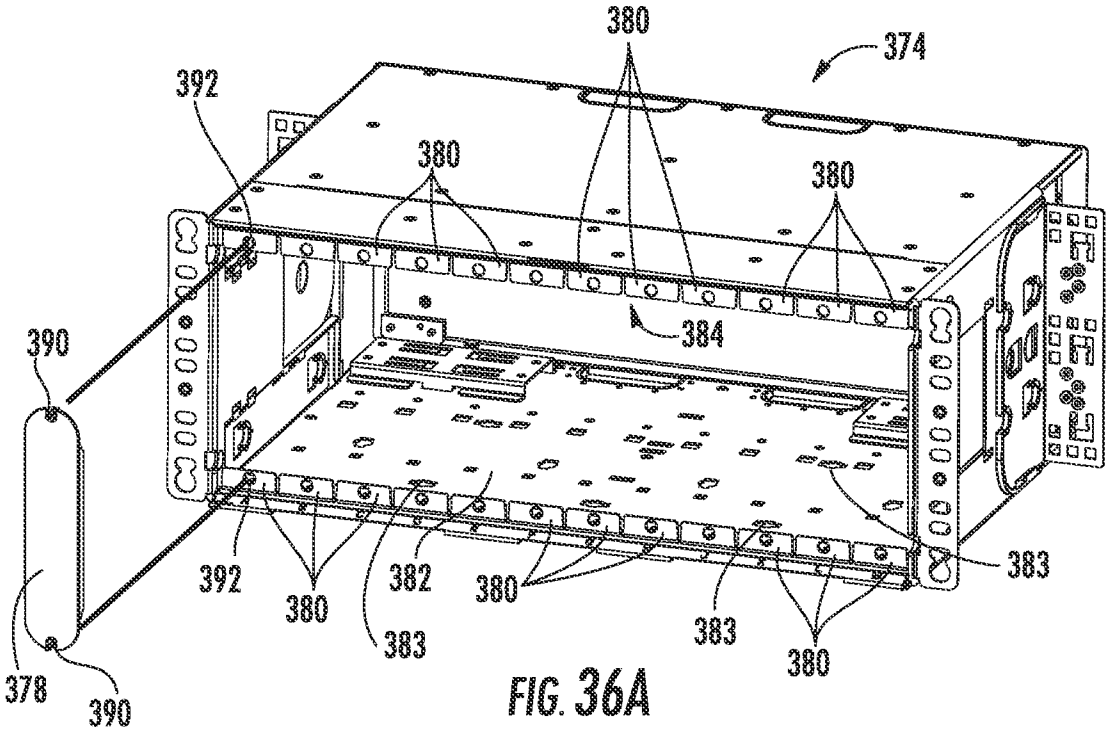

FIG. 36A

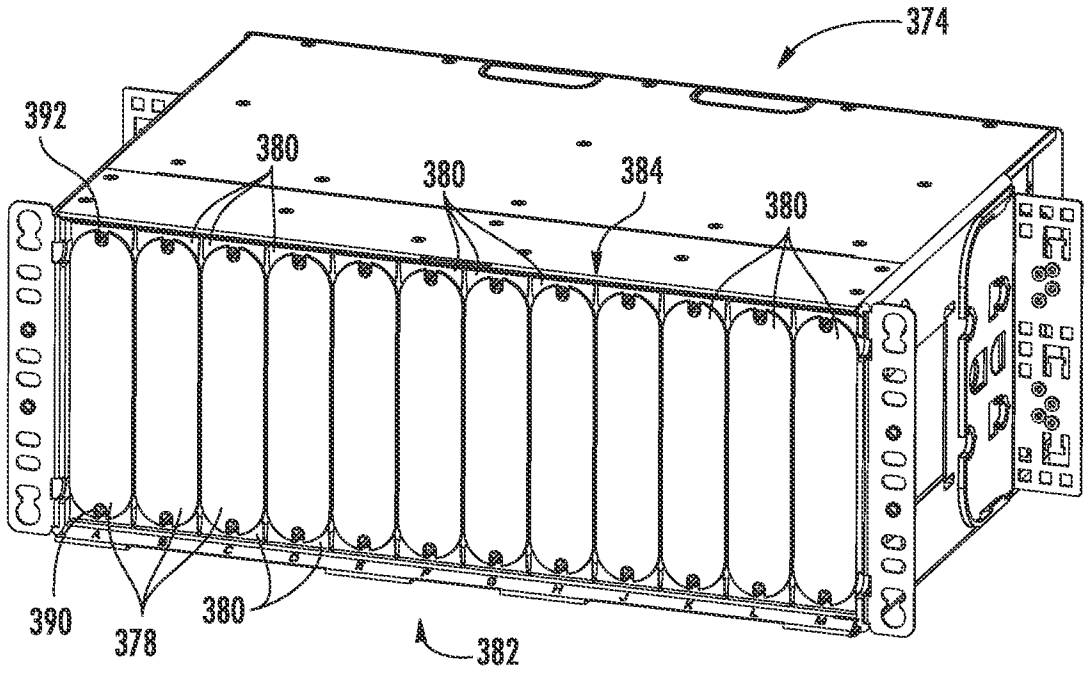

FIG. 36B

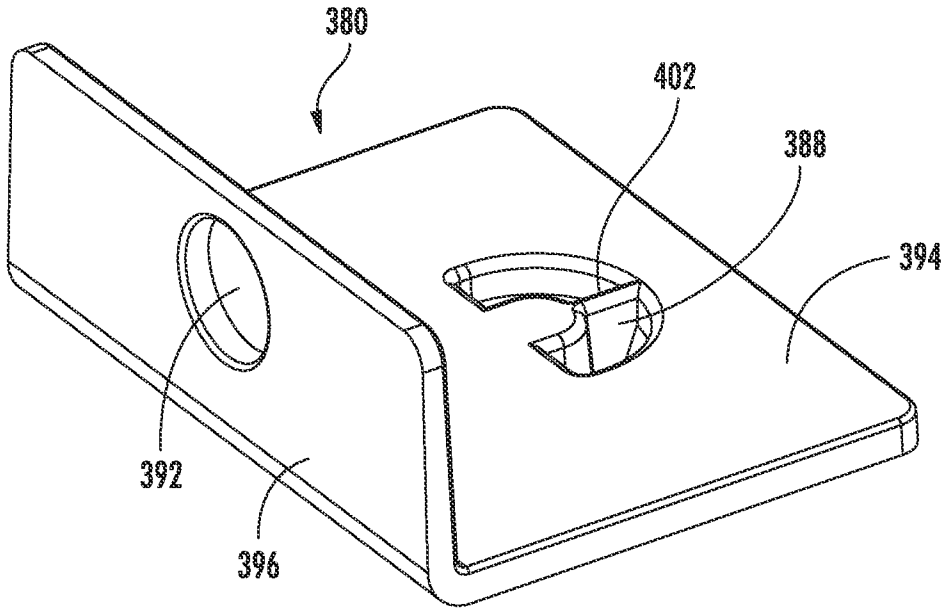

FIG. 37A

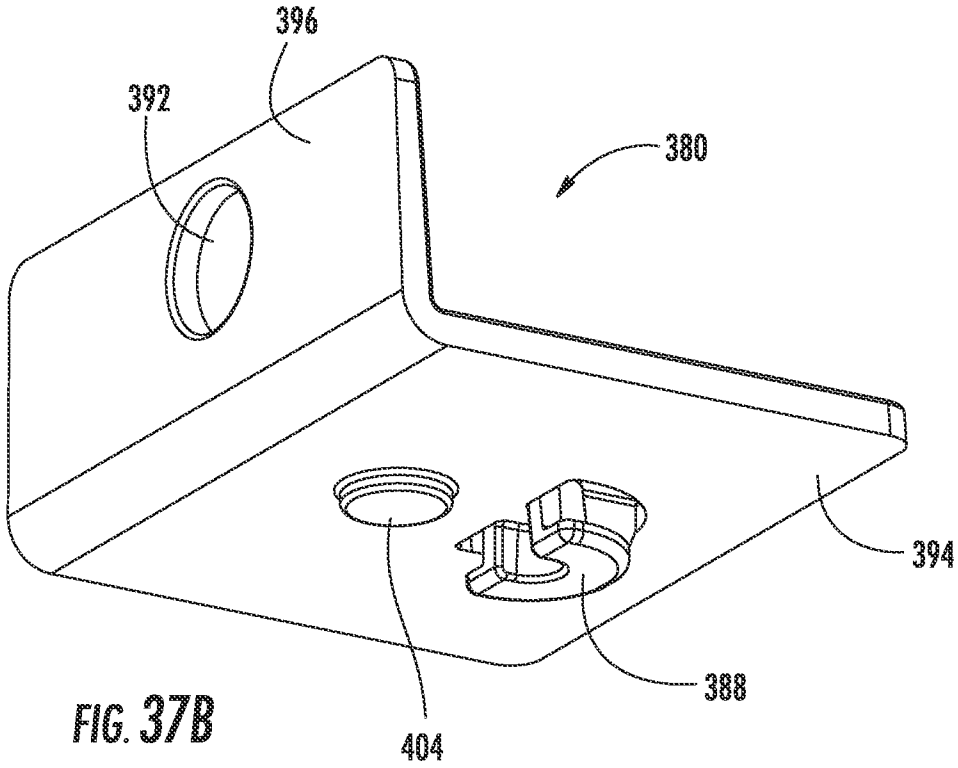

FIG. 37B

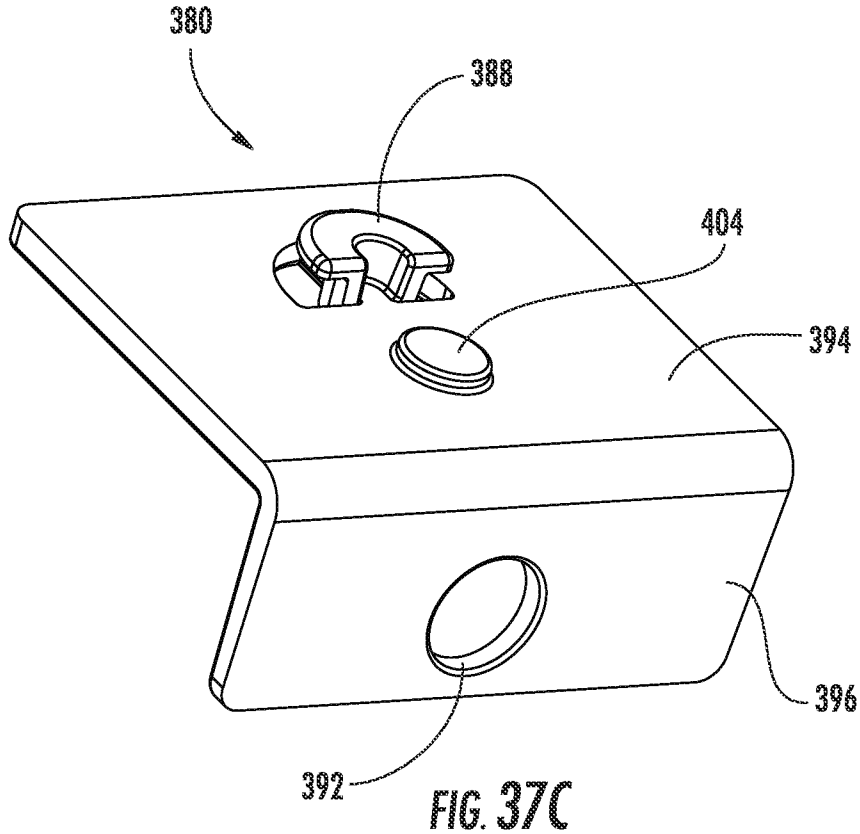

FIG. 37C

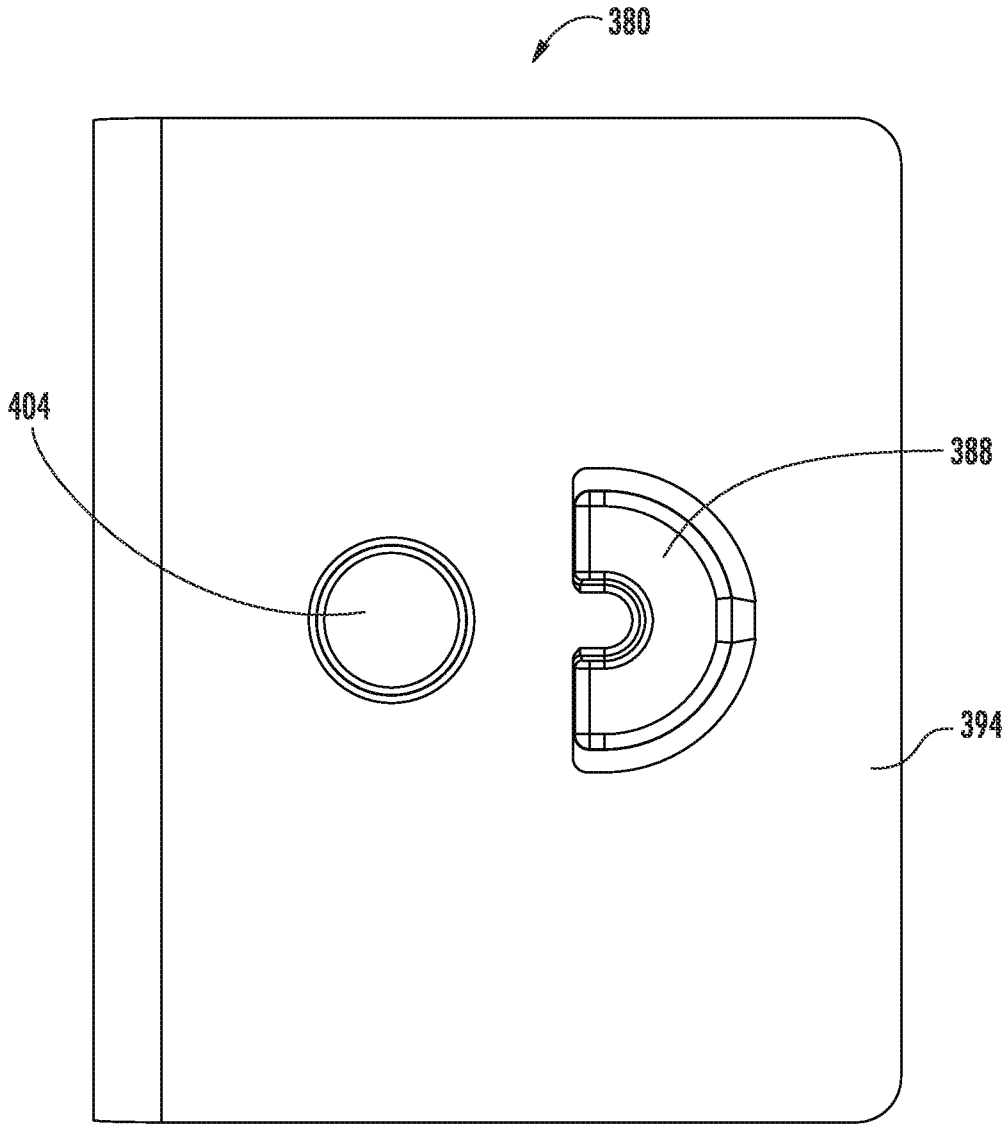

FIG. 37D

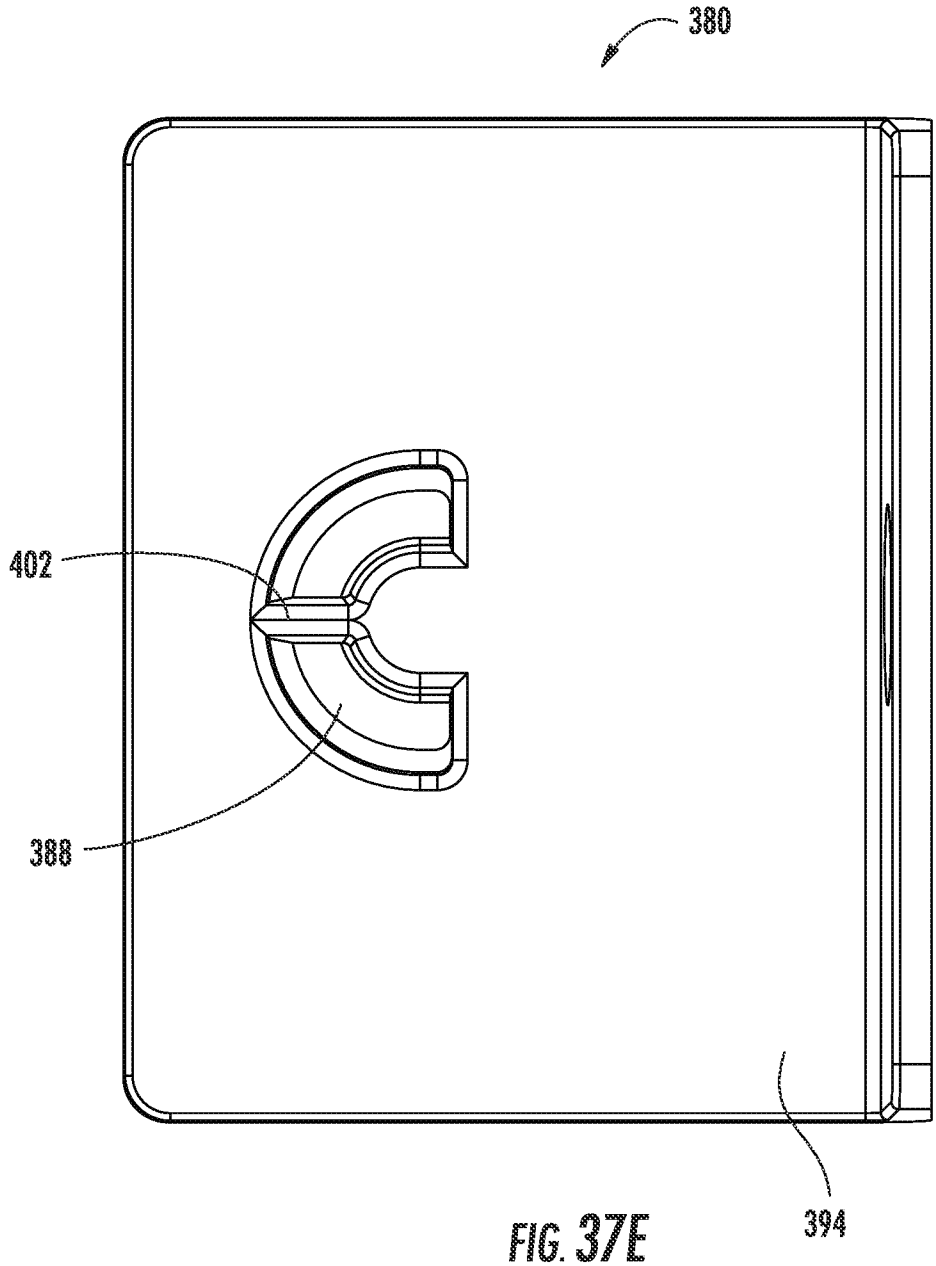

FIG. 37E

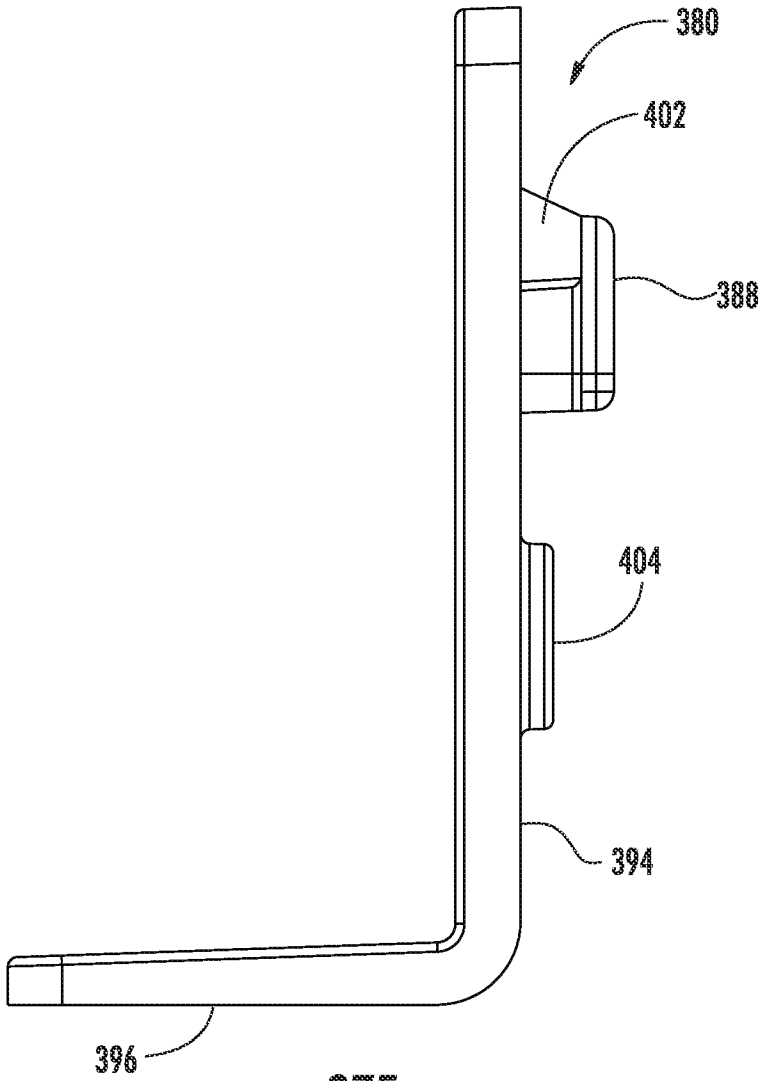

FIG. 37F

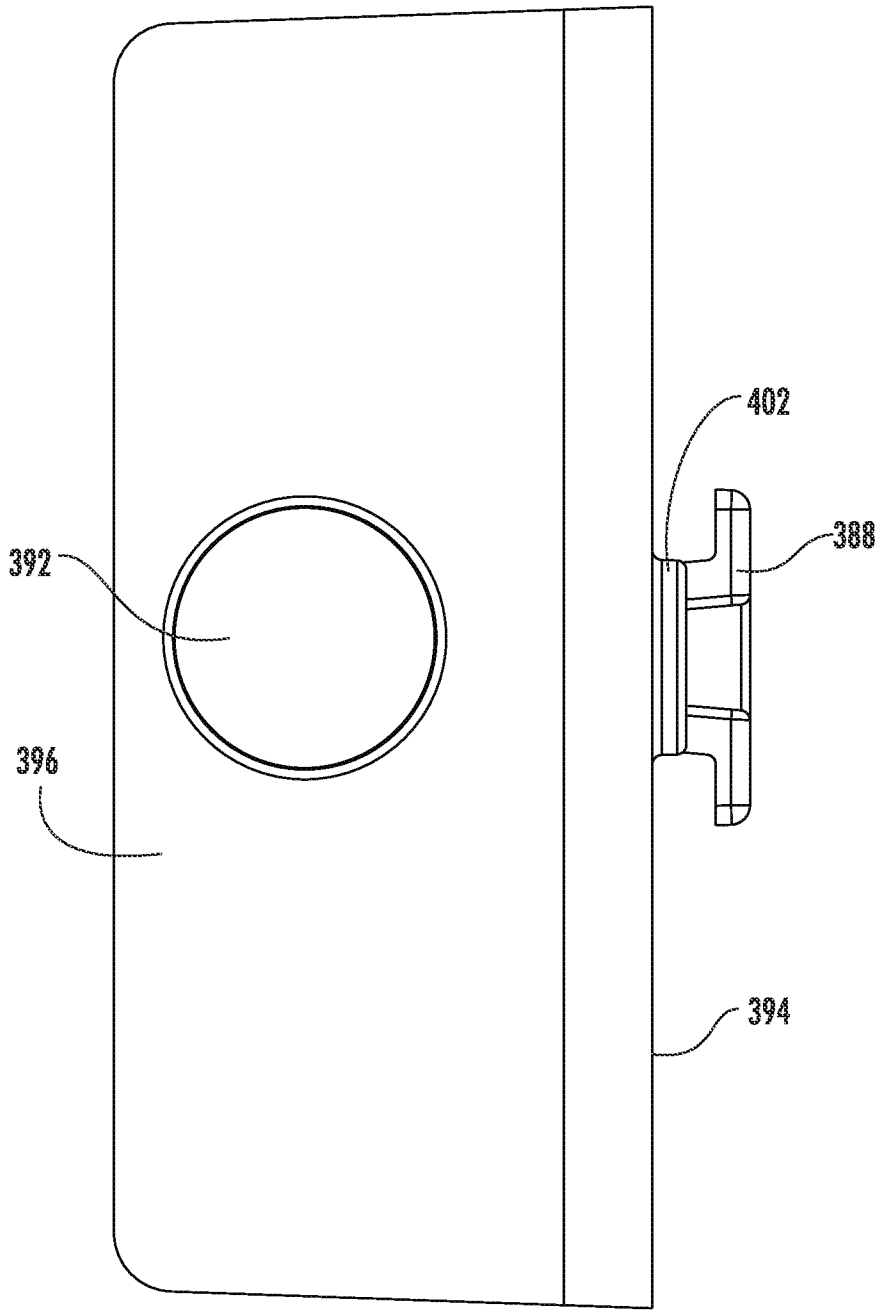

FIG. 37G

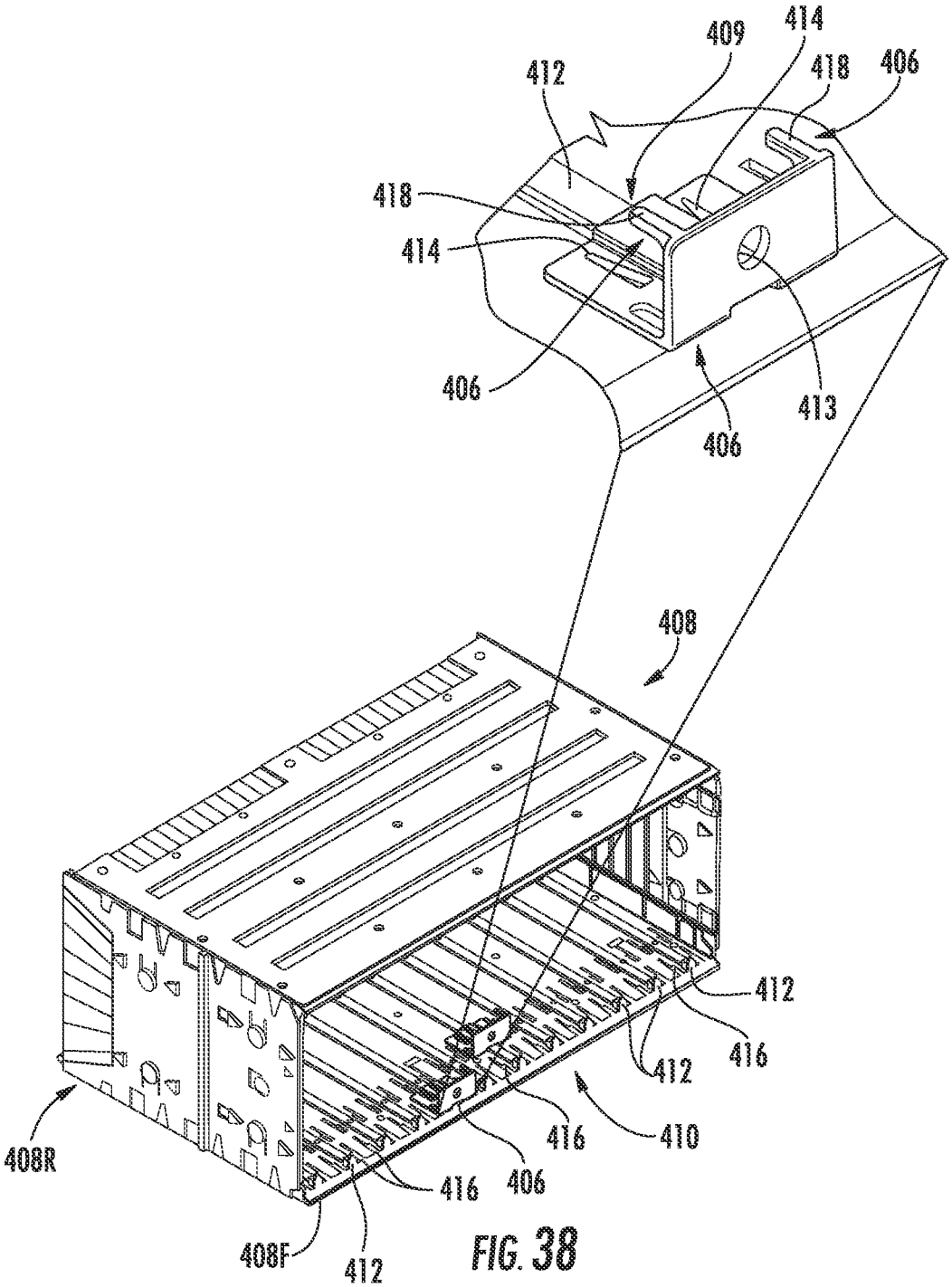
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FIG. 38

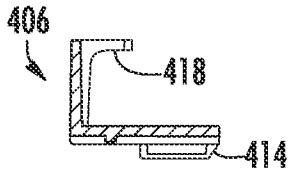

FIG. 39A

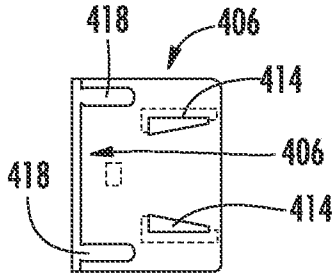

FIG. 39B

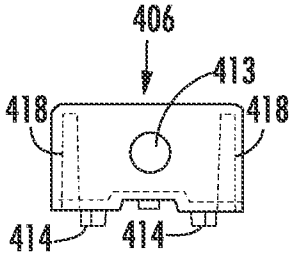

FIG. 39C

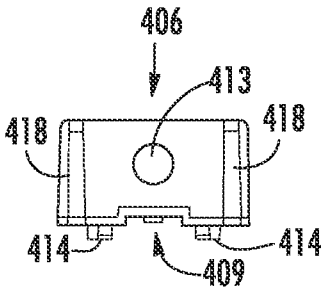

FIG. 39D

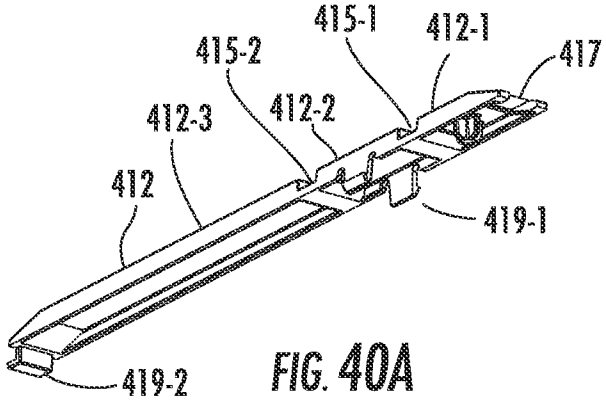

FIG. 40A

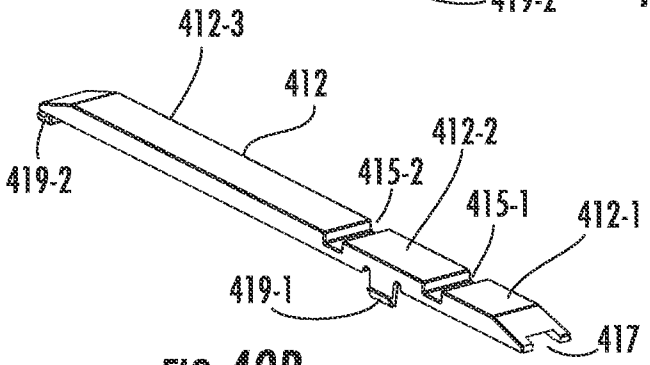

FIG. 40B

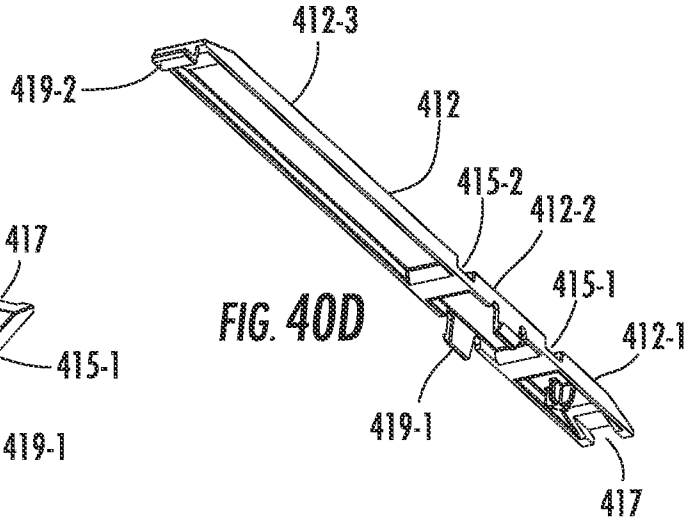

FIG. 40D

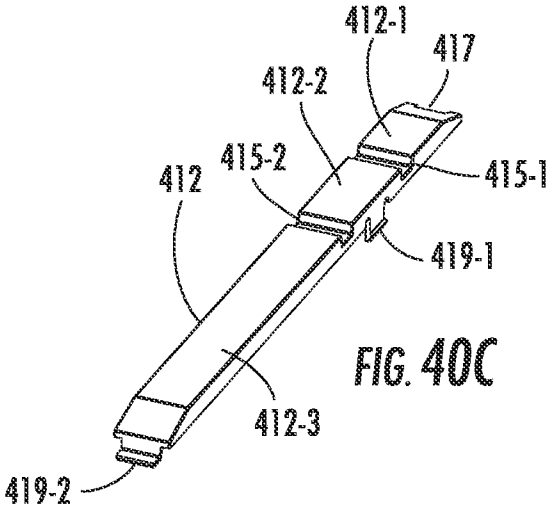

FIG. 40C

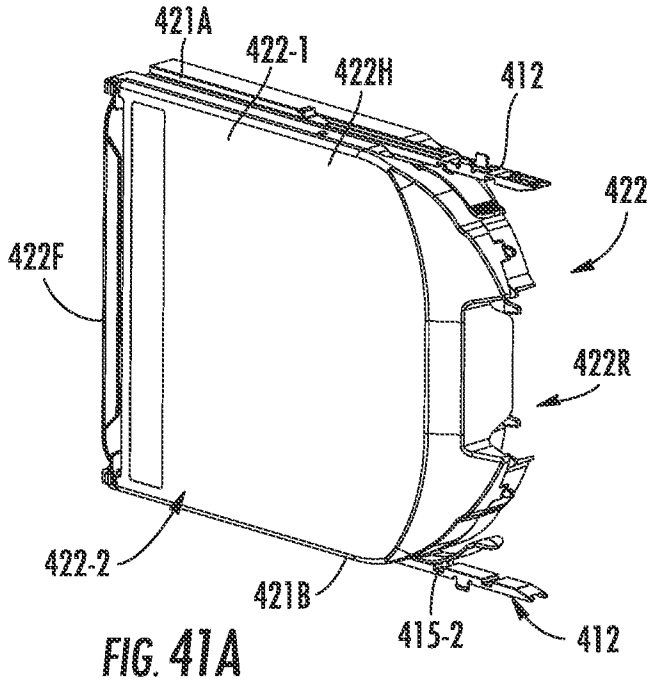

FIG. 41A

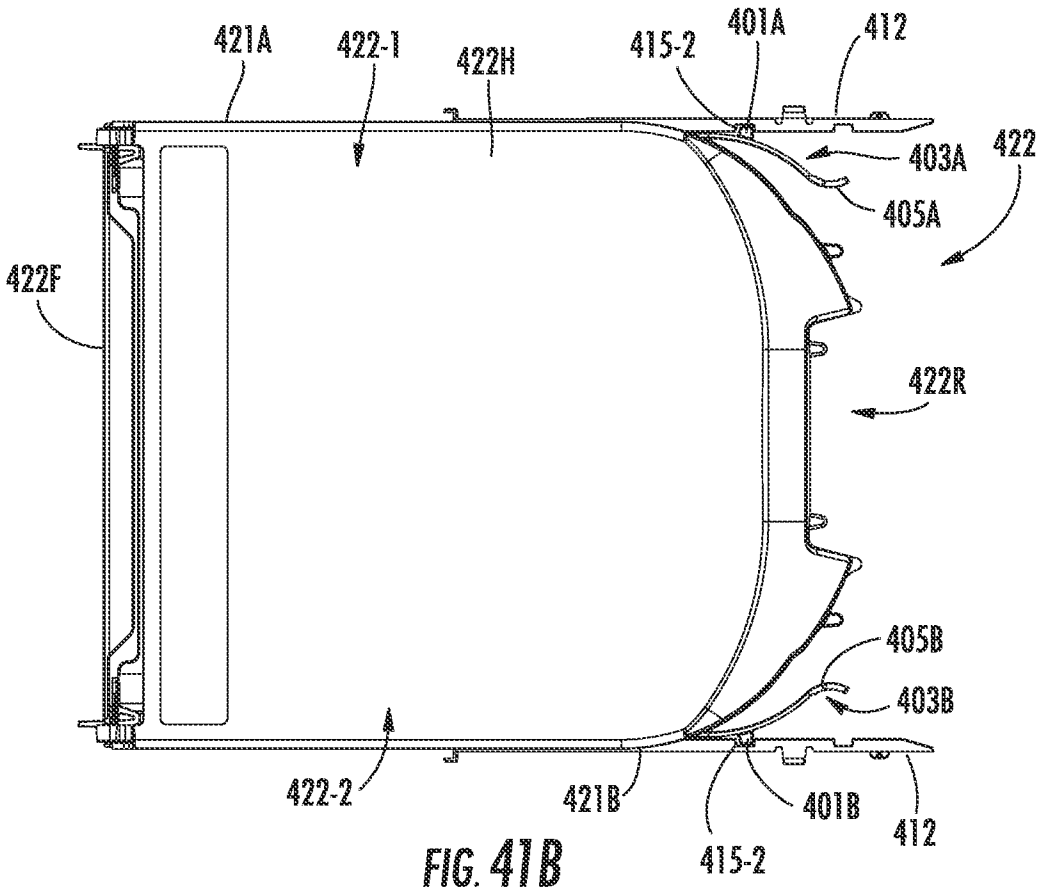

FIG. 41B

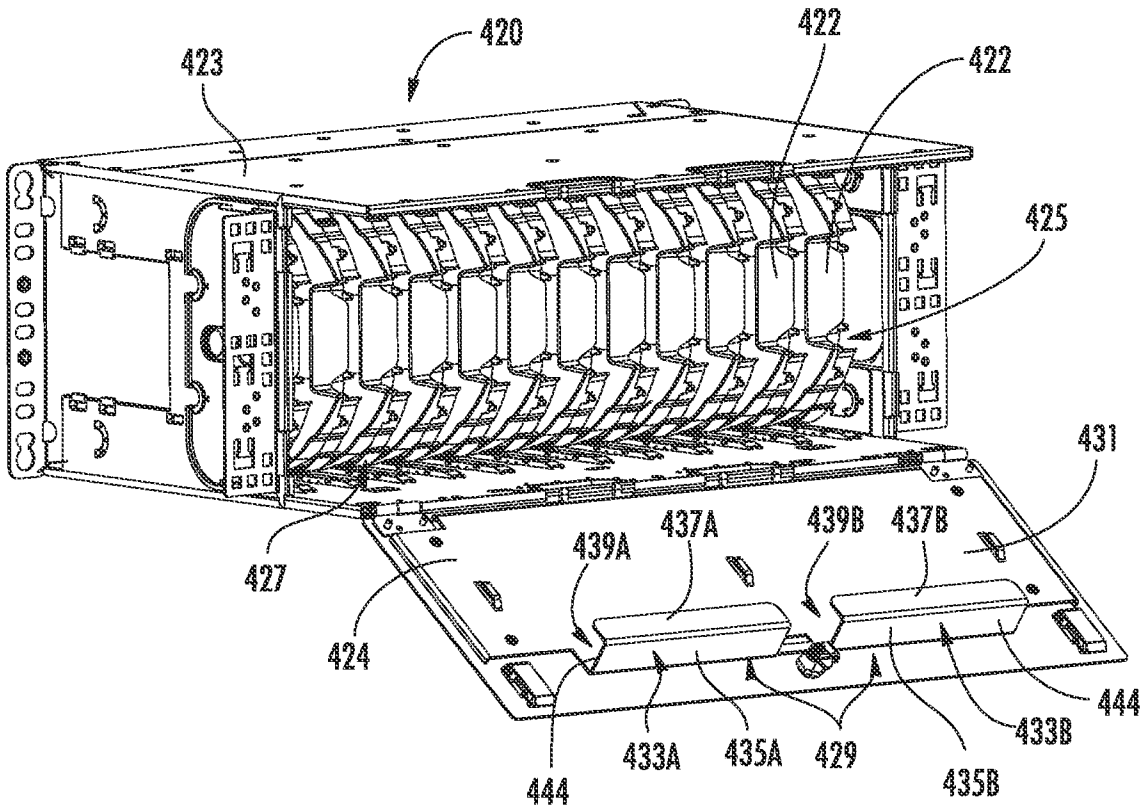
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FIG. 42

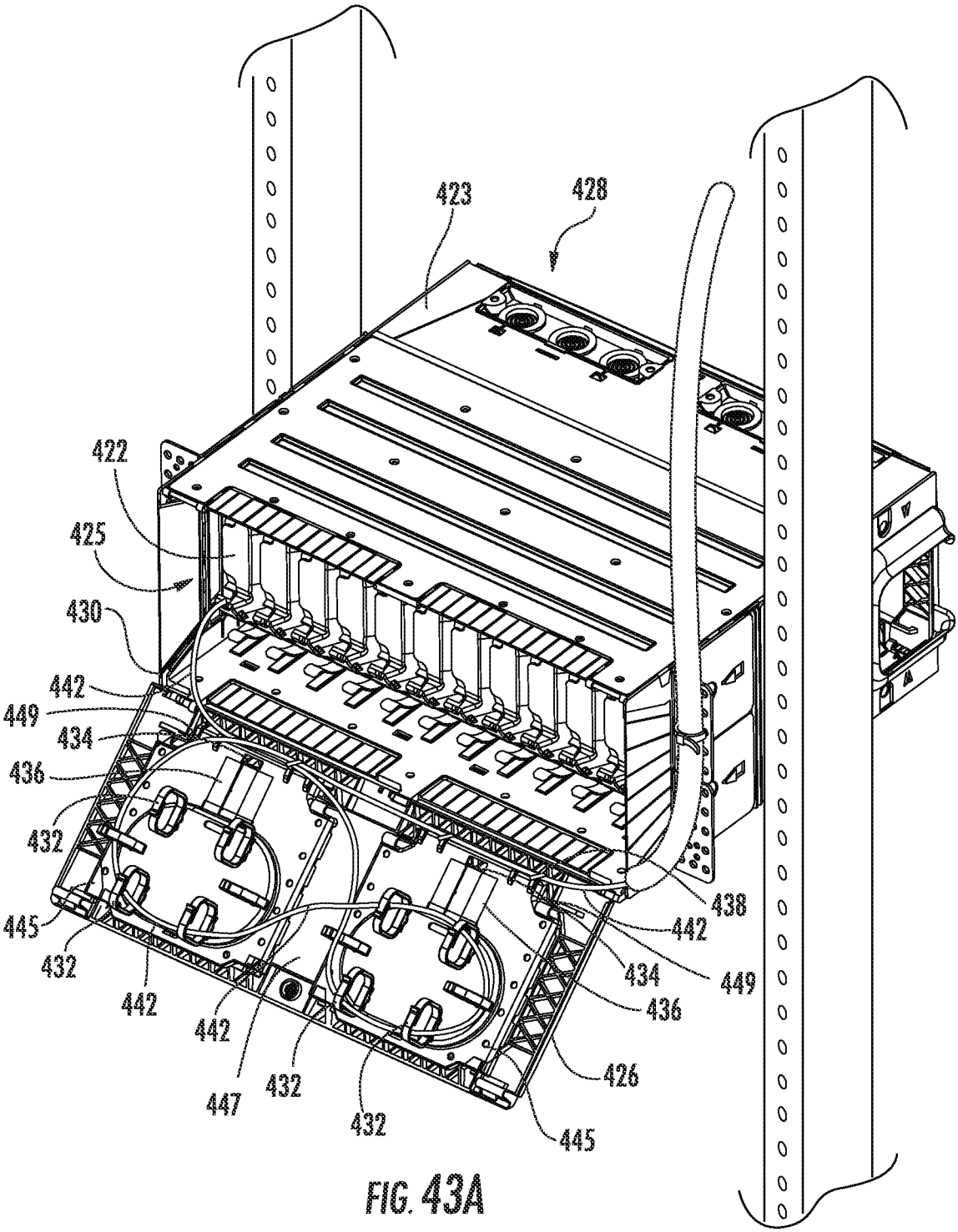
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FIG. 43A

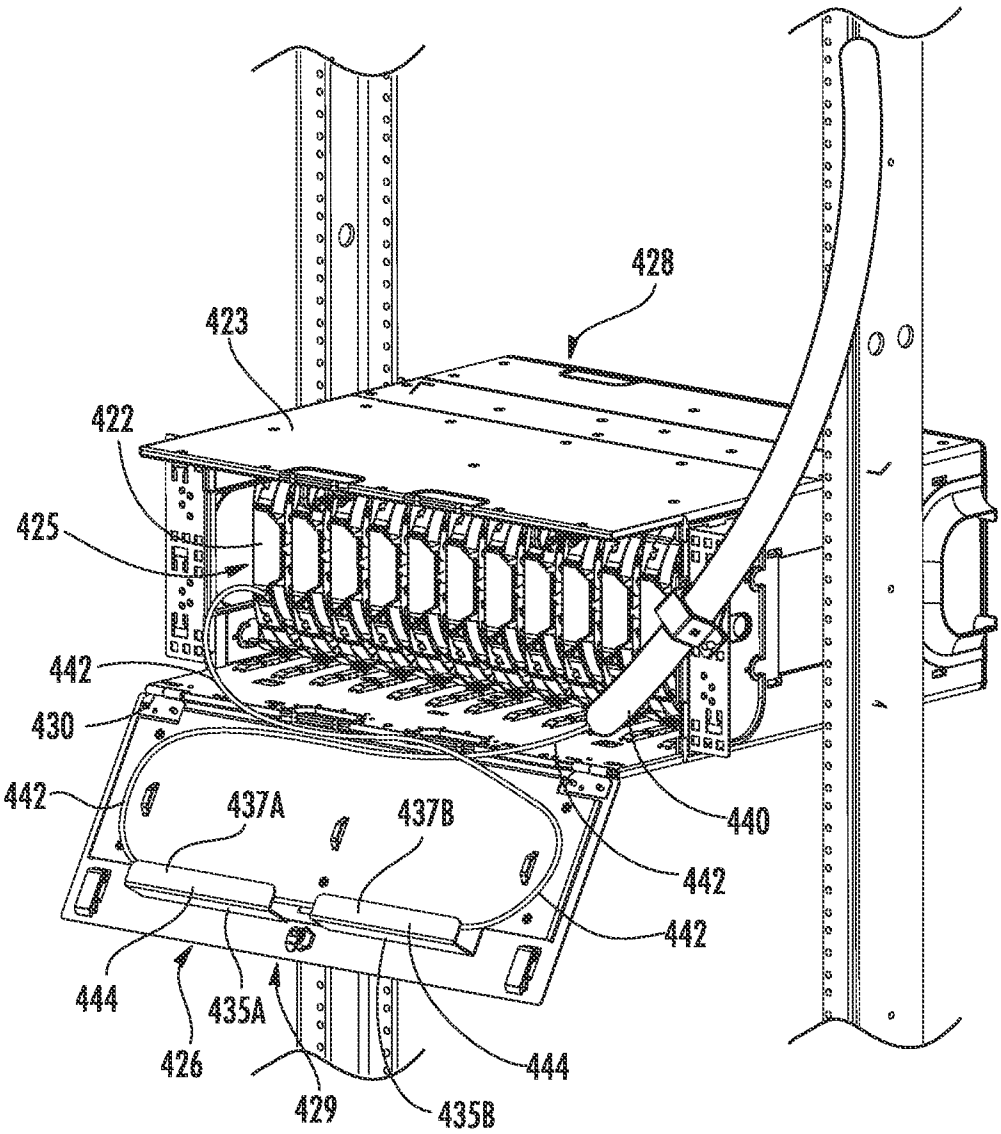
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FIG. 43B

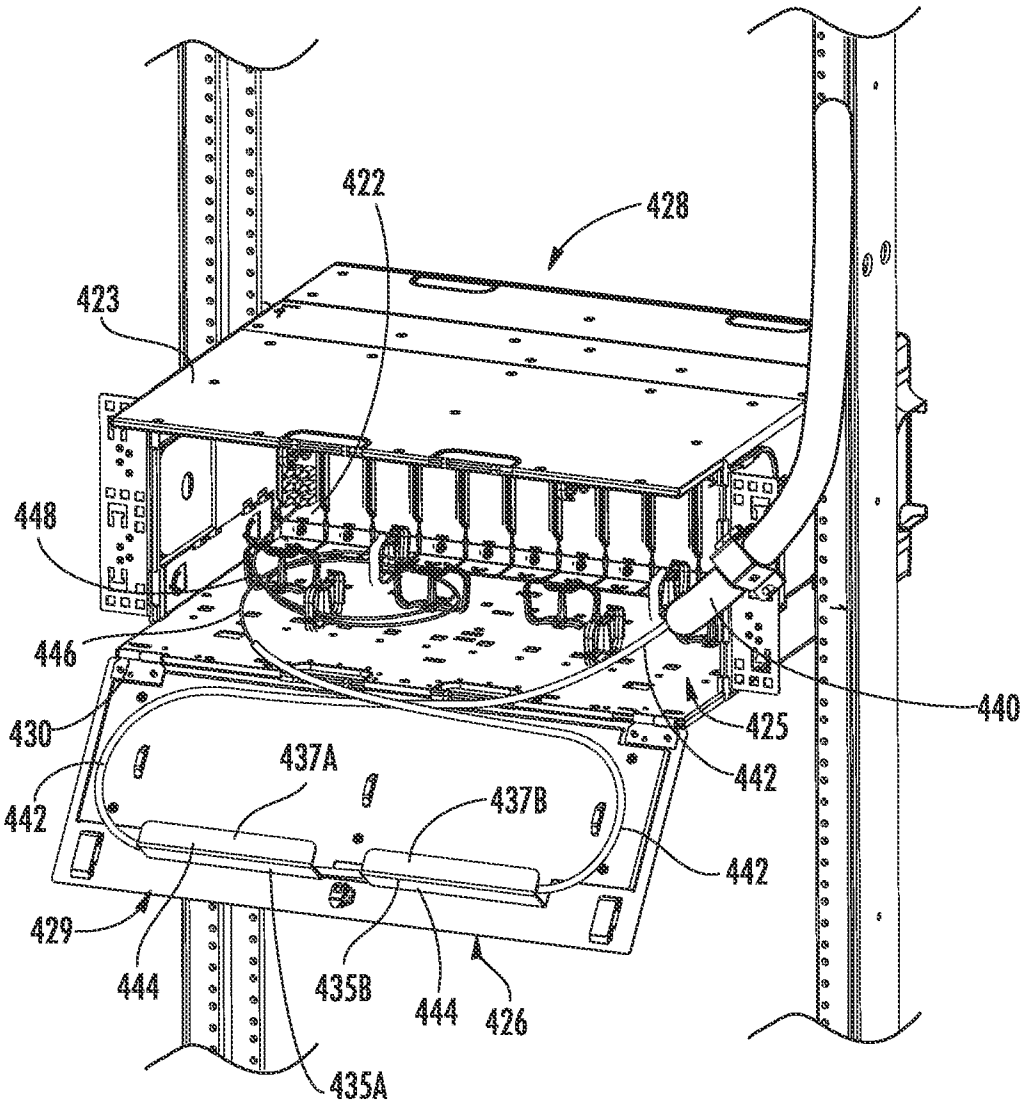
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FIG. 43C

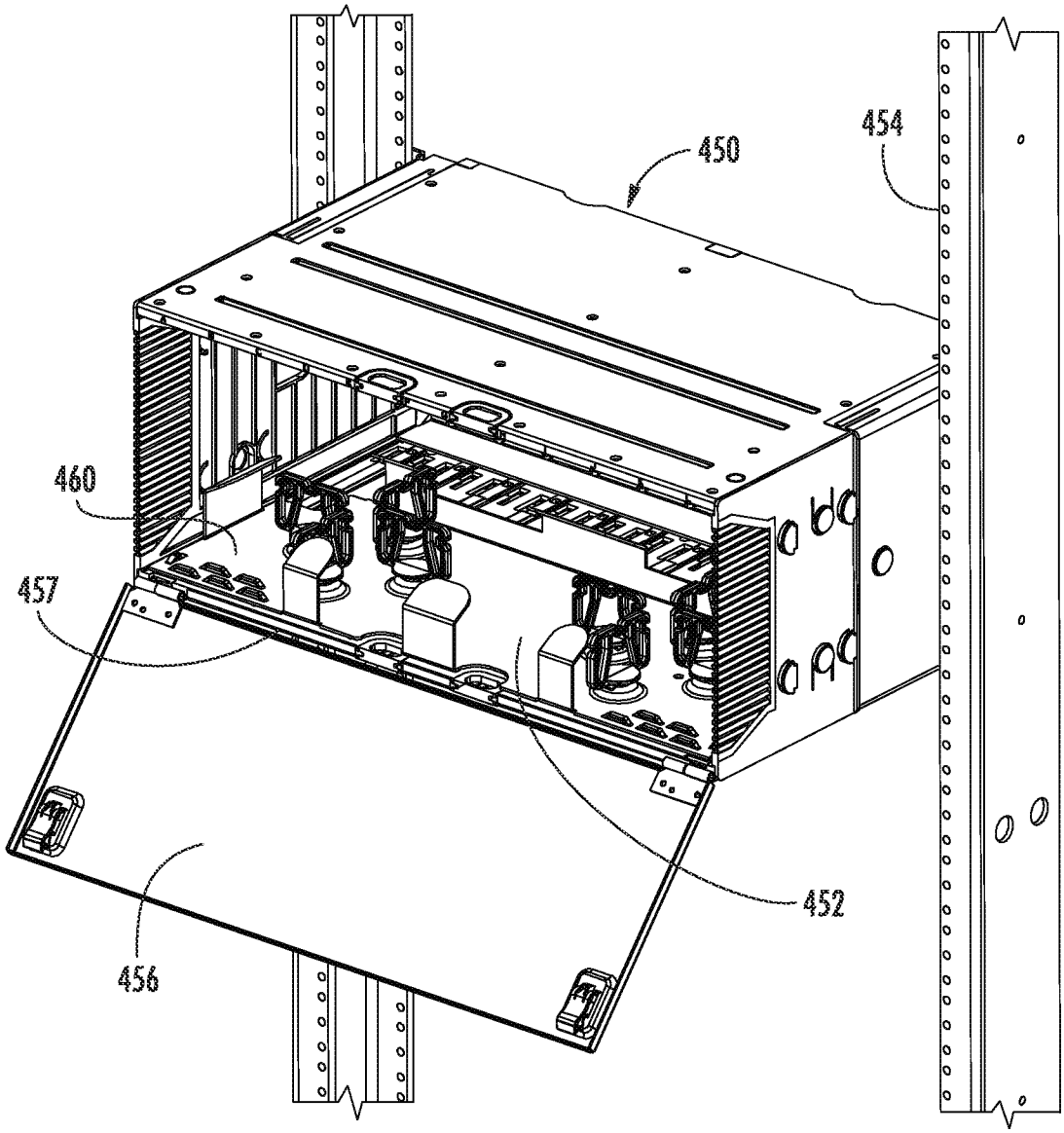

FIG. 44

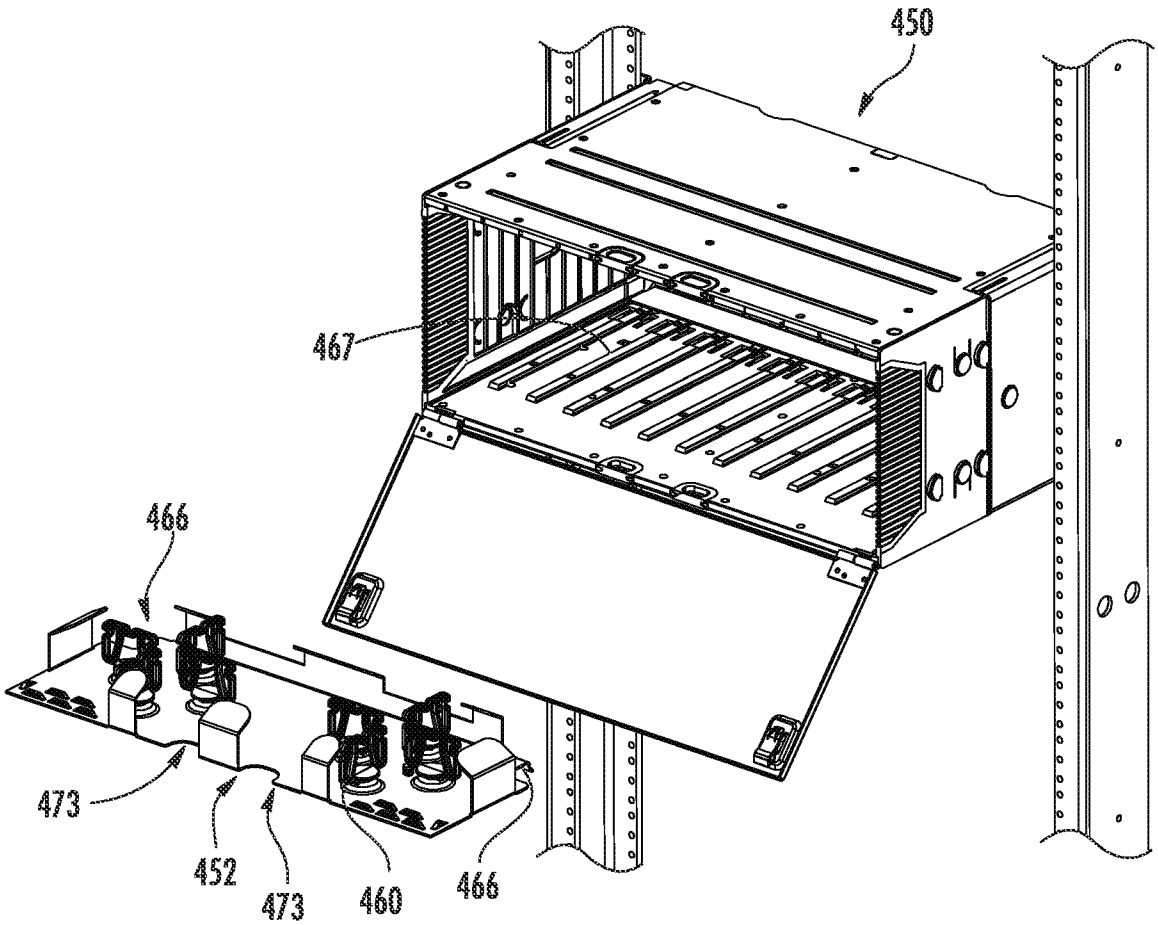

FIG. 45

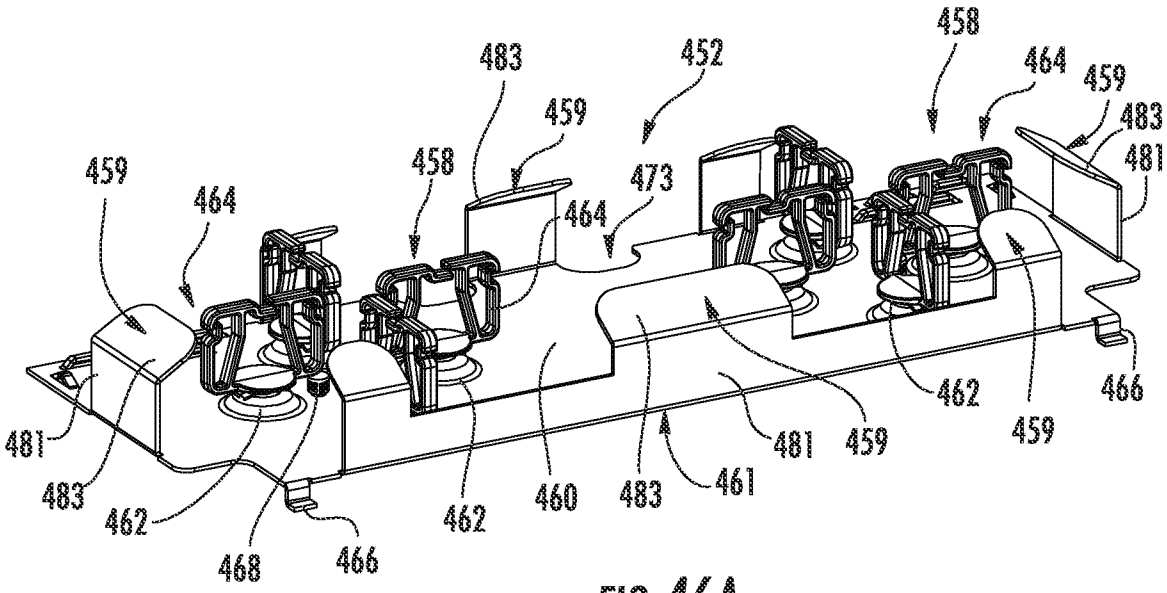

FIG. 46A

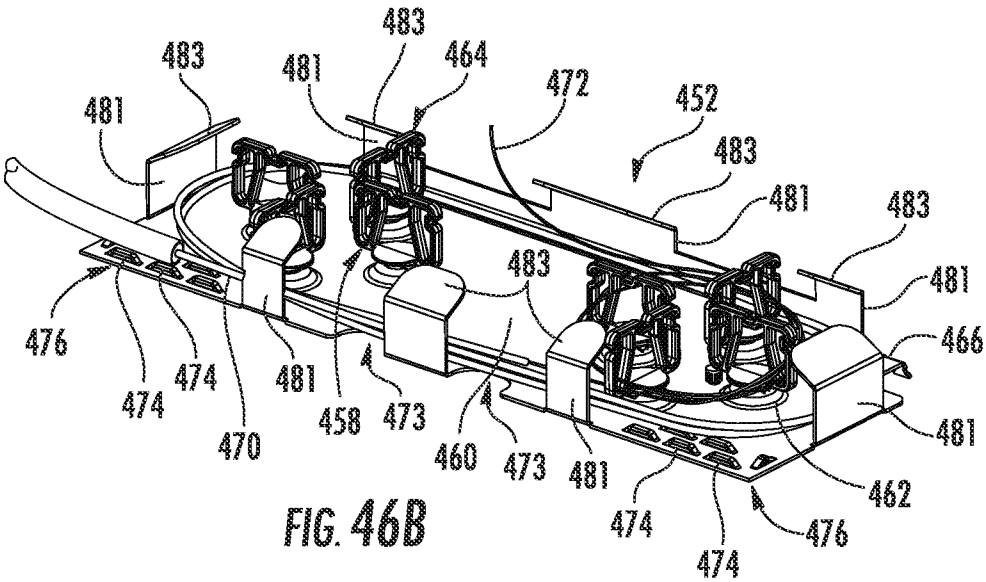

FIG. 46B

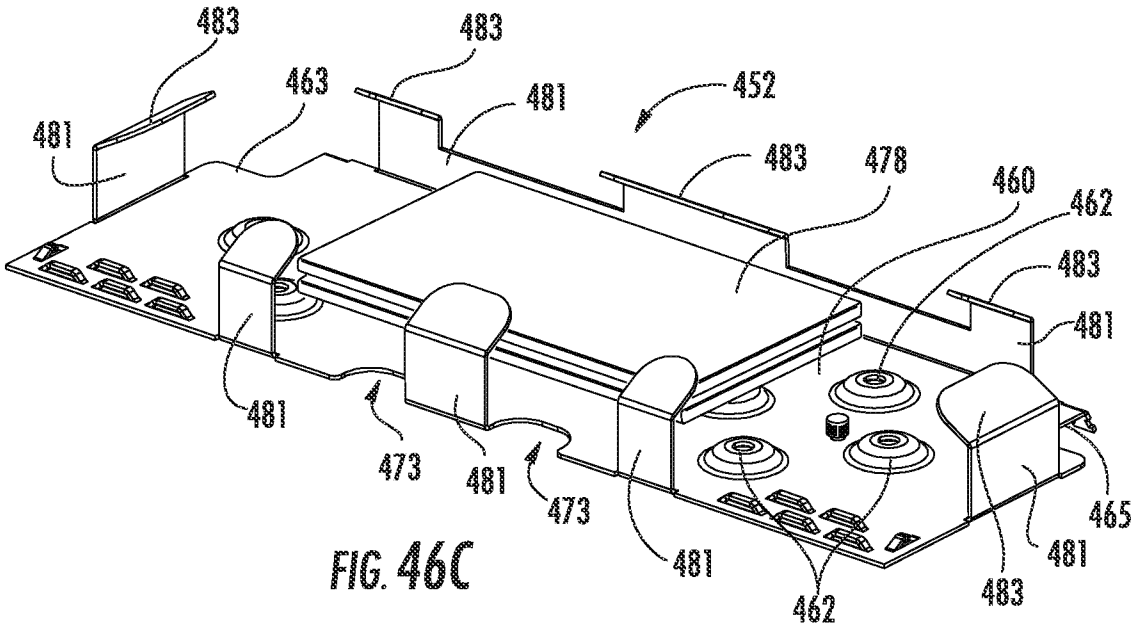

FIG. 46C

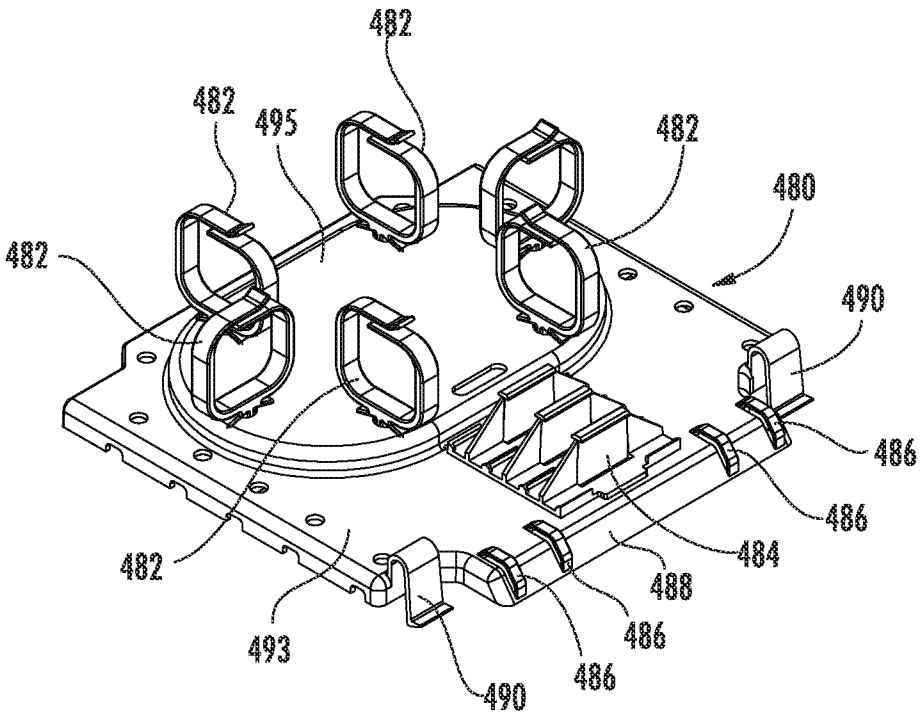

FIG. 46D

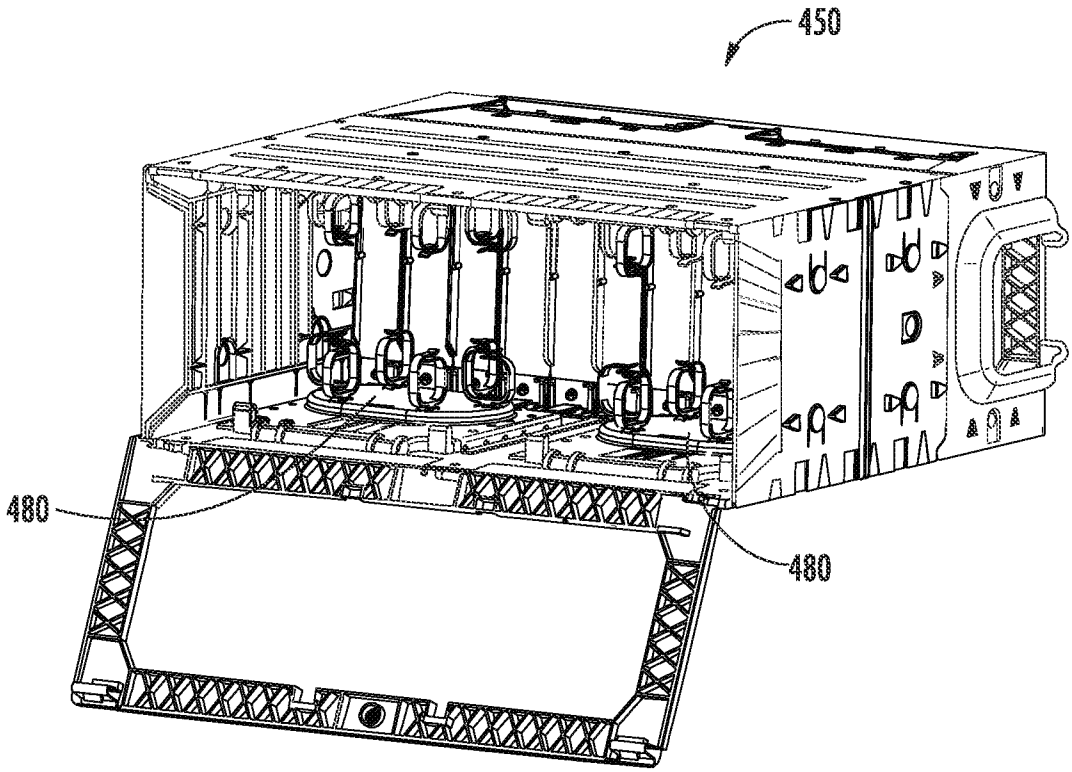

FIG. 47

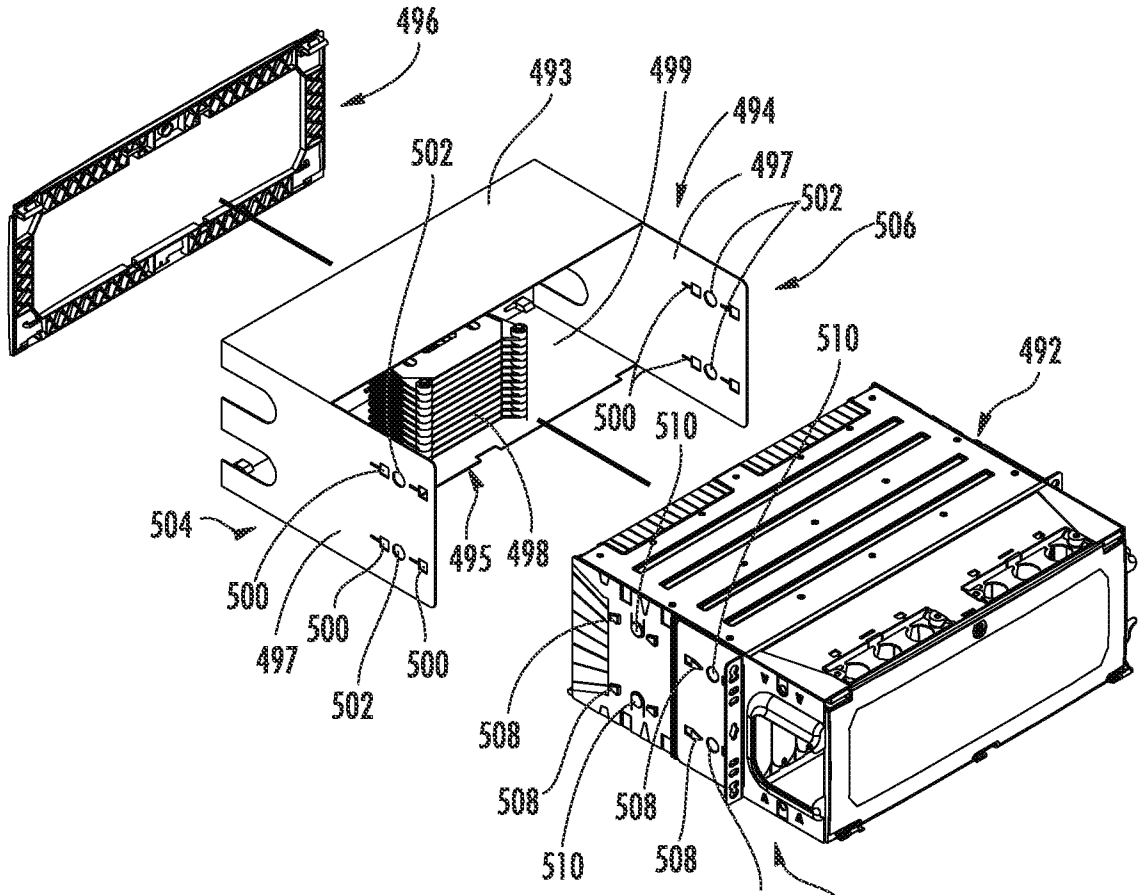
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FIG. 48

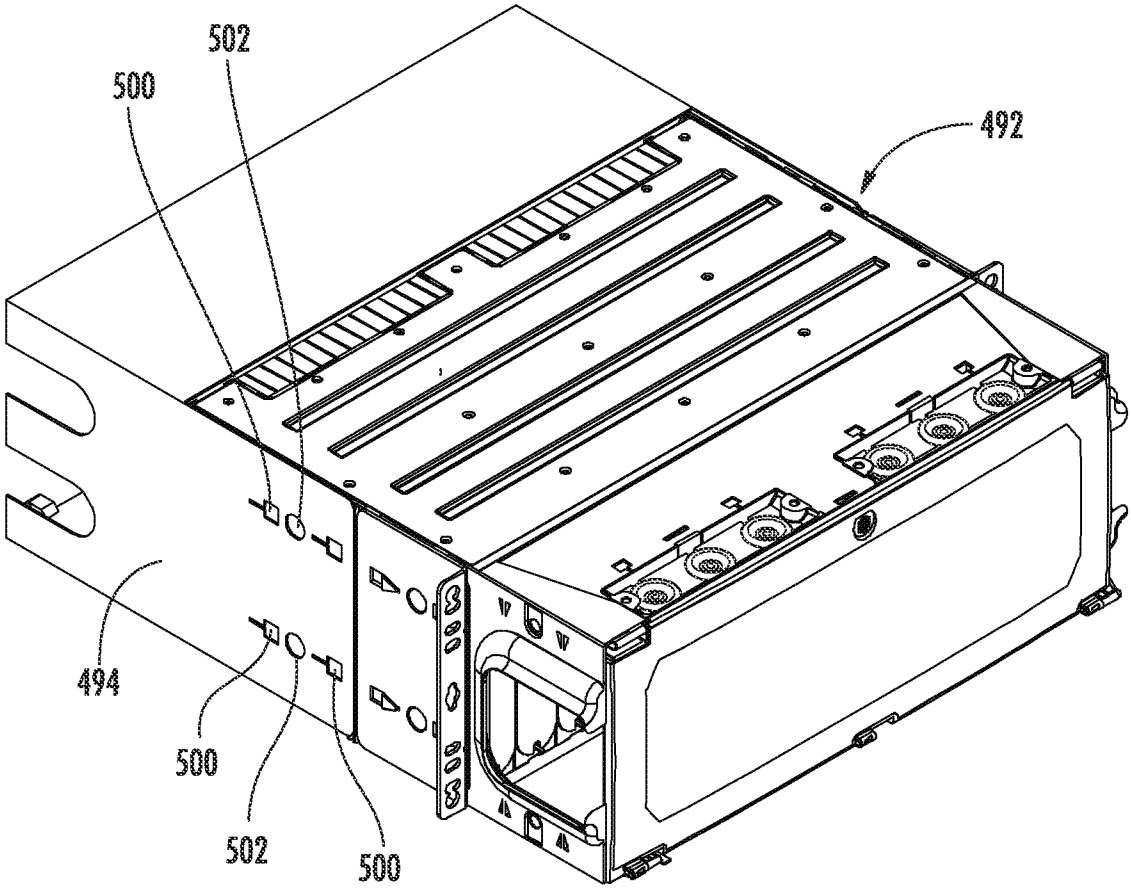


FIG. 49

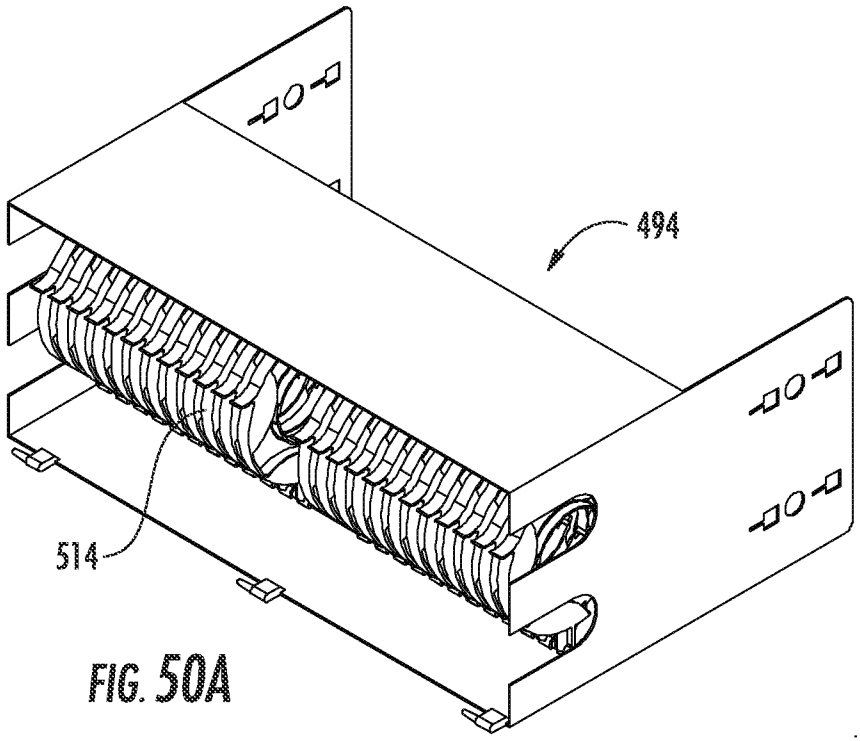


FIG. 50A

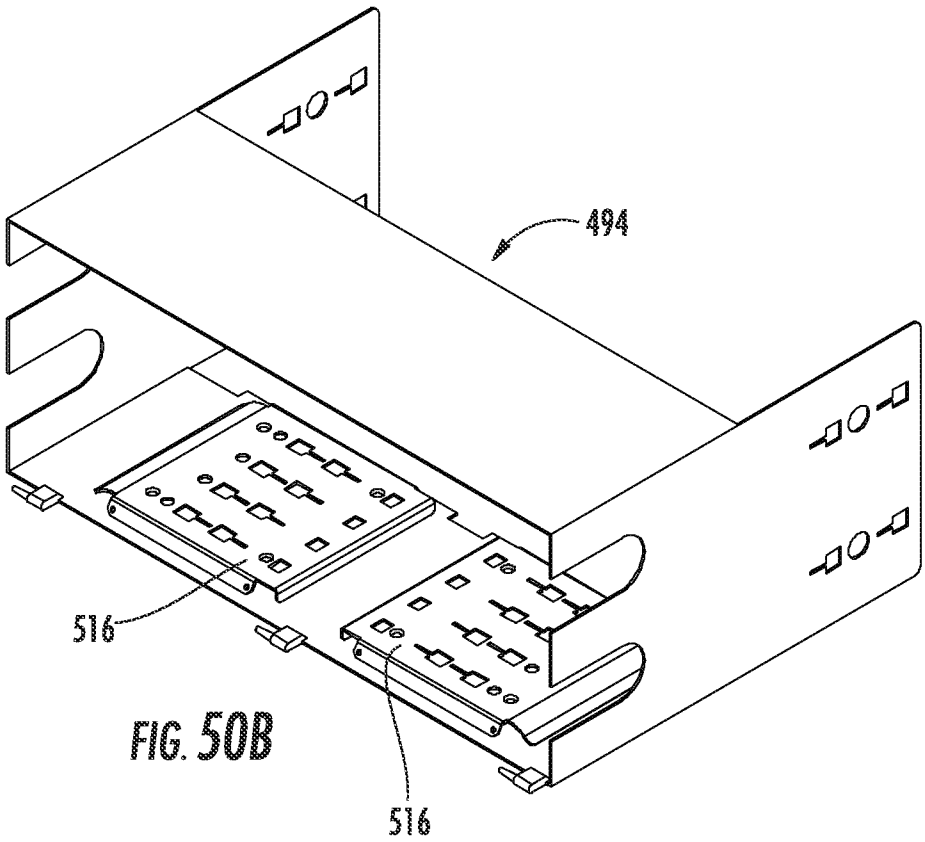
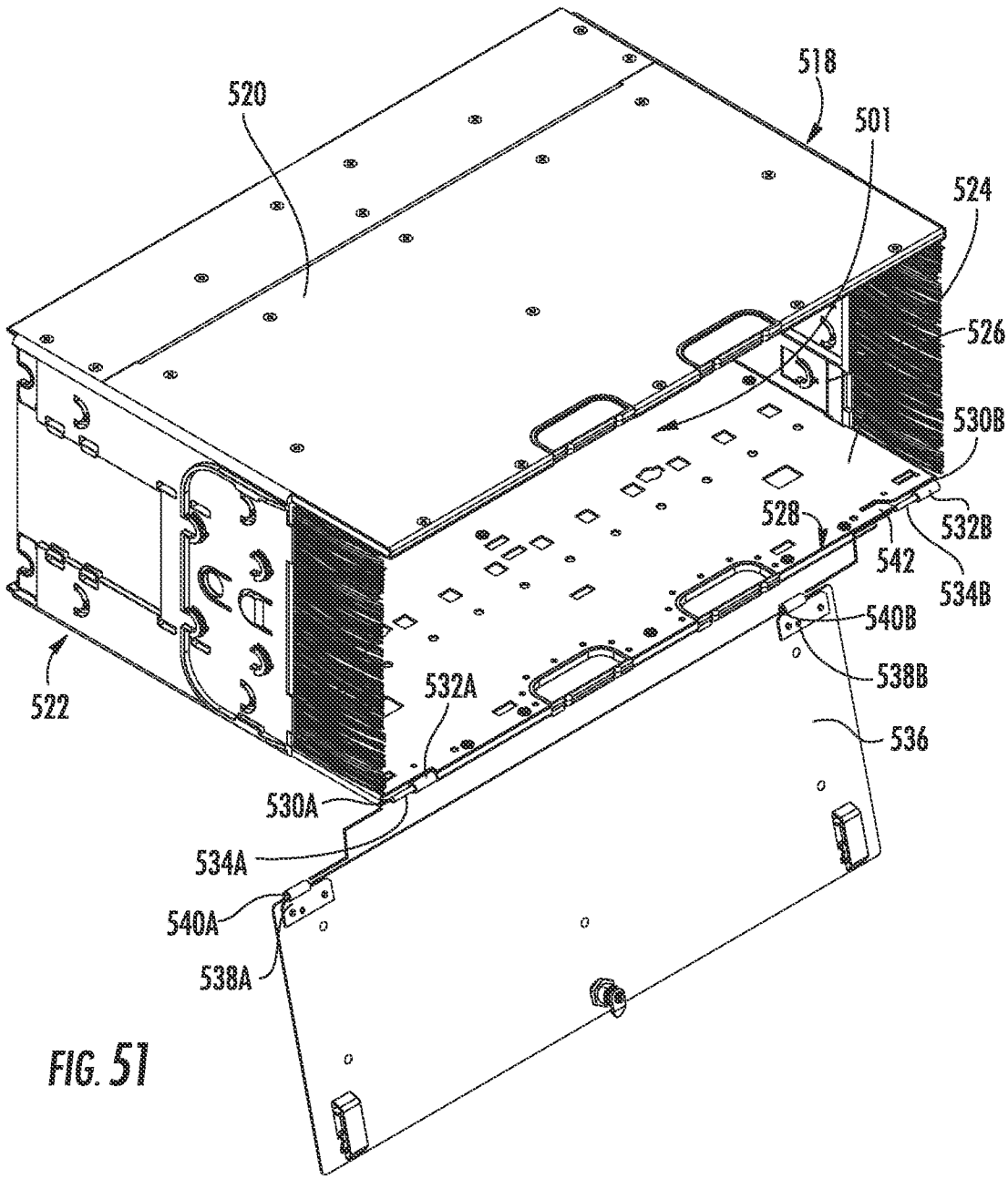


FIG. 50B


518
520
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534A
540A
538A

FIG. 51

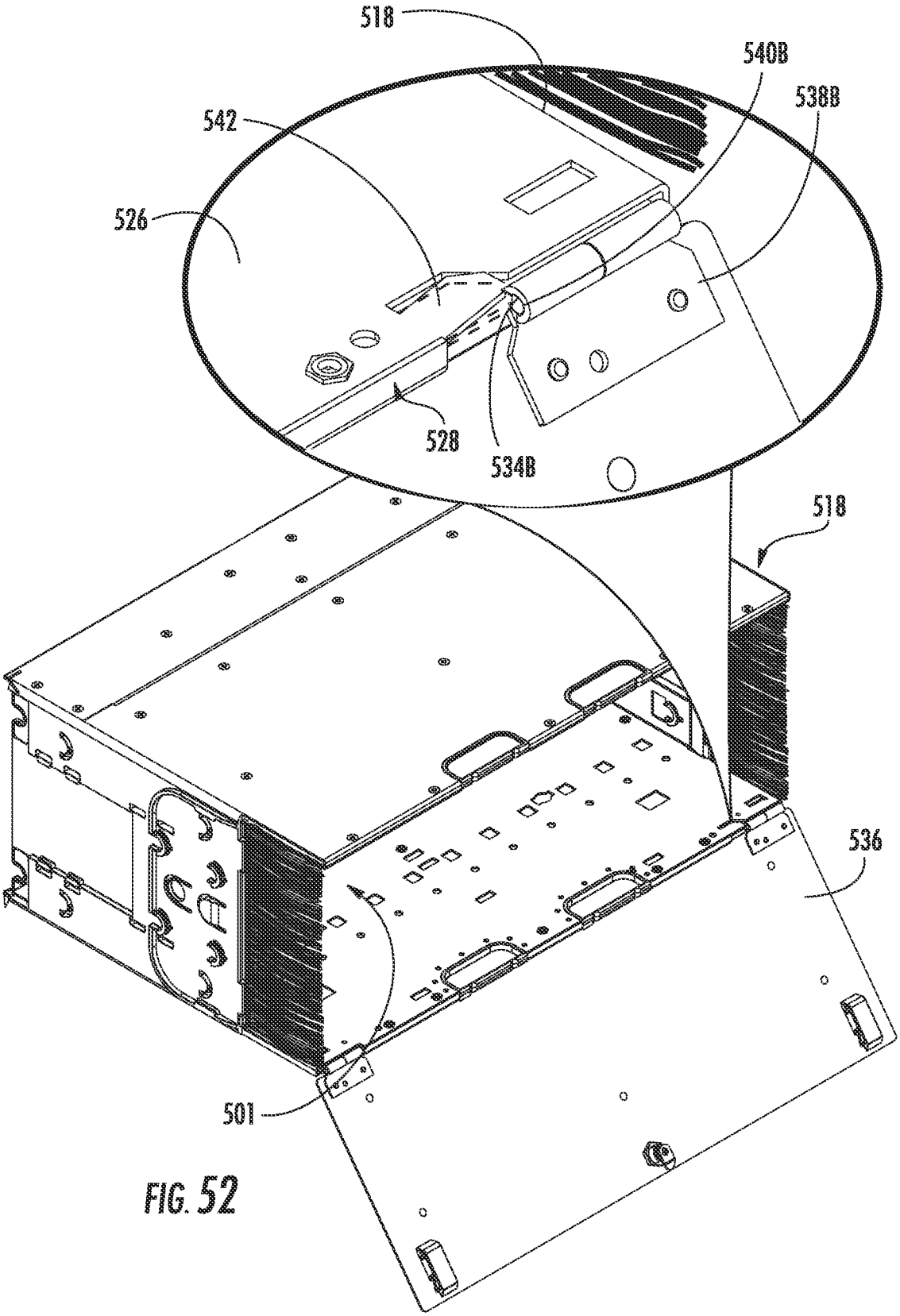

FIG. 52

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/035692

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 practical, 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 5 408 570 A (COOK DAVID D [US] ET AL) 18 April 1995 (1995-04-18) column 2, line 5 - line 32 column 2, line 62 - column 3, line 53 column 5, line 4 - line 27 figures 1,2,4,5,7	1-27
A	US 2002/150370 A1 (BATTEY JENNIFER A [US] ET AL) 17 October 2002 (2002-10-17) paragraphs [0032], [0033], [0039]; figures 1,2,4,5	2-4, 20-22
A	US 2005/067358 A1 (LEE DANIEL G [US] ET AL) 31 March 2005 (2005-03-31) abstract paragraphs [0022] - [0025]; figures 1-3	3,4,21, 22

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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 July 2011	20/07/2011

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	Cohen, Adam

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/035692

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 044 194 A (MEYERHOEFER CARL E [US]) 28 March 2000 (2000-03-28) abstract column 3, line 20 - column 5, line 12; figure 1	2,5,6, 20,23,24
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Information on patent family members

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