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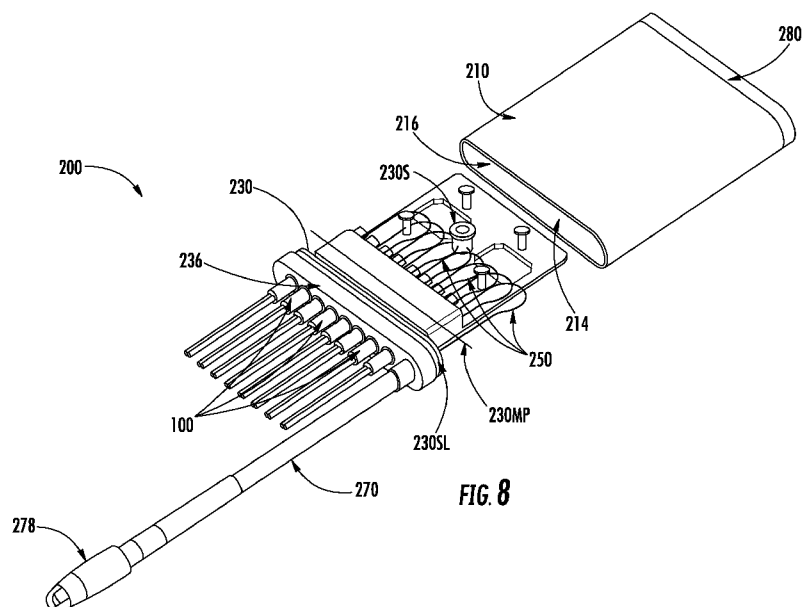
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(54) Title: MULTIPORTS HAVING A CONNECTION PORT INSERT AND METHODS OF MAKING THE SAME



(57) Abstract: Multiports comprising a connection port insert having at least one optical port along with methods for making are disclosed. One embodiment is directed to a multiport for providing an optical connection comprising a shell and a connection port insert. The shell comprises a first end having a first opening leading to a cavity. The connection port insert comprises a body having a front face and at least one connection port comprising an optical connector opening extending from the front face into the connection port insert with a connection port passageway extending through part of the connection port insert to a rear portion, where the connection port insert is sized so that at least a portion of the connection port insert fits into the first opening and the cavity of the shell.

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## **MULTIPORTS HAVING A CONNECTION PORT INSERT AND METHODS OF MAKING THE SAME**

### **CROSS-REFERENCE TO RELATED APPLICATIONS**

[0001] This application claims the benefit of U.S. Application No. 62/428,212, filed on November 30, 2016, U.S. Application No. 62/428,219, filed on November 30, 2016, U.S. Application No. 62/428,224, filed on November 30, 2016, U.S. Application No. 62/428,230, filed on November 30, 2016, U.S. Application No. 62/428,234, filed on November 30, 2016, U.S. Application No. 62/428,244, filed on November 30, 2016, U.S. Application No. 62/428,252, filed on November 30, 2016, U.S. Application No. 62/451,221, filed on January 27, 2017, U.S. Application No. 62/451,234, filed on January 27, 2017, U.S. Application No. 62/526,011, filed on June 28, 2017, U.S. Application No. 62/526,018, filed on June 28, 2017, and U.S. Application No. 62/526,195, filed on June 28, 2017, the content of which is relied upon and incorporated herein by reference in entirety.

### **BACKGROUND**

[0002] The disclosure is directed to devices for providing optical connections in a communications network along with methods for making the same. More specifically, the disclosure is directed to devices having a compact form-factor and simplified design along with an along with methods of making the same.

[0003] Optical fiber is increasingly being used for a variety of applications, including but not limited to broadband voice, video, and data transmission. As bandwidth demands increase optical fiber is migrating deeper into communication networks such as in fiber to the premises applications such as FTTx, 5G and the like. As optical fiber extended deeper into communications networks the need for making robust optical connections in outdoor applications in a quick and easy manner was apparent. To address this need for making quick, reliable, and robust optical connections in communication networks for the outside the plant environment hardened fiber optic connectors such as the OptiTap® plug connector were developed.

[0004] Multiports were also developed for making an optical connection with hardened connectors such as the OptiTap. Prior art multiports have a plurality of receptacles mounted through a wall of the housing for protecting an indoor connector inside the housing that makes an optical connection to the external hardened connector of the branch or drop cable.

[0005] Illustratively, FIG. 1 shows a conventional fiber optic multiport 1 having an input fiber optic cable 4 carrying one or more optical fibers to indoor-type connectors inside a housing 3. The multiport 1 receives the optical fibers into a housing 3 and distributes the optical fibers to receptacles 7 for connection with a hardened connector. The receptacles 7 are separate assemblies attached through a wall of housing 3 of multiport 1. The receptacles 7 allow mating with hardened connectors attached to drop or branching cables (not shown) such as drop cables for “fiber-to-the-home” applications. During use, optical signals pass through the branch cables, to and from the fiber optic cable 4 by way of the optical connections at the receptacles 7 of multiport 1. Fiber optic cable 4 may also be terminated with a fiber optic connector 5. Multiports allowed quick and easy deployment for optical networks.

[0006] Although, the housing 3 of the prior art multiport 1 is rugged and weatherable for outdoor deployments, the housings 3 of multiport 1 are relatively bulky for mounting multiple receptacles 7 for the hardened connector on the housing 3. Receptacles 7 allow an optical connection between the hardened connector such as the OptiTap male plug connector on the branch cable with a non-hardened connector such as the SC connector disposed within the housing 3, which provides a suitable transition from an outdoor space to an protected space inside the housing 3.

[0007] Receptacle 7 for the OptiTap connector is described in further detail in US Pat. No. 6,579,014. As depicted in US 6,579,014, the receptacle includes a receptacle housing and an adapter sleeve disposed therein. Thus, the receptacles for the hardened connector are large and bulky and require a great deal of surface array when arranged in an array on the housing 3 such as shown with multiport 1. Further, conventional hardened connectors use a separate threaded or bayonet coupling that requires rotation

about the longitudinal axis of the connector and room for grabbing and rotating the coupling by hand when mounted in an array on the housing 3.

[0008] Consequently, the housing 3 of the multiport 1 is excessively bulky. For example, the multiport 1 may be too boxy and inflexible to effectively operate in smaller storage spaces, such as the underground pits or vaults that may already be crowded. Furthermore, having all of the receptacles 7 on the housing 3, as shown in **FIG. 1**, requires sufficient room for the drop or branch cables attached to the hardened connectors attached to the multiport 1. While pits can be widened and larger storage containers can be used, such solutions tend to be costly and time-consuming. Network operators may desire other deployment applications for multiports 1 such as aerial, in a pedestal or mounted on a façade of a building that are not ideal for the prior art multiports 1 for numerous reasons such as congested poles or spaces or for aesthetic concerns.

[0009] Other multiports designs have been commercialized to address the drawbacks of the prior art multiports depicted in **FIG. 1**. By way of explanation, US 2015/0268434 discloses multiports 1' having one or more connection ports 9 positioned on the end of extensions 8 that project from the housing of the multiport 1' such as depicted in **FIG. 2**. Connection ports 9 of multiport 1' are configured for mating directly with a hardened connector (not shown) such as an OptiTap without the need to protect the receptacle 7 within a housing like the prior art multiport 1 of **FIG. 1**.

[0010] Although, these types of multiport designs such as shown in **FIG. 2** and disclosed in US 2015/0268434 allow the device to have smaller footprints for the housing 3', these designs still have concerns such as the space consumed by the relatively large ports 9 and associated space requirements of optical connections between the ports and hardened connector of the drop cables along with organizational challenges. Simply stated, the ports 9 on the extensions 8 of the multiport 1' and the optical connections between ports 9 and hardened connector occupy significant space at a location a short distance away from the multiport housing 3' such as within a buried vault or disposed on a pole. In other words, a cluster of optical ports 9 of multiport 1' are bulky or occupy limited space. The conventional hardened connectors used with multiport 1' also use a

separate threaded or bayonet coupling that requires rotation about the longitudinal axis of the connector along with sufficient space for grabbing and rotating the coupling means by hand. Further, there are aesthetic concerns with the prior art multiports 1' as well.

[0011] Consequently, there exists an unresolved need for multiports that allow flexibility for the network operators to quickly and easily make optical connections in their optical network while also addressing concerns related to limited space, organization, or aesthetics.

### SUMMARY

[0012] The disclosure is directed to multiport and methods of making multiports as disclosed herein and recited in the claims.

[0013] One aspect of the disclosure is directed to a multiport for providing an optical connection comprising a shell and a connection port insert. The shell comprises a first end having a first opening leading to a cavity. The connection port insert comprises a body having a front face and at least one connection port comprising an optical connector opening extending from the front face into the connection port insert with a connection port passageway extending through part of the connection port insert to a rear portion, where the connection port insert is sized so that at least a portion of the connection port insert fits into the first opening and the cavity of the shell.

[0014] Another aspect of the disclosure is directed to a multiport for providing an optical connection comprising a shell and a connection port insert. The shell comprises a first end having a first opening leading to a cavity. The connection port insert comprises a body having a front face and at least one connection port comprising an optical connector opening extending from the front face into the connection port insert with a connection port passageway extending through part of the connection port insert to a rear portion and comprising a retention feature associated with the connection port passageway, where the connection port insert is sized so that at least a portion of the connection port insert fits into the first opening and the cavity of the shell.

[0015] Still another aspect of the disclosure is directed to a multiport for providing an optical connection comprising a shell, a connection port insert, and at least one optical

fiber. The shell comprises a first end having a first opening leading to a cavity. The connection port insert comprises a body having a front face and at least one connection port comprising an optical connector opening extending from the front face into the connection port insert with a connection port passageway extending through part of the connection port insert to a rear portion, where the connection port insert is sized so that at least a portion of the connection port insert fits into the first opening and the cavity of the shell. The at least one optical fiber is routed from at least one connection port toward an input connection port for providing optical connectivity with the multiport.

[0016] Yet another aspect of the disclosure is directed to a multiport for providing an optical connection comprising a shell, a connection port insert, at least one optical fiber, and at least one rear connector. The shell comprises a first end having a first opening leading to a cavity. The connection port insert comprises a body having a front face and at least one connection port comprising an optical connector opening extending from the front face into the connection port insert with a connection port passageway extending through part of the connection port insert to a rear portion, where the connection port insert is sized so that at least a portion of the connection port insert fits into the first opening and the cavity of the shell. The at least one optical fiber is routed from at least one connection port toward an input connection port within the shell. The at least one rear connector is in communication with the at least one connection port passageway from the rear portion, where the at least one rear connector is associated with the plurality of optical fibers.

[0017] Another aspect of the disclosure is directed to a multiport for providing an optical connection comprising a shell, a connection port insert, at least one optical fiber and at least one rear connector. The shell comprises a first end having a first opening leading to a cavity. The connection port insert comprises a body having a front face and at least one connection port comprising an optical connector opening extending from the front face into the connection port insert with a connection port passageway extending through part of the connection port insert to a rear portion, where the connection port insert is sized so that at least a portion of the connection port insert fits into the first opening and the cavity of the shell. The connection port insert comprises a sealing location disposed a first distance from the front face and a connector mating plane is

disposed at a second distance from the front face with the second distance being greater than the first distance. At least one optical fiber being routed from the at least one connection port toward an input connection port within the shell. The at least one rear connector is in communication with the at least one connection port passageway from the rear portion, where the at least one rear connector is associated with the at least one optical fiber.

[0018] The disclosure is also directed to methods of making a multiport. One method comprises routing at least one optical fiber from a rear portion of at least one connection port of a connection port insert so that the at least one optical fiber is available for optical communication at an input connection port of the connection port insert; inserting the connection port insert into an opening disposed in a first end of a shell so that at least a portion of the connection port insert fits into the opening and is disposed within a cavity of the shell; and the connection port insert comprises a body comprising a front face and at least one connection port comprising an optical connector opening extending from the front face into the connection port insert with a connection port passageway extending through part of the connection port insert to the rear portion.

[0019] 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 same as described herein, including the detailed description that follows, the claims, as well as the appended drawings.

[0020] It is to be understood that both the foregoing general description and the following detailed description present embodiments that are intended to provide an overview or framework for understanding the nature and character of the claims. The accompanying drawings are included to provide a further understanding of the disclosure, 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.

#### **BRIEF DESCRIPTION OF THE FIGURES**

[0021] **FIGS. 1 and 2** are prior art depictions showing various conventional multiports;



[0022] **FIGS. 3 and 4** respectively depict perspective and detail views of a multiport having a connection port insert with a plurality of connection ports and an input connection port;

[0023] **FIG. 5** depicts a perspective view of another multiport having a shell comprising more than one component with the connection port integrally formed with a portion of the shell along with an input tether terminated with an input connector;

[0024] **FIG. 6** is a front perspective view of another multiport having an input connection port configured for receiving a furcation body of an input tether and is visible through the shell for showing details;

[0025] **FIG. 7** is a front perspective view of another multiport similar to **FIG. 6** having an input connection port having an input tether attached to the connection port insert and is visible through the shell for showing details;

[0026] **FIG. 8** is a partially exploded view of a multiport similar to the multiport of **FIG. 7** showing the input connection port removed from the shell and having the input tether terminated with a fiber optic connector;

[0027] **FIG. 9** is a perspective view the input connection port of **FIGS. 7 and 8**;

[0028] **FIG. 10** is a sectional view of a multiport similar to **FIGS. 7 and 8** showing the optical connections between respective rear connectors secured to the connection port insert of the multiport and the external fiber optic connectors of the fiber optic cable assemblies attached at the front face of the multiport with the input tether removed;

[0029] **FIGS. 11 and 12** respectively are a sectional view of the optical connections of **FIG. 10** and an isolated perspective view of the optical connection between a rear connector and a fiber optic connector of the fiber optic cable assembly;

[0030] **FIGS. 13-15** respectively are a rear perspective sectional view, a top view and a rear perspective view of the optical connections and features of another connection port insert where one or more adapters are integrally formed with the connection port insert;

[0031] **FIG. 16 and 16A** are rear perspective sectional views of a representative force diagram for the force interactions between the mating optical connections;

[0032] **FIGS. 17A-17C** are perspective views of shells for multiports having various configurations;

[0033] **FIGS. 18A-18C** are perspective views of other shells for multiports having various configurations;

[0034] **FIGS. 19A-19C** are perspective views of various other multiports configurations having other form-factors such as multi-row arrays in similar sized packages;

[0035] **FIG. 20** is a top view of a multiport having fiber optic cable assemblies removably secured using retention features or securing features;

[0036] **FIG. 20A** depicts a portion of a multiport having a pin having a flat surface that acts as a securing feature for the connector;

[0037] **FIG. 21** is a perspective view of a multiport having an end cap with O-rings for sealing;

[0038] **FIGS. 22-24** are various perspective views of multiports having one or more floating adapters received in the connection port insert;

[0039] **FIGS. 25A and 25B** depict perspective views of multiports having a second insert with at least one pass-through port;

[0040] **FIG. 26** depicts a perspective view of an alternative second insert having a pass-through port with and integrated adapter for receiving a fiber optic connector;

[0041] **FIGS. 27-30** are various views of multiports having one or more attachment features;

[0042] **FIGS. 31-38** are various views of multiports and designs associated with mounting structures for the multiport;

[0043] **FIGS. 39A-39C** are various perspective views of multiports having at least one securing feature associated with one or more of the connection ports and a connection port insert having an input connection port;

[0044] **FIGS. 40A-40C** are various perspective views of multiports similar to the multiports of **FIGS. 39A-39C** having at least one securing feature associated with one or more of the connection ports and a connection port insert having an input tether;

[0045] **FIG. 41** is a front partially exploded view of the multiport of **FIGS. 40A-40C**;

[0046] **FIG. 42** is a rear partially exploded view of a portion of the multiport of **FIGS. 40A-40C**;

[0047] **FIGS. 43 and 44** are front assembled views of a portion of the multiport of **FIGS. 40A-40C** with the shell removed for clarity;

[0048] **FIG. 45** is a rear assembled view of a portion of the multiport of **FIGS. 40A-40C** with the shell removed for clarity;

[0049] **FIGS. 46A and 46B** are front and rear perspective views of the connection port insert of the multiport of **FIGS. 40A-40C**;

[0050] **FIGS. 47A-47D** are various views of the connection port insert of **FIGS. 40A-40C**;

[0051] **FIGS. 48A-48C** are perspective views of the connection port insert and a securing feature to explain the open position, intermediate position and close position for the securing feature relative to the fiber optic connector being inserted into the connection port;

[0052] **FIG. 49** is an isolated perspective view of the securing feature that cooperates with the fiber optic connector of **FIGS. 48A-48C**;

[0053] **FIG. 49A** is an isolated perspective view of another securing feature for the fiber optic connector that cooperates with the multiport;

[0054] **FIGS. 49B and 49C** are isolated perspective view of another securing feature for the fiber optic connector that cooperates with the multiport;

[0055] **FIGS. 50 and 51** respectively are a top view and a detailed perspective view of the connector port insert and the securing feature cooperating for securing the fiber optic connector in a multiport;

[0056] **FIGS. 52A-52D** are various views of the securing feature of multiports of **FIGS. 39A-40C**;

[0057] **FIGS. 53 and 54** are perspective and partially assembled views of another multiports similar to the multiports of **FIGS. 40A-40C** having multiple adapter ganged together on either side of the input tether;

[0058] **FIG. 55** is a sectional views of the optical connections of the multiport in **FIGS. 53 and 54** showing the optical connection between a rear connector and a fiber optic connector of the fiber optic cable assembly;

[0059] **FIGS. 56 and 57** are perspective views of another multiport similar to **FIGS. 40A-40C** showing a different dust cap configuration that can be mated with the dust cap of the fiber optic connector for storage;

[0060] **FIGS. 58A and 58B** are perspective views of another multiport similar to **FIGS. 40A-40C** showing another dust cap configuration for storage;

[0061] **FIGS. 59A-59D** are perspective views of still another multiport similar to **FIGS. 40A-40C** showing yet another dust cap configuration;

[0062] **FIGS. 59A-59C** are perspective views of still another multiport similar to **FIGS. 40A-40C** showing yet another dust cap configuration;

[0063] **FIGS. 60-64** are perspective and sectional views of still another multiport having at least one rotating securing feature associated with a plurality of connection ports and the connection port insert having at least one flexure associated with at least one of the connection ports;

[0064] **FIGS. 65-66** are perspective views of still others multiports similar to the multiport of **FIGS. 61-64** having at least one rotating securing feature associated with a plurality of connection ports and the connection port insert having at least one flexure associated with at least one of the connection ports along with a second insert;

[0065] **FIGS. 67-69** are perspective views of still another multiport having a dedicated rotating securing feature associated with each connection port and the connection port insert having a flexure associated with each of the connection ports;

[0066] **FIGS. 70 and 71** are sectional views of the multiport of **FIGS. 67-69** showing details of the dedicated rotating securing feature associated with each connection port and flexure;

[0067] **FIG. 72** is a perspective view of the multiport of **FIGS. 67-69** with the connection port insert removed for showing the orientation of the dedicated rotating securing feature associated with each connection port and flexure;

[0068] **FIG. 73** is a perspective view of still another multiport similar to the multiport of **FIGS. 67-69** and having a dedicated rotating securing feature associated with the input connection port similar to the other connection ports;

[0069] **FIGS. 74A and 74B** are partial perspective and sectional views of another multiport showing a translating securing feature associated with each connection port and flexure;

[0070] **FIG. 75** is a partial sectional view of another multiport showing a translating securing feature associated with each connection port and flexure along with a cover for protecting the securing mechanism;

[0071] **FIG. 76** is a view of still another multiport showing a rotating securing feature associated with each connection port and flexure along with a cover for protecting the securing mechanism;

[0072] **FIG. 77** is a partial perspective view of yet another multiport showing a rotating securing feature associated with each connection port and flexure along with a cover for protecting the securing mechanism;

[0073] **FIG. 78** is a partial sectional view of still another connection port insert for a multiport having a securing feature associated with each connection port that receives a connector having a partial-turn securing feature; and

[0074] **FIGS. 79A-79D** are a perspective views of a connection port insert that may be used with multiports disclosed herein.

#### **DETAILED DESCRIPTION**

[0075] Reference will now be made in detail to the embodiments of the disclosure, examples of which are illustrated in the accompanying drawings. Whenever possible, like reference numbers will be used to refer to like components or parts.

[0076] The concepts for the devices disclosed herein are suitable for providing at least one optical connection to a device for indoor, outdoor or other environments as desired. Generally speaking, the devices disclosed and explained in the exemplary embodiments are multiports, but the concepts disclosed may be used with any suitable device as appropriate. As used herein, the term “multiport” means any device comprising at least one connection port for making an optical connection and a retention feature or securing feature associated with the at least one connection port. By way of example, the multiport may be any suitable device having at least one optical connection such as a passive device like an optical closure (hereinafter “closure”) or an active device such as a wireless device having electronics for transmitting or receiving a signal.

[0077] The concepts disclosed advantageously allow compact form-factors for devices such as multiports comprising at least one connection port and the retention feature or securing feature associated with the connection port. The concepts are scalable to many connection ports on a device in a variety of arrangements or constructions. The compact form-factors may allow the placement of the devices in tight spaces in indoor, outdoor, buried, aerial, industrial or other applications while providing at least one connection port that is advantageous for a robust and reliable optical connection in a removable and replaceable manner. The disclosed devices may also be aesthetically pleasing and provide organization for the optical connections in manner that the prior art multiports cannot provide.

[0078] The devices disclosed are simple and elegant in their designs. The devices disclosed comprise at least one connection port and a retention feature or securing feature associated with the connection port that is suitable for retaining an external fiber optic connector received by the connection port. Unlike prior art multiports, some of the concepts disclosed advantageously allow the quick and easy connection and retention by inserting the fiber optic connectors directly into the connection port of the device without the need or space considerations for turning a threaded coupling nut or bayonet for retaining the external fiber optic connector. Generally speaking, the retention features or securing features disclosed for use with devices herein may comprise one or more components with at least one component translating for releasing or securing the external fiber optic connector to the device. As used herein, the term “securing feature” excludes threaded portions or features for securing a bayonet disposed on a connector.

[0079] Since the connector footprint used with the devices disclosed does not require the bulkiness of a coupling nut or bayonet, the fiber optic connectors used with the devices disclosed herein may be significantly smaller than conventional connectors used with prior art multiports. Moreover, the present concepts using the securing features with the connection ports on devices allows an increased density of connection ports per volume of the shell since there is no need for accessing and turning the coupling nut or bayonets by hand for securing a fiber optic connector like the prior art multiports.

[0080] The devices disclosed comprise a retention feature or securing feature for directly engaging with a suitable portion of a connector housing of the external fiber optic

connector or the like for securing an optical connection with the device. Different variations of the concepts are discussed in further detail below. The structure for securing the fiber optic connectors in the devices disclosed allows much smaller footprints for both the devices and the fiber optic connectors. Devices may also have a dense spacing of connection ports if desired. The devices disclosed advantageously allow a relatively dense and organized array of connection ports in a relatively small form-factor while still being rugged for demanding environments. As optical networks increase densifications and space is at a premium, the robust and small-form factors for devices such as multiports, closures and wireless devices becomes increasingly desirable for network operators.

[0081] The concepts disclosed herein are suitable for optical distribution networks such as for Fiber-to-the-Home applications, but are equally applicable to other optical applications as well including indoor, automotive, industrial, wireless or other suitable applications. Additionally, the concepts may be used with any suitable fiber optic connector footprint that cooperates with the retention feature or securing features disclosed, but the concepts disclosed herein may be used with other fiber optic connectors as well. Various designs, constructions or features for devices are disclosed in more detail as discussed herein.

[0082] **FIGS. 3 and 4** respectively depict a perspective and detail views of an explanatory multiport 200 having a shell 210 and connection port insert 230. Shell 210 comprises a first end 212 having a first opening 214 leading to a cavity 216 (see **FIGS. 17A-17C**). Connection port insert 230 comprises a body 232 having a front face 234 and a plurality of connection ports 236. Each connector port 236 has an optical connector opening 238 extending from the front face 234 into the connection port insert 230 with a connection port passageway 233 extending through part of the connection port insert 230 to a rear portion 237 of the connection port insert 230. Connection port insert 230 is sized so that at least a portion of the connection port insert 230 fits into the first opening 214 and the cavity 216 of the shell 210.

[0083] Multiports provide optical connections to the multiport by inserting one or more external fiber optic connectors 10 as needed. Specifically, the connection port passageway 233 is configured for receiving a suitable fiber optic connector 10

(hereinafter connector) of fiber optic cable assembly 100 (hereinafter cable assembly) as depicted in **FIG. 3**. Connection port passageway 233 may comprise one or more retention features 233a (see **FIG. 11**) for securing connector 10 as desired. The retention feature 233a may be disposed in the connection port passageway or be disposed in other locations as appropriate for retaining one of the mating connectors. By way of example, the retaining feature may be a friction fit, a detent, a protrusion, bayonet, threaded portion or the like. Connection ports 236 of multiports 200 may also comprise a keying feature (236K) for mating with an appropriate connector 10. Additionally, other multiport embodiments may have one or more securing features 310 for engaging with a suitable locking portion 20L of connector 10 or the like.

[0084] A plurality of optical fibers 250 are routed from one or more of the plurality of connection ports 236 toward an input connection port 260 for optical communication with the multiport 200. The input connection port 260 may be configured in a variety of different manners with any of the multiports disclosed herein as appropriate. For the sake of simplicity and clarity in the drawings, all of the optical fiber pathways may not be illustrated or portions of the optical fiber pathways may be removed in places so that other details of the design are visible.

[0085] Multiport 200 of **FIGS. 3 and 4** has eight optical fibers 250 routed from one or more of the plurality of connection ports 236 toward an input connection port 260 for optical communication with the multiport. Input connection port 260 may be configured in several different configuration for the multiports disclosed as desired for the given application. Examples of input connection ports include being configured as a single-fiber input connection, a multi-fiber input connector, a tether input that may be a stubbed cable or terminated with a connector or even one of the connection ports 236 may function as an input connection port as desired (see **FIG. 73**). To make identification of the input connection port to the user, a marking indicia may be used such as color-coding of the input tether (e.g. an orange or green polymer) or physically marking the input connection port 260.

[0086] In the embodiment shown in **FIGS. 3 and 4**, the input connection port 260 is configured as an 8-fiber MT connection port as best shown in **FIG. 4**. Consequently, an input cable (not numbered) comprises a complementary 8-fiber MT connector 262 for



mating with the 8-fiber MT input connection port 260 and may be attached in any suitable manner such as a threaded connection, bayonet, push-pull, etc. as desired. Thus, there is a one-to-one correspondence of input optical fibers to the connection ports 230 for this multiport; however, other variations of multiports can have other configuration such as pass-through optical fibers, splitters, or the like which may not use a one-to-one correspondence of input optical fibers to connection ports 236 of the multiport. In other words, eight optical fibers from connector 262 are routed to the rear portion of connection port insert 230 for optical communication with the eight connection ports 236.

[0087] Although not visible in **FIG. 4**, a plurality of rear connectors 252 (not visible in **FIGS. 2-5**) are sized for fitting into one or more of the respective connector port passageways 233 from the rear portion 237 of connection port insert 230, and the plurality of rear connectors 252 are associated with the plurality of optical fibers 250. Thus, each of the eight optical fibers 250 of multiport 200 of **FIG. 4** comprises a respective rear connector 252 that attaches to the connector port insert 230 from the rear portion 237 similar to arrangement shown in **FIG. 10**. The plurality of rear connectors 252 may comprise a rear connector ferrule 252F as desired.

[0088] Multiports may also have one or more dust caps 295 for protecting the connection port 236 or input connection ports 260 from dust, dirt or debris entering the multiport or interfering with the optical performance. Thus, when the user wishes to make an optical connection to the multiport, the appropriate dust cap 295 is removed and then connector 10 of cable assembly 100 may be inserted into the respective connection port 236 for making an optical connection to the multiport 200. Shells 210 may have any suitable shape, design or configuration as desired. The shell 210 of multiport 200 shown in **FIGS. 3 and 4**, further comprises a second end 213 comprising a second opening 215 and a second insert 230' sized so that at least a portion of the second insert 230' fits into the second opening 215 and cavity 216 of shell 210. As shown second insert 230' is configured as an end cap 280. Second insert 230' is an end cap 280 since it does not have any connection ports, pass-throughs, adapters or the like, but simply closes off the second opening 215 of multiport 200. Still further, the connection port insert 230 or second insert 230' may be secured to the shell using a fastener or the like if desired. Other shells 210 may only have a first opening as desired.

[0089] Any of the multiports 200 disclosed herein may optionally be weatherproof by appropriately sealing the connection port insert(s) 230,230' with the shell 210 using any suitable means such as gaskets, O-rings, adhesive, sealant, welding, overmolding or the like. Moreover, the interface between the connection ports 236 and the dust cap 295 or connector 10 may be sealed using appropriate geometry and/or a sealing element such as an o-ring or gasket. Likewise, the input connection port may be weatherproofed in a suitable manner depending on the configuration such as a gasket, or O-ring with an optical connection or a heat shrink when using an input tether. If the multiport 200 is intended for indoor applications, then the weatherproofing may not be required.

[0090] However, the devices disclosed may locate the at least one connection port 236 in other portions or components of the device other than the connection port insert 230 using the concepts as disclosed herein as desired.

[0091] By way of explanation, other embodiments using the concepts disclosed herein may have the at least one connection port 236 being formed as a portion of a shell of the device. By way of explanation, at least one connection port 236 is molded as a first portion of shell 210 and a second portion of the shell 210 is a cover used for closing the opening such as at the bottom of the two-piece shell. In other words, instead of the parting line being in a vertical direction between the components of the connection port insert 230 and the shell 210 as shown in **FIG. 3**, a parting line PL between components of the shell may be in a horizontal direction between a first portion 210A of the shell comprising at least one connection port 236 and a second portion 210B of the shell 210 such as depicted by a parting line PL in the devices of **FIG. 5**. Thus, the concepts of the connection port 236 described herein may be integrated into a portion of the shell 210, instead of being a portion of the connection port insert 230. For the sake of brevity, the concept of forming at least one connection port 236 in a portion of the shell 210 will be shown with respect to **FIG. 5**, but any suitable concepts disclosed herein may have the connection port 236 and construction for the retention feature or securing feature formed in a portion of the shell along with the other features or constructions disclosed.

[0092] **FIG. 5** depicts a perspective view of another multiport 200 comprising shell 210 comprising a first portion 210A and a second portion 210B that is similar to the multiport 200 of **FIGS. 3 and 4**, but has the connection ports 236 formed with the first

portion 210A of the shell instead of being formed in a connection port insert 230. Besides being formed from multiple components, this multiport 200 has a different shell 210 that further comprises integrated mounting features 210 disposed at the second portion 210B of shell 210, but mounting features 210 may be disposed at any suitable location on the shell 210 or be used with other suitable shells 210. Thus, the user may simply use a fastener and mount the multiport 200 to a wall or pole as desired. This multiport 200 also has a plurality of securing features 310 (in addition to the retention features 233a) for engaging with a suitable locking portion 20L of connector 10 or the like, which will be discussed in further detail below. Any of the other concepts disclosed herein may also be used with the connection ports 236 formed as a portion of the shell 210 as well.

[0093] Additionally, multiport 200 of **FIG. 5** comprises an input tether 270 attached to the first portion 210A of the shell 210. In this case, input tether 270 is terminated with a fiber optic connector 278. An example of a suitable fiber optic connector 278 is an OptiTip® connector available from Corning Optical Communications LLC of Hickory, NC. However, other suitable single-fiber or multi-fiber connectors may be used for terminating the input tether 270 as desired. Input tether 270 may be secured to connection port insert 230 in any suitable manner such as adhesive, a collar or crimp (see **FIG. 42**), heat shrink or combinations of the same.

[0094] Furthermore, the input tether 270 may further comprise a furcation body 270F that has a portion that fits into a portion of the shell or the connection port insert 230 such as the bore of input connection port or that is disposed within the shell 210. The furcation body 270 is a portion of the input tether that transitions the optical fibers 250 to individual fibers for routing within the cavity 216 of the shell to the respective connector ports. As an example, a ribbon may be used for insertion into the back end of the ferrule of fiber optic connector 278 and then be routed through the input tether 270 to the furcation body 270F where the optical fibers are then separated out into individual optical fibers 250. From the furcation body 270F the optical fibers 250 may be protected with a buffer layer or not inside the cavity 216 of the multiport 200 and then terminated on a rear connector 252 (see **FIG. 10**) as desired.

[0095] Consequently, the input tether 270 with the furcation body 270F may be assembled with the rear connectors 252 and/or fiber optic connector 278 in a separate operation from the assembly of multiport 200. Thereafter, the rear connectors 252 may be individually threaded through a bore 260B of the input connection port 260 (see **FIGS. 6 and 9**) of the connection port insert 230 with the appropriate routing of the optical fiber slack and then have the rear connectors 252 attached to the appropriate structure for optical communication with the connection port passageways 233 of the connection port insert 230. The furcation body 270F may also be secured to the connection port insert in the manner desired.

[0096] **FIGS. 6-9** depict similar multiports and will be discussed together and **FIG. 10** depicts a suitable connection port insert 230 for these multiports. **FIG. 6** is a front perspective view of multiport 200 having an input connection port 200 configured for receiving furcation body 260F of an input tether 270 as discussed, and **FIG. 7** is a front perspective view of another multiport similar to **FIG. 6** having an input tether 270 attached to the connection port 260 and configured as a stub cable. **FIG. 8** is a partially exploded view of a multiport similar to the multiport of **FIG. 7** showing the connection port insert 230 removed from shell 210 and the input tether 270 terminated with fiber optic connector 278. **FIG. 9** depicts a perspective view of the input connection insert of **FIGS. 7 and 8**, which is similar to the connection port insert 230 of **FIG. 6**.

[0097] As depicted in **FIGS. 6-10**, input connection insert 230 comprises a fiber tray (not numbered) integrated with the body 232. Fiber tray may include one or more supports 230S for providing strength for shell 210 to withstand any crushing forces. Including supports for multiports 200 greatly improves the strength between the opposing walls, and the supports may be included on other components such as the shell 210 or the integrated in a separate fiber tray such as depicted in the multiport 200 of **FIG. 41**. Supports 230S may also act as fiber routing guides 230G to inhibit tight bending or tangling of the optical fibers and aid with slack storage of optical fibers 250. Other embodiments can have other designs besides the body 232 of the connection port insert 230 comprising one or more fiber routing guides 230G or supports 230S. For instance, the fiber tray with supports or guides could be a dedicated component of multiports 200 (see **FIG. 41**).

[0098] As shown in **FIGS. 7 and 9**, connection port inserts 230 may also comprise a sealing location 230SL to provide a surface and location for making a weatherproof attachment to shell 210. Sealing location may be disposed at a first distance D1 from the front face 234 of the connector port insert 230. Sealing location is disposed at a suitable distance D1 for providing a suitable seal with the shell 210. Connection port inserts 230 also have a connector mating plane 230MP disposed at a second distance D2 from the front face 234. The connector mating plane 230MP is disposed within the cavity of the shell 210 of the multiport for protecting the connector mating interface. In some particular embodiments, the connector port insert 230 comprises a sealing location 230SL disposed at a first distance D1 from the front face 234 and the connector mating position 230MP is disposed at the second distance D2 from the front face 234 with the second distance D2 being greater than the first distance D1.

[0099] The connection port passageways 233 may be configured for the specific connector 10 intended to be received externally into the multiport 200. Moreover, the connection port passageways 233 may be configured to provide a weatherproof seal with connector 10 or dust cap 295 for inhibiting dust, dirt, debris or moisture from entering the multiport 200 at a connection port passageway sealing surface 233SS (see **FIG. 11**). Likewise, the connection port passageways 233 should be configured to receive the specific rear connector 252 from the rear portion 237 for mating and making an optical connection with the connector 10. The connection port insert 230 shown in **FIG. 9** is configured as a monolithic (e.g., integral) component for making the optical connection between the rear connectors 252 and the external connectors 10 of cable assembly 100; however, other embodiments are possible according to the concepts disclosed that use multiple components. For instance, the connection port insert 230 may be configured to secure one or more adapters 230A thereto, and the adapters 230A can “float” relative to the connection port insert 230. “Float” means that the adapter 230A can have slight movement in the X-Y plane for alignment, but is essentially inhibited from moving in the Z-direction along the axis of connector insertion so that suitable alignment may be made between mating connectors.

[00100] **FIGS. 10 and 11** depict sectional views showing the optical connections between respective rear connectors 252 attached at the rear portion 237 of the connection

port insert 230 of the multiport 200 and connectors 10 of cable assemblies 100 attached from the front face 234, and are similar to the optical connections shown in multiports 200 of **FIGS. 6-9**. **FIG. 12** is an isolated perspective view of the optical connection between rear connector 252 and connector 10 as represented in **FIG. 11**.

[00101] Rear connector 252 shown in **FIGS. 10-12** comprises a ferrule 252F attached to optical fiber 250 and a retention body 252R attached to ferrule 252F, thereby forming a simple connector. Retention body 252R comprises a plurality of arms 252A with a protrusion 252P for securing the rear connector 252 with the retention feature 233A in the connection port passageway 233. As shown, the connector mating plane 230MP is disposed within the cavity of the shell 210 of the multiport for protecting the connector mating interface. As shown in **FIG. 12**, connector 10 comprises at least one O-ring 65 for sealing with the connection port passageway 233 when fully inserted into the connection port 236. Moreover, some connectors 10 may have a locking feature 20L on the housing 20 for cooperating with a securing feature 310 of multiports 200 if desired and discussed in more detail below.

[00102] Rear connectors 252 can have other configurations for use with the multiports disclosed herein. By way of example, rear connectors 252 may comprise a resilient member for biasing the rear connector ferrule 252F. Additionally, rear connectors 252 may further comprise a keying feature. Likewise, connection port insert 230 can have other configurations for use with the multiports disclosed herein. By way of example, the connection port insert may comprise a plurality of adapters 230A that are integrally-formed with the connection port insert 230.

[00103] **FIGS. 13-15** respectively are a rear perspective sectional view, a top view and a rear perspective view of the optical connections and features of another connection port insert 230. Connection port insert 230 shown in **FIGS. 13-15** comprise one or more adapters 230A that are integrally formed with the connection port insert 230. In this particular example, the plurality of adapters 230A that are integrally formed with connection port insert 230 are configured for receiving SC connectors. Thus, rear connector 252 shown in **FIG. 14** has a SC footprint. The SC connectors used as the rear connector 252 has a keying feature 252K that cooperates with the keying feature of adapter 230A. Additionally, adapters 230A comprise a retention feature 233A disposed

in the connection port passageway 233 and are configured as latch arms for securing a SC connector at the rear portion 237 of connection port insert 230. As best shown in **FIG. 15**, connection port insert 230 depicts comprises a plurality of slots 230S for receiving one or more securing features 310 that translate for engaging with a suitable locking portion 20L of connector 10 or the like.

[00104] Connection port insert 230 may have the input connection port 260 disposed in any suitable location on the connection port insert 230. The previous embodiments of the connection port insert 230 depicted the input connection port 260 disposed in an outboard position of the connection port insert 230. However, the input connection port 260 may be disposed in a medial portion of the connection port insert 230 as desired. As best shown in **FIG. 15**, connection port insert 230 has input connection port 260 disposed in a medial portion of the connector port insert 230. Further, the integrated adapters 230A are arranged in groups on either side of the input connection port 260 as depicted. Specifically, connection port insert 230 of **FIGS. 13-15** has a first group of integrated adapters 230A1 and a second group of integrated adapters 230A2 disposed on opposite sides of input connection port 260. Consequently, the connection port insert 230 of **FIGS. 13-15** comprises a plurality of connection port sections 232A, 232B.

[00105] **FIG. 16 and 16A** are rear perspective sectional views of a representative force diagram for the force interactions between the mating optical connections. In particular, the force diagrams are directed to mating optical connections where both sides of the mated optical connection may be displaced. Simply stated, the forces should between the both sides of these types of mated optical connections may be displayed there may be concerns with one side of the mated connection to over-travel beyond its desired location, which may lead to optical performance issues especially if the connection experiences several matings and uses a floating ferrule sleeve for alignment. This over-travel condition typically is not of concern for mated connections where only side of the connection may be displaced and the other side is fixed. An example of both sides of the mated optical connection being able to be displaced is represented when both connectors have ferrules that are biased and mated within a ferrule sleeve such as when a SC connector is mated with a connector 10 as depicted in **FIG. 16A**. Other embodiments could have an adapter sleeve that is biased instead of the rear connector ferrule being

biased, which would result in a similar concern for being aware of forces that may result in over-travel conditions that could impact optical performance.

[00106] Multiports 200 that mate a rear connector 252 such as a SC with connector 10 that has a SC ferrule that is biased forward should have a spring force in connector 10 that mitigates concerns when mated within a ferrule sleeve or use a connector 10 that has a fixed ferrule for mitigating concerns. The spring force for connector 10 should be selected to be in a range to overcome sleeve friction and the spring force of the rear connector 10. By way of explanation, when the rear connector 252 is first inserted into the adapter 230A of connection port insert 230, the ferrule 252F of the rear connector 252 contact the ferrule sleeve 230FS and may displace the ferrule sleeve 230FS to extreme position on the right before the ferrule sleeve 230FS hits a physical stop in the adapter and the ferrule 252F is inserted into the ferrule sleeve 230FS. Thus, when the connector 10 is later inserted into the connector port 236 of the multiport it would be helpful for the ferrule to push the ferrule sleeve 230FS from an extreme position in the adapter if it was displaced. Consequently, the spring selected for biasing the ferrule of connector 10 should overcome the sum of initial friction along with the insertion friction to move the ferrule sleeve 230FS, thereby inhibiting the ferrule sleeve 230FS from being displaced at a maximum displaced position due to the rear connector 252 being inserted for mating first. **FIGS. 17A-18C** are perspective views of shells 210 for multiports 200 having various configurations. As depicted, shells 210 are monolithically formed and comprise at least a first end 212 having a first opening 214 leading to a cavity 216. Other variations of shells 210 may comprise a second end 213 having a second opening 215 such as depicted herein. Second opening 215 is configured for receiving a second insert 230' so that at least a portion of the second insert 230' fits into the second opening 215 and cavity 216 of shell 210. Second insert 230' may comprise a body 232 having a front face 234 and comprise a plurality of connection ports 236 having an optical connector opening 238 like the connection port insert 230. Shells 210 may be made from any suitable material such as metal or plastic and may have any suitable shape as desired. As discussed with other embodiments, multiports may include mounting features 210M integrated into the shell 210. Additionally, shells 210 may comprise at least one support



210S disposed within cavity 216, thereby providing crush support for the multiport and resulting in a robust structure.

[00107] Shells 210 and connector port inserts 230 allow relative small multiports 200 having a relatively high-density of connections along with an organized arrangement for connectors 10 exiting the multiports 200. Shells have a given height H, width W and length L that define a volume for the multiport as depicted in **FIG. 19C**. By way of example, shells 210 may define a volume of 800 cubic centimeters or less, other embodiments of shells 210 may define the volume of 400 cubic centimeters or less, other embodiments of shells 210 may define the volume of 100 cubic centimeters or less as desired. Some embodiments of multiports 200 comprise a connection port insert 230 having a density of at least one connection port 236 per 20 millimeters of width W of the connection port insert. Likewise, embodiments of multiports 200 may comprise a given density per volume of the shell 210 as desired.

[00108] Furthermore, multiports 200 may have any suitable arrangement of connection ports 236 in connector port insert 230. By way of explanation, **FIGS. 19A-19C** are perspective views of various other multiports 200 having other form-factors such as multi-row arrays in similar sized packages. In other words, the multiports 200 of **FIGS. 19A-19C** have similar lengths L and widths W, but by slightly changing the height H of the multiports 200 the density of connectors per width of the multiport may be significantly increased. For instance, multiport 200 of **FIG. 19A** has four connector ports for its volume with a given height H, with a small increase in height H multiport 200 of **FIG. 19B** has eight connector ports for its volume, and with another small increase in height H multiport 200 of **FIG. 19C** has twelve connector ports for its volume. Part of the increase in connection port density per volume is attributable to the staggered position of the connection ports 236 in the rows. Although, the multiports shells depicted have generally planar major surfaces other suitable shapes are possible such as a curved shell or other shapes as desired. The skilled person will immediately recognize the advantages of the multiports of the present disclosure over the conventional multiports.

[00109] Table 1 below compares representative dimensions, volumes, and normalized volume ratios with respect to the prior art of the shells (i.e., the housings) for multiports having 4, 8 and 12 ports as examples of how compact the multiports of the present

application are with respect to convention prior art multiports. Specifically, Table 1 compares examples of the conventional prior art multiports such as depicted in FIG. 1 with multiports having a linear array of ports and a staggered array of ports such as shown in FIGS. 19A-19C. As depicted, the respective volumes of the conventional prior art multiports of FIG. 1 with the same port count are on the order of ten times larger than multiports with the same port count as disclosed herein. By way of example and not limitation, the shell of the multiport may define a volume of 400 cubic centimeters or less for 12-ports, or even if double the size could define a volume of 800 cubic centimeters or less for 12-ports. Shells for smaller port counts such as 4-ports could be even smaller such as the shell defining a volume of 100 cubic centimeters or less for 4-ports, or even if double the size could define a volume of 200 cubic centimeters or less for 4-ports. Consequently, it is apparent the size (e.g., volume) of multiports of the present application are much smaller than the conventional prior art multiports of FIG.1. In addition to being significantly smaller, the multiports of the present application do not have the issues of the conventional prior art multiports depicted in FIG. 2. Of course, the examples of Table 1 are for comparison purposes and other sizes and variations of multiports may use the concepts disclosed herein as desired.

**[00110]** One of the reasons that the size of the multiports may be reduced in size with the concepts disclosed herein is that the connectors 10 that cooperate with the multiports may have locking features 20L that are integrated into the housing 20 of the connectors. In other words, the locking features for securing connector 10 are integrally formed in the housing 20 of the connector, instead of being a distinct and separate component like the conventional connector. Conventional connectors for multiports have threaded connections that require finger access for connection and disconnecting. By eliminating the threaded coupling nut (which is a separate component that must rotate about the connector) the spacing between conventional connectors may be reduced. Also eliminating the dedicated coupling nut from the conventional connectors also allows the footprint of the connectors to be smaller, which also aids in reducing the size of the multiports disclosed herein.

| Multiport Type      | Port Count | Dimension LxWxH<br>(mm) | Volume (cm <sup>3</sup> ) | Normalized<br>Volume Ratio |
|---------------------|------------|-------------------------|---------------------------|----------------------------|
| Prior Art<br>FIG. 1 | 4          | 274 x 66 x 73           | 1320                      | 1.0                        |
|                     | 8          | 312 x 76 x 86           | 2039                      | 1.0                        |
|                     | 12         | 381 x 101 x 147         | 5657                      | 1.0                        |
| Linear              | 4          | 76 x 59 x 15            | 67                        | 0.05                       |
|                     | 8          | 123 x 109 x 15          | 201                       | 0.10                       |
|                     | 12         | 159 x 159 x 15          | 379                       | 0.07                       |
| Staggered           | 4          | 76 x 59 x 15            | 67                        | 0.05                       |
|                     | 8          | 76 x 59 x 25            | 112                       | 0.06                       |
|                     | 12         | 76 x 59 x 35            | 157                       | 0.03                       |

**Table 1: Comparison of Conventional Multiport of FIG. 1 with Multiports of Present Application**

[00111] FIG. 20 is a top view of multiport 200 having cable assemblies 100 removably secured using retention features 233A. Multiport is similar to other multiports discussed herein, but further comprise retention features 233A that fit into a bore 230B of connector port insert 230. Bore 230B intersects a portion of the connector opening 238 so that retention features 233A intersects a portion of the connector opening 238 and provides a snap-fit with a groove, scallop or the like formed in a housing 20 of connector 10. Stated another way, when connector 10 is pushed into connector opening 238 of connection port 236 the connector 10 engages and slightly deflects the respective retention feature 233A until the retention feature 233A is seated in the groove or scallop of connector 10, thereby provide a retention for the connector 10 in the connector port. By way of example, one embodiment could have the retention feature 233A configured as a fixed plastic pin sized to snugly fit or be attached within bore 230B so a slight force is required to seat connector 10.

[00112] However, by changing the material and operation, the retention feature 233A may become a securing feature 310. By way of explanation, the pin could be configured so that it translates into and out of the paper within bore 230B and made of a more rigid material such as metal. Consequently, the metal pin could secure a dust cap 295 by

cooperating with a scallop or groove in the dust cap 295 so when the pin is in a closed position the dust cap 295 could not be removed and protects the connection port 236. When the user desired to insert a connector into the connection port 236, he would move the pin to an open position by translating the pin out of paper so the pin did not interfere with the removal of the dust cap 295. Then the user could insert the connector 10 into the connection port 236 and translate the pin back into the paper so that the pin engaged a complementary scallop or groove on connector 10 and removal of the connector is inhibited. Thus, the retention 233A becomes securing feature 310 for securing the connector 10 within the connection port 236. Alternatively, the pin could have a flat portion and when the pin is rotated to the flat portion facing the scallop or groove then insertion and removal of the connector past the pin is allowed and when the pin rotates to a round portion the scallop or groove is engaged by the pin and the connector 10 is inhibited from being removed or inserted, thereby acting as a securing feature 310. Other variations could have the pin with a flat surface that rotates as the connector 10 is inserted or removes by having the rotation of the pin being driven by the surface of the connector 10. Illustratively, FIG. 20A depicts such an arrangement for the pin acting as a securing feature 310 for connector 10.

[00113] **FIG. 21** is a perspective view of multiport 200 similar to the other multiport disclose having connector port insert 230 sealing location 230SL and an end cap 280 with sealing location 280SL. The multiport of **FIG. 21** has a sealing element 290 disposed between the connection port insert 230 and the shell 210. Any of the other multiports 200 may also use similar features as described. In this embodiment, the sealing locations 230SL, 280SL comprise respective grooves in the connector port insert 230 and end cap 280. Grooves (not numbered) of the sealing locations 230SL, 280SL extend about the perimeter of the connection port insert 230 and the end cap 280 and are located at respective distances D1 from the front face 234 of the connection port insert 230 and end cap 280. Grooves may receive one or more appropriately sized O-rings or gaskets 290A for weatherproofing multiport 200. In other words, the O-rings or gaskets 290A are disposed about a part of the connector port insert 230 and the end cap 280. As depicted, distance D1 is less than distance D2 to the connector mating plane 230MP. The O-rings are suitable sized for creating a seal between the connector port insert 230 and the shell

210 and for the end cap 280. By way of example, suitable O-rings are a compression O-ring that may maintain a weatherproof seal.

[00114] Any of the multiports 200 disclosed herein may optionally be weatherproof by appropriately sealing the connection port insert or second insert 230,230' with the shell 210 using other suitable means such as adhesive, sealant, welding, overmolding or the like. For instance, adhesive or sealant may be applied about the perimeter of the insert. Likewise, welding such as ultrasonic or induction welding may be used as appropriate for the sealing element 290. Moreover, the interface between the connection ports 236 and the dust cap 295 or connector 10 may be sealed using appropriate geometry and/or a sealing element such as an O-ring or gasket. Likewise, the input connection port may be weatherproofed in a suitable manner depending on the configuration such as a gasket, or O-ring with an optical connection or a heat shrink when using an input tether. Thus, making the multiports 200 suitable for an outdoor environment.

[00115] Multiports 200 can have other features or constructions using a second insert 230' that is similar to the connection port insert 230. For instance, the second insert 230' comprises a body 232 having a front face 234 comprising a plurality of connection ports 236 having an optical connector port opening 238 like the connection port insert 230. Second inserts 230' can have other configurations as well for use with the multiports disclosed herein. Moreover, any of the multiport designs disclosed herein may use an optical splitter 275 (hereinafter "splitter") within a cavity 216 or furcation body 270F of the multiports 200. By way of example, splitters 275 allow a single optical signal to be split into multiple signals such as 1xN split, but other splitter arrangements are possible such as a 2xN split. For instance a single optical fiber may feed an input tether 270 of multiport 200 and use a 1x8 splitter to allow eight connection ports 236 on the connection port insert.

[00116] **FIGS. 22-24** are perspective views of multiports 200 similar to the multiport of **FIG. 6**, but use one or more adapters 230AF received in the connection port insert 230 that float relative to the connection port insert 230. **FIG. 22** depicts multiport 200 having splitter 275 and a second insert 230'. Connection port insert 230 and second insert 230' both are configured to securing one or more adapters thereto where the adapters 230AF float relative to the connection port insert and the second insert 230'. Second insert 230'

is similar to connection port insert 230, but it does not have an input connector port 260 like the connection port insert, but second insert 230' comprises connection ports 236 for receiving connectors 10. Connection port insert 230 includes an integrated housing 230H for receiving individual adapters 230AF from the rear portion. Housing 230H has suitable structure for securing adapters 230AF so they float by using suitable geometry for securing the adapters 230AF. Specifically, housing 230H allows that adapters 230A to have slight movement in the X-Y plane for alignment, but essentially inhibits the adapters 230A from moving in the Z-direction along the axis of connector insertion so that suitable alignment may be made between mating connectors. Multiport of FIG. 22 also comprises a splitter 275 that receives an optical fiber 250 for a 1x16 split for feeding eight optical fibers to the connection port insert 230 and eight optical fibers to the second insert 230'.

[00117] **FIGS. 23 and 24** are perspective views of multiports 200 similar to the multiport 200 of **FIG. 22**. **FIG. 23** is a close-up of showing housing 230H and **FIG. 24** shows the connector port insert with housing 230H for showing the individual adapters 230AF. Adapters 230AF receive rear connectors 252 that are similar to the rear connectors 252 depicted in **FIGS. 10-12** for mating with connectors 10 received in respective connection ports 236 of connector port insert 230 as shown. Rear connectors 252 and connectors 10 make their optical connections at mating optical plane 230MP as discussed herein.

[00118] **FIGS. 25A and 25B** depict perspective views of multiports 200 similar to other multiports having a second insert such as disclosed herein, except that the second inserts 230' comprises at least one pass-through port 239. **FIG. 25A** shows the tethers 270 configured with boots for providing strain relief. Tethers 270 may either be configured as stub cables or may be terminated with fiber optic connectors 278 as desired. **FIG. 26** depicts a perspective view of an alternative second insert 230' having a pass-through port with an integrated adapter 230A for receiving a fiber optic connector. Second insert 230' also includes a retaining structure 230RS for securing connector 10 to the second insert 230' such as depicted in **FIG. 74D**.

[00119] **FIGS. 27-30** are various views of multiports having one or more attachment features 240. As depicted, the connector port insert 230 or second insert 230' further

comprise one or more attachment features 240. By way of explanation, the attachment features 240 are dovetail openings 240A or a dovetail protrusion 240B disposed on the connection port insert 230 or second insert 230'. **FIGS. 27 and 28** show the one or more attachment features 240 may comprise a top attachment feature 240A and a bottom attachment feature 240B where the top attachment feature 240A is offset from the bottom attachment feature 240B along a longitudinal direction of the connector port insert. **FIG. 29** shows the one or more attachment features 240 are arranged along a longitudinal direction of the multiport 200 and **FIG. 30** shows the one or more attachment features 240 are arranged transverse to a longitudinal direction of the multiport 200.

[00120] **FIGS. 31-38** are various views of multiports 200 and designs associated with mounting structures 300 for the multiports 200. Specifically, the mounting structure 300 comprises a cover 306. In some embodiments, the cover 306 pivots relative to a base 302. **FIG. 38** shows a mounting structure 300' for multiport 200 that may rotate.

[00121] **FIGS. 39A-39C** are various perspective views of multiports 200 having at least one securing feature 310 associated with one or more of the connection ports 236. Although, this multiport 200 is shown with a connection port insert 230, the construction of this multiport may be similar to the multiport of **FIG. 5** with a first portion 210A of the shell 210 having the connection port 236 formed therein as well as the other multiports disclosed herein. Multiport 200 of **FIGS. 39A-39C** comprise an input connection port 260 suitable for making a connection with a fiber optic connector 262 of the input tether similar to the multiport of **FIGS. 3 and 4**. In this embodiment, securing feature 310 has an open position OP and a closed position CP. Securing feature 310 translates between the open position OP and the closed position, but other securing features may rotate when transitioning from positions. In the open position OP the dust cap 295 may be removed and the connector 10 inserted into connection port 236. The open position for the securing feature 310 occurs when the securing feature is translated to an upward position to stick-up from the slots 230S and the closed position occurs when the securing feature 310 is translated to fully-seated within the respective slot 230S. However, the securing feature 310 may have other positions as discussed herein.

[00122] Any suitable type of securing features may be used with the concepts disclosed herein and examples of the same are disclosed. Depending on the type of

securing feature different types of actuation movement may be used for translation such as rotation, translation, or deforming of components. Further, embodiments may include other components such as protectors or covers 230C for keeping dirt, debris and other contaminants away from the actuation mechanism as desired.

[00123] By way of example and illustration, securing feature 310 of the multiport of **FIGS. 39A-39C** is a U-clip that translates within a respective slot 230S formed in connection port insert 230. U-Clip is shown in further detail in **FIGS. 52A-52D**. Each securing feature 310 of this embodiment is associated with a single connection port 236 such as shown in **FIGS. 39A-39C** so that a securing feature 310 must be translated when accessing an individual connection port 236. Securing feature 310 interfaces with the locking feature 20L disposed on the housing of connector 10 for securing or releasing connector 10. Likewise, the securing feature 310 interfaces with a the locking feature disposed on the dust cap 295 for securing or releasing dustcape 295 as desired.

[00124] **FIGS. 40A-40C** are various perspective views of multiport 200 similar to the multiports of **FIGS. 39A-39C** having at least one securing feature 310 associated with each connection port 236 and is configured as a U-clip. Multiport 200 of **FIGS. 40A-40C** comprises an input tether 270 similar to the multiport of **FIG. 5** and will not be discussed with this embodiment for brevity. Moreover, the designs with securing features may use any suitable concepts or features disclosed herein. **FIG. 40C** depicts the securing feature 310 on the near end of the multiport 200 in an open position OP with a connector 10 aligned for insertion into the connection port 236.

[00125] **FIG. 41** is a front exploded view of the multiport 200 of **FIGS. 40A-40C** and **FIGS. 42** is a partially rear exploded view of a portion of the multiport 200 of **FIGS. 40A-40C**. **FIGS. 43-45** are various assembled views of a portion of the multiport 200 of **FIGS. 40A-40C** with the shell 210 removed for clarity. Multiport 200 of **FIGS. 40A-40C** comprises shell 210 having a first opening 214 leading to a cavity 216 and a connection port insert 230 similar to other multiports 200. The connection port insert 230 of multiport 200 is configured to secure one or more adapters 230AF thereto, where the adapters 230AF float relative to the connection port insert. Adapters 230AF are configured to receive rear connectors 252 with a SC footprint and the respective adapters 230AF include ferrule sleeves 250FS for aligning mating ferrules between rear



connectors 252 and connector 10. Adapters 230AF may be ganged together or formed individually. Moreover, the adapters 230AF may be formed from several components, but some components could be integrally formed. This multiport include a fiber tray 220 that is a discrete component that may attach to connector port insert 230. Like other fiber trays, this fiber tray includes supports 220S and fiber routing guides 220G. Support 220S provides crush strength to the shell 210.

[00126] As best shown in **FIG. 42**, input tether 270 is secured to the connection port insert 230 using a collar 273 that fits into cradle 273C (see **FIG. 46B**) of the connection port insert 230. This attachment of the input tether 270 using collar 273 and cradle 273C provides improved pull-out strength and aids in manufacturing; however, other constructions are possible for securing the input tether 270. Input tether 270 may also comprise tubes 271 for organizing and protecting the optical fibers 250 as they transition to the respective connection port sections 230A1 and 230A2 and route about supports 220S. Tubes 271 also protected the optical fibers from overly tight bends, pinching and tangling, but may be omitted as desired.

[00127] **FIGS. 46A and 46B** are front and rear perspective views of the connection port insert 230 and **FIGS. 47A and 47D** are various views of the connection port insert 230 multiport of **FIGS. 40A-40C**. Connection port insert 230 is similar to other connection port inserts, but comprises a plurality of fingers 230F for securing the adapters 230AF so they may float. As depicted, connection port insert 230 has slots 230S molded therein for receiving the securing features 310 therein in a translating manner. Securing features 310 of the multiport 200 of **FIGS. 40A-40C** may have more than two positions as desired. By way of example, **FIGS. 48A-48C** are perspective views of the connection port insert 230 and a securing feature 310 for explaining the open position OP, intermediate position IP and close position CP for the securing features 310 relative to connector 10 being inserted into the connection port 236. This explanation is also suitable for the dust caps 295. **FIG. 48A** depicts the securing feature 310 in an open position where the securing feature translates to the extended position where connector 10 may be freely inserted or removed from the connection port 236. **FIG. 48B** depicts the securing feature 310 in an intermediate position where the securing feature translates to a middle position where connector 10 may be inserted or removed from the connection

port with some effort required to overcome the interference with the securing feature 310. This is advantageous if a user wishes to work in difficult location and needs his hands free since unintended disconnection is not as likely. **FIG. 48C** depicts the securing feature 310 in a closed position where the securing feature translates to fully seated position and the connector 10 will not be inserted or removed without great difficulty or damage.

[00128] **FIG. 49** is an isolated perspective view of securing feature 310 and connector 10 of **FIGS. 48A-48C**. A depicted the tapered portion 310TP of the legs of the securing feature 310 push the connector 10 forward for mating after engaging the securing feature 310. However, other types of securing features 310 configured as clips may be used with the concepts disclosed. By way of example, **FIG. 49A** show securing feature 310 formed as a bent wire that cooperates with the multiport for securing connector 10. Likewise, **FIGS. 49B and 49C** depict another securing feature 310 configured as a flexible or deformable wire that cooperates with the multiport for securing connector 10.

[00129] **FIGS. 50 and 51** respectively are detailed top and perspective views of the connector port insert 230 having slots 230S for cooperating with securing feature 310 of **FIGS. 48A-48C** and securing the connector 10 in multiports 200. Generally speaking, the slots 230S may have a generally T-shaped opening for receiving a rolled edge 310RE of securing feature 310 and a bell-shaped recess at the top for receiving a portion of handle 310H. Moreover, the slots 230 may include protruding stops PS for helping the user stop at the correct positions.

[00130] **FIGS. 52A-52D** are various views of the securing feature 310 that translates within the slots 230S. Securing feature 310 comprises legs 310L that are flexible along the lateral axis so they can spread when the connector 10 is pushed-in or pulled-out when in the intermediate position IP. Rolled edges 310RE provide stiffness and durability for the securing feature. Securing feature 310 may also have a handle 310H to help grab and move the securing feature 310. The securing feature 310 may also include a hydrophobic coating for weather-resistance such as PTFE as desired.

[00131] **FIGS. 53 and 54** are perspective and partially assembled views of other multiports 200 similar to the multiports of **FIGS. 40A-40C** having multiple adapters ganged together in common adapter blocks 200A1, 200A2 on either side of the input

tether. **FIG. 55** is a sectional view of the optical connections of the multiport in **FIGS. 53 and 54** showing the optical connection between a rear connector 252 and connector 10 being mated in the common adapter block 200A2.

[00132] **FIGS. 56 and 57** are perspective views of another multiport 200 similar to **FIGS. 40A-40C** showing a different dust cap configuration that can be mated with the dust cap 70 of the optic connector 10 for storage. Specifically, the dust cap 295 of multiport 200 is suitable for attaching to the dust cap 70 of connector 10 when connector 10 is optically connected with multiport 200 to prevent loss of the dust caps and inhibit dust, debris or the like to contaminate the dust caps. The dust caps of the multiport 200 are tethered to the multiport 200 so the mated dust caps 70,295 will not be lost.

[00133] **FIGS. 58A-58C** are perspective views of another multiport similar to **FIGS. 40A-40C** showing another dust cap configuration for storage. In this configuration, the multiport 200 has ganged dust caps 295G with each dust cap 295 attached to a rail 295R by a tether 295T. The rail 295R is configured to engage a groove 230DR formed in the connection port insert 230. Consequently, the dust caps 295 of the multiport 200 are tethered to the multiport 200 so the dust caps 295 will not be lost.

[00134] **FIGS. 59A-59D** are perspective views of still another multiport 200 similar to **FIGS. 40A-40C** showing yet another dust cap configuration that is similar to the dust cap configuration of **FIGS. 58A-58C**. In this case, the multiport 200 has ganged dust caps 295G with each dust cap 295 attached to a rail 295R by a tether 295T. The rail 295R is configured to engage a bores 230DB formed in the connection port insert 230 using protrusions 295P on rail 295R that cooperate with bores 230DB. Consequently, the dust caps 295 of the multiport 200 are tethered to the multiport 200 so the dust caps 295 will not be lost.

[00135] **FIGS. 60-64** are perspective and sectional views of still another multiport 200 having at least one rotating securing feature 310 associated with a plurality of connection ports 236. The multiport 200 depicted in **FIGS. 60-64** comprises connection port insert 230 having at least one flexure 230F (see **FIG. 62**) associated with at least one of the connection ports 236. In this multiport 200 each connection port 236 has a dedicated flexure 230F disposed on the connection port insert 230. The securing feature 310 of this multiport 200 is associated with a plurality of flexures 230F. Like the translating

securing feature 310, the rotating securing feature 310 has an open position OP and a closed position CP. The rotating securing feature 310 comprises a cam surface 310CS that determines whether the flexures 230F are deflected or not based on the rotational position of the cam surface. Further, the rotating securing feature 310 may be configured for comprising an open position OP, an intermediate position IP and a closed position CP if desired by configuring the cam surface 310CS to provide the three positions based on the degree of deflection of the flexure 230F. The securing feature 310 depicted in **FIGS. 60-64** deflects at least one and in this case a plurality of flexures 230F when in the closed position CP.

[00136] As depicted in **FIG. 60**, multiport 200 comprises two securing features 310. Specifically, a first securing feature operates the flexures 230F on a first side of input tether 270 and a second securing feature operates the flexures 230F on the second side of input tether 270. **FIG. 61** is a detailed perspective view of flexure 230F being associated with at least one of the connection ports 236. In this case, each securing feature 310 is associated with four connection ports 236 and cooperates with four flexures 230F. **FIG. 62** is a sectional view depicting cam surface 310CS. Connection port insert 230 comprises one or more bores for receiving a portion of the at least one securing feature 310 as shown. In this case, bore 230B is arranged transversely to a longitudinal axis LA of the connection port insert. When cam surface 310CS deflects flexure 230F the flexure 230F engages the locking feature 20L on the housing of connector 10 to determine which position is achieved open position, intermediate position or closed position. **FIG. 64** depicts the cam surfaces 310CS of securing feature 310 uses the multiport 200 of **FIGS. 60-64**. Securing feature 310 also includes a handle 310H that is accessible near the end of the connection port insert as shown in **FIG. 64**. Other variations of these concepts are also possible such as having the securing feature 310 cooperate with more or less connection ports 236. Likewise, the securing feature may have different orientations relative to the connection port insert.

[00137] **FIGS. 65-66** are perspective views of still other multiports 200 similar to the multiport 200 of **FIGS. 60-64** having at least one rotating securing feature associated with a plurality of connection ports. Like the multiport 200 of **FIGS. 60-64**, this multiport 200 comprises the connection port insert 230 having at least one flexure 230F

associated with at least one of the connection ports 230 just like before; however, in these embodiments the second insert is used that is similar to the first connection port insert. Thus, both ends of shell 210 have connection port inserts with securing features 310 such as described with respect to **FIGS. 60-64**.

[00138] **FIGS. 67-69** are perspective views of still another multiport having a dedicated rotating securing feature 310 associated with each connection port and the connection port insert 230 having a flexure 230F associated with each of the connection ports 236. The operation of this multiport 200 is very similar to the operation of the multiport 200 in **FIGS. 60-64**, except that each connector port has a dedicated securing feature 310 to individually control the flexure 230F for each connection port 236. In other words, the eight connection ports 236 each has their own securing feature to deflect the flexure 230F associated with each connection port 236. Thus, each securing feature cooperates with only one flexure 230F for this configuration. To accomplish this arrangement, the securing features 310 are angled with respect the horizontal axis. Moreover, the flexures 230F are also angle with the horizontal axis to allow room for the securing features 310. Like the other embodiments the cam surfaces 310CS can be tailor to provide the desired positions either open position and closed position or add an intermediate position between the open position and closed position. Like the other embodiments, the securing feature 310 may also work with the dust cap such as shown in **FIG. 70**. **FIG. 71** shows details of how the securing feature 310 is disposed with the bore 230B of the connection port insert. **FIG. 72** shows the arrangement of the securing features 310 with the connection port insert 230 removed to depict the angled arrangement.

[00139] **FIGS. 74A and 74B** are perspective and sectional views of another multiport 200 showing a translating securing feature 310 associated with each connection port 236 and a flexure 230F. Each connection port 236 has its own securing feature 310 to deflect the flexure 230F associated with each connection port 236; however, several flexures 230F may be driven by a single securing feature 310 if desired. This construction uses securing features 310 that translate from left-to-right so that a protrusion 310P disposed on each securing feature 310 drives each flexure 230F as best shown in **FIG. 74B**. Like the other embodiments the protrusion or flexures may be tailored for providing the

desired positions either open position and closed position or add an intermediate position between the open position and closed position. Like the other embodiments, the securing feature 310 may also work with the dust cap such as shown in **FIG. 74B**. Further, the connection port insert 230 may further comprise a cover 230C for protecting the securing mechanism from dirt, debris and the like. Cover 230C may also inhibit unintended actuation of the securing features 310 when in the closed position.

[00140] **FIG. 75** is a partial sectional view of another multiport 200 showing a translating securing feature 310 associated with each connection port 236 and a flexure 230F similar to the embodiment shown in **FIGS. 74A and 74B**. Each connection port 236 has its own securing feature 310 to deflect the flexure 230F associated with each connection port 236; however, several flexures 230F may be driven by a single securing feature 310 if desired. This construction uses securing features 310 that translate from front-to-back so that a protrusion 310P on the securing feature 310 drives each flexure 230F. Like the other embodiments the protrusion or flexures may be tailored for providing the desired positions either open position and closed position or add an intermediate position between the open position and closed position. Like the other embodiments, the securing feature 310 may also work with the dust cap. Further, the connection port insert 230 may further comprise a cover 230C for protecting the securing mechanism from dirt, debris and the like.

[00141] **FIG. 76** is a partial view of another multiport 200 showing a rotating securing feature 310 associated with each connection port 236 and a flexure 230F similar to other embodiments. Each connection port 236 has its own securing feature 310 to deflect the flexure 230F associated with each connection port 236. This construction uses securing features 310 that rotates about the Z-axis from left-to-right so that a protrusion 310P on the securing feature 310 drives each flexure 230F. In this embodiment the securing feature 310 acts like a toggle, but could be tailored for providing the desired positions either open position and closed position or add an intermediate position between the open position and closed position. Like the other embodiments, the securing feature 310 may also work with the dust cap. Further, the connection port insert 230 may further comprise a cover 230C for protecting the securing mechanism from dirt, debris and the like. Other variations of securing features that rotate about the Z-axis are also possible such as

rotating partially concentric with the port instead of having the axis of rotation at a distance from the middle of the port.

[00142] FIG. 77 is a partial top view of another multiport 200 showing a rotating securing feature 310 associated with each connection port 236 and a flexure 230F similar to the embodiment shown in FIG. 76. Each connection port 236 has its own securing feature 310 to deflect the flexure 230F associated with each connection port 236. This construction uses securing features 310 that rotates about the Y-axis from left-to-right so that a protrusion 310P on the securing feature 310 drives each flexure 230F. In this embodiment the securing feature 310 acts like a toggle, but could be tailored for providing the desired positions either open position and closed position or add an intermediate position between the open position and closed position. Like the other embodiments, the securing feature 310 may also work with the dust cap. Further, the connection port insert 230 may further comprise a cover 230C for protecting the securing mechanism from dirt, debris and the like.

[00143] FIG. 78 is a perspective view of a portion of a connection port insert 230 for a multiport having a securing feature associated with each connection port that receives a connector 10 having a partial-turn securing feature.

[00144] FIGS. 79A-79D are a perspective views of an connection port insert 230 and variation configured as single adapter port that may be used with multiports 200 disclosed herein such as at entry and exit locations.

[00145] The present application also discloses methods for making a multiport. One method comprises inserting a connection port insert 230 into an opening 214 disposed in a first end 212 of an shell 210 so that at least a portion of the connection port insert 230 fits into the opening 212 and is disposed within a cavity 216 of the shell 210; and wherein the connection port insert 230 comprises a body 232 having a front face 234 and a plurality of connection ports 236 with each connector port 236 having an optical connector opening 238 extending from the front face 234 into the connection port insert 230 with a connection port passageway 233 extending through part of the connection port insert to a rear portion 237.

[00146] Another method for making a multiport comprises routing a plurality of optical fibers 250 from one or more rear portions 237 of a plurality of connection ports

236 of a connection port insert 230 so that the plurality of optical fibers 250 are available for optical communication at an input connection port 260 of the connection port insert 230. Then inserting the connection port insert 230 into an opening 214 disposed in a first end 212 of a shell 210 so that at least a portion of the connection port insert 230 fits into the opening 212 and is disposed within a cavity 216 of the shell 210; and wherein the connection port insert 230 comprises a body 232 having a front face 234 and a plurality of connection ports 236 with each connector port 236 having an optical connector opening 238 extending from the front face 234 into the connection port insert 230 with a connection port passageway 233 extending through part of the connection port insert to the rear portion 237.

[00147] The methods disclosed may further include installing at least one securing feature 310 into the connection port insert 230 so that the at least one securing feature 310 is associated with one or more of the plurality of connection ports 236. The securing feature 310 may include an open position OP and a closed position CP. The method may include translating or rotating the at least one securing feature 310 to the open position OP and the closed position CP.

[00148] The method may also comprise a connector port insert 230 having one or more slots 230S for receiving a portion of the at least one securing feature 310. The securing feature may be a U-clip with the methods disclosed.

[00149] The methods of actuating the securing features may comprises one or more bores 230B for receiving a portion of the at least one securing feature 310. Further, the one or more bores 230B may be arranged transversely to a longitudinal axis LA of the connection port insert 230. The securing feature may comprises a cam surface 310C. The method of actuating may comprise a plurality of securing features 310 associated with one or more of the plurality of connection ports 236 or using a single securing feature 310 associated with a plurality of connection ports 236. Additionally, the step of actuating the at least one securing feature 310 may comprises an intermediate position IP, wherein the intermediate position IP permits connector insertion into the one or more of the plurality of connection ports 236 and connector removal into the one or more of the plurality of connection ports 236.



[00150] Methods of making multiport make also include providing connection port inserts 230 having one or more flexures that cooperate with one or more securing features 310 as disclosed herein.

[00151] Although the disclosure has been illustrated and described herein with reference to explanatory embodiments and specific examples thereof, it will be readily apparent to those of ordinary skill in the art that other embodiments and examples can perform similar functions and/or achieve like results. All such equivalent embodiments and examples are within the spirit and scope of the disclosure and are intended to be covered by the appended claims. It will also be apparent to those skilled in the art that various modifications and variations can be made to the concepts disclosed without departing from the spirit and scope of the same. Thus, it is intended that the present application cover the modifications and variations provided they come within the scope of the appended claims and their equivalents.

We claim:

1. A multiport (200) for providing an optical connection, comprising:  
a shell (210) comprising a first end (212) having a first opening (214) leading to a cavity (216); and  
a connection port insert (230) comprising a body (232) having a front face (234) and at least one connection port (236) comprising an optical connector opening (238) extending from the front face (234) into the connection port insert (230) with a connection port passageway (233) extending through part of the connection port insert (230) to a rear portion (237), wherein the connection port insert (230) is sized so that at least a portion of the connection port insert (230) fits into the first opening (214) and the cavity (216) of the shell (210).
2. The multiport of claim 1, the connection port passageway (233) further comprising a retention feature (233a).
3. A multiport (200) for providing an optical connection, comprising:  
a shell (210) comprising a first end (212) having a first opening (214) leading to a cavity (216); and  
a connection port insert (230) comprising a body (232) having a front face (234) and at least one connection port (236) comprising an optical connector opening (238) extending from the front face (234) into the connection port insert (230) with a connection port passageway (233) extending through part of the connection port insert (230) to a rear portion (237) and comprising a retention feature (233A) associated with the connection port passageway (233), wherein the connection port insert (230) is sized so that at least a portion of the connection port insert (230) fits into the first opening (214) and the cavity (216) of the shell (210).
4. The multiport of any one of claims 1-3, further comprising at least one optical fiber (250) being routed from the at least one connection port (236) toward an input connection port (260) for optical communication at the input connection port (260).

5. A multiport (200) for providing an optical connection, comprising:

a shell (210) comprising a first end (212) having a first opening (214) leading to a cavity (216);

a connection port insert (230) comprising a body (232) having a front face (234) and at least one connection port (236) comprising an optical connector opening (238) extending from the front face (234) into the connection port insert (230) with a connection port passageway (233) extending through part of the connection port insert (230) to a rear portion (237), wherein the connection port insert (230) is sized so that at least a portion of the connection port insert (230) fits into the first opening (214) and the cavity (216) of the shell (210); and

at least one optical fiber (250) being routed from at least one connection port (236) toward an input connection port (260) for providing optical connectivity with the multiport (200).

6. The multiport of any one of claims 1-5, further comprising at least one rear connector (252) in communication with the at least one connection port passageway (233) from the rear portion (237).

7. A multiport (200) for providing an optical connection, comprising:

a shell (210) comprising a first end (212) having a first opening (214) leading to a cavity (216);

a connection port insert (230) comprising a body (232) having a front face (234) and at least one connection port (236) comprising an optical connector opening (238) extending from the front face (234) into the connection port insert (230) with a connection port passageway (233) extending through part of the connection port insert (230) to a rear portion (237), wherein the connection port insert (230) is sized so that at least a portion of the connection port insert (230) fits into the first opening (214) and the cavity (216) of the shell (210);

at least one optical fiber (250) being routed from the at least one connection port (236) toward an input connection port (260) within the shell (210); and

at least one rear connector (252) is in communication with the at least one connection port passageway (233) from the rear portion (237), wherein the at least one rear connector is associated with the plurality of optical fibers (250).

8. A multiport (200) for providing an optical connection, comprising:

a shell (210) comprising a first end (212) having a first opening (214) leading to a cavity (216);

a connection port insert (230) comprising a body (232) having a front face (234) and at least one connection port (236) comprising an optical connector opening (238) extending from the front face (234) into the connection port insert (230) with a connection port passageway (233) extending through part of the connection port insert (230) to a rear portion (237), wherein the connection port insert (230) is sized so that at least a portion of the connection port insert (230) fits into the first opening (214) and the cavity (216) of the shell (210),

wherein the connection port insert (230) comprises a sealing location (230SL) disposed a first distance (D1) from the front face (234) and a connector mating plane (230MP) is disposed at a second distance (D2) from the front face (234) with the second distance (D2) being greater than the first distance (D1);

at least one optical fiber (250) being routed from the at least one connection port (236) toward an input connection port (260) within the shell (210); and

at least one rear connector (252) is in communication with the connection port passageway (233) from the rear portion (237), wherein the at least one rear connector is associated with the at least one optical fiber (250).

9. The multiport of any one of claims 6-8, the at least one rear connectors (252) comprising a rear connector ferrule.

10. The multiport of claim 9, the at least one rear connector (252) further comprising a resilient member for biasing the rear connector ferrule.

11. The multiport of any one of claims 6-10, the at least one rear connector (252) further comprising a keying feature.

12. The multiport of any one of claims 6-11, wherein the at least one rear connector (252) has a SC footprint.

13. The multiport of any one of claims 1-12, wherein the connection port insert (230) comprises at least one adapter (230A) that is integrally-formed with the connection port insert (230).

14. The multiport of any one of claims 1-12, wherein the connection port insert (230) is configured to secure one or more adapters (230A) thereto, wherein the one or more adapters (230 AF) float relative to the connection port insert (230).

15. The multiport of any one of claims 1-14, wherein the multiport (200) is weatherproof.

16. The multiport of any one of claims 1-15, further comprising an optical splitter (275) disposed within the cavity (216).

17. The multiport of any one of claims 1-16, the shell (210) further comprising a second end (213) comprising a second opening (215) and a second insert (230') sized so that at least a portion of the second insert (230') fits into the second opening and cavity (216) of the shell (210).

18. The multiport of any one of claims 1-16, the shell (210) further comprising a second end (213) comprising a second opening (215) and a second insert (230') sized so that at least a portion of the second insert (230') fits into the second opening and cavity (216) of the shell (210), wherein the second insert (230') comprises a body (232) having a front face (234) comprising at least one connection port (236) having an optical connector port opening (238).

19. The multiport of claim 17, the second insert being an end cap (280).
20. The multiport of claim 17, wherein the end cap (280) comprises one or more mounting features.
21. The multiport of claim 17, the second insert comprising at least one pass-through port (239).
22. The multiport of any one of claims 1-21, wherein the shell (210) is monolithically formed.
23. The multiport of any one of claims 1-22, wherein the at least one connection port (236) comprises a keying feature (236K).
24. The multiport of any one of claims 4-23, wherein the input connection port (260) is configured as a single-fiber input connection.
25. The multiport of any one of claims 4-23, wherein the input connection port (260) is configured as a multi-fiber input connection.
26. The multiport of any one of claims 4-23, wherein the input connection port (260) further comprises an input tether (270).
27. The multiport of claim 26, wherein the input tether (270) further comprises a furcation body (270F).
28. The multiport of claims 26 or 27, wherein the input tether (270) is terminated with a fiber optic connector (278).
29. The multiport of any one of claims 4-28, wherein the input connection port (260) is disposed in a medial portion of the connection port insert (230).
30. The multiport of any one of claims 4-28, wherein the input connection port (260) is disposed at an outboard portion of the connection port insert (230).

31. The multiport of any one of claims 1-30, wherein the body (232) of the connection port insert (230) comprises one or more fiber routing guides (230G) or supports (230S).

32. The multiport of any one of claims 1-31, wherein the body (232) of the connection port insert (230) comprises a plurality of connection port sections (232A,232B).

33. The multiport of any one of claims 1-32, wherein the shell (210) defines a volume of 800 cubic centimeters or less.

34. The multiport of any one of claims 1-32, wherein the shell (210) defines a volume of 400 cubic centimeters or less.

35. The multiport of any one of claims 1-32, wherein the shell (210) defines a volume of 100 cubic centimeters or less.

36. The multiport of any one of claims 1-35, wherein the shell (210) comprises at least one support (219) disposed within the cavity (216).

37. The multiport of any one of claims 1-35, wherein the connection port insert (230) has a density of at least one connection port (236) per 20 millimeters of width (W) of the connection port insert.

38. The multiport of any one of claims 1-37, further comprising one or more fasteners (210F) for securing the connection port insert (230) to shell (210)

39. The multiport of any one of claims 1-38, wherein the connection port insert (230) further comprises one or more attachment features (240).

40. The multiport of claim 39, wherein the one or more attachment features are a dovetail opening (240a) or a dovetail protrusion (240b) disposed on the connection port insert (230).

41. The multiport of claim 39, wherein the one or more attachment features (240) comprise a top attachment feature (240A) and a bottom attachment feature (240B), wherein the top attachment feature (240A) is offset from the bottom attachment feature (240B) along a longitudinal direction of the connection port insert (230).

42. The multiport of claim 41, wherein the one or more attachment features (240) are arranged along a longitudinal direction of the multiport (200) or arranged transverse to a longitudinal direction of the multiport (200).

43. The multiport of any one of claims 1-42, further including a sealing element (290) disposed between the connection port insert (230) and the shell (210).

44. The multiport of claim 41, wherein the sealing element (290) comprising one or more O-rings or gaskets (290A) disposed about a part of the connection port insert (230).

45. The multiport of claim 41, wherein the sealing element (290) comprises a adhesive, sealant or welded portion.

46. The multiport of any one of claims 1-45, further comprising a dust cap (295) sized for cooperating with one of the optical connector openings (238).

47. The multiport of any one of claims 1-46, further comprising a mounting structure (300) for receiving the multiport.

48. The multiport of claim 47, the mounting structure (300) comprising a cover (306).

49. The multiport of claim 48, wherein the cover (306) pivots relative to a base (302).

50. A method of making a multiport (200), comprising:



inserting a connection port insert (230) into an opening (214) disposed in a first end (212) of a shell (210) so that at least a portion of the connection port insert (230) fits into the opening (212) and is disposed within a cavity (216) of the shell (210); and,

wherein the connection port insert (230) comprises a body (232) having a front face (234) and at least one connection port (236) comprising an optical connector opening (238) extending from the front face (234) into the connection port insert (230) with a connection port passageway (233) extending through part of the connection port insert to a rear portion (237).

51. A method of making a multiport (200), comprising:

routing at least one optical fiber (250) from a rear portion (237) of at least one connection port (236) of a connection port insert (230) so that the at least one optical fiber (250) is available for optical communication at an input connection port (260) of the connection port insert (230);

inserting the connection port insert (230) into an opening (214) disposed in a first end (212) of a shell (210) so that at least a portion of the connection port insert (230) fits into the opening (212) and is disposed within a cavity (216) of the shell (210); and

wherein the connection port insert (230) comprises a body (232) having a front face (234) and at least one connection port (236) comprising an optical connector opening (238) extending from the front face (234) into the connection port insert (230) with a connection port passageway (233) extending through part of the connection port insert to the rear portion (237).

52. The method of claims 50 or 51, wherein the connection port insert (230) comprises a sealing location (230SL) disposed a first distance (D1) from the front face (234) and a connector mating plane (230MP) is disposed at a second distance (D2) from the front face (234).

53. The method of any one of claims 50-52, further comprising attaching an input tether to an input connection port (260).

54. The method of claim 53, wherein the input tether comprises a furcation body.

55. The method of any one of the claims 50-54, further comprising attaching one or more adapters to the connection port insert.

56. The method of any one of claims 50-55, further comprising installing at least one rear connector (252) into the connection port passageway (233) from the rear portion (237).

57. The method of any one of claims 50-56, the connection port passageway (233) further comprising a retention feature.

58. The method of any one of claims 50-57, further comprising disposing an optical splitter (275) within the cavity (216) of the shell (210).

59. The method of any one of claims 50-58, further comprising attaching a second insert (230') to the shell (210).

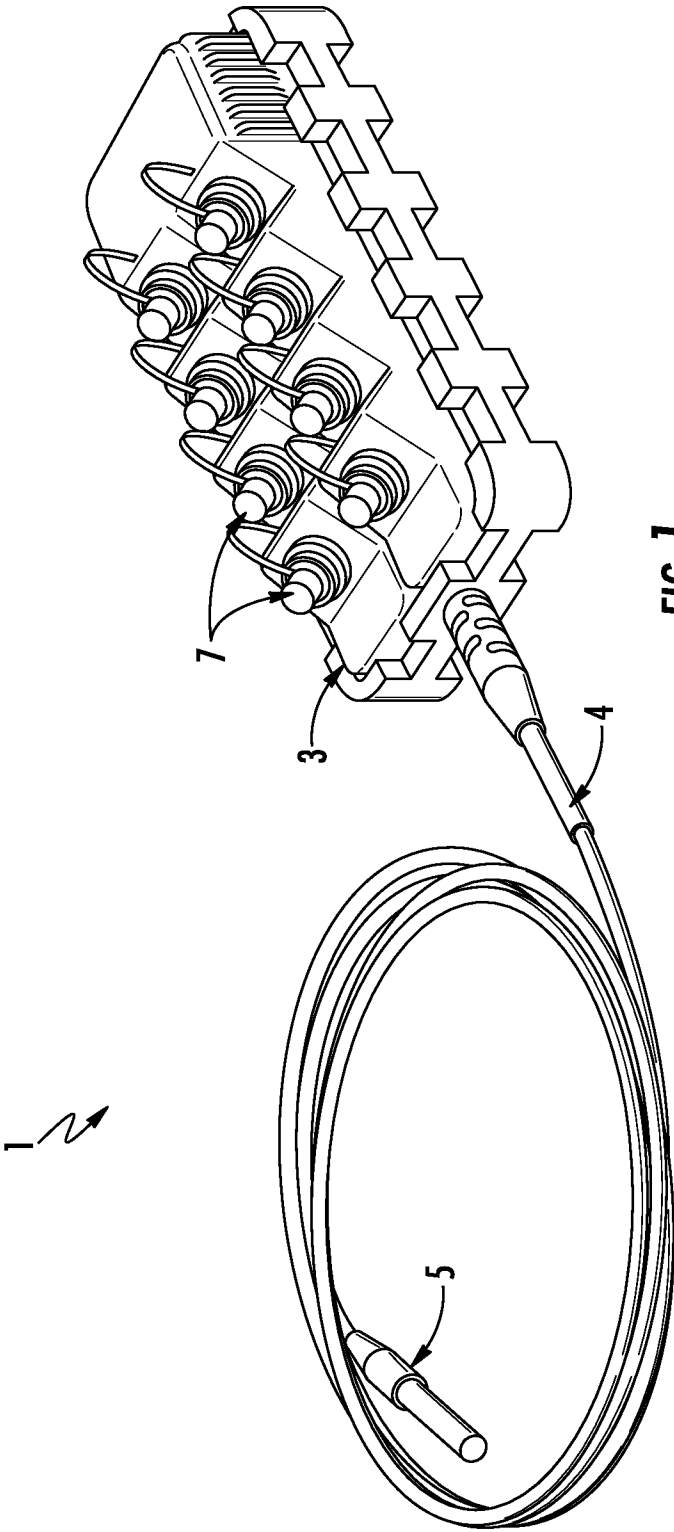
60. The method of any one of claims 50-59, further comprising sealing the connection port insert (230) to shell (210).

61. The method of claim 60, the sealing comprising installing one or more O-rings or gaskets about the connection port insert (230) before inserting the connection port insert (230) into the shell (210).

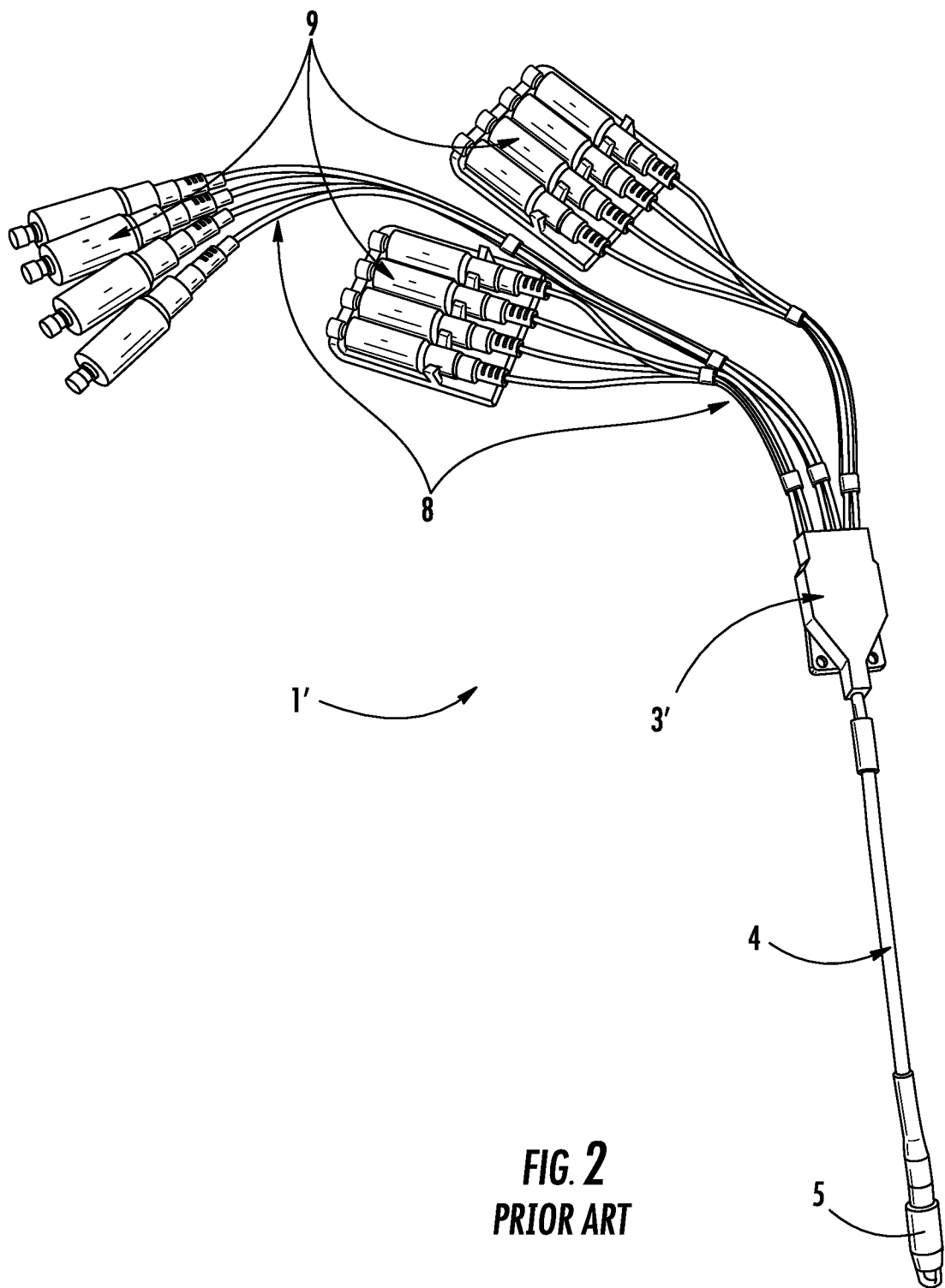
62. The method of claim 60, the sealing comprising applying an adhesive, sealant or welding.

63. The method of any one of claims 50-62, wherein the body (232) of the connection port insert (230) comprises a plurality of connection port sections (232a,232b).

64. The method of any one of claims 50-63, further comprising placing the multiport (200) in a mounting structure (300).



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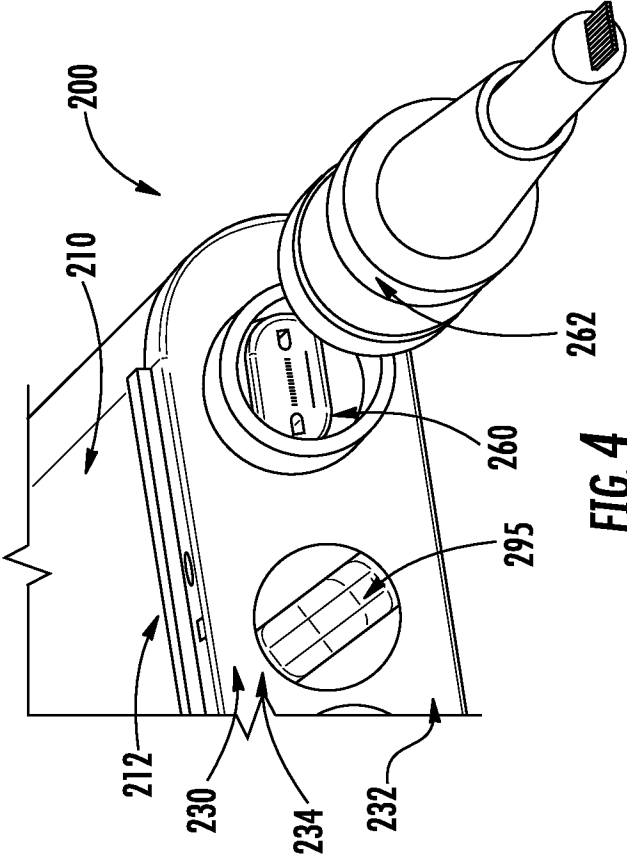


FIG. 4

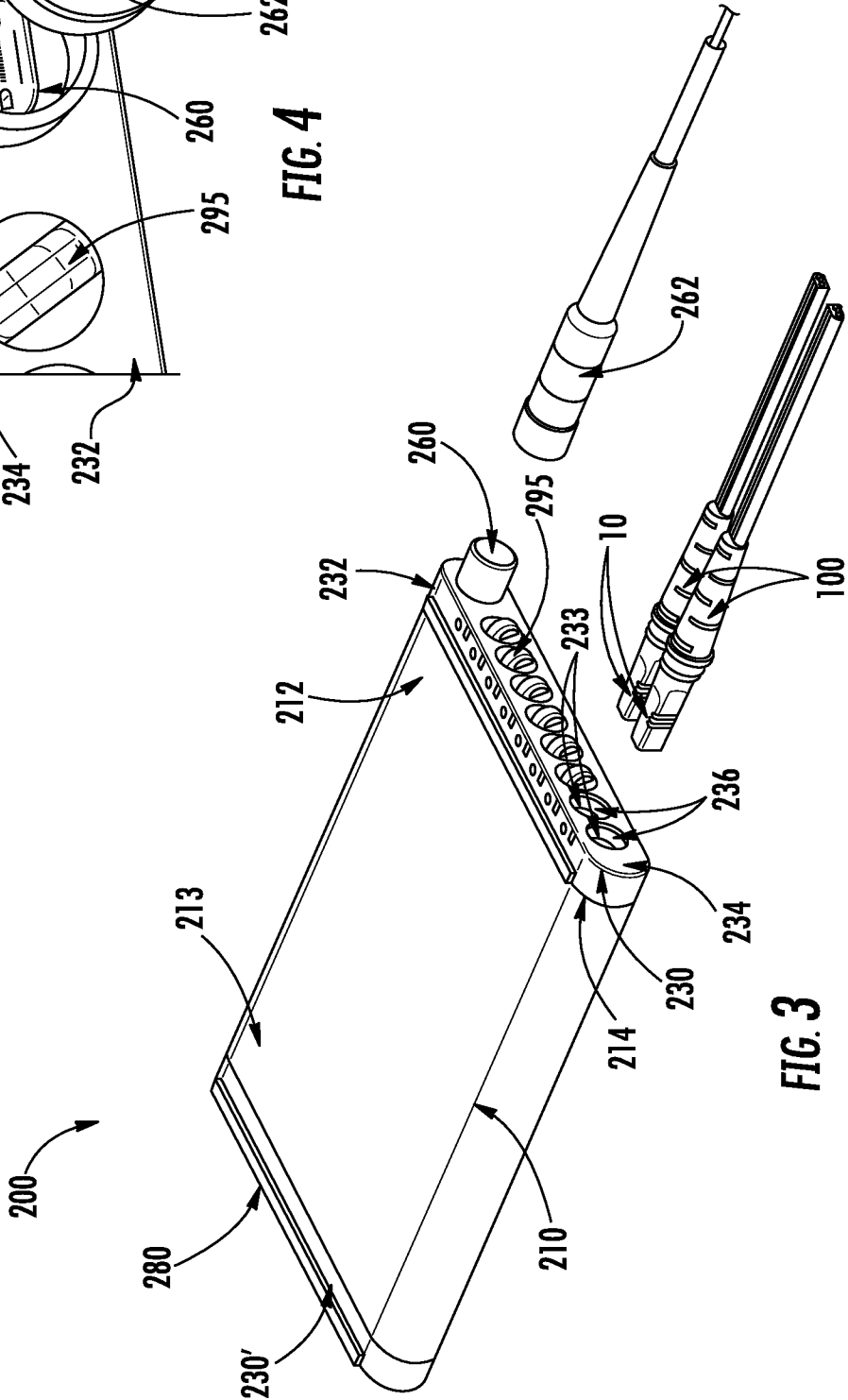
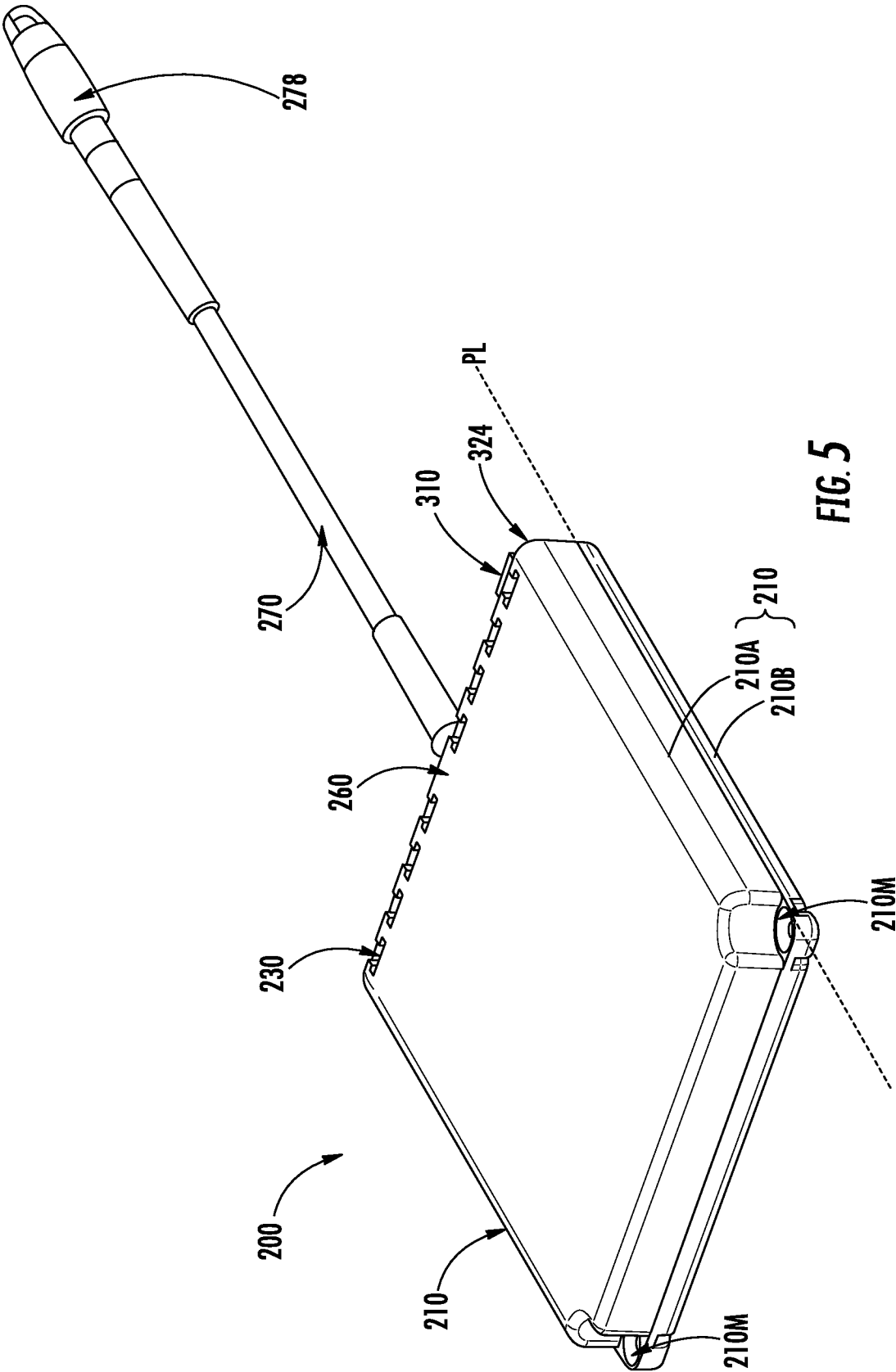
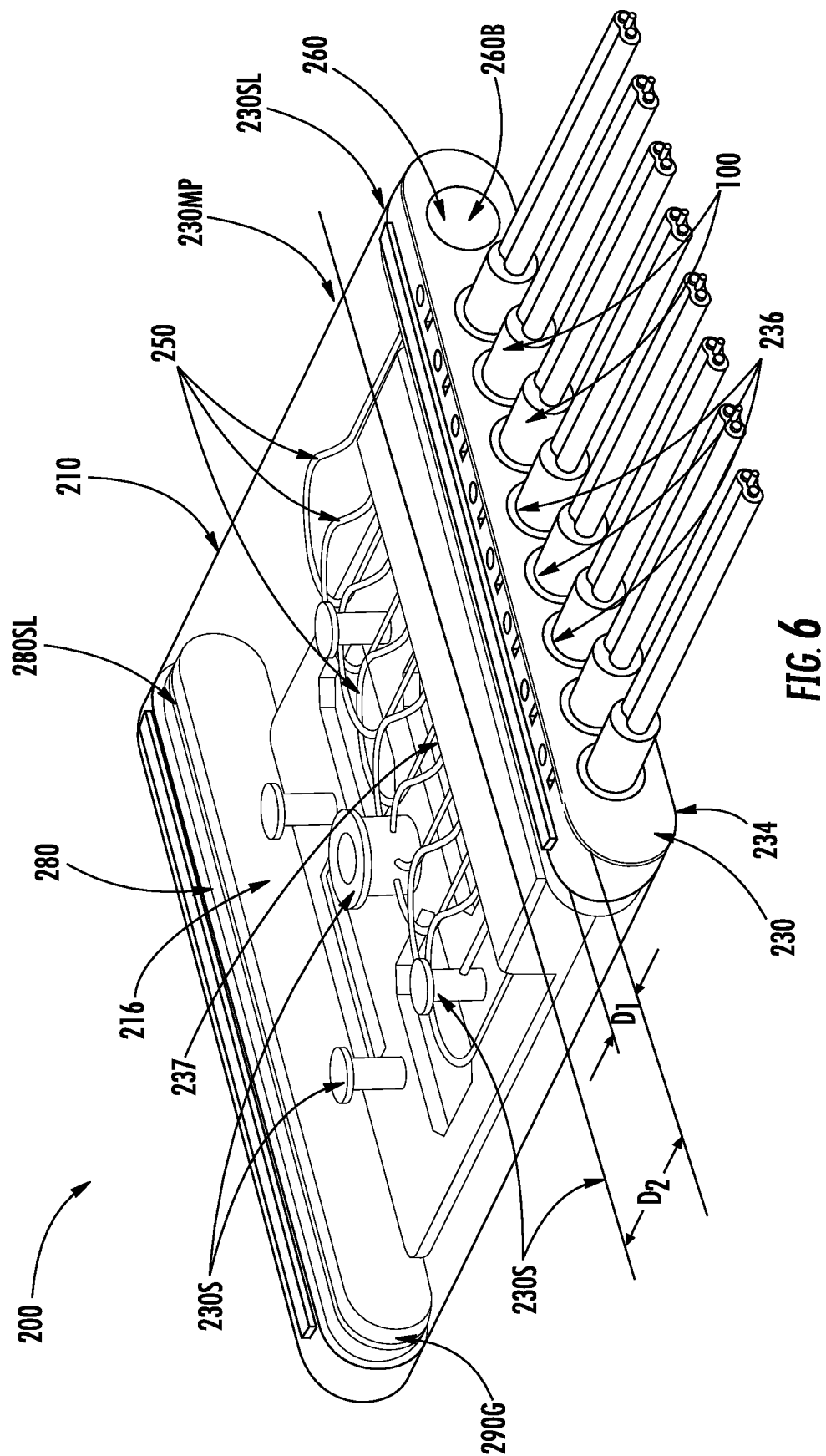


FIG. 3





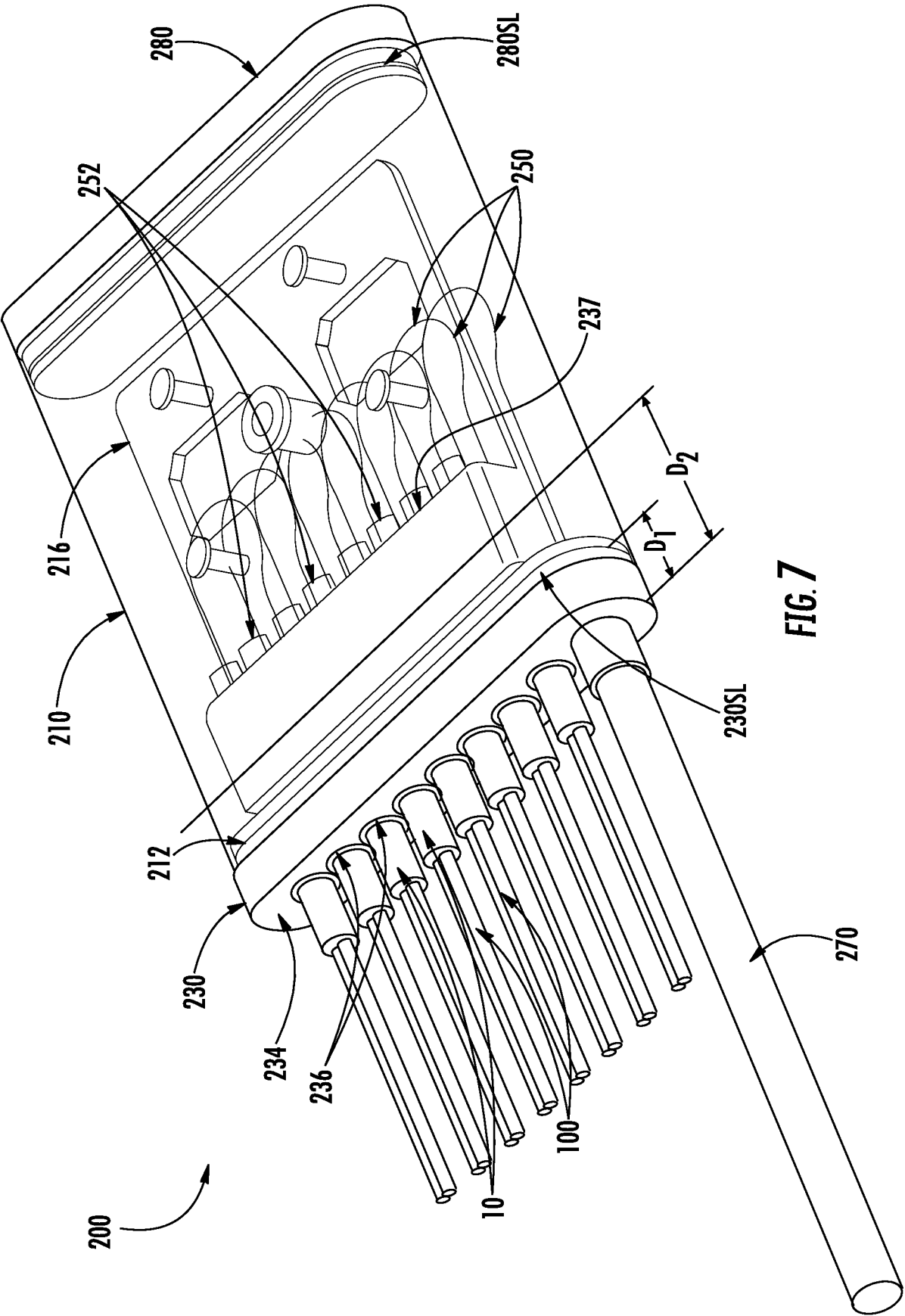
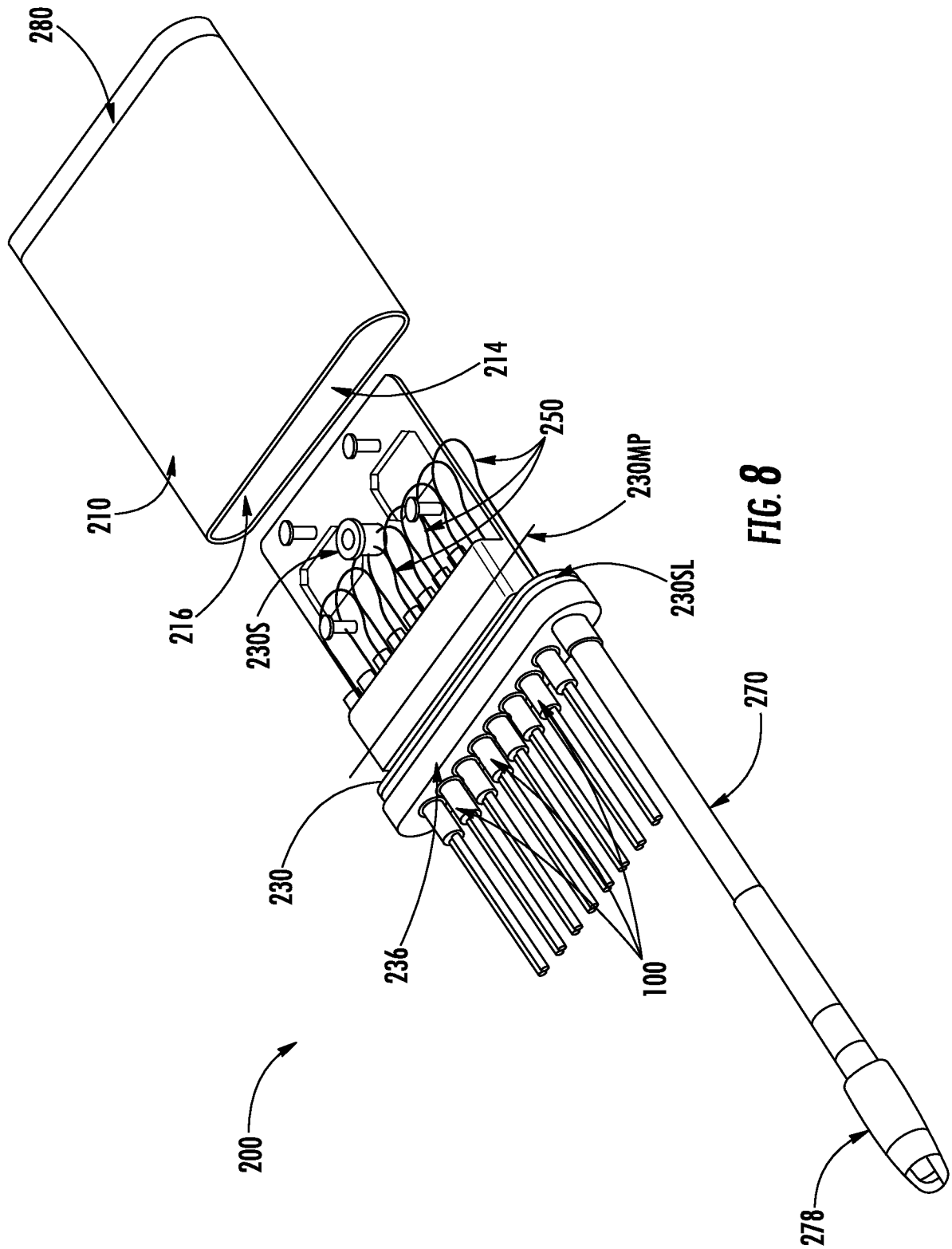
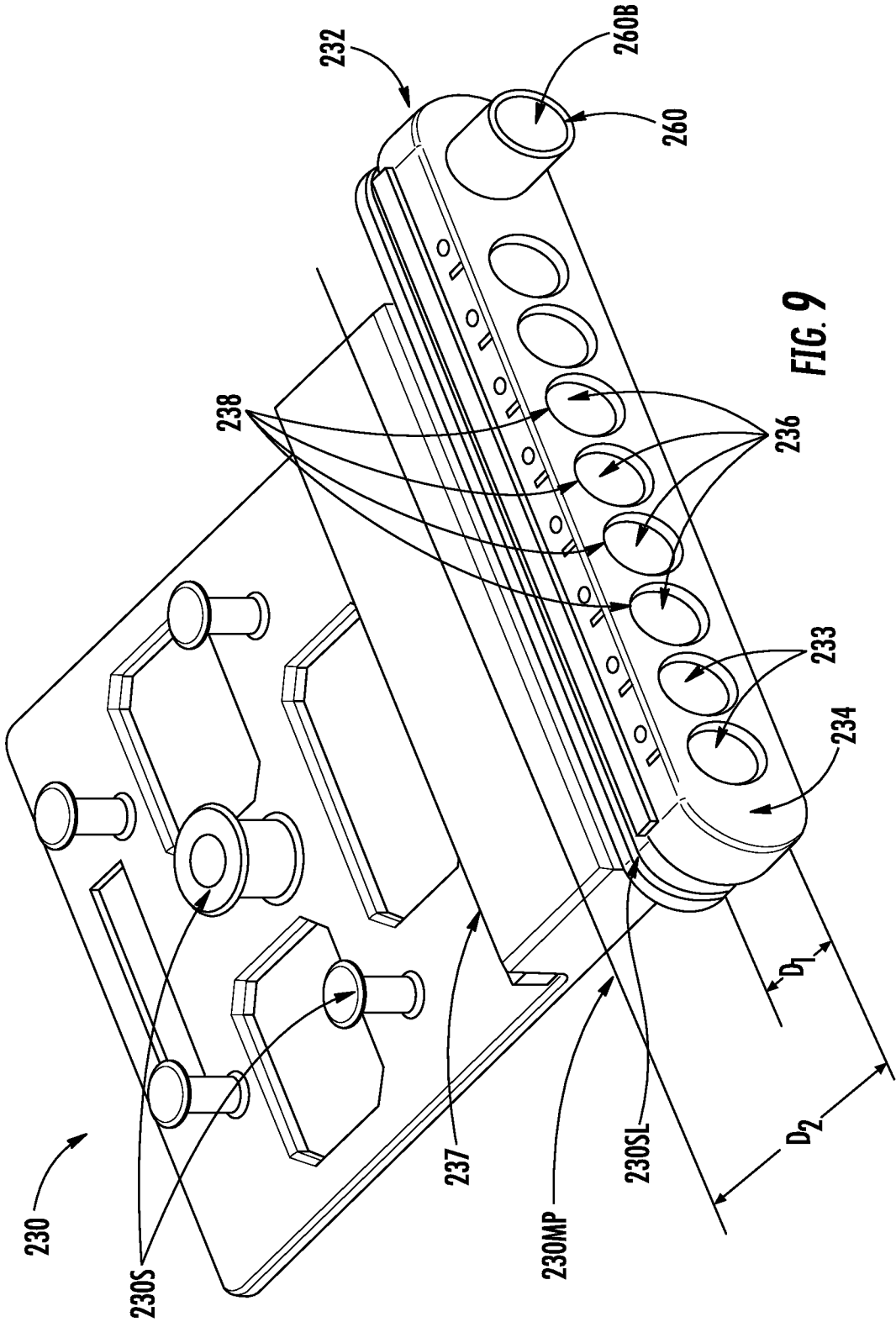


FIG. 7







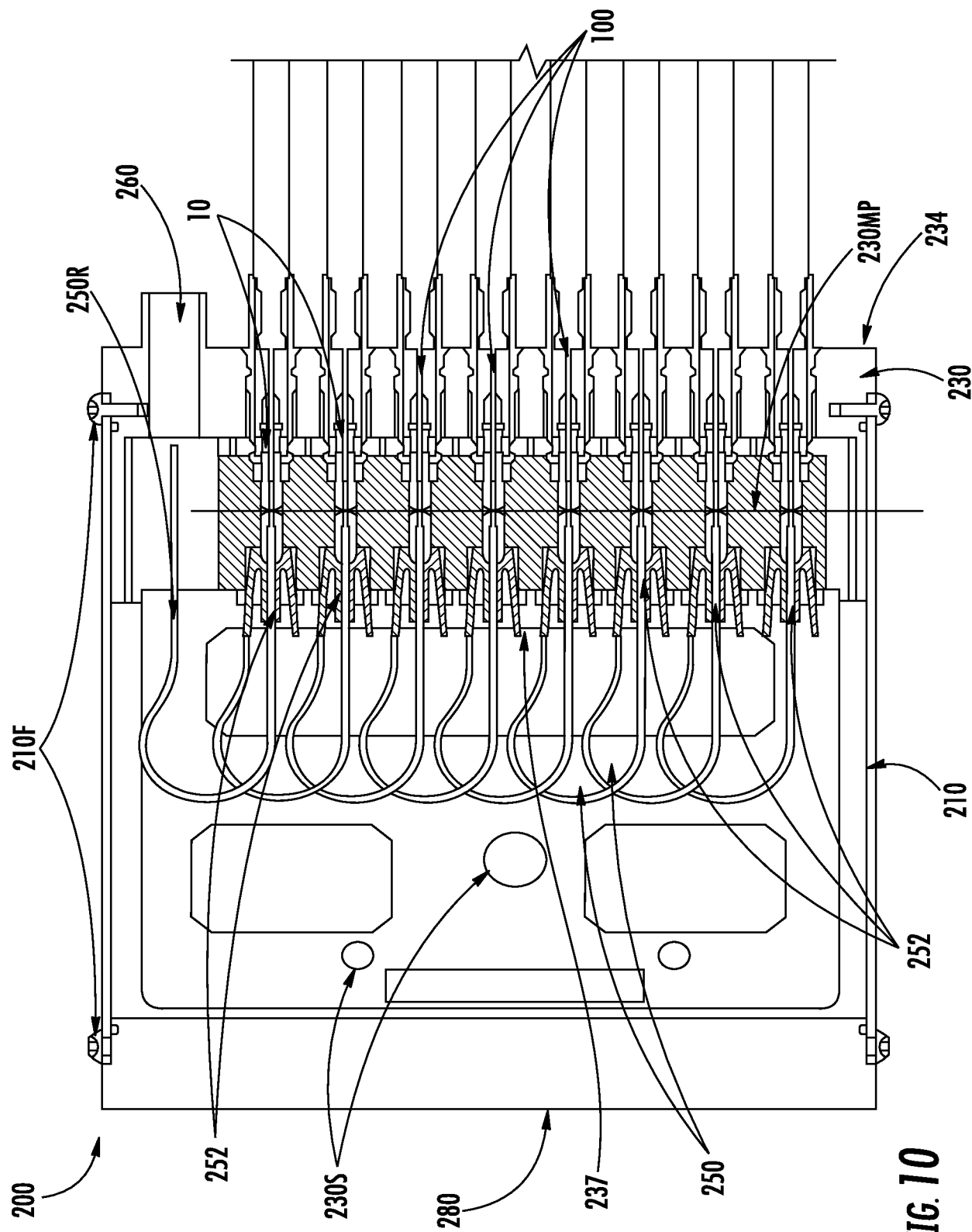


FIG. 10

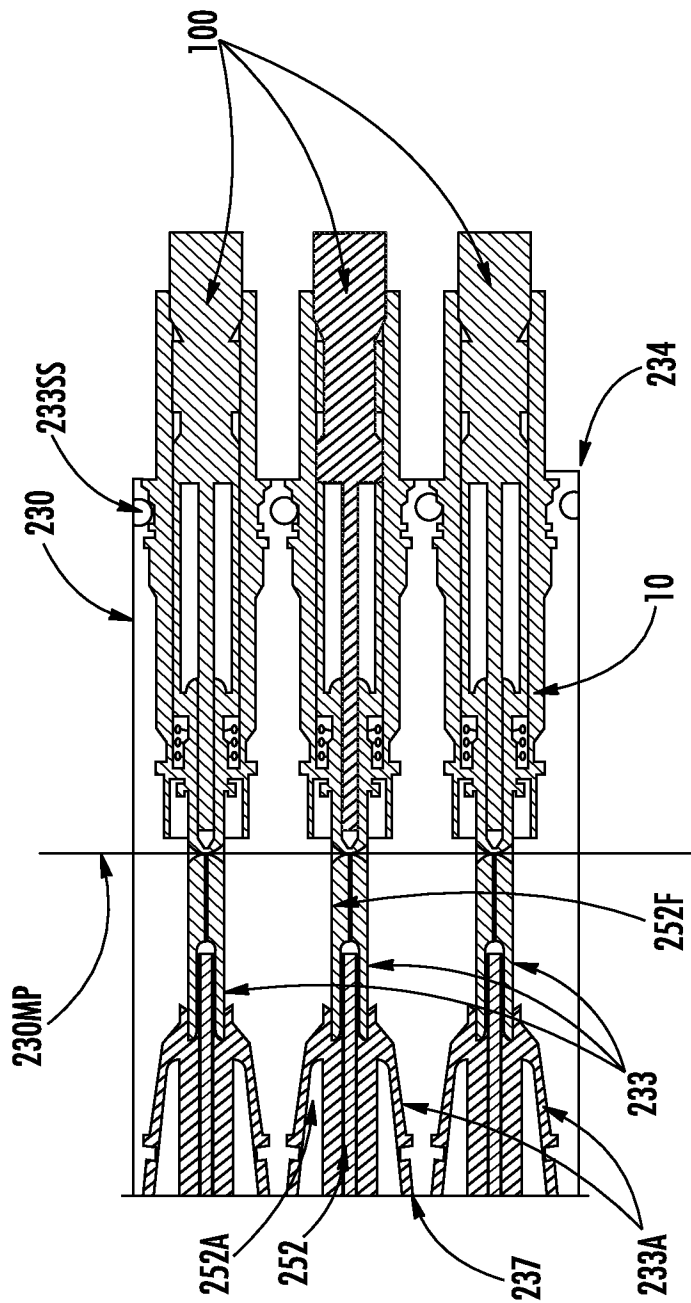


FIG. 11

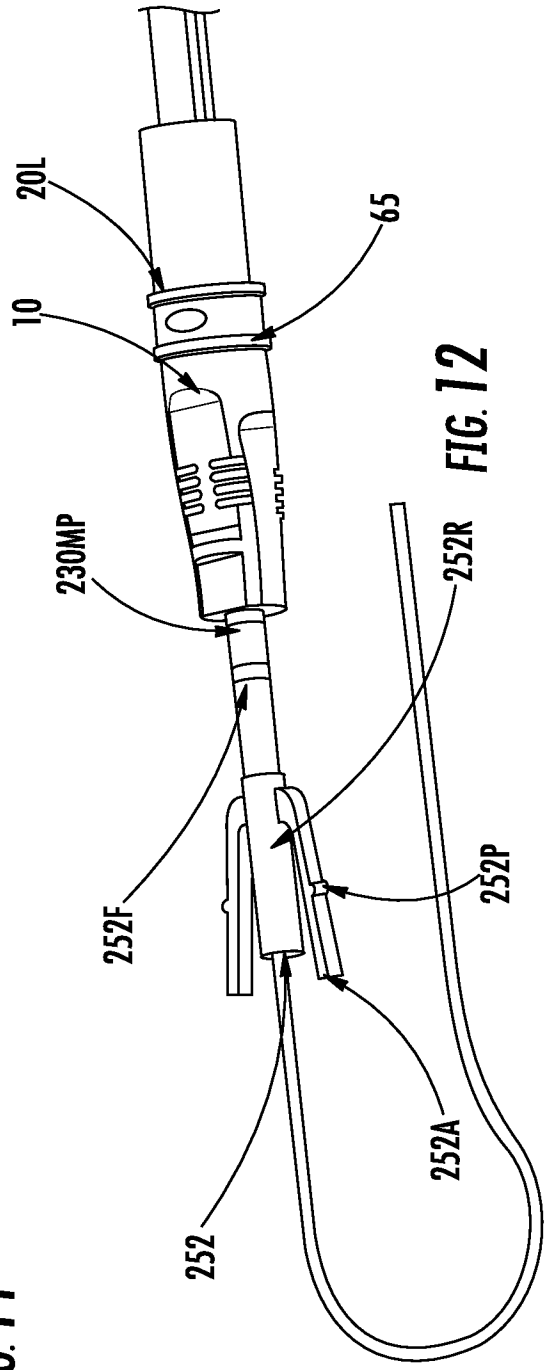
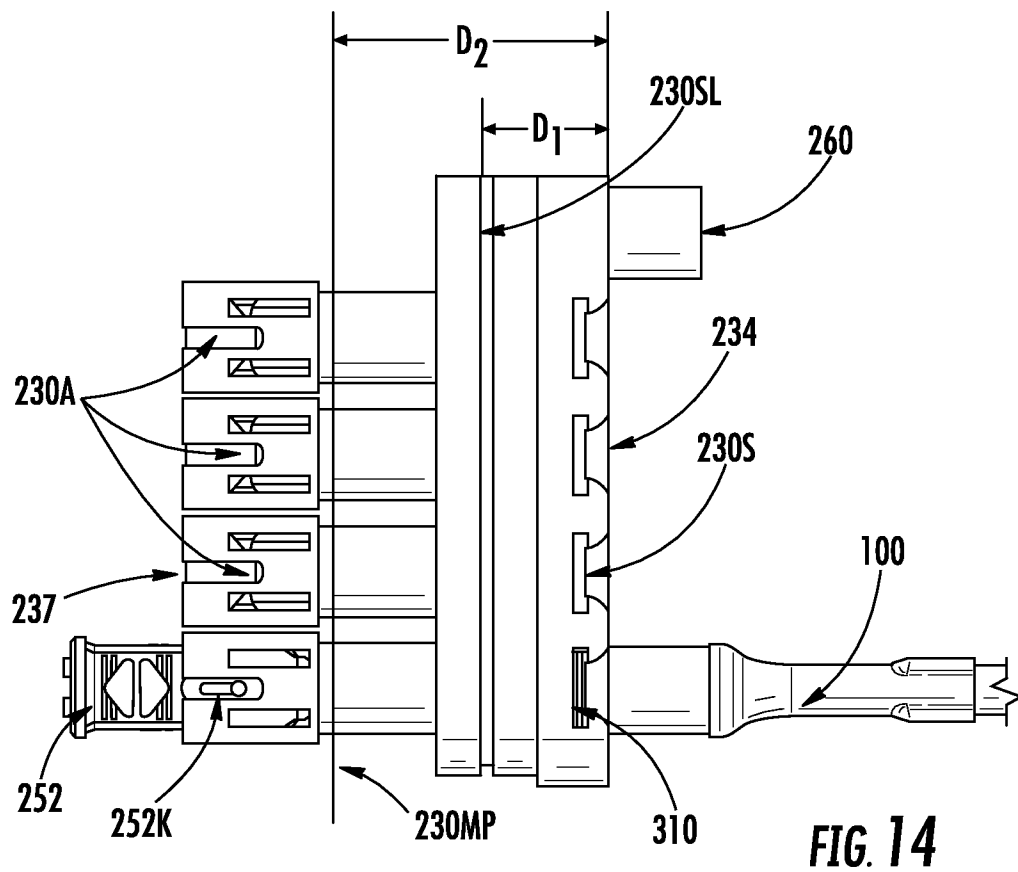
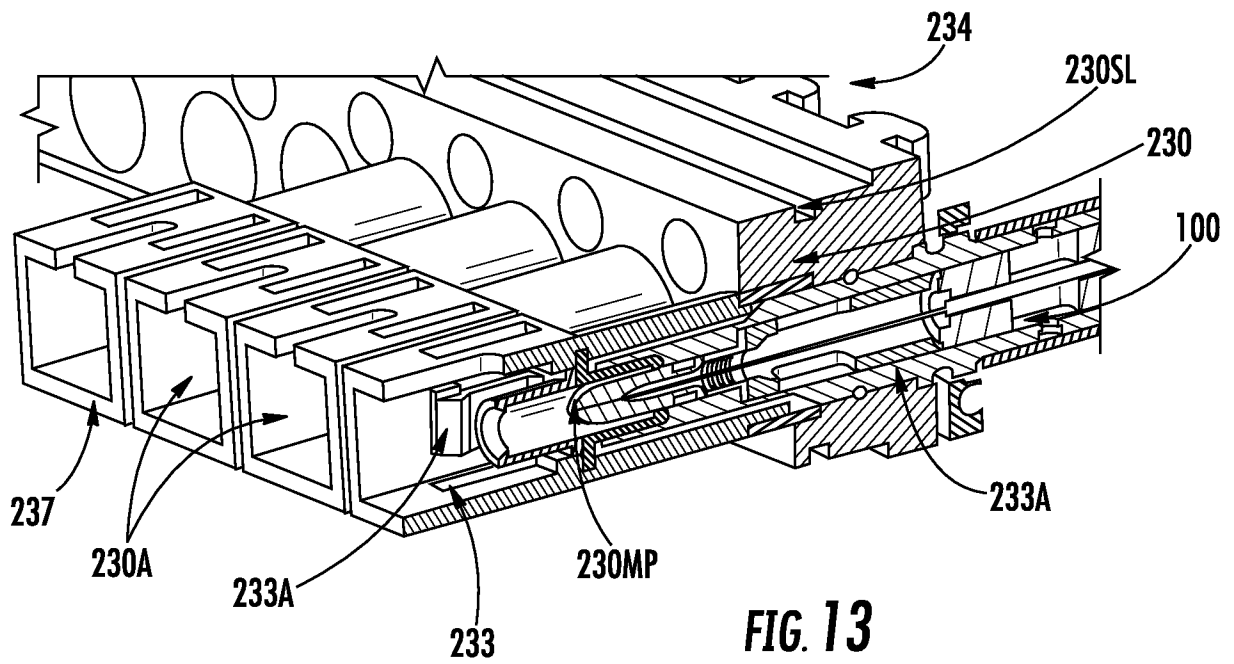


FIG. 12

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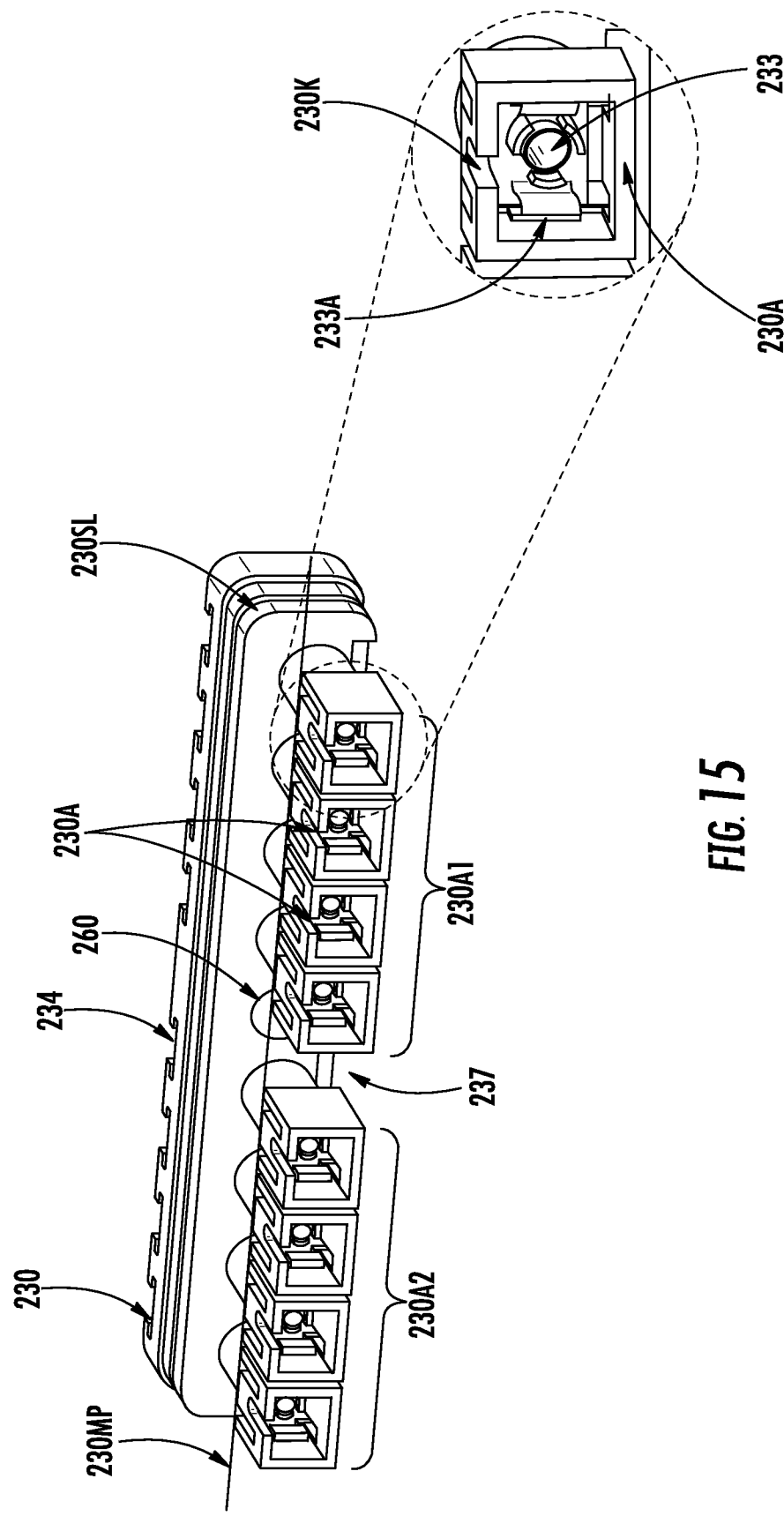


FIG. 15

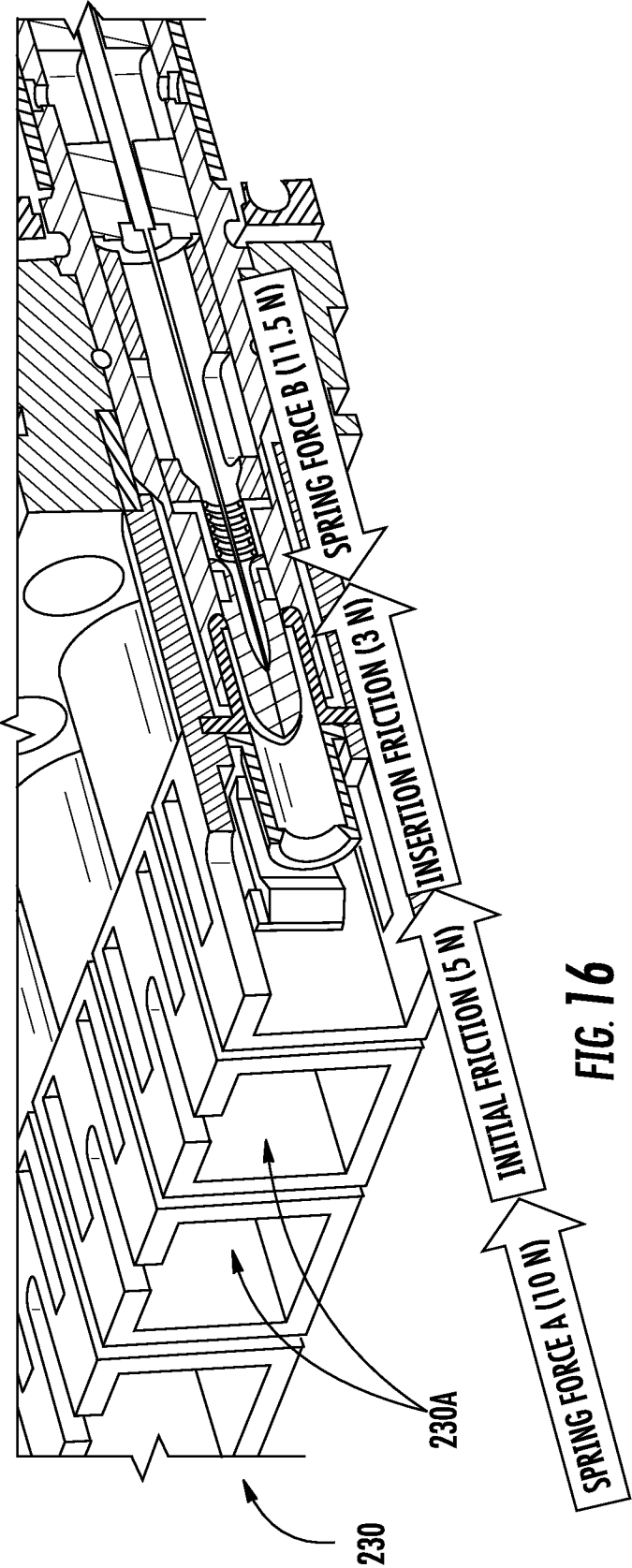


FIG. 16

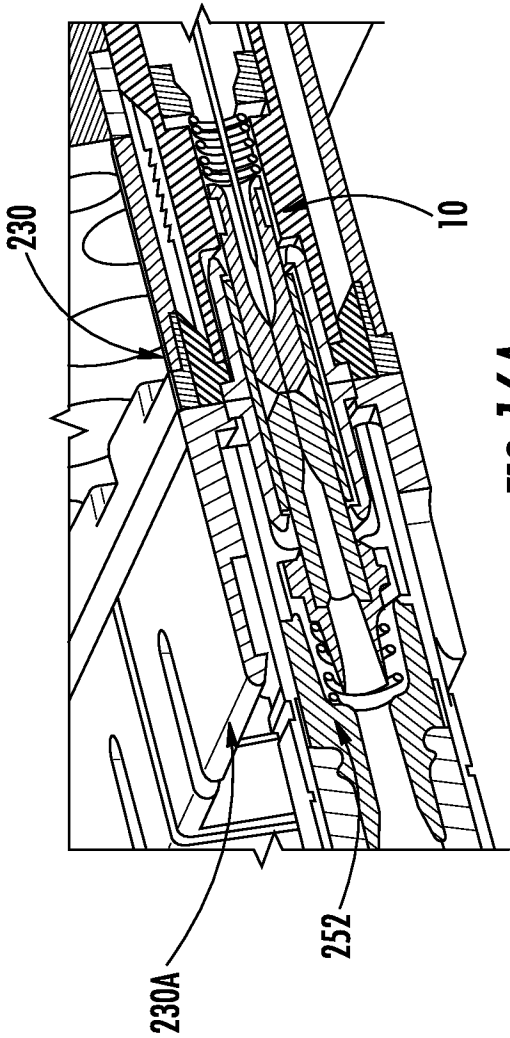
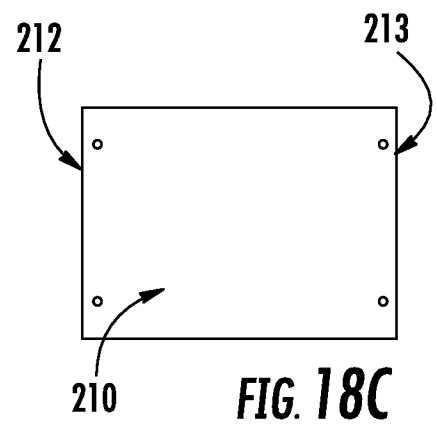
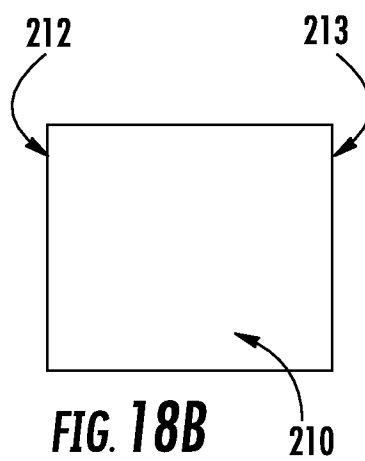
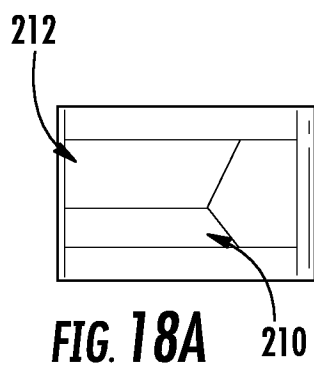
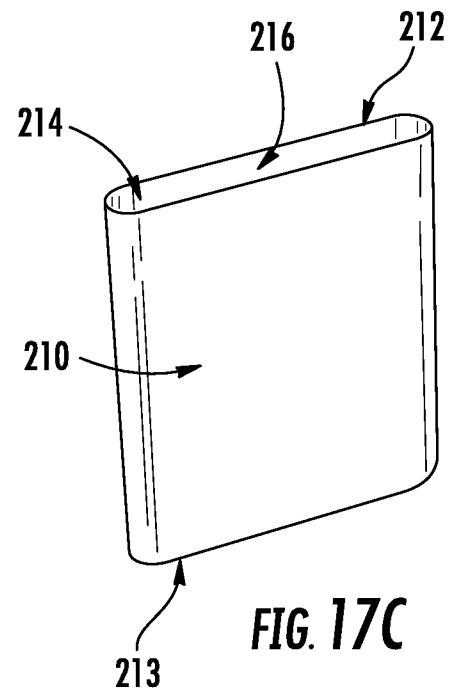
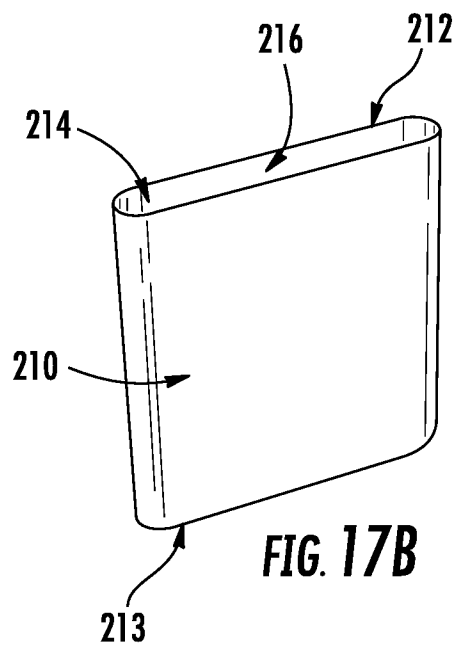
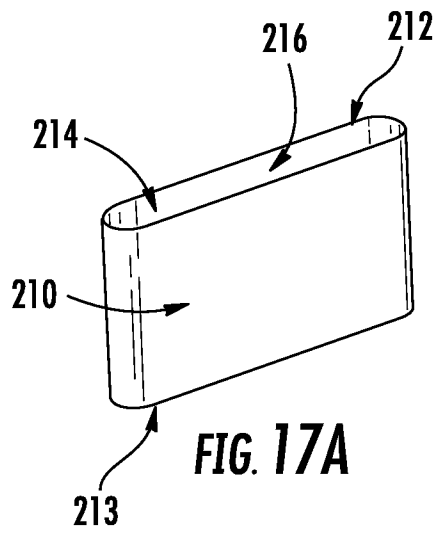
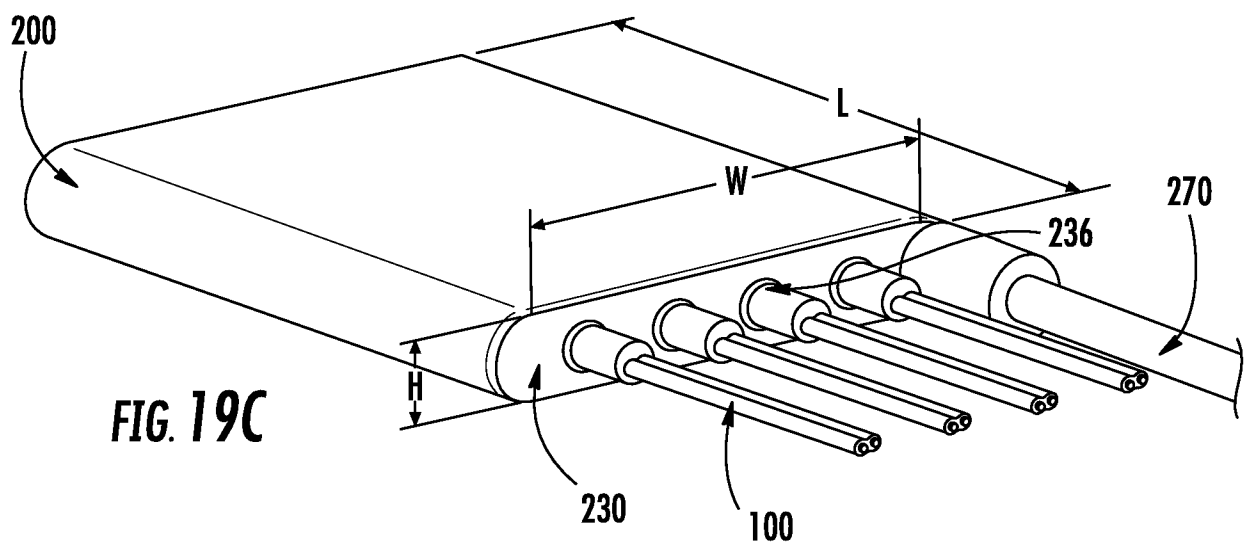
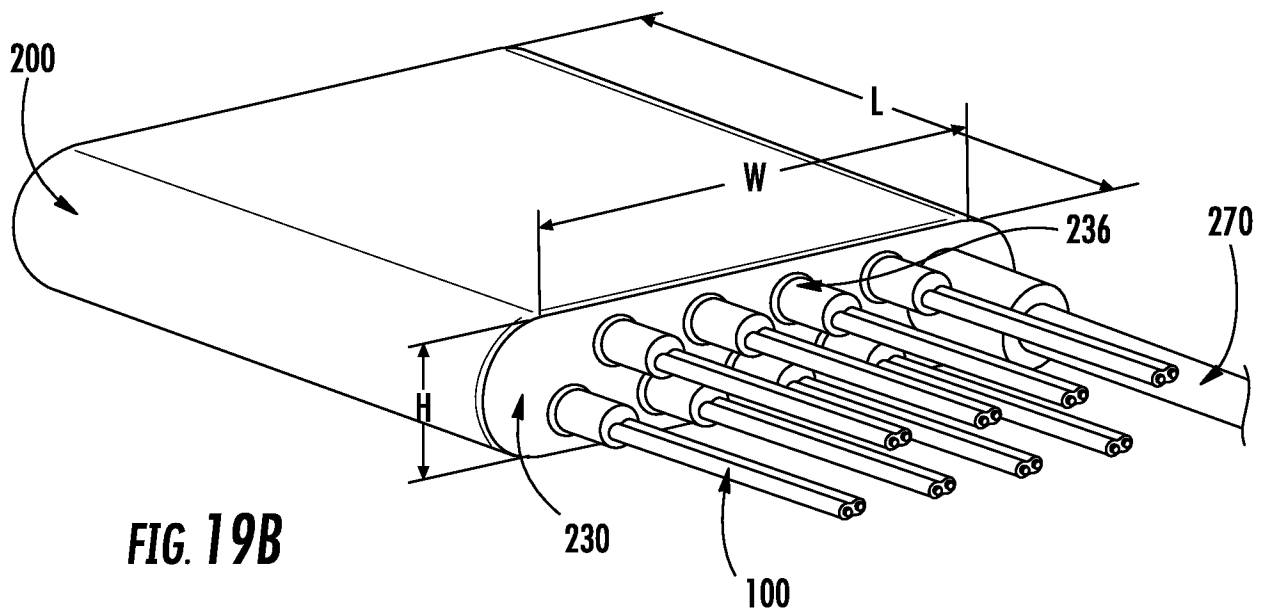
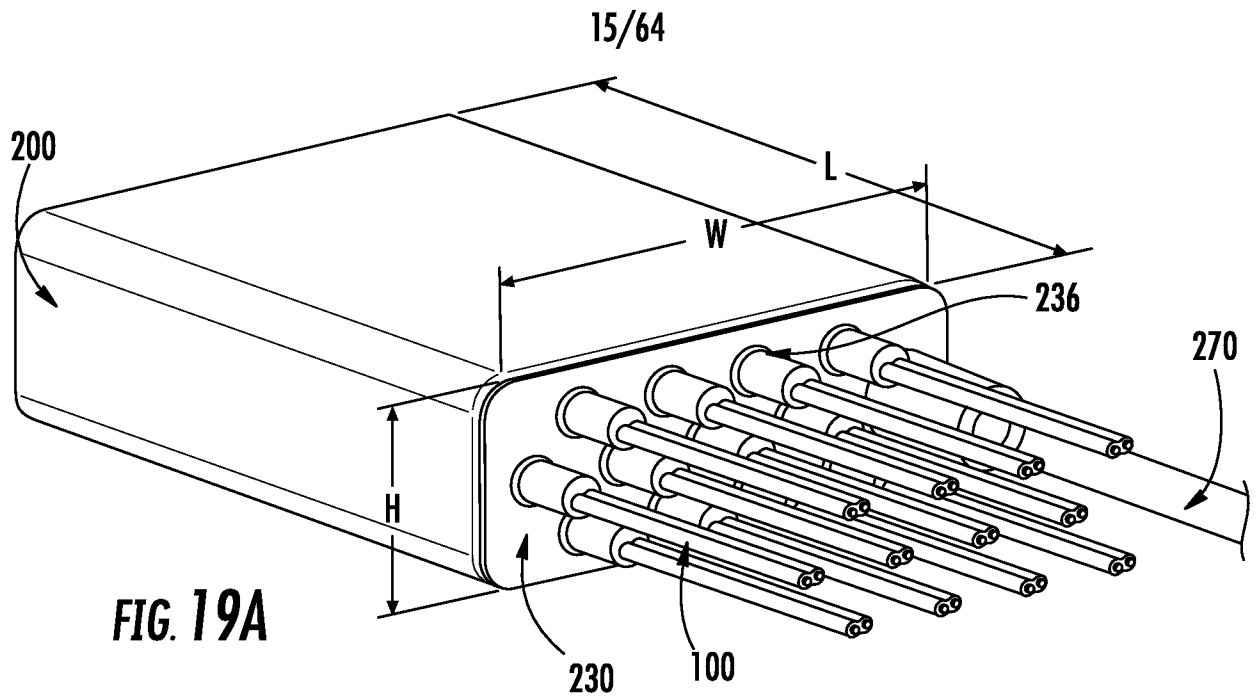


FIG. 16A

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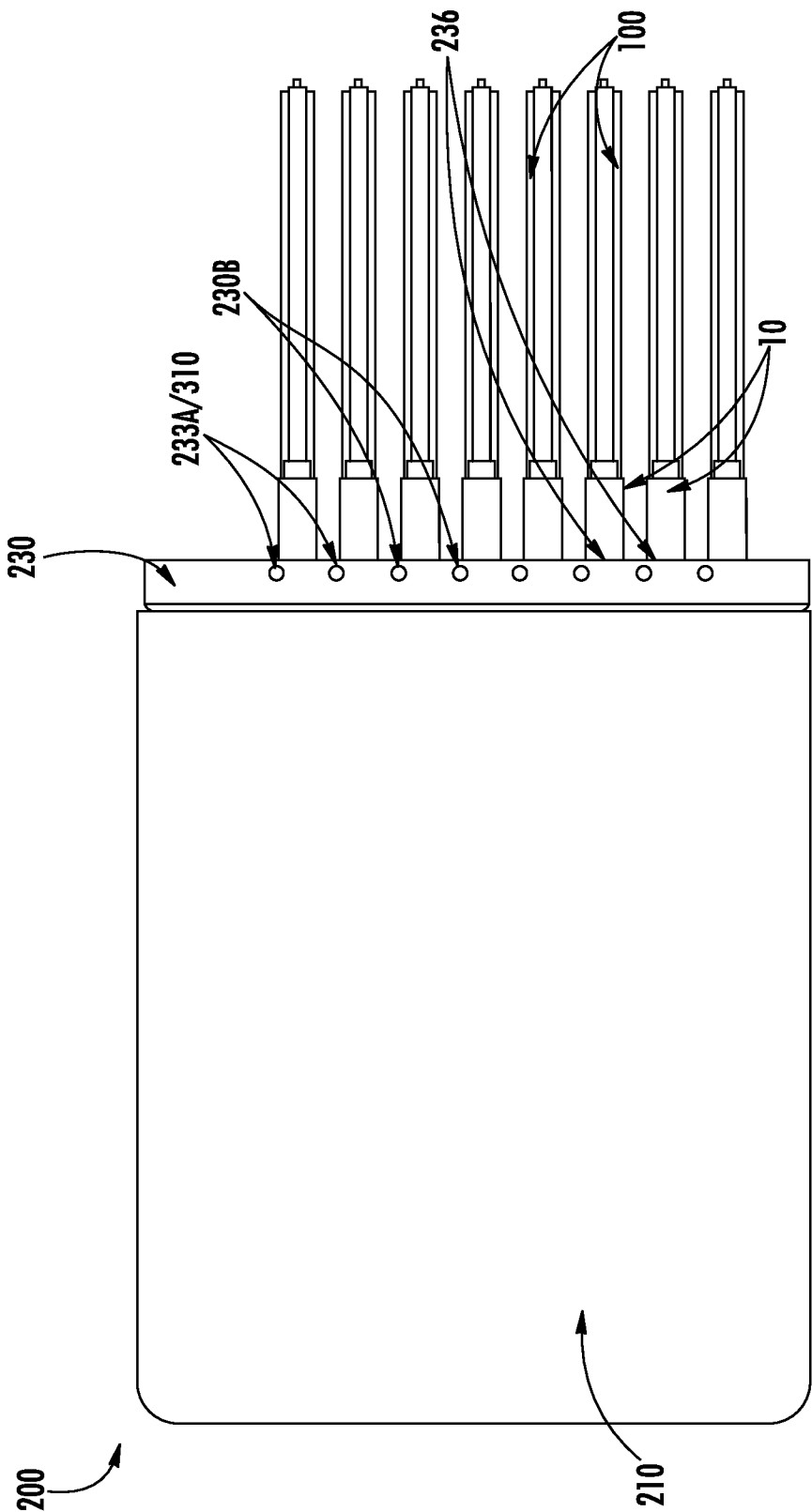
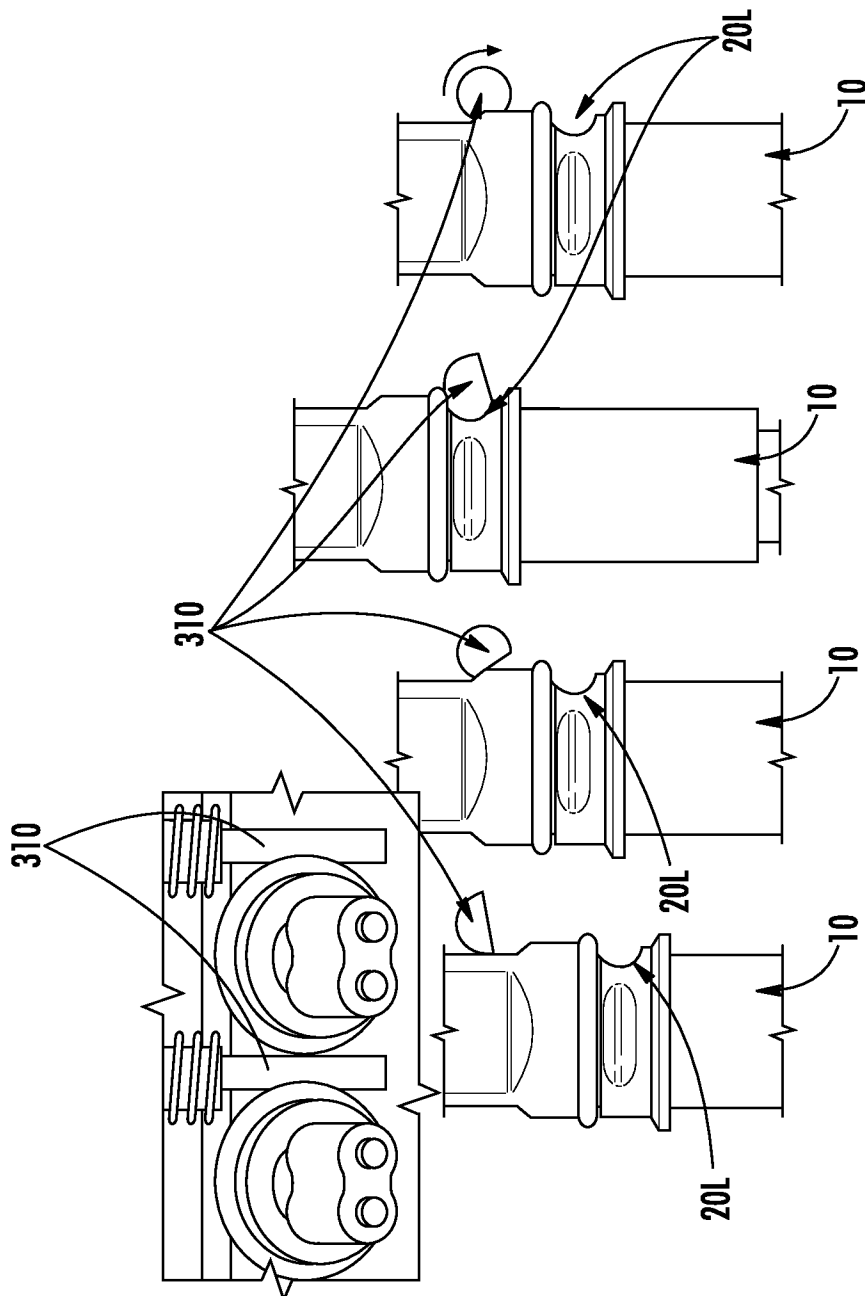
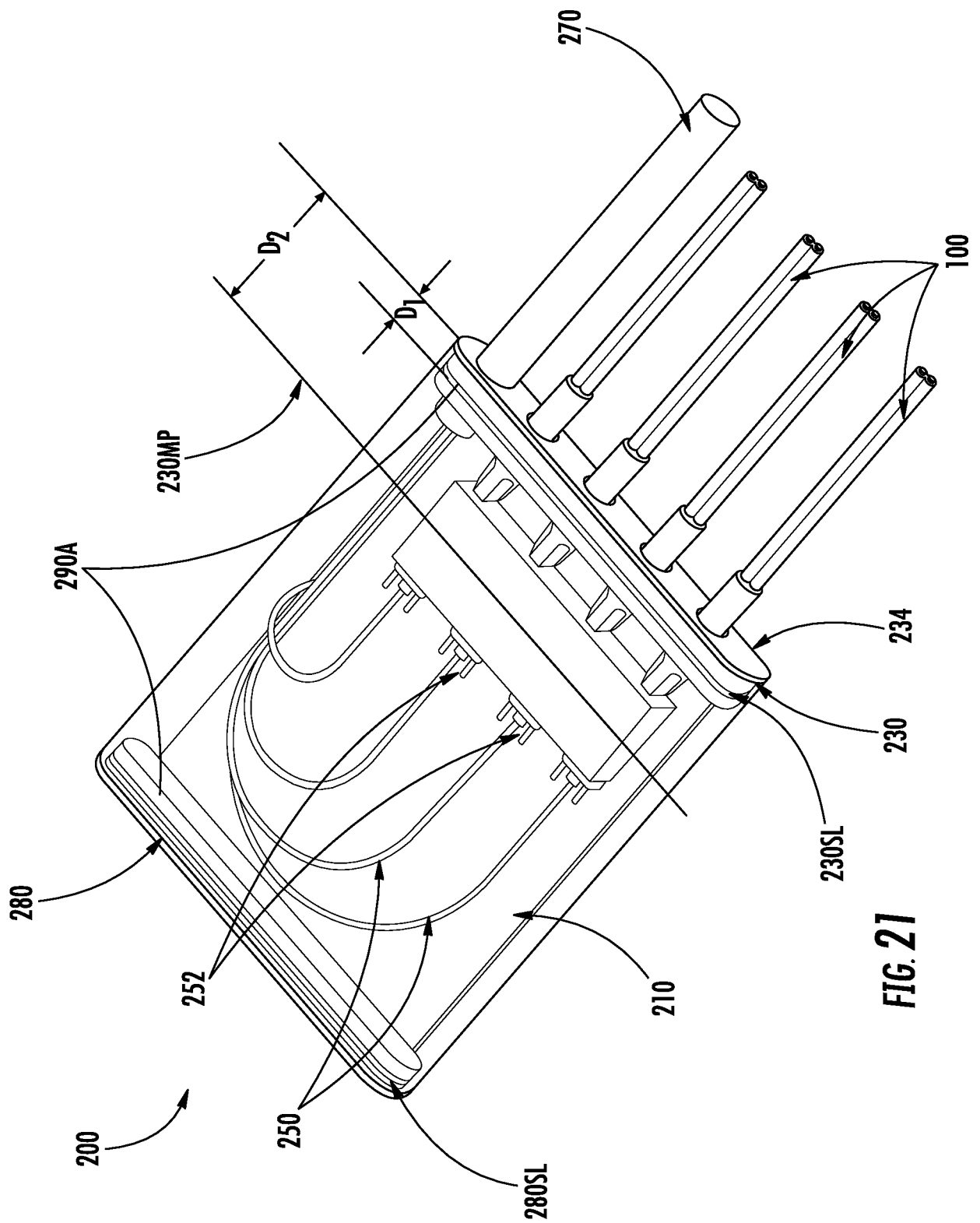


FIG. 20



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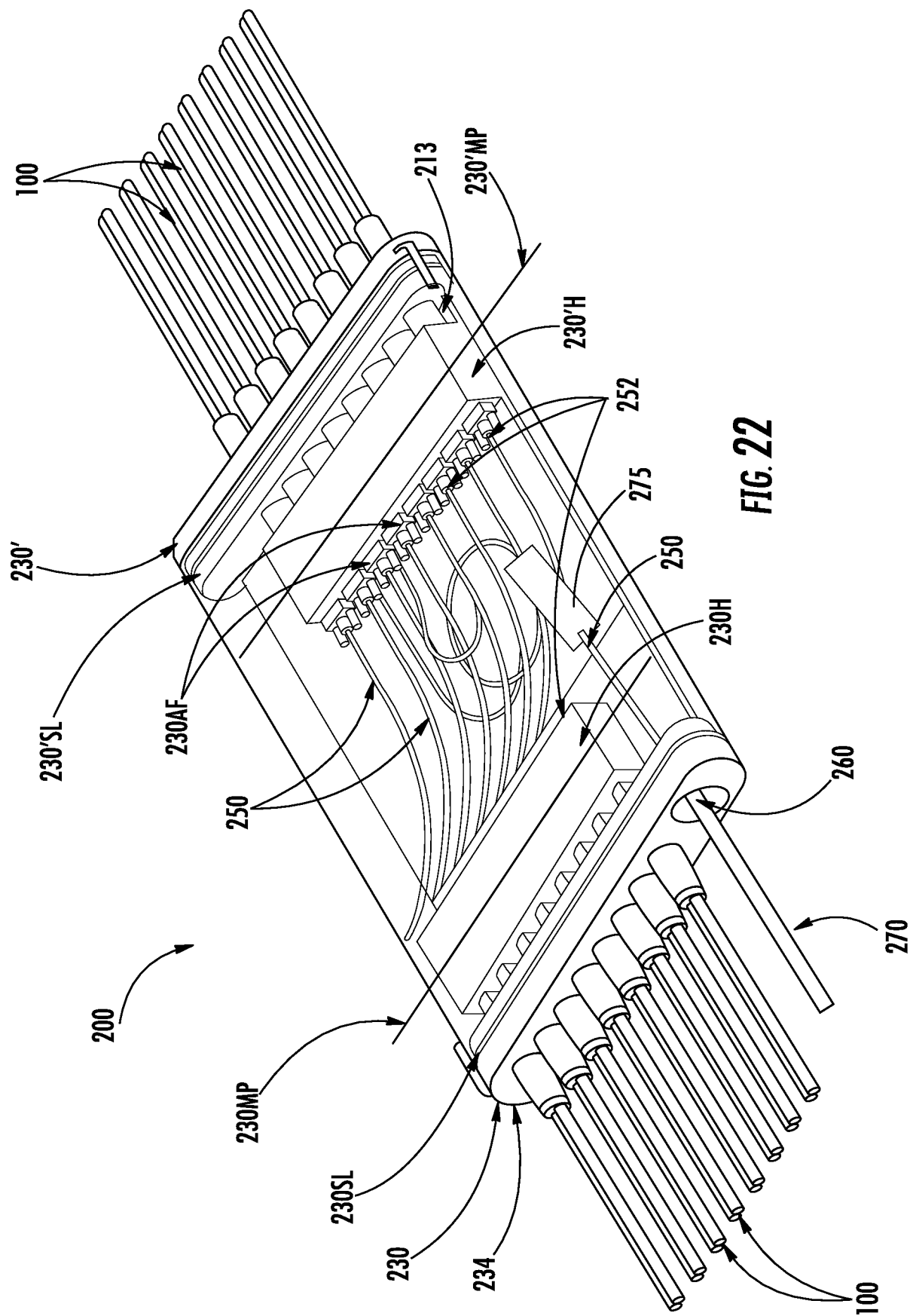
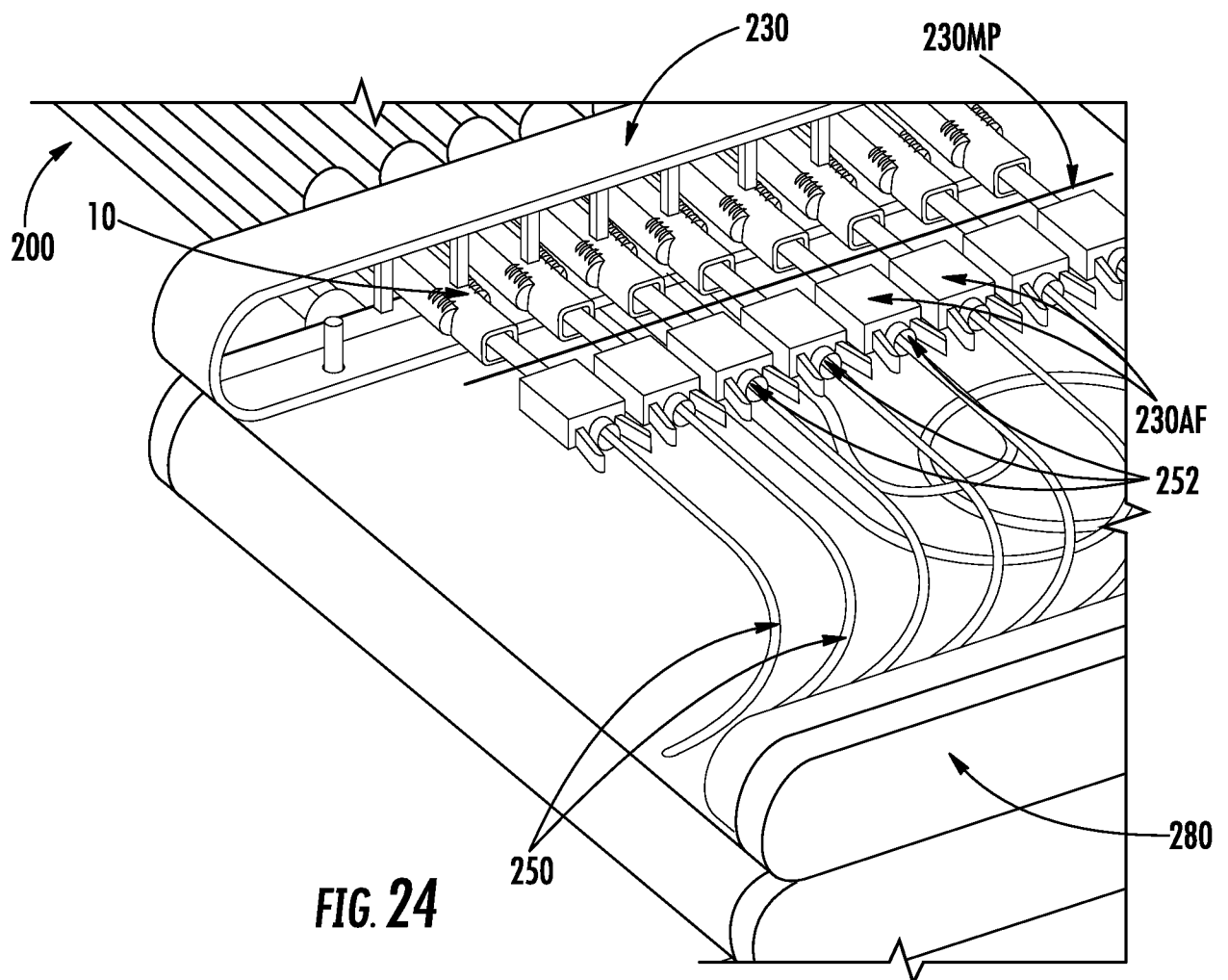
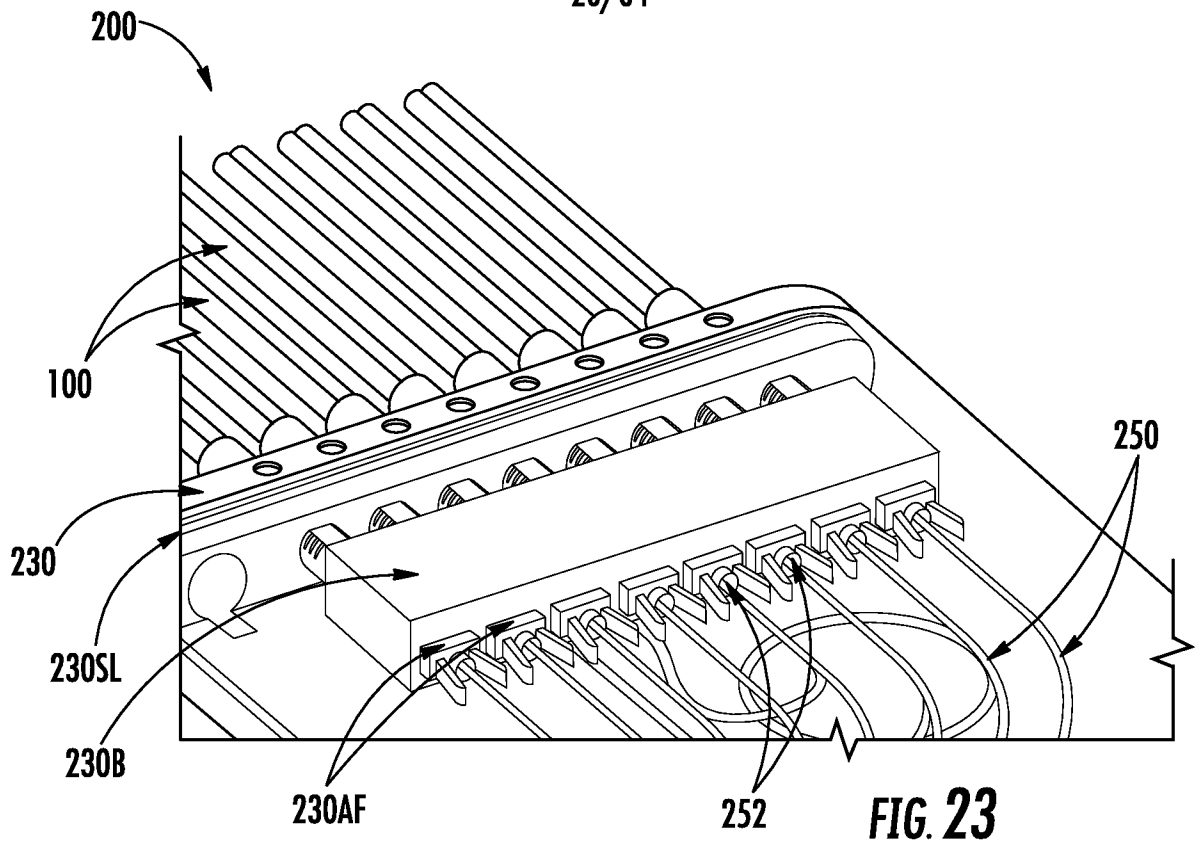


FIG. 22

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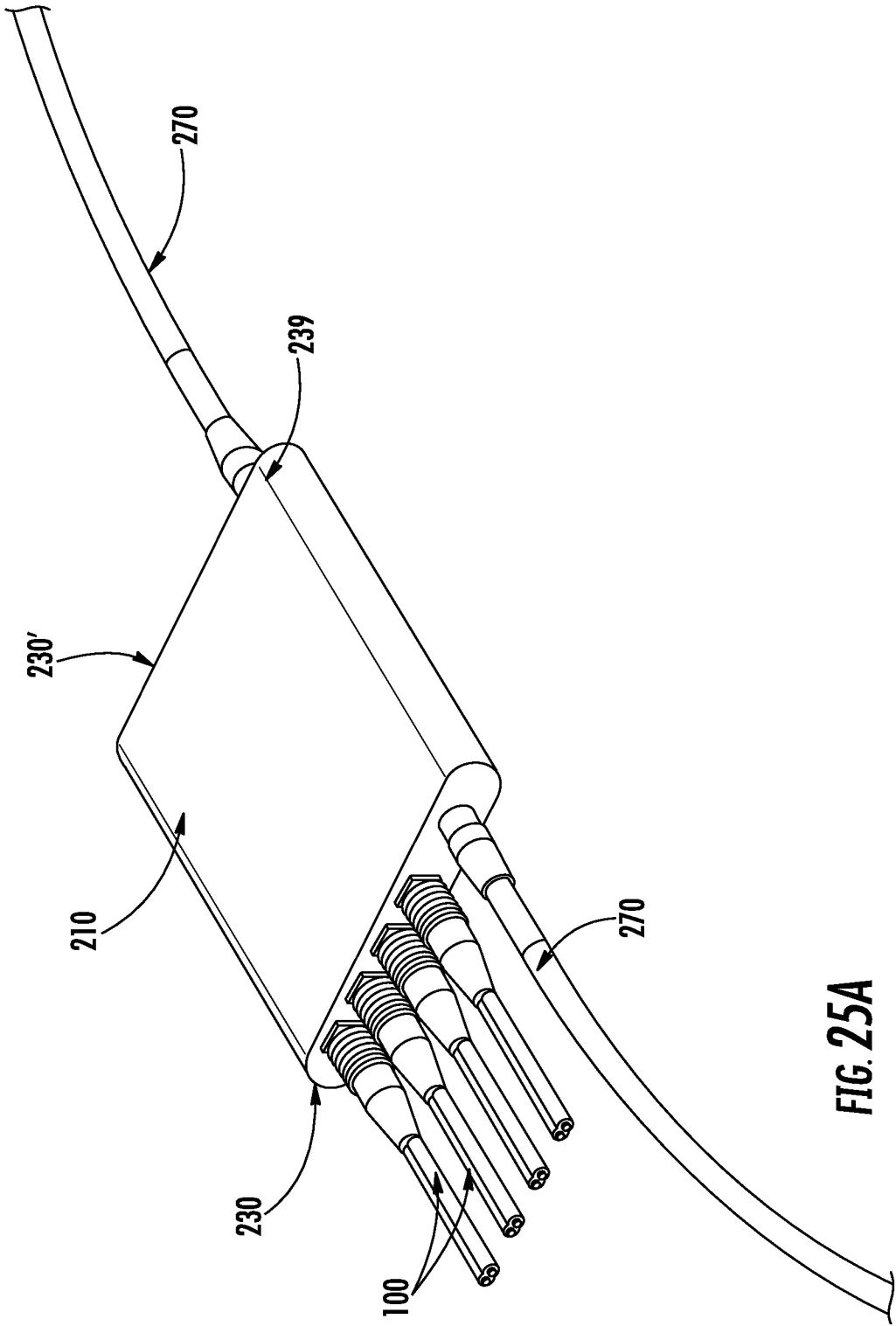
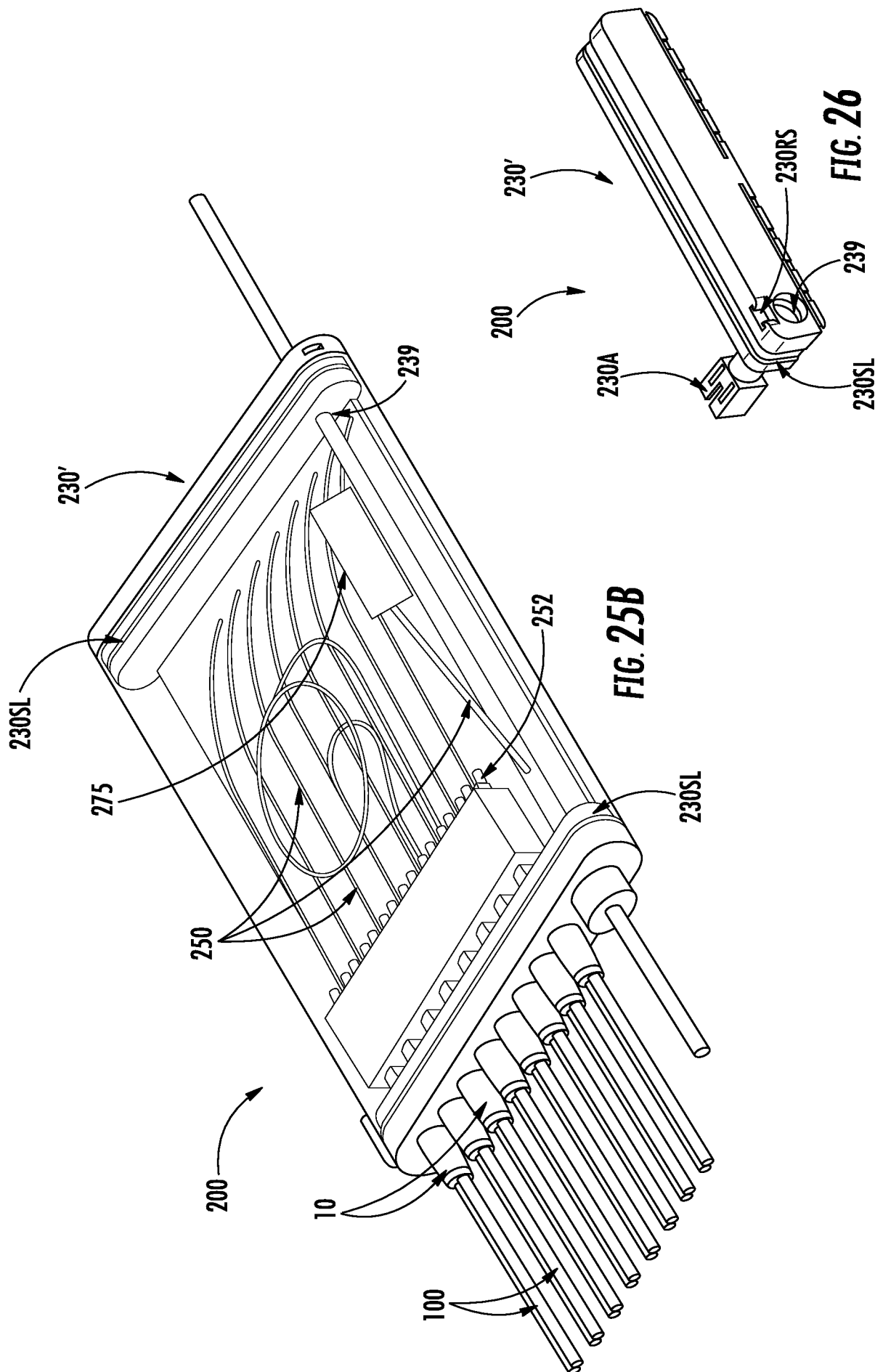
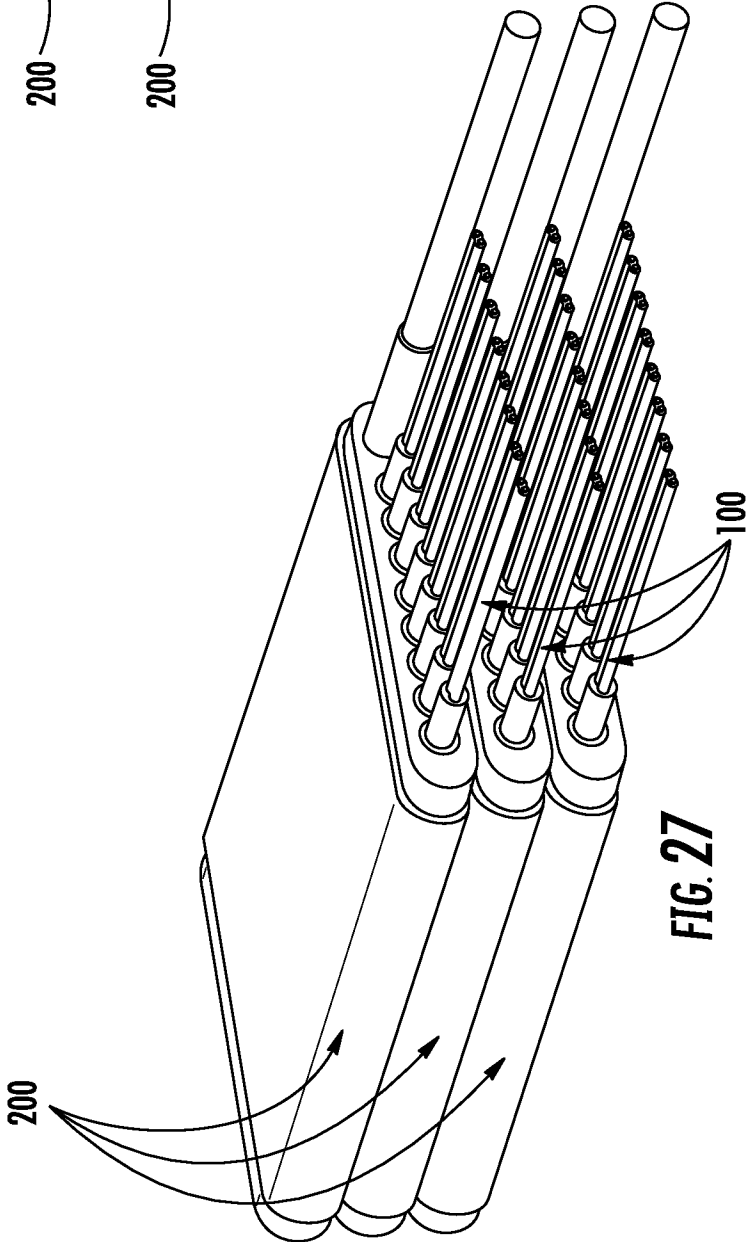
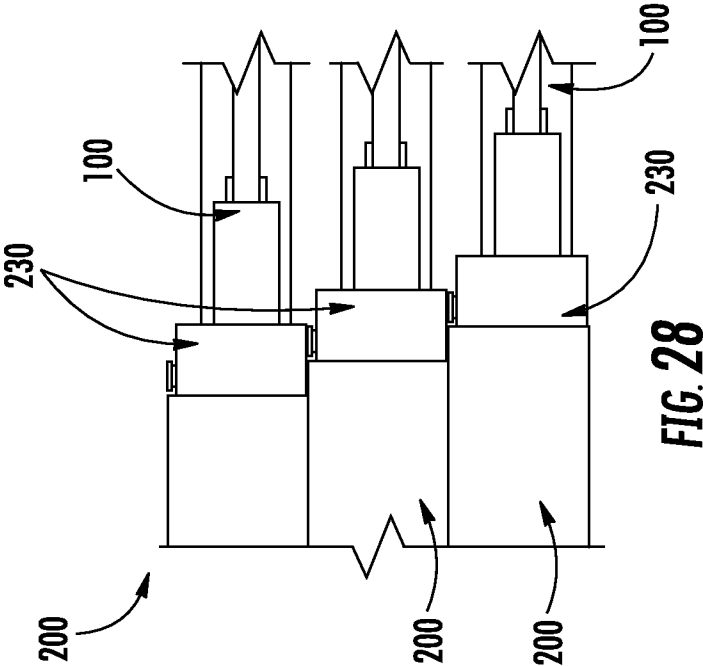


FIG. 25A

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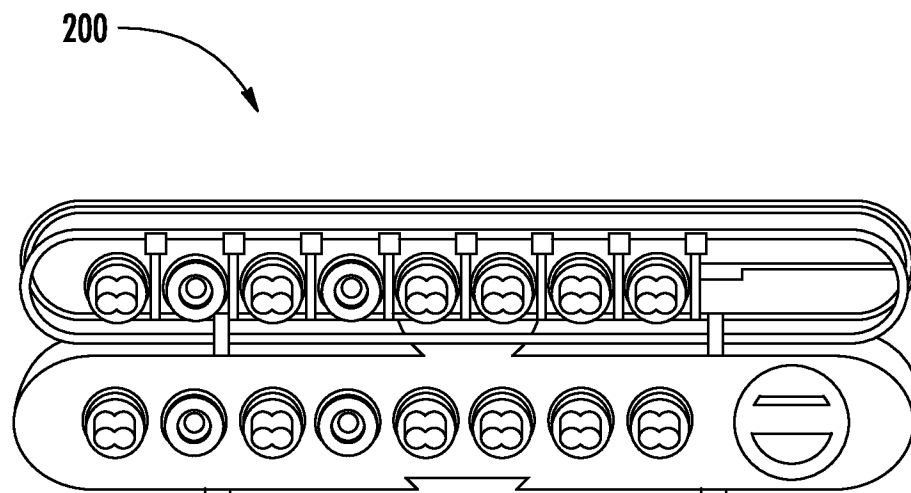
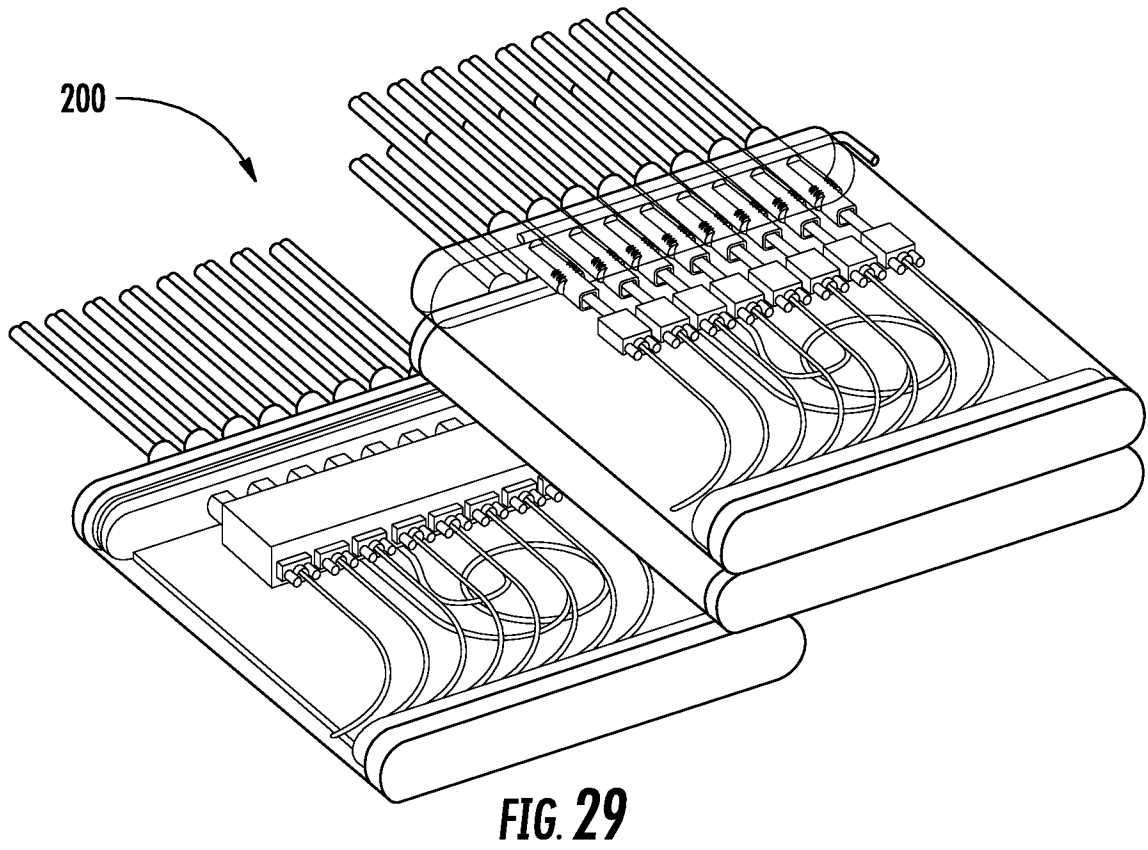


FIG. 30

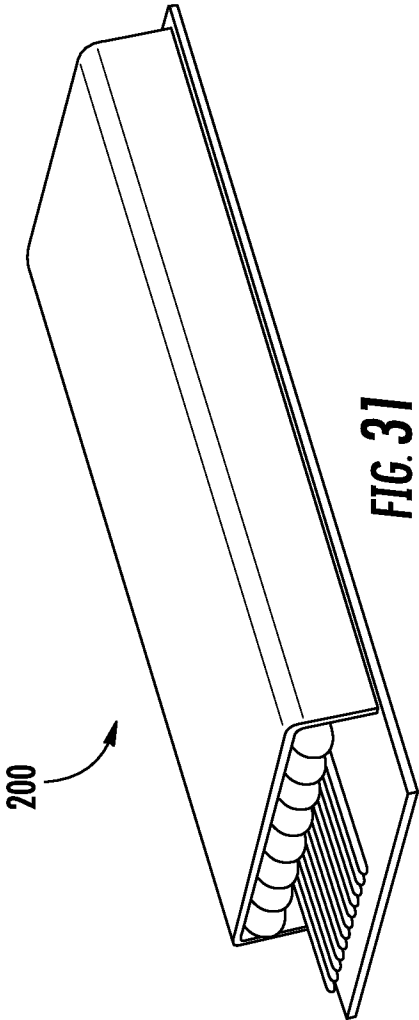


FIG. 31

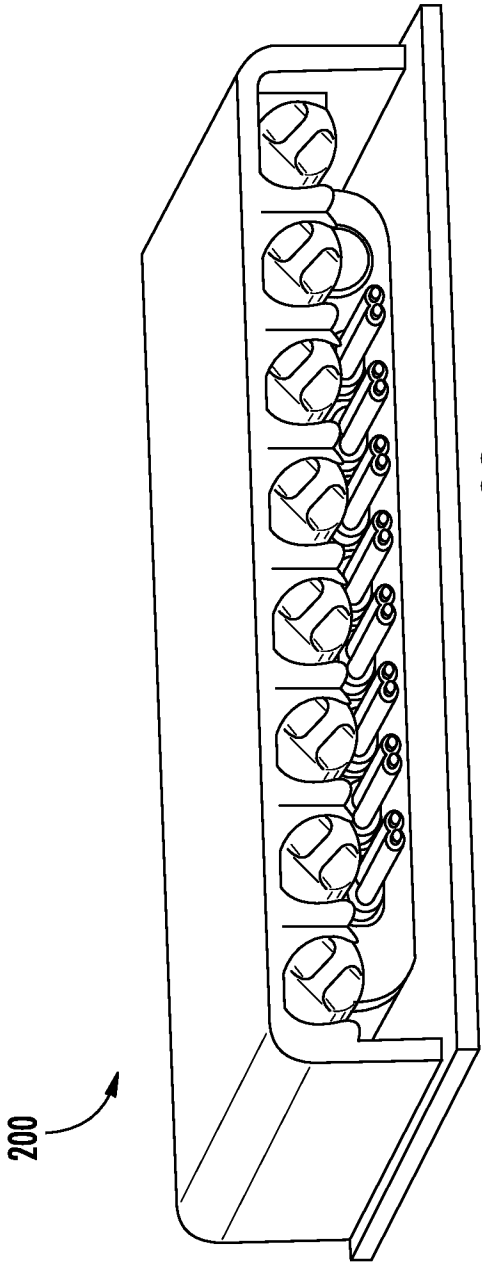
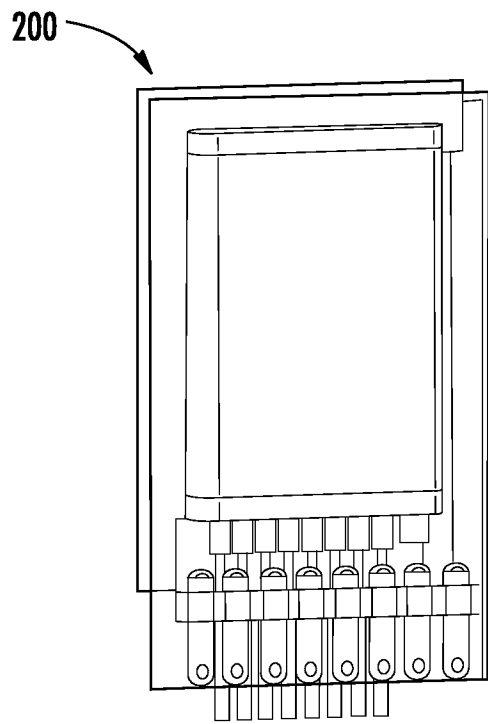
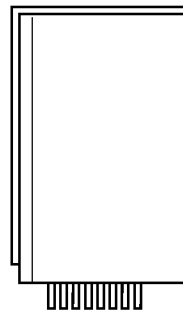


FIG. 32

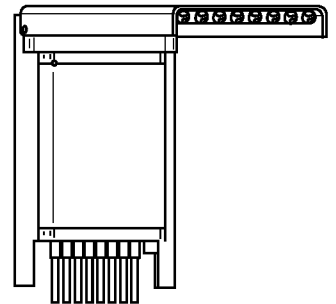
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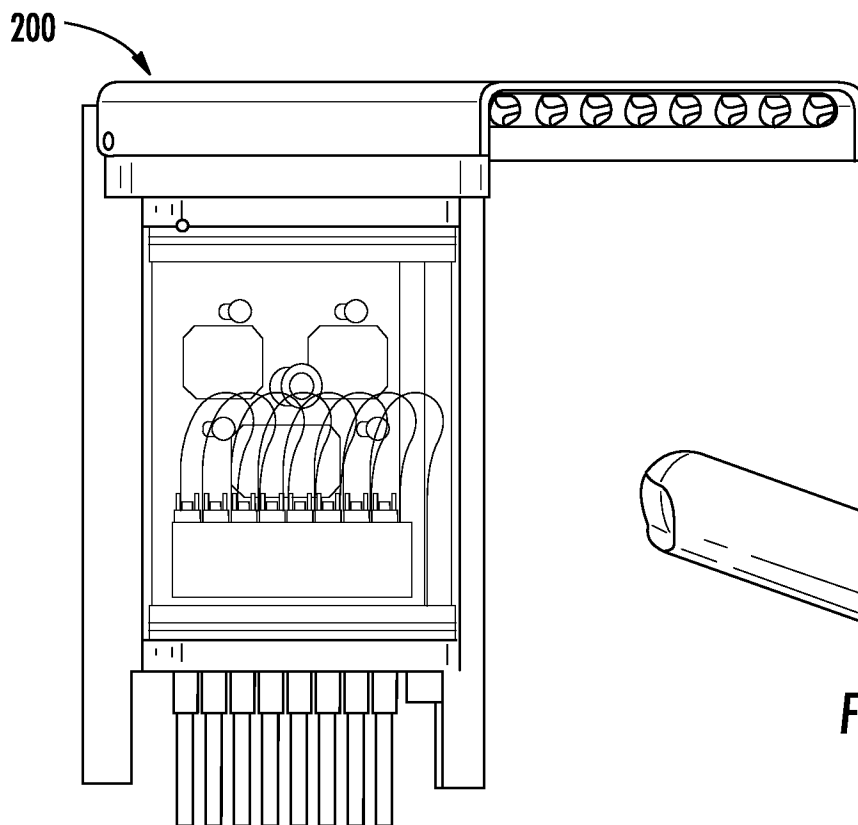
**FIG. 33**



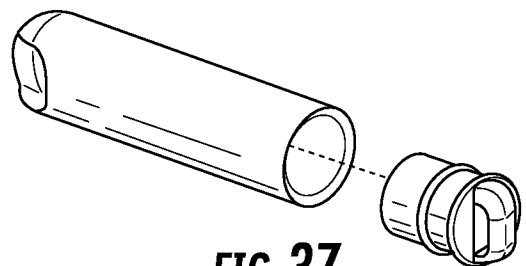
**FIG. 35**



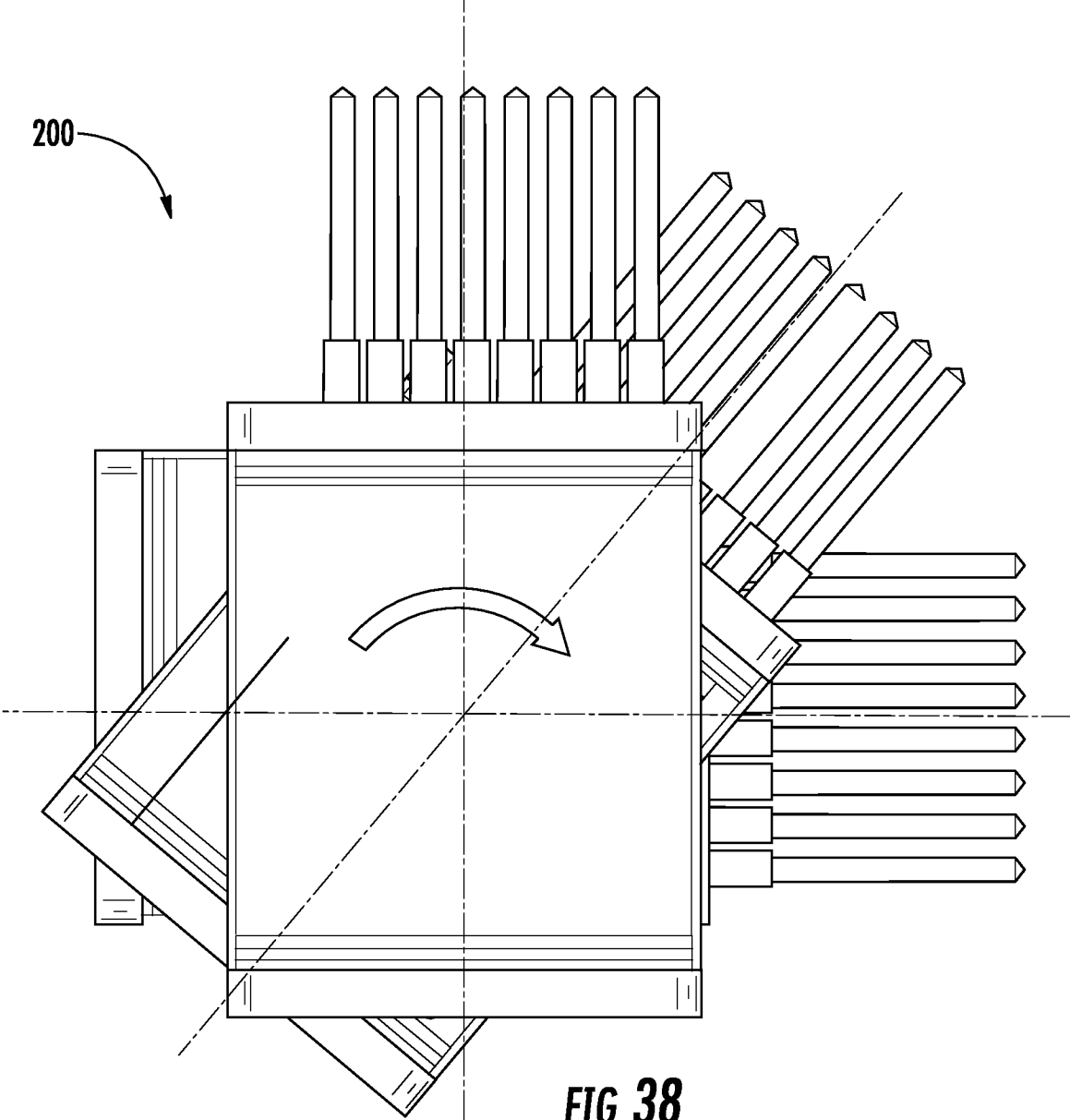
**FIG. 36**



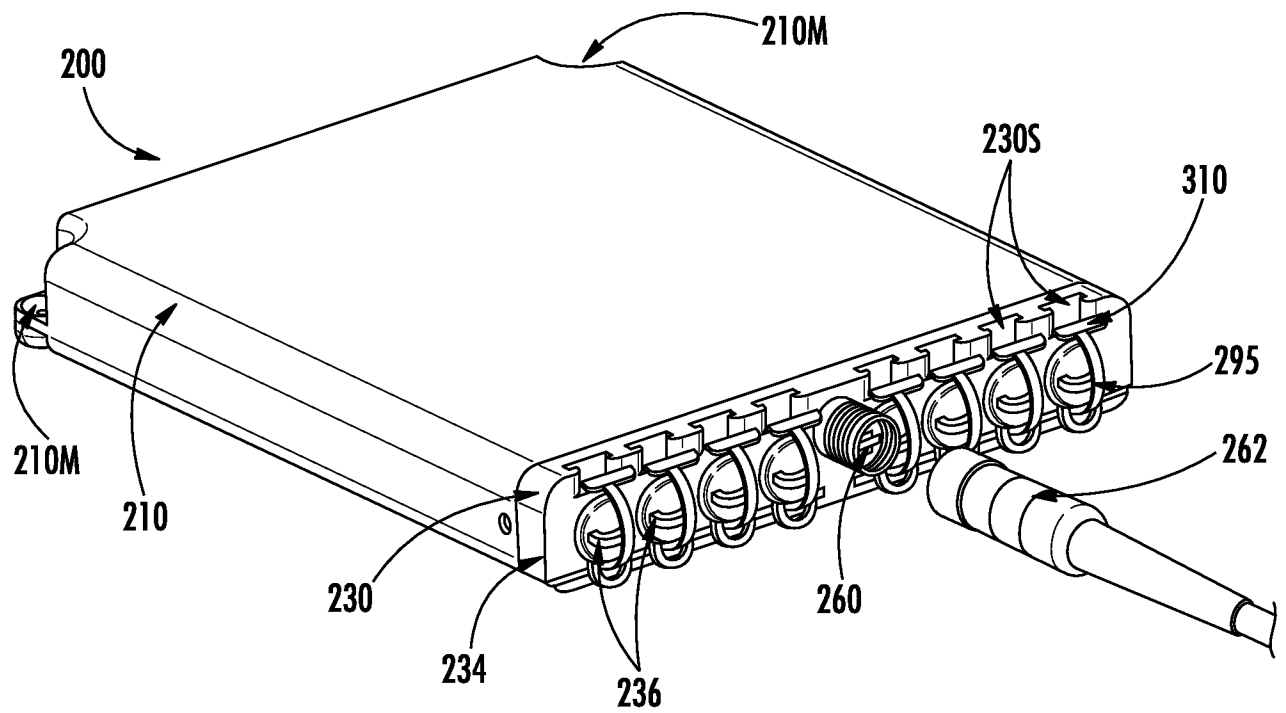
**FIG. 34**



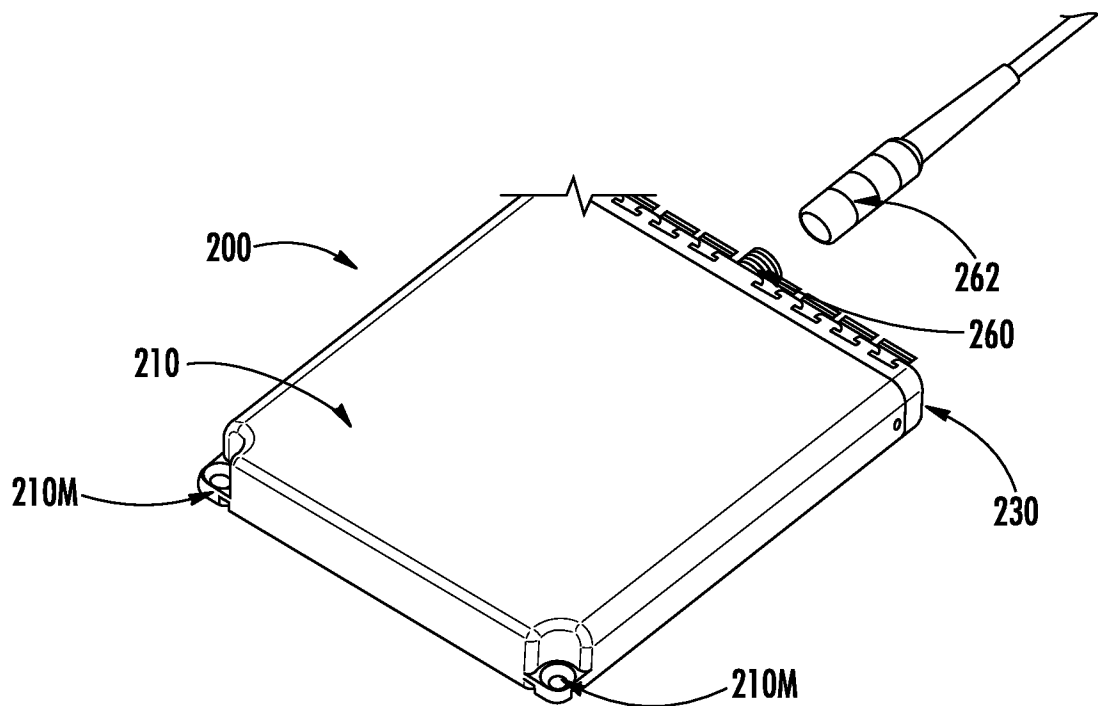
**FIG. 37**



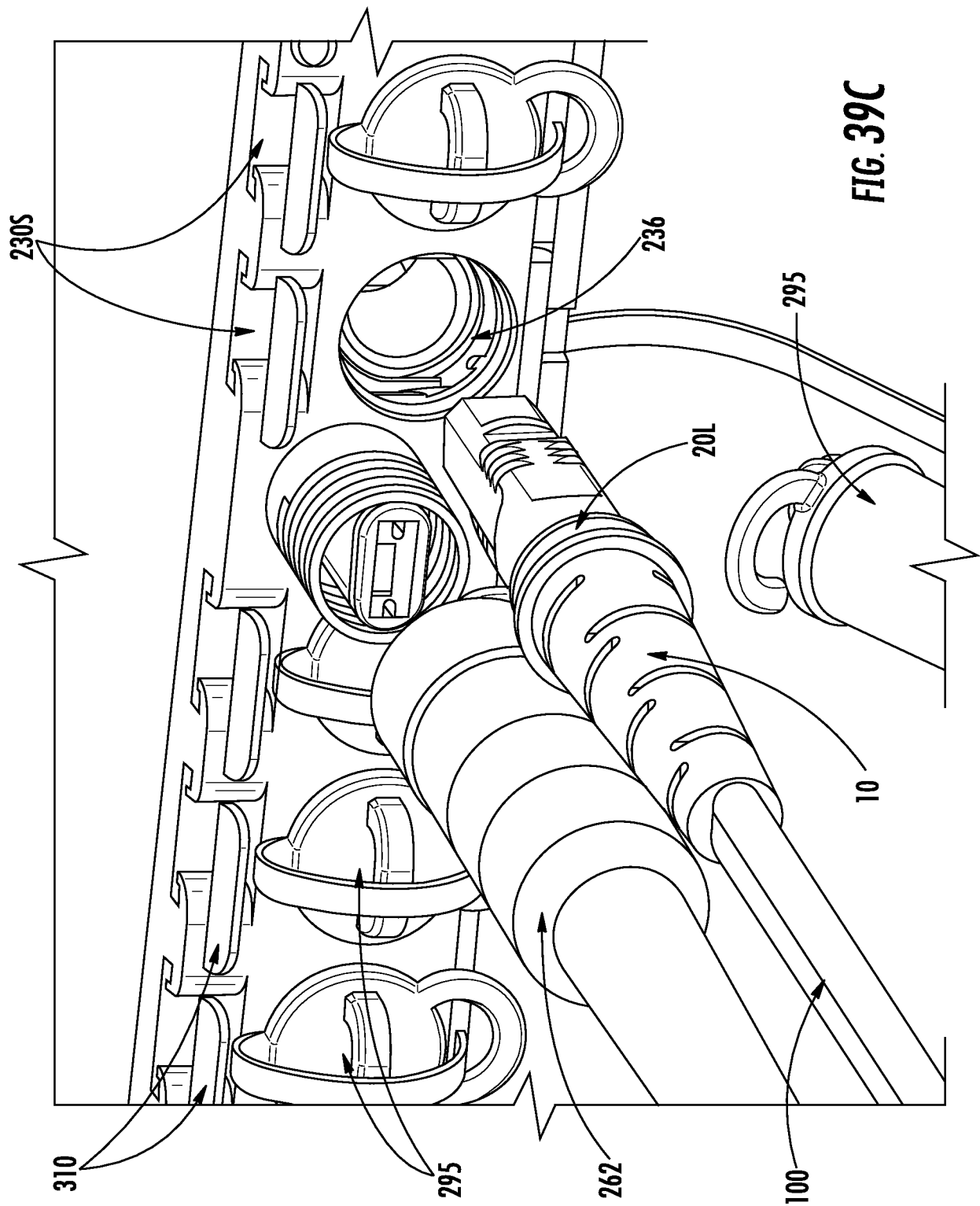
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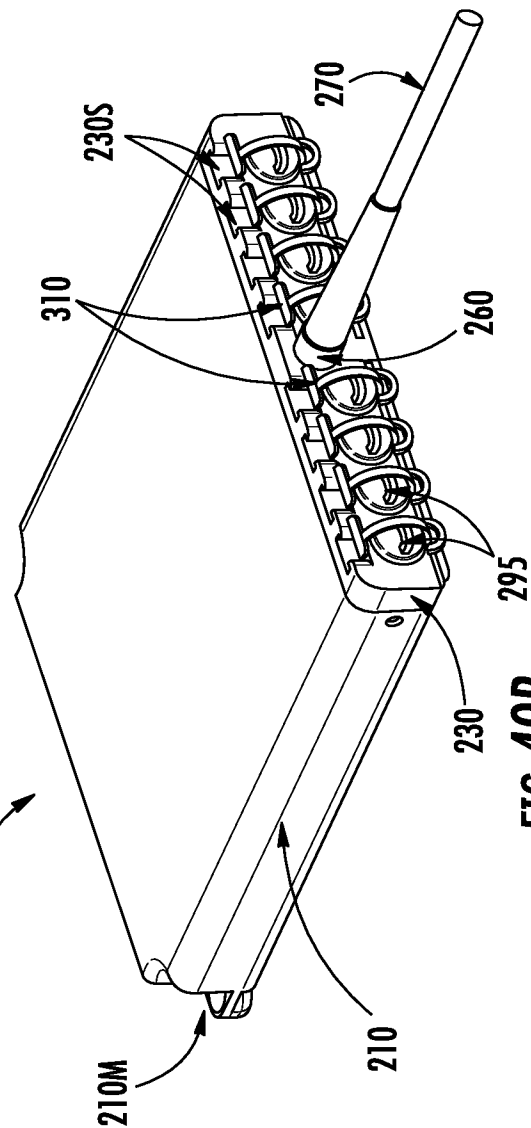
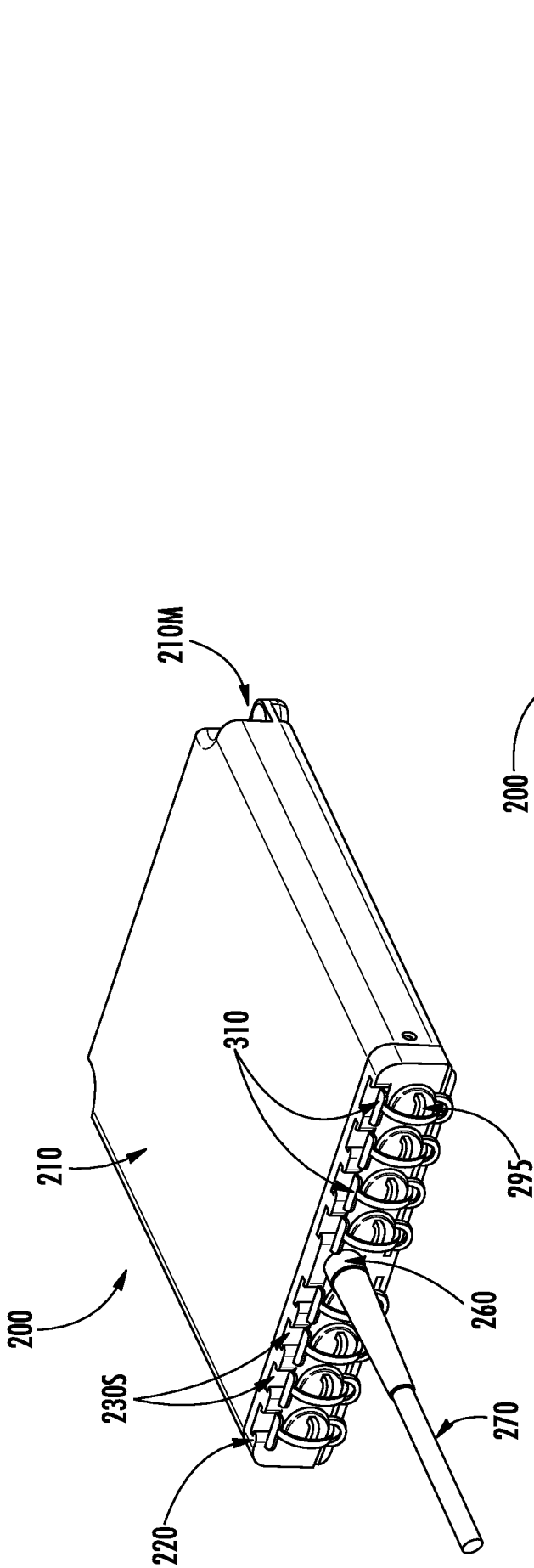


**FIG. 39A**



**FIG. 39B**







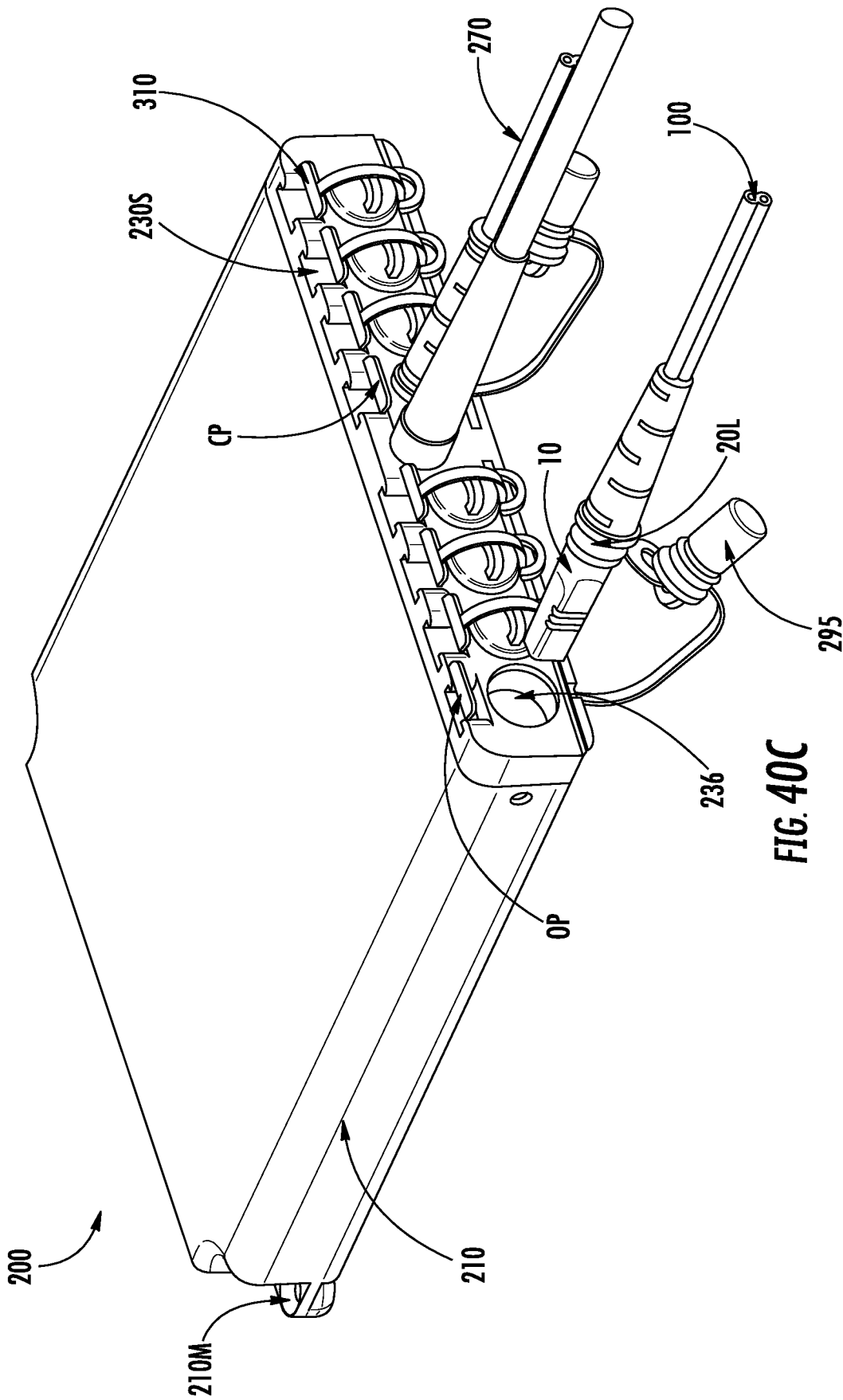


FIG. 40C

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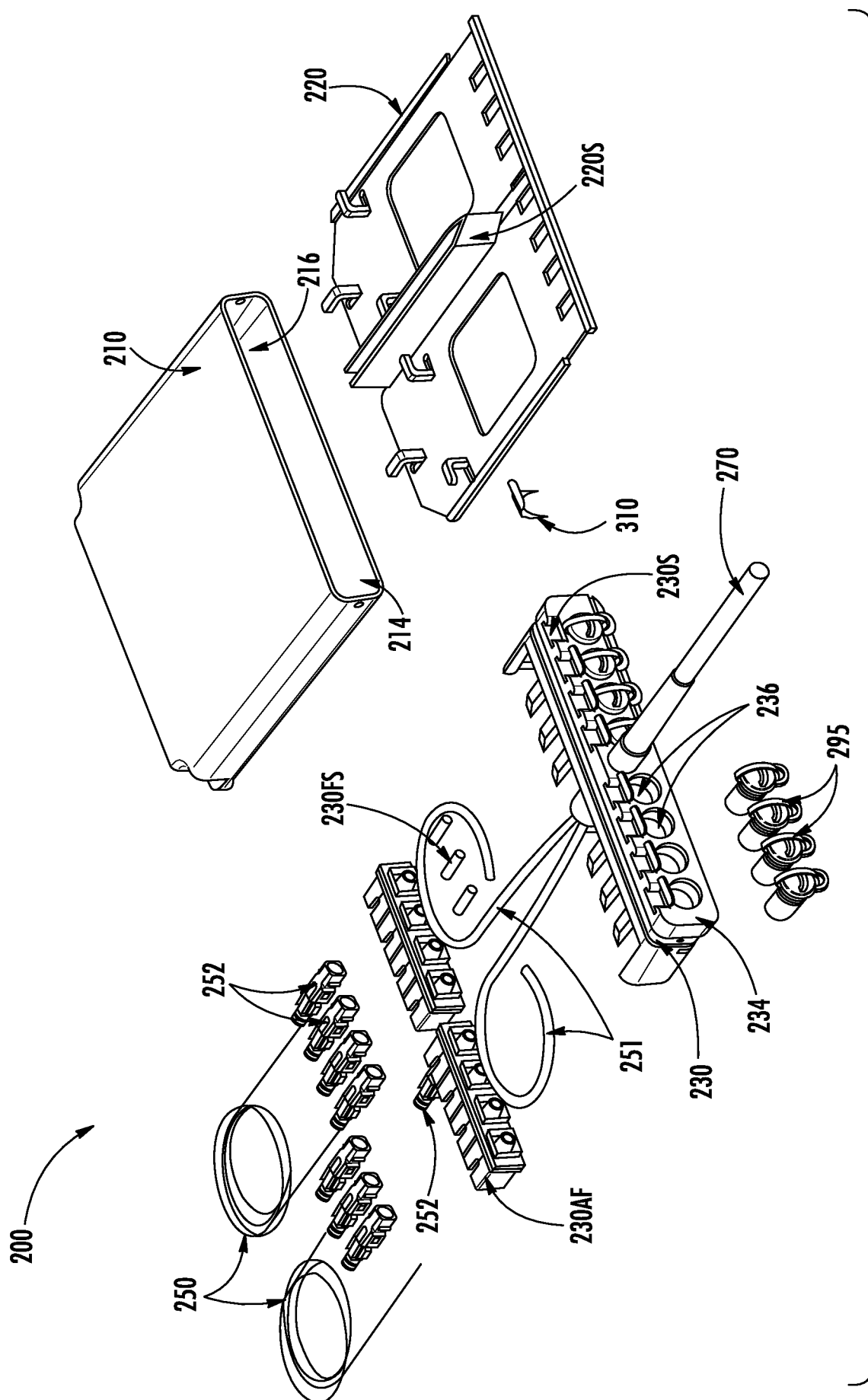
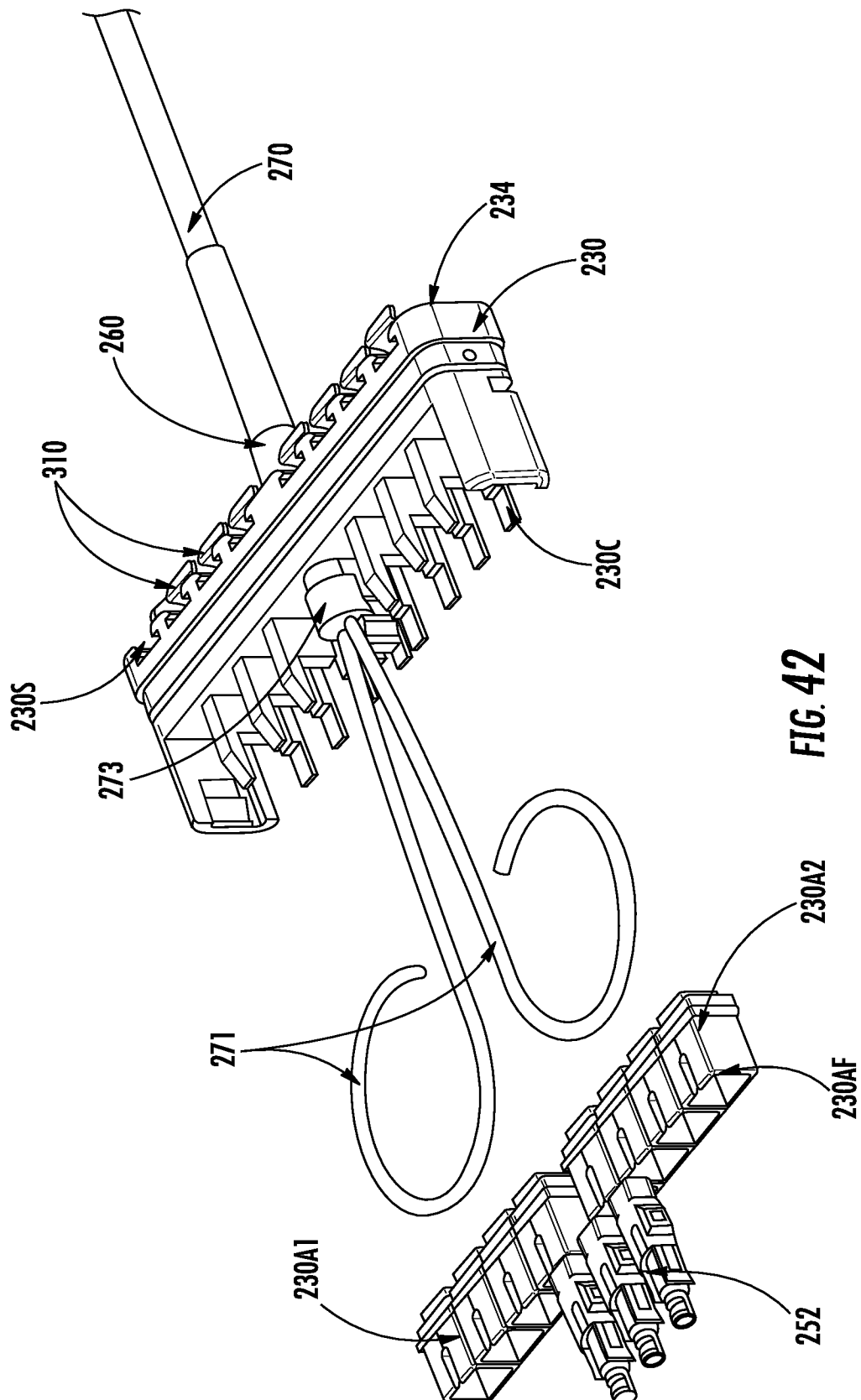
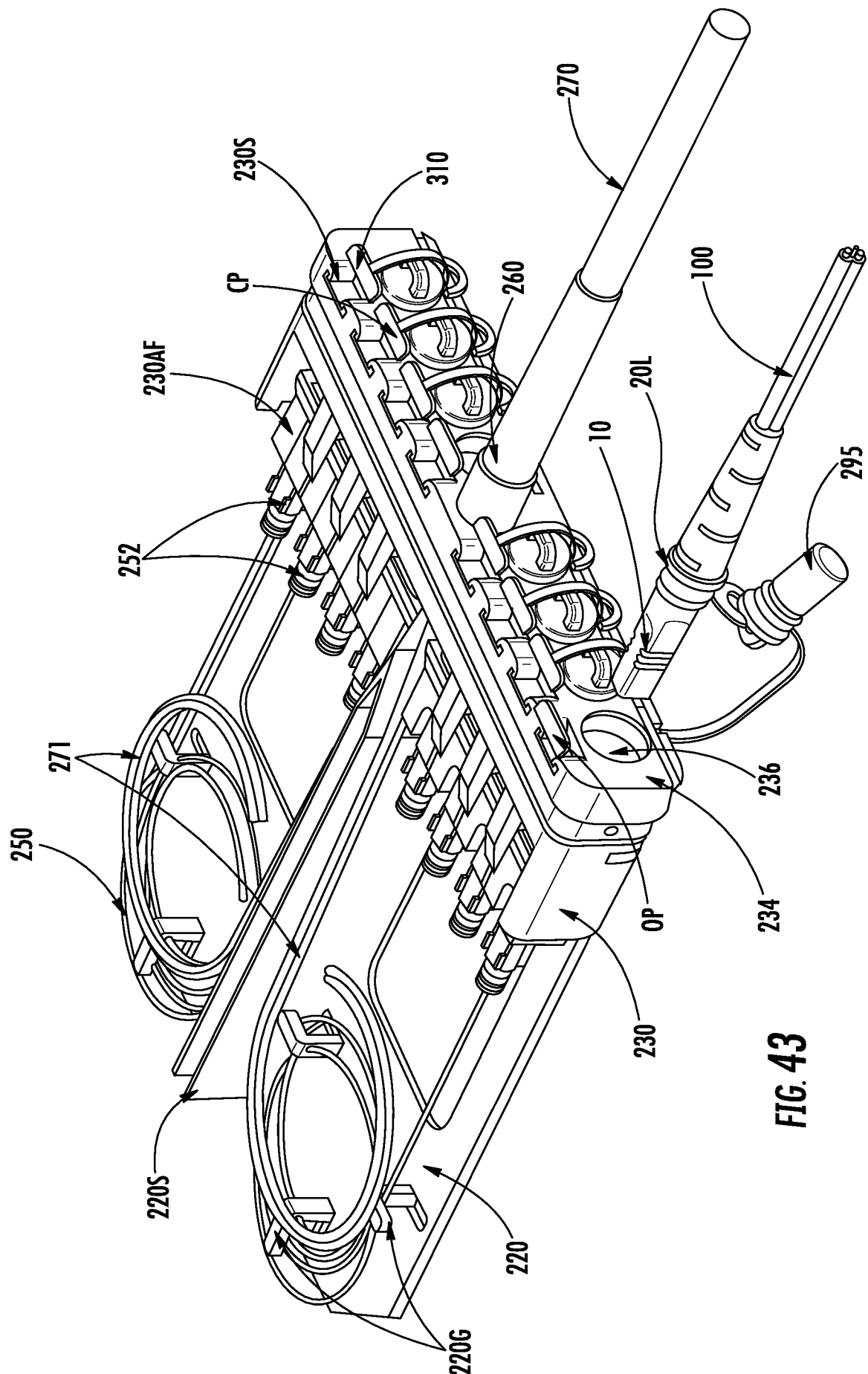


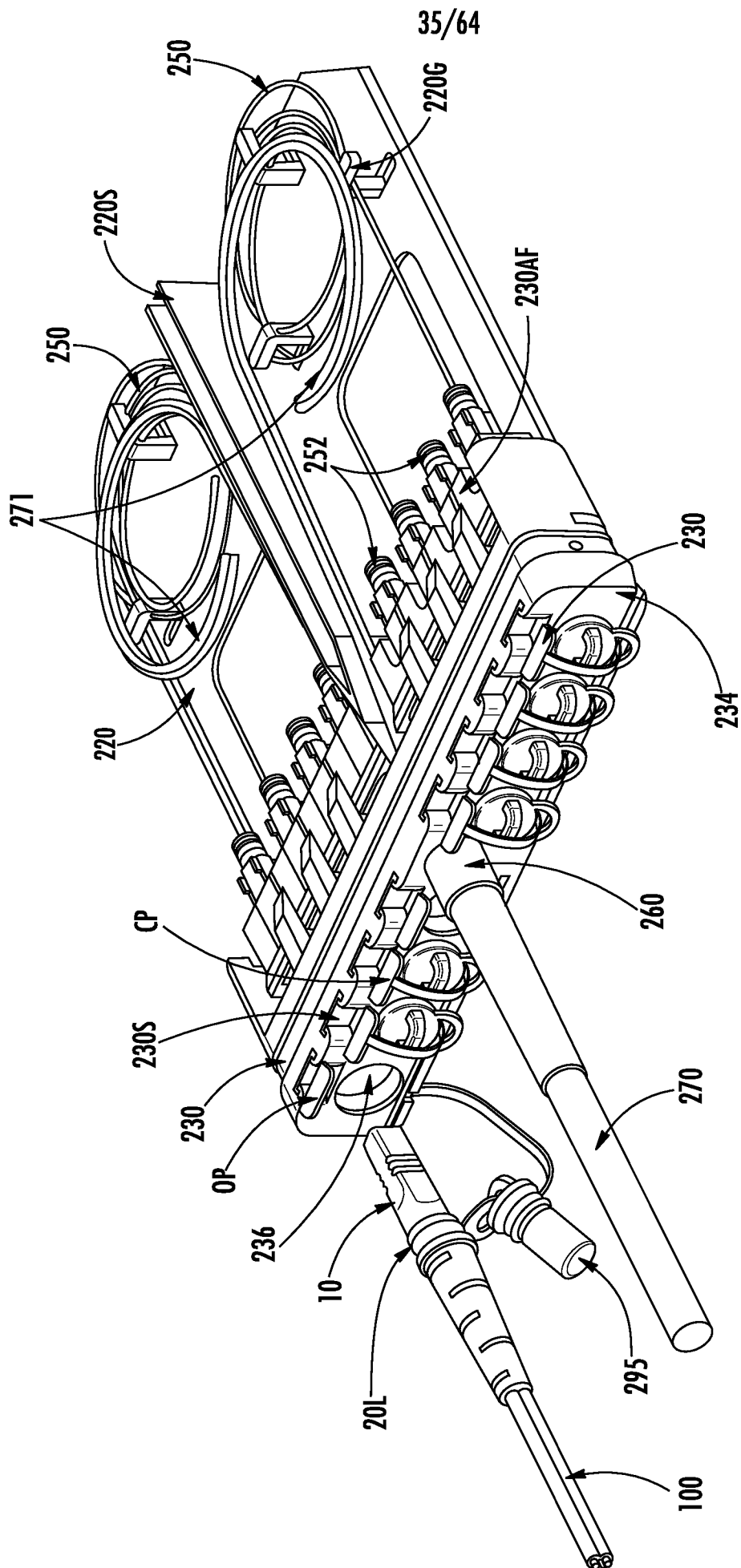
FIG. 41



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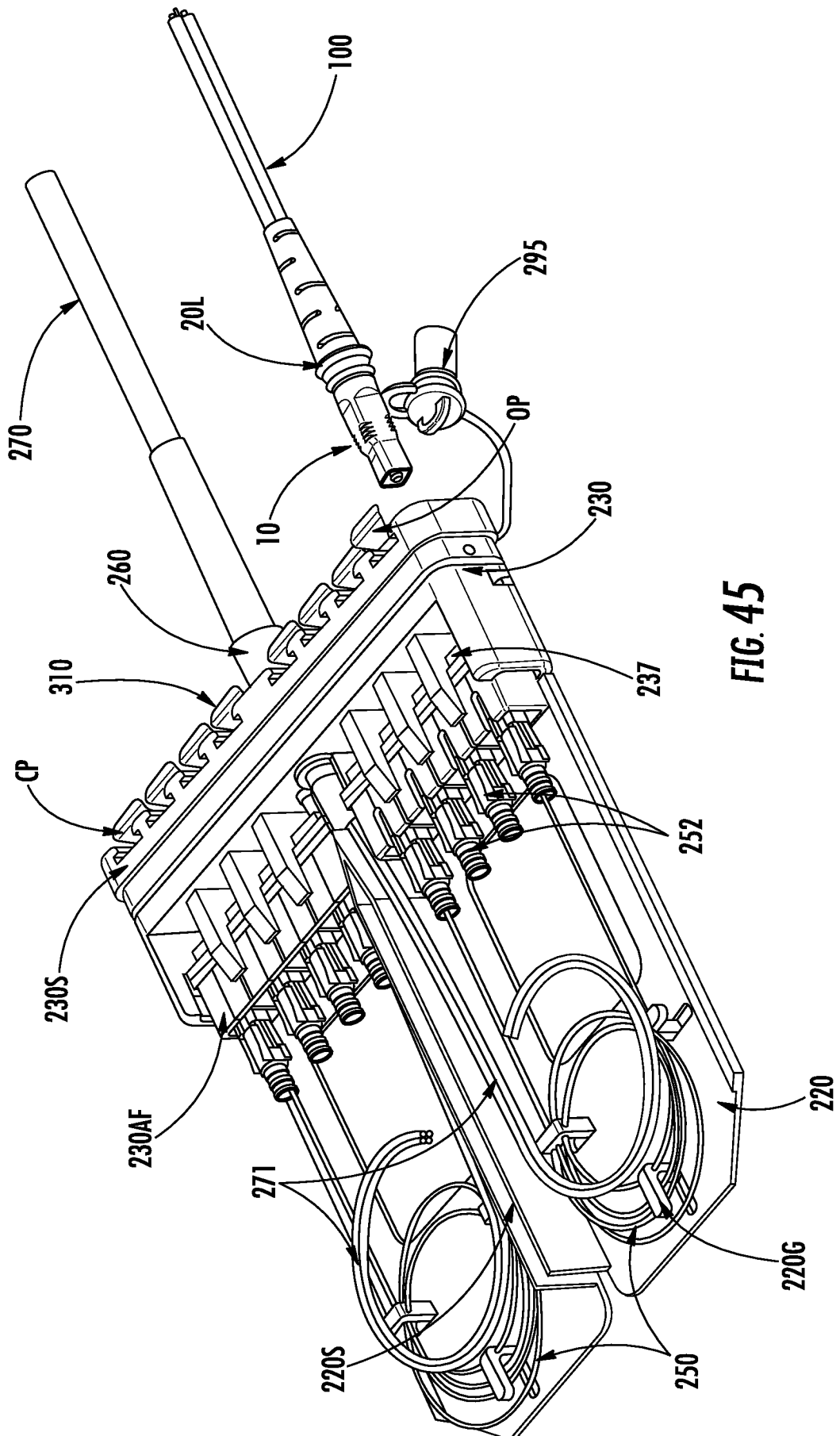


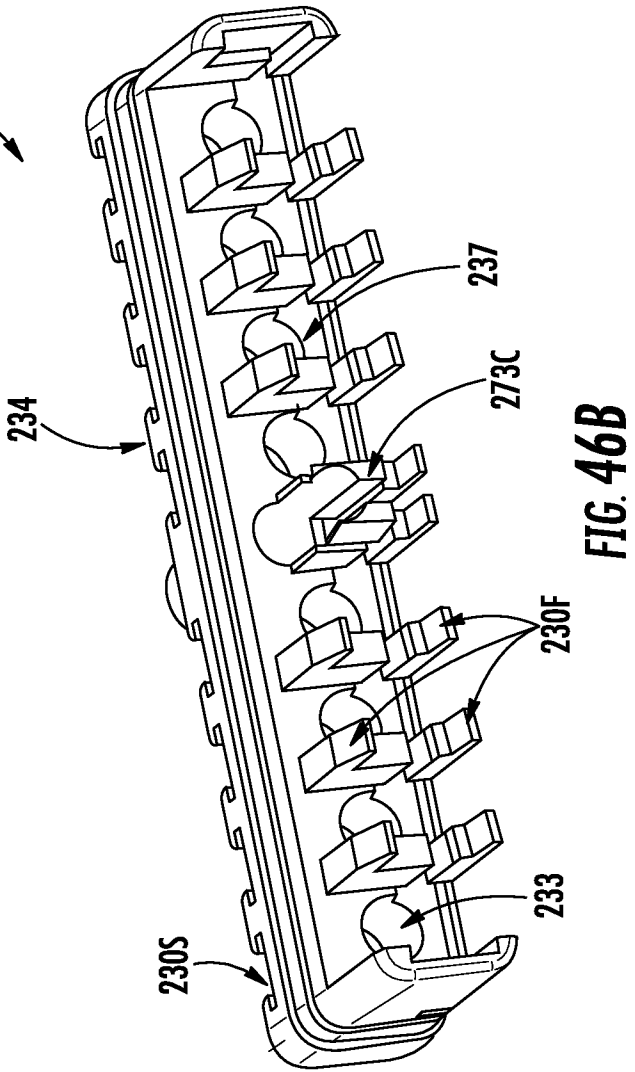
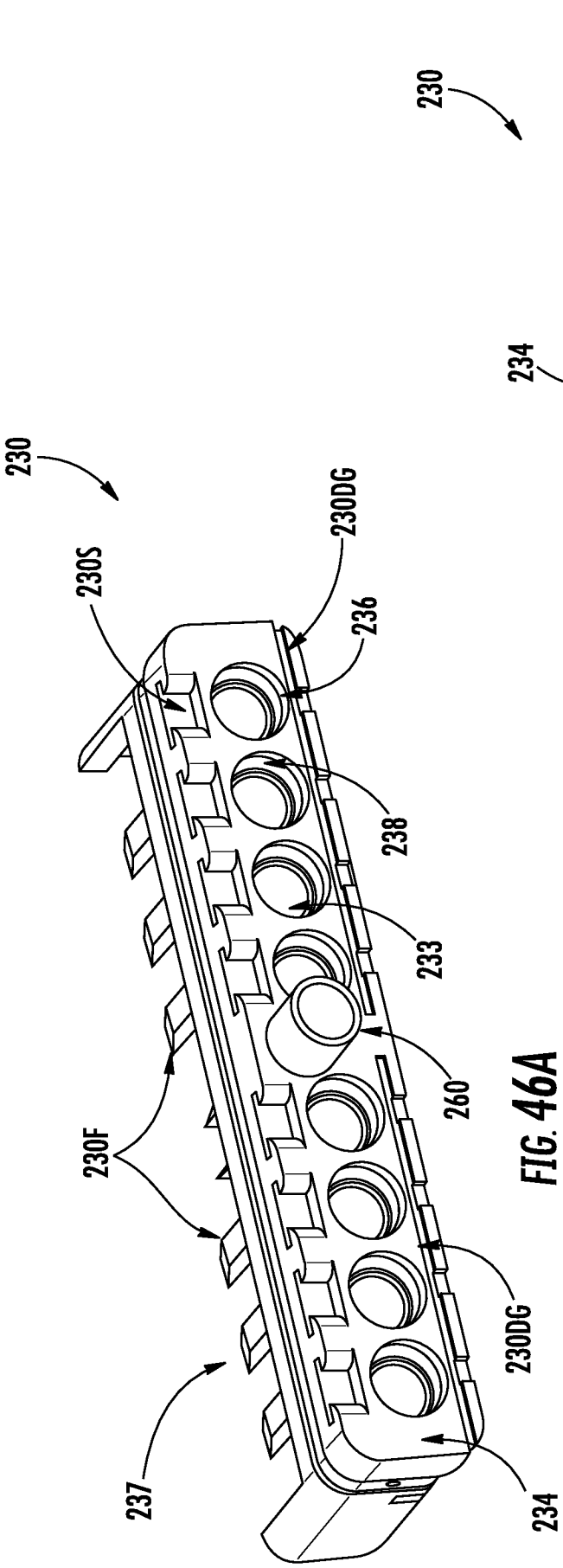
**FIG. 43**



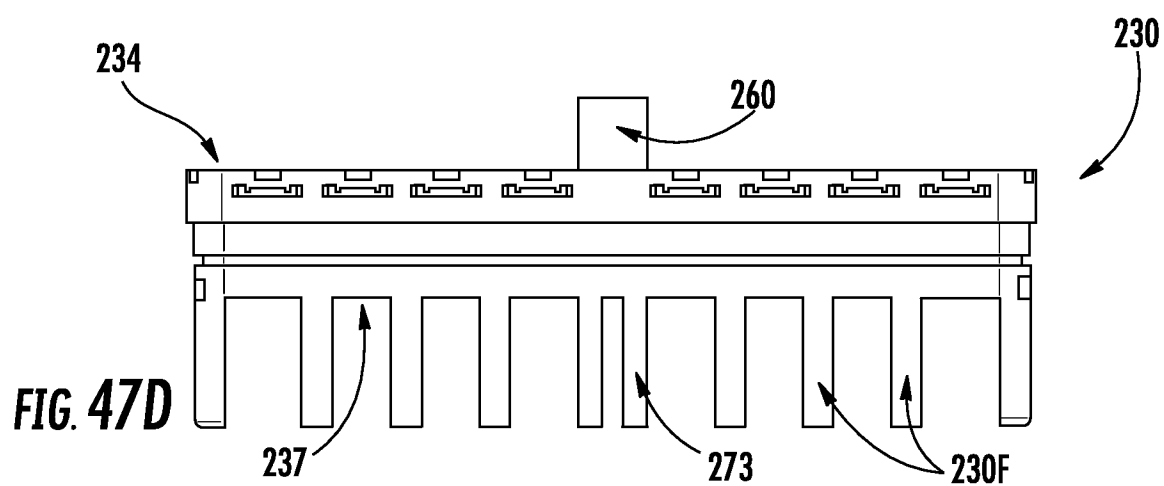
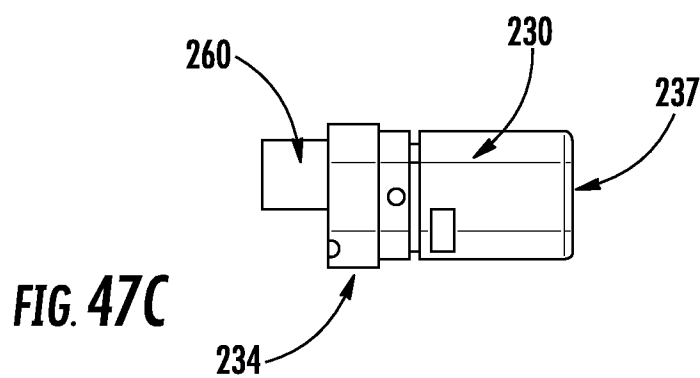
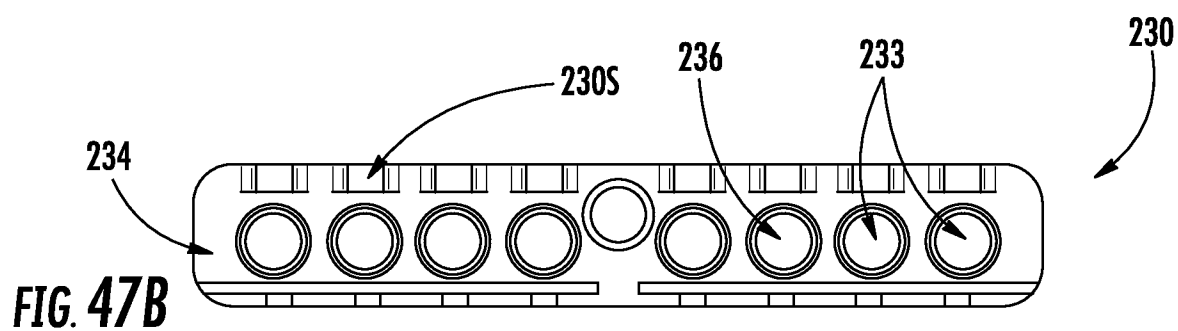
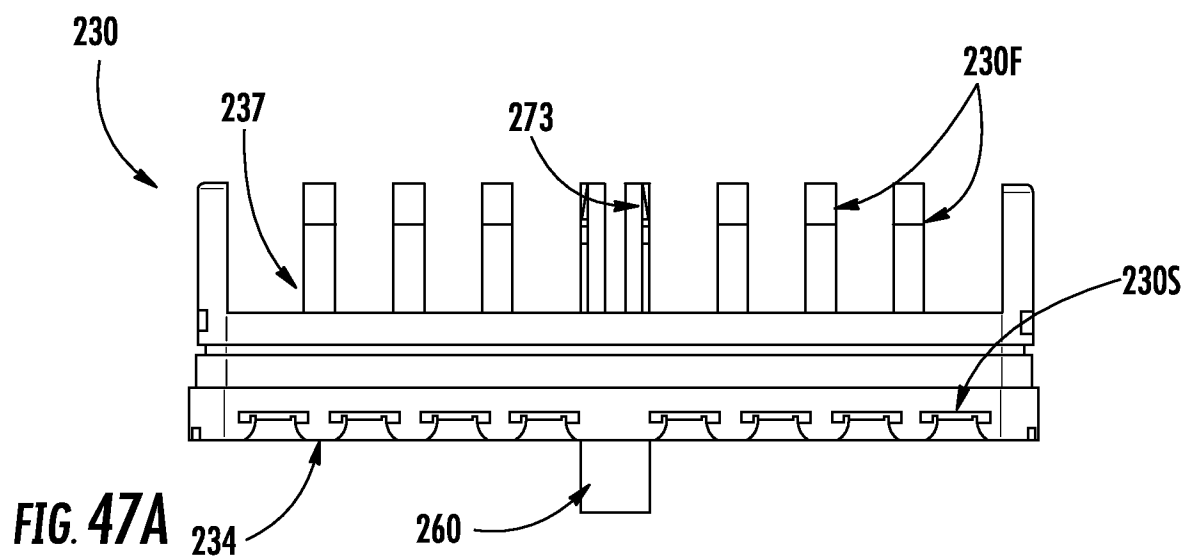
**FIG. 44**

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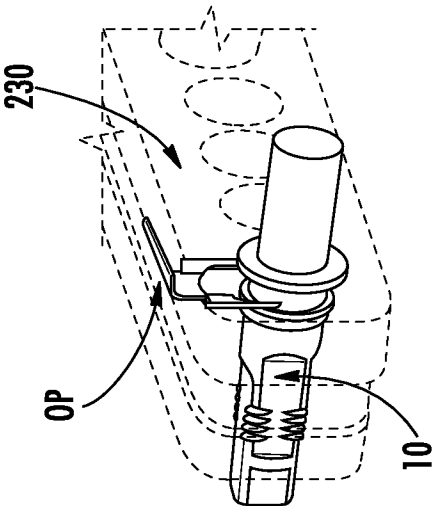


FIG. 48A

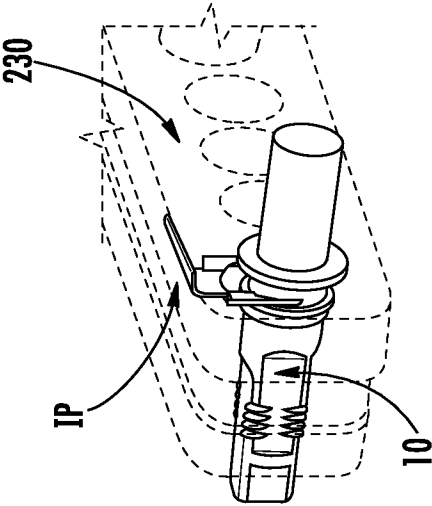


FIG. 48B

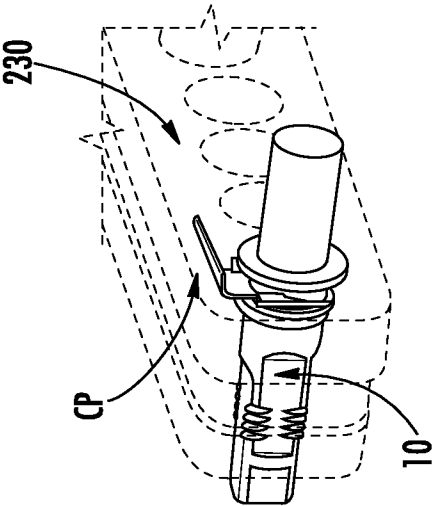


FIG. 48C

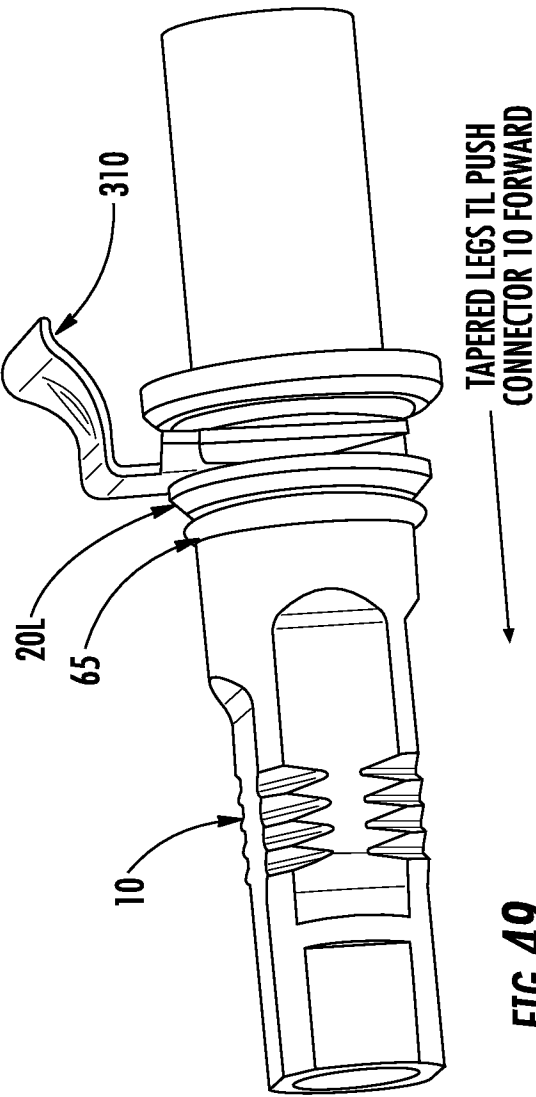
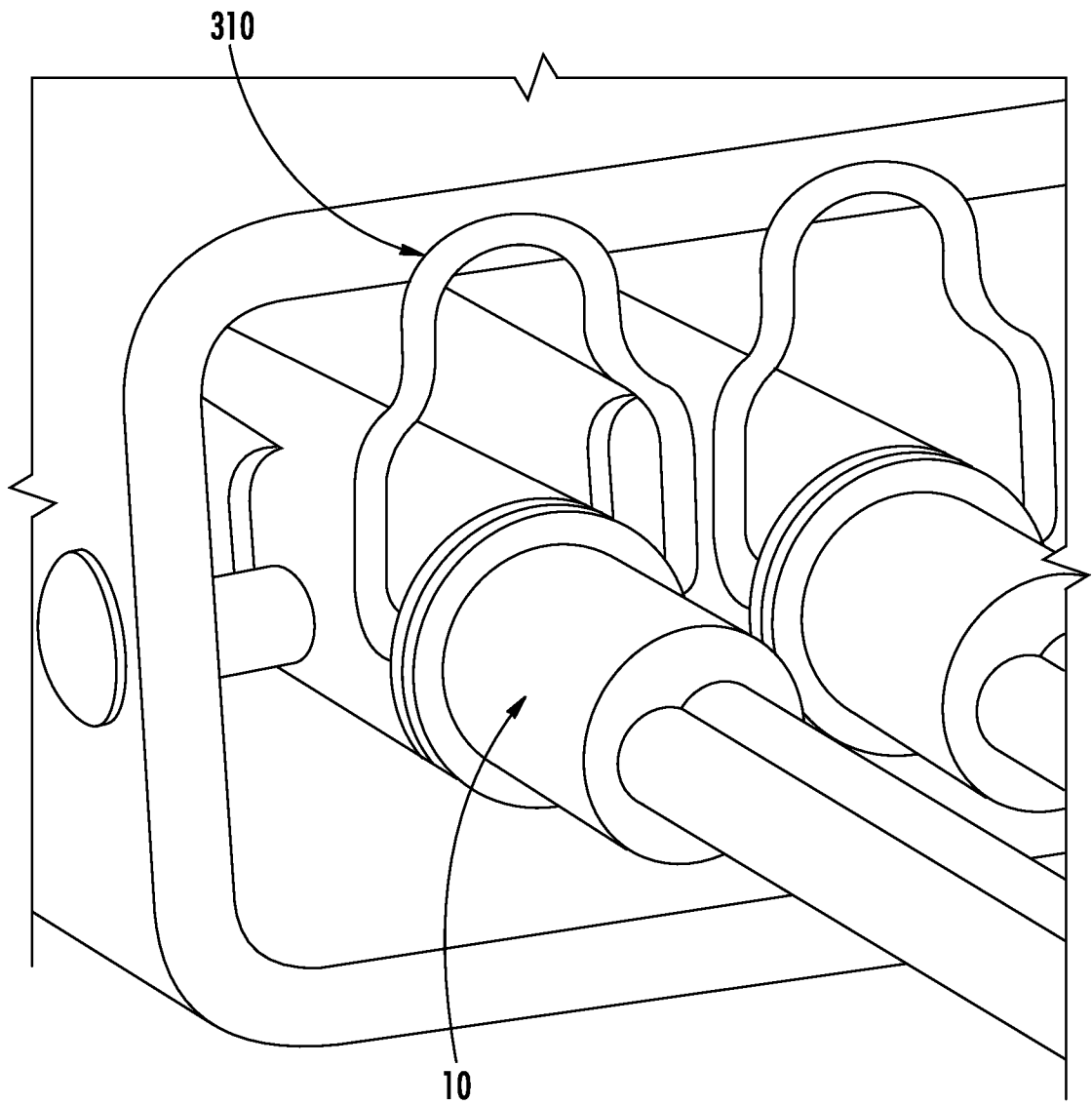
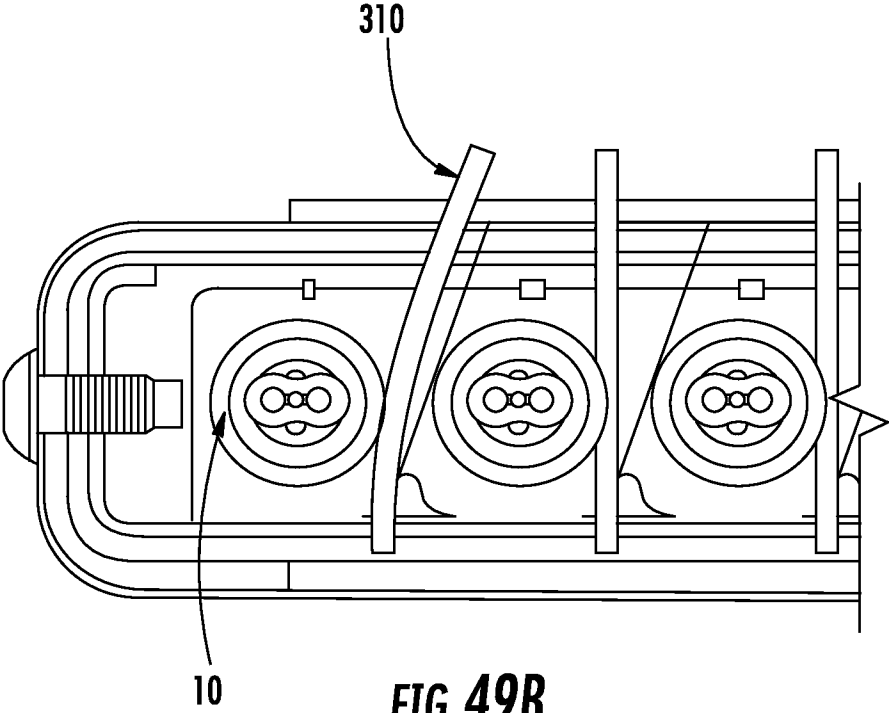


FIG. 49

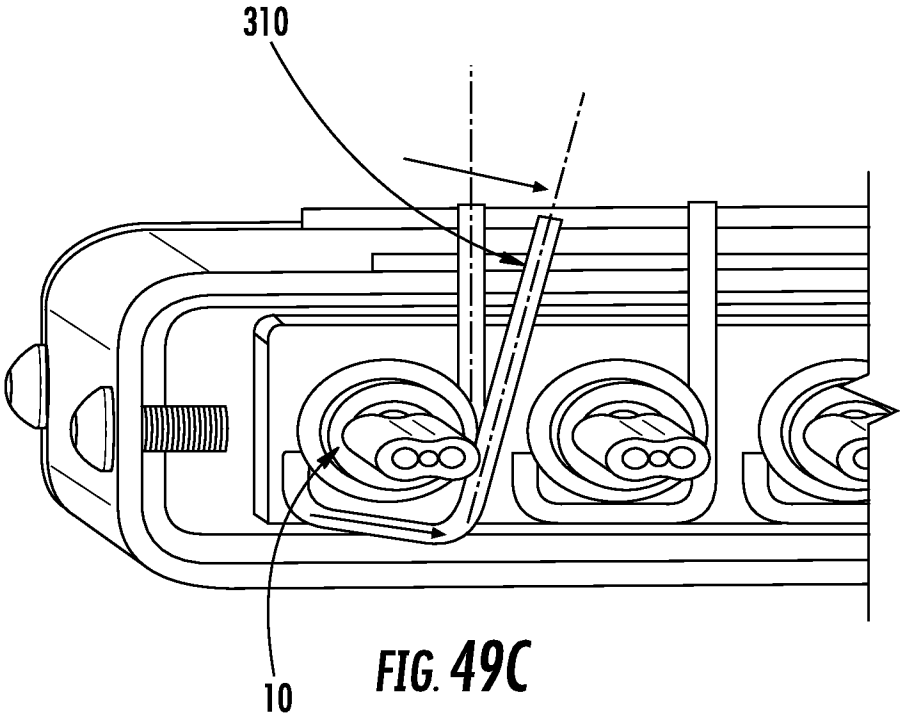
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**FIG. 49A**



**FIG. 49B**



**FIG. 49C**

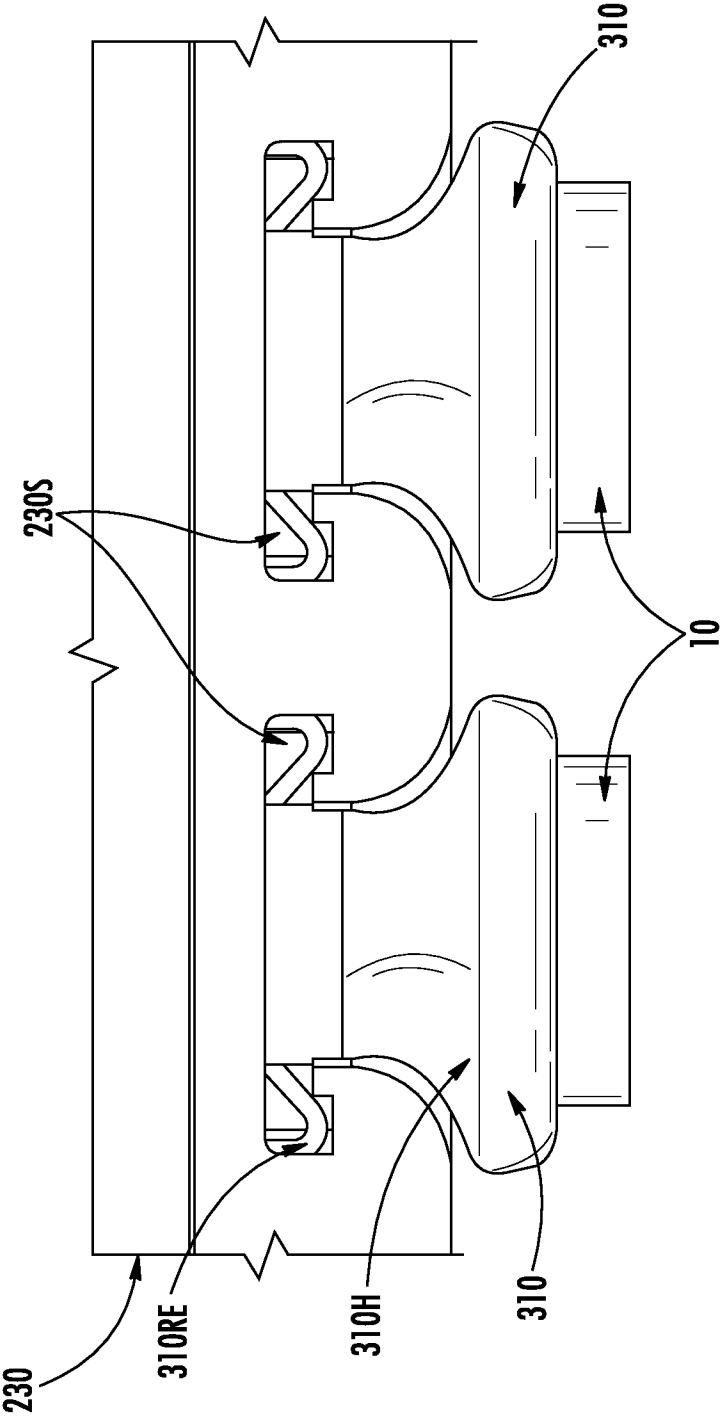
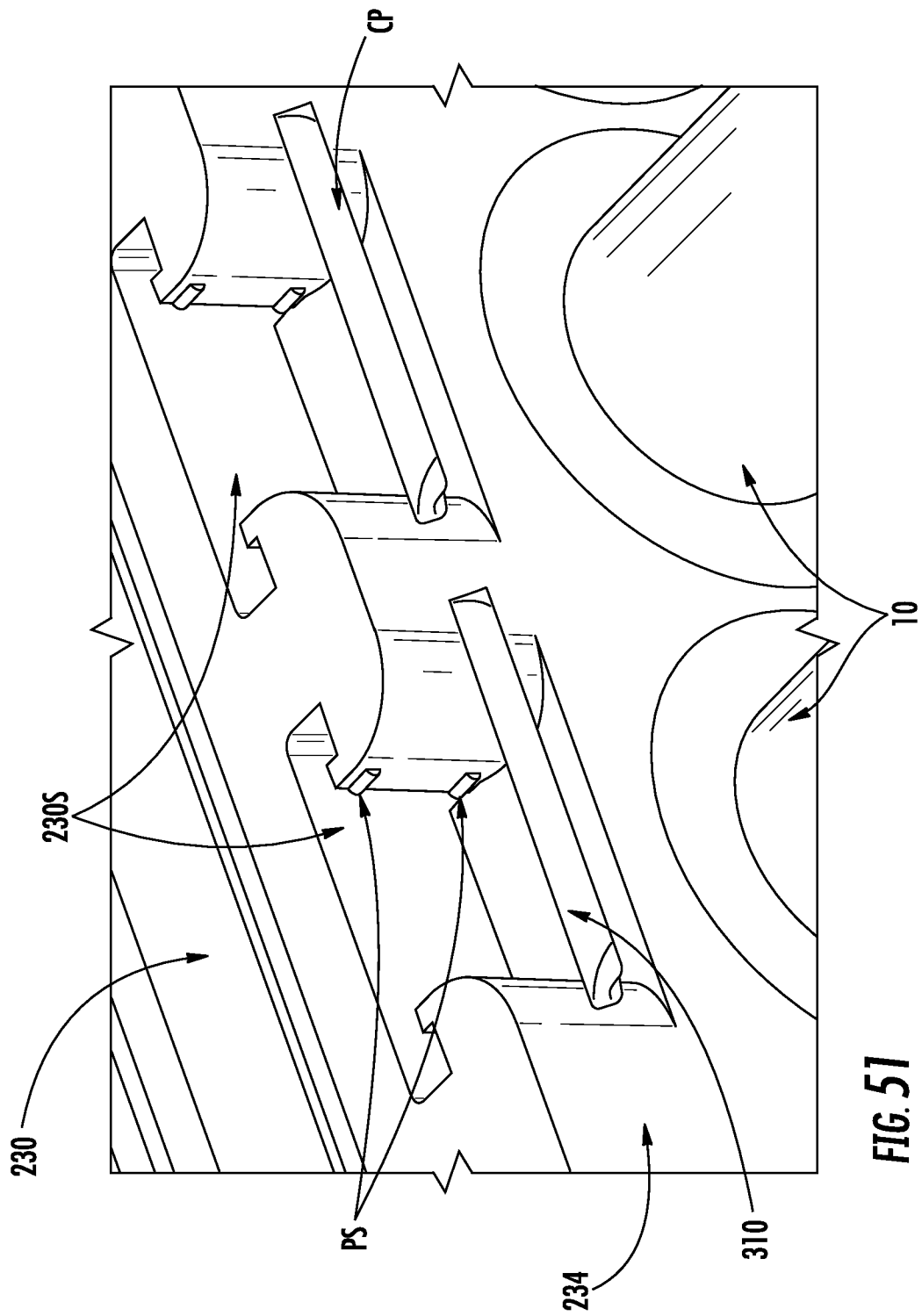
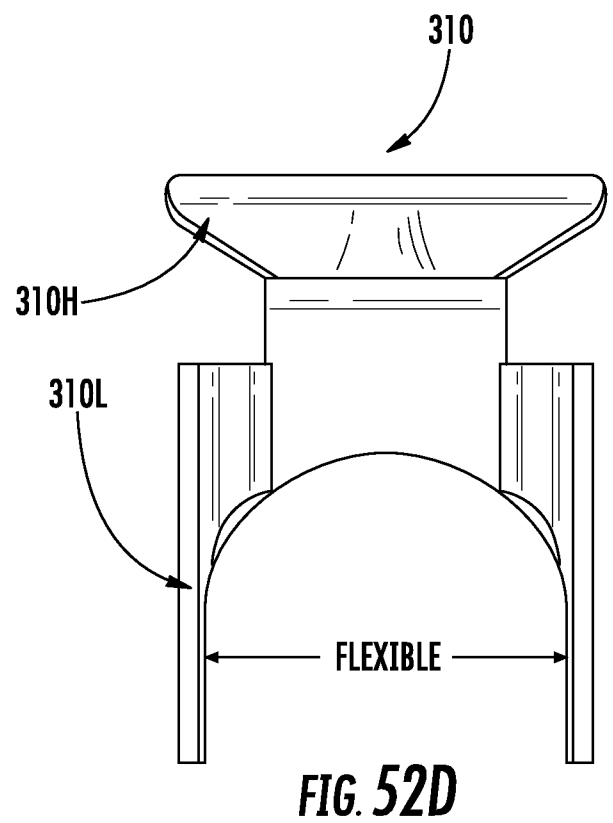
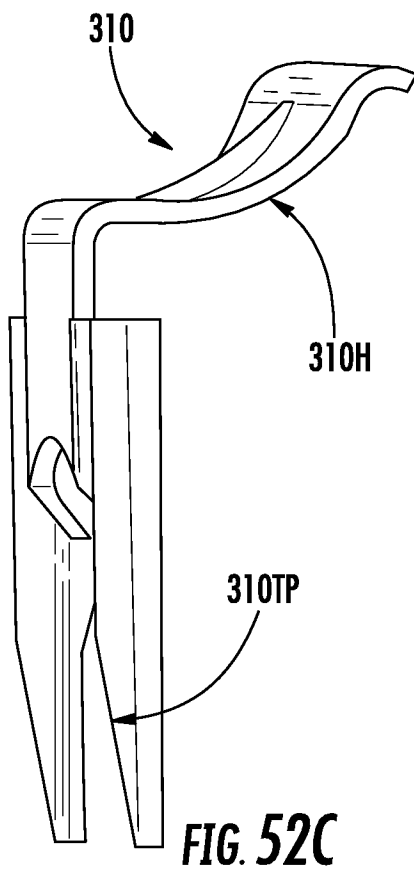
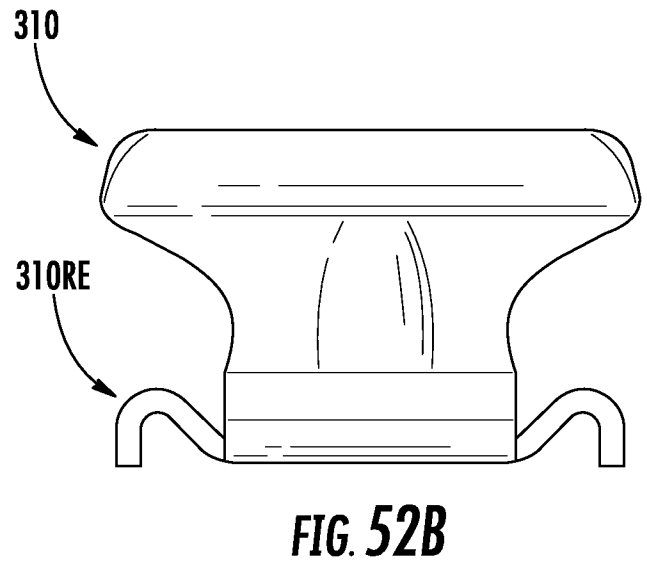
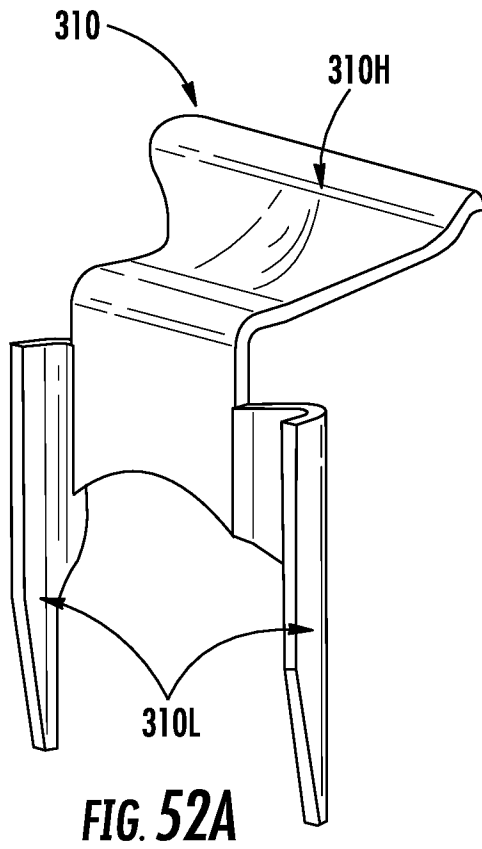


FIG. 50



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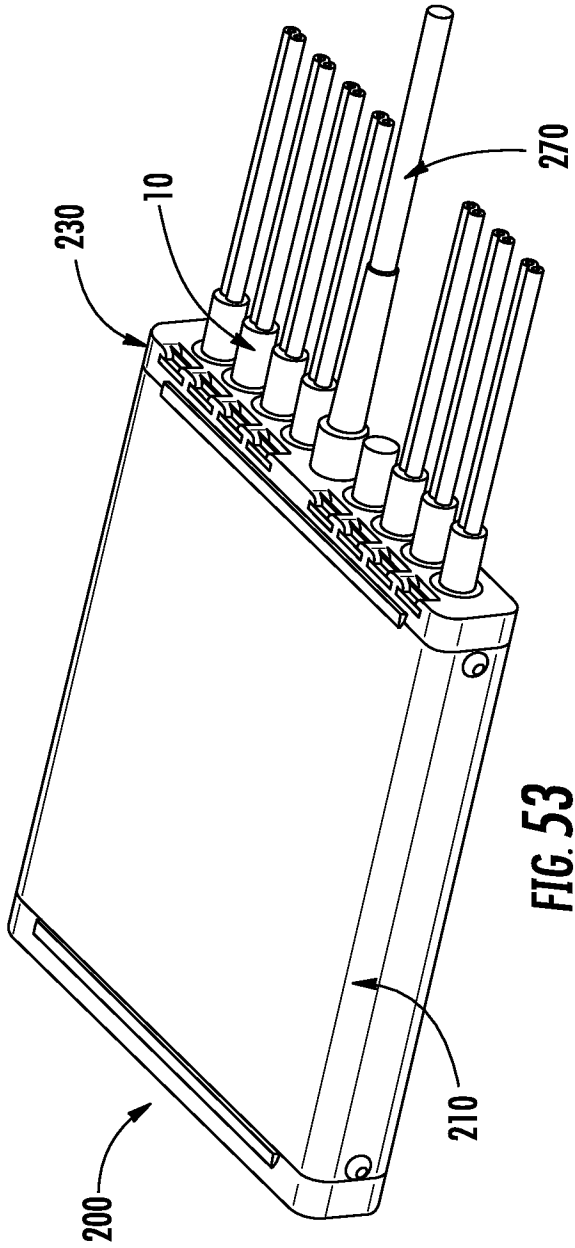


FIG. 53

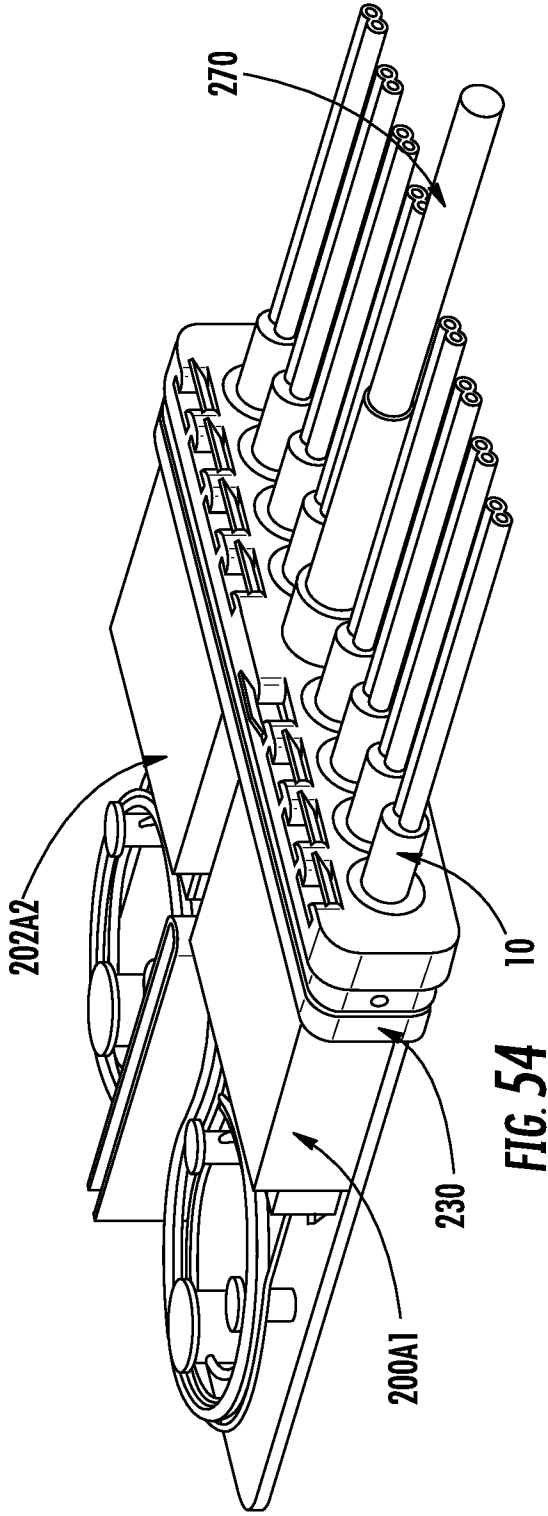


FIG. 54

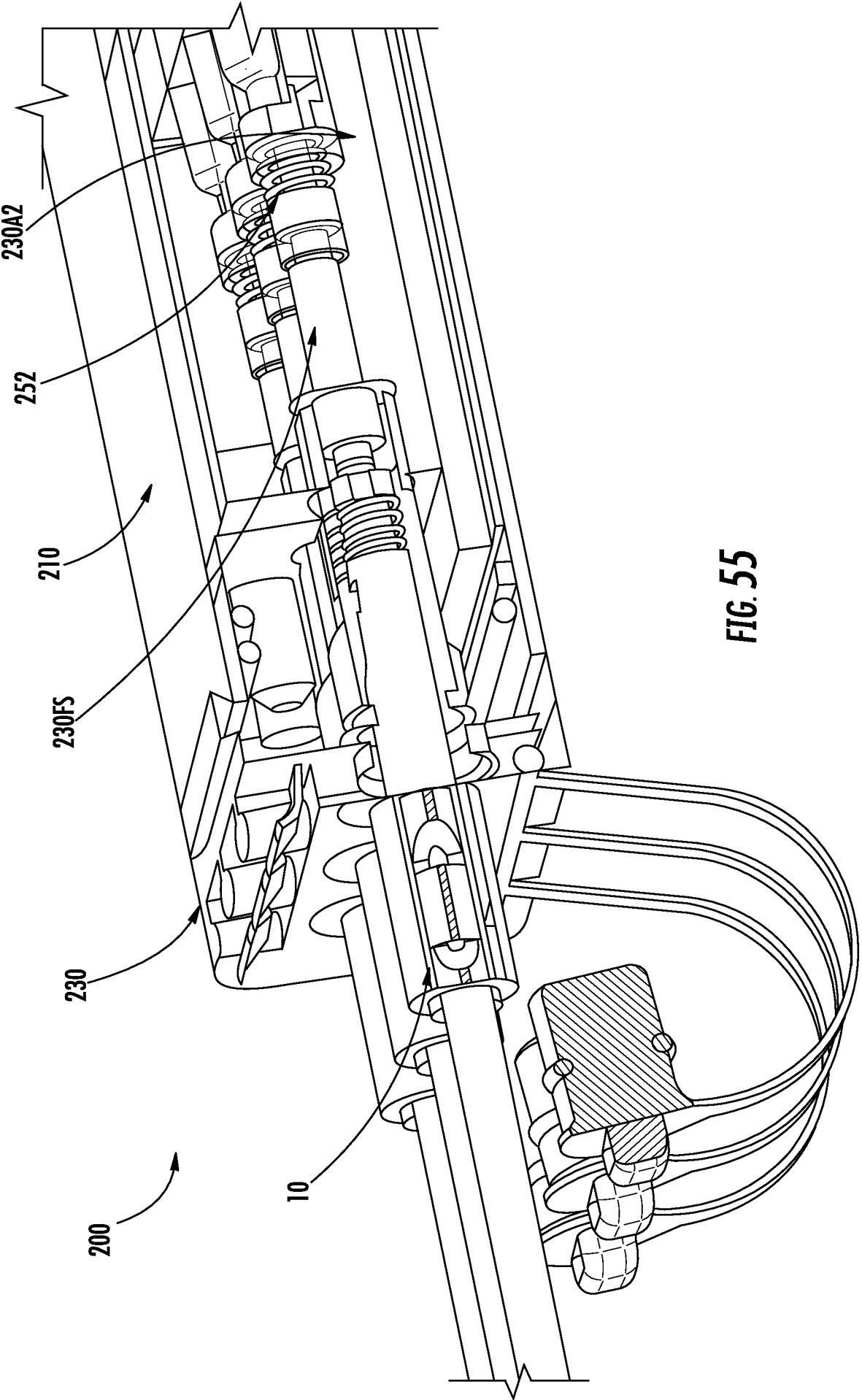


FIG. 55



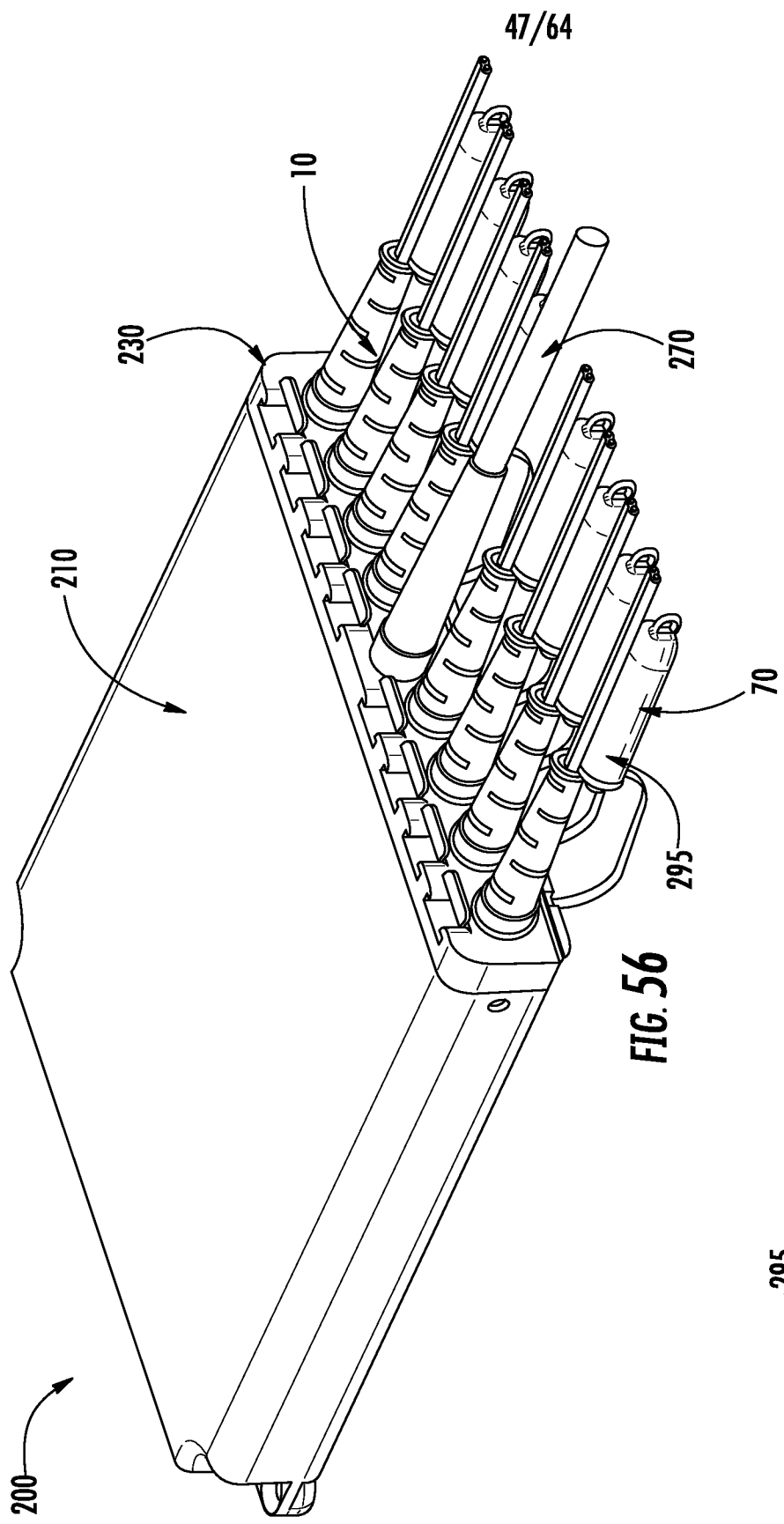


FIG. 56

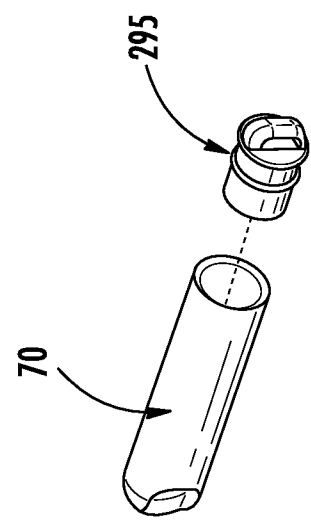
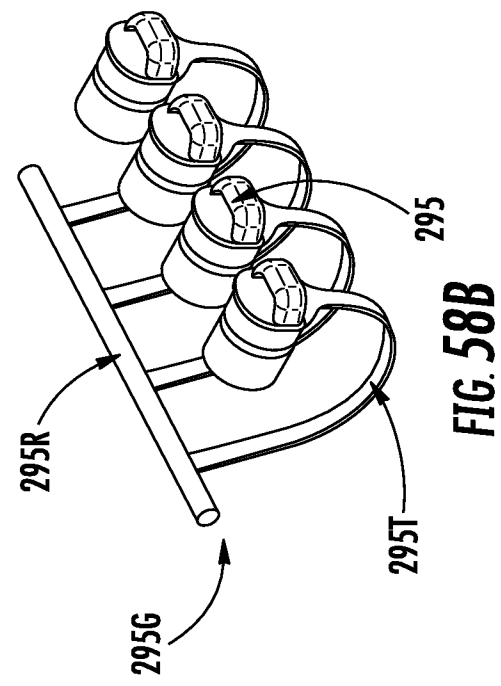
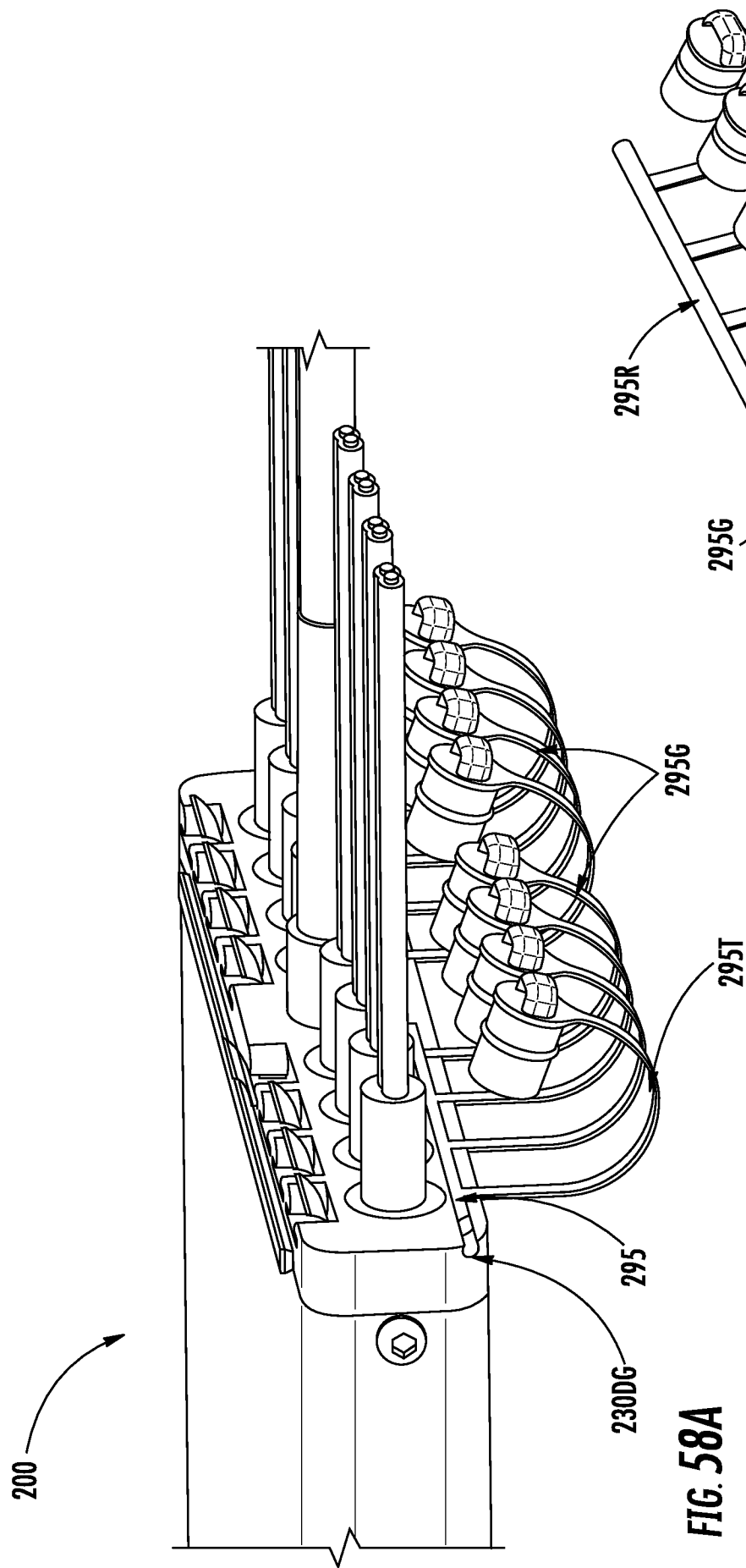
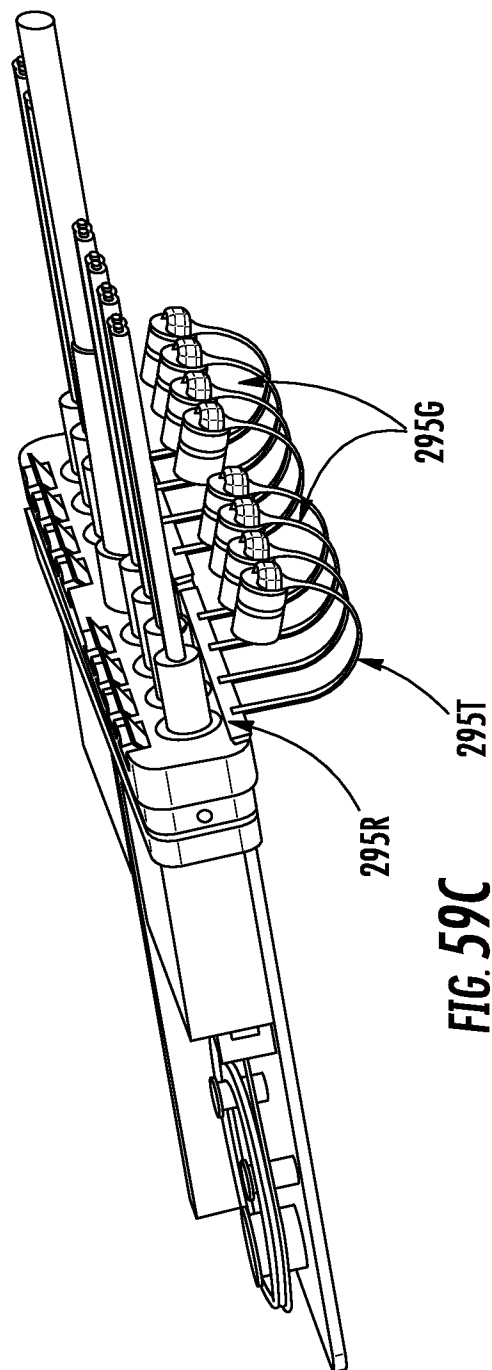
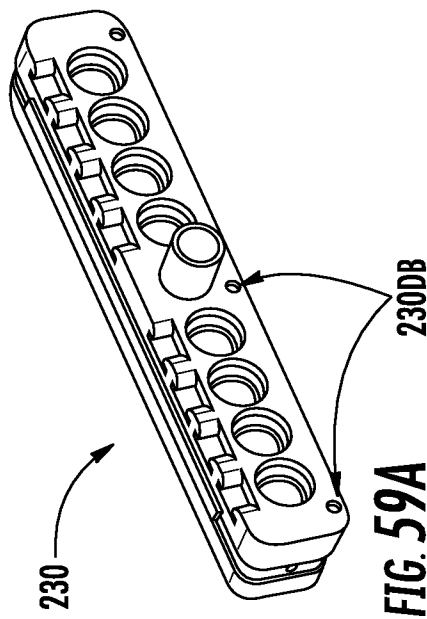
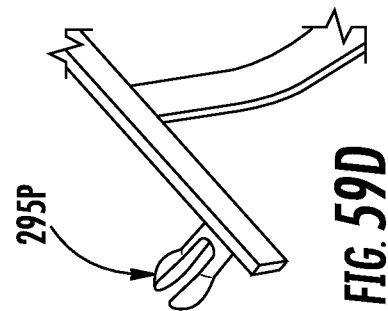
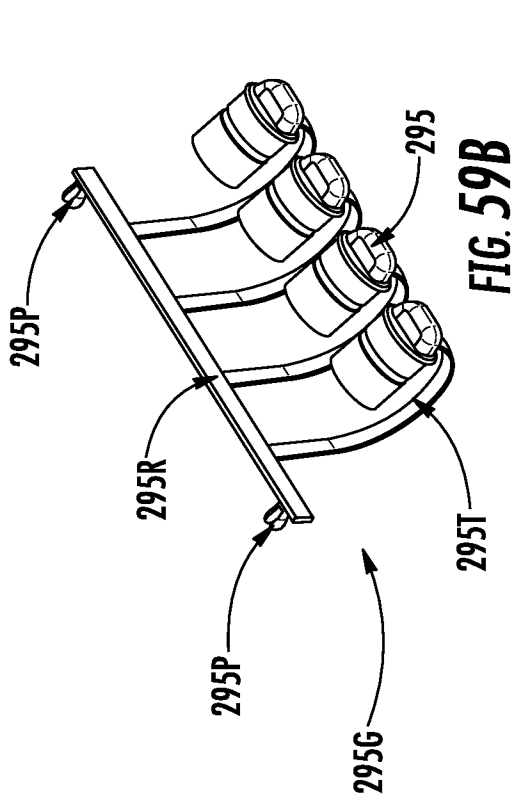
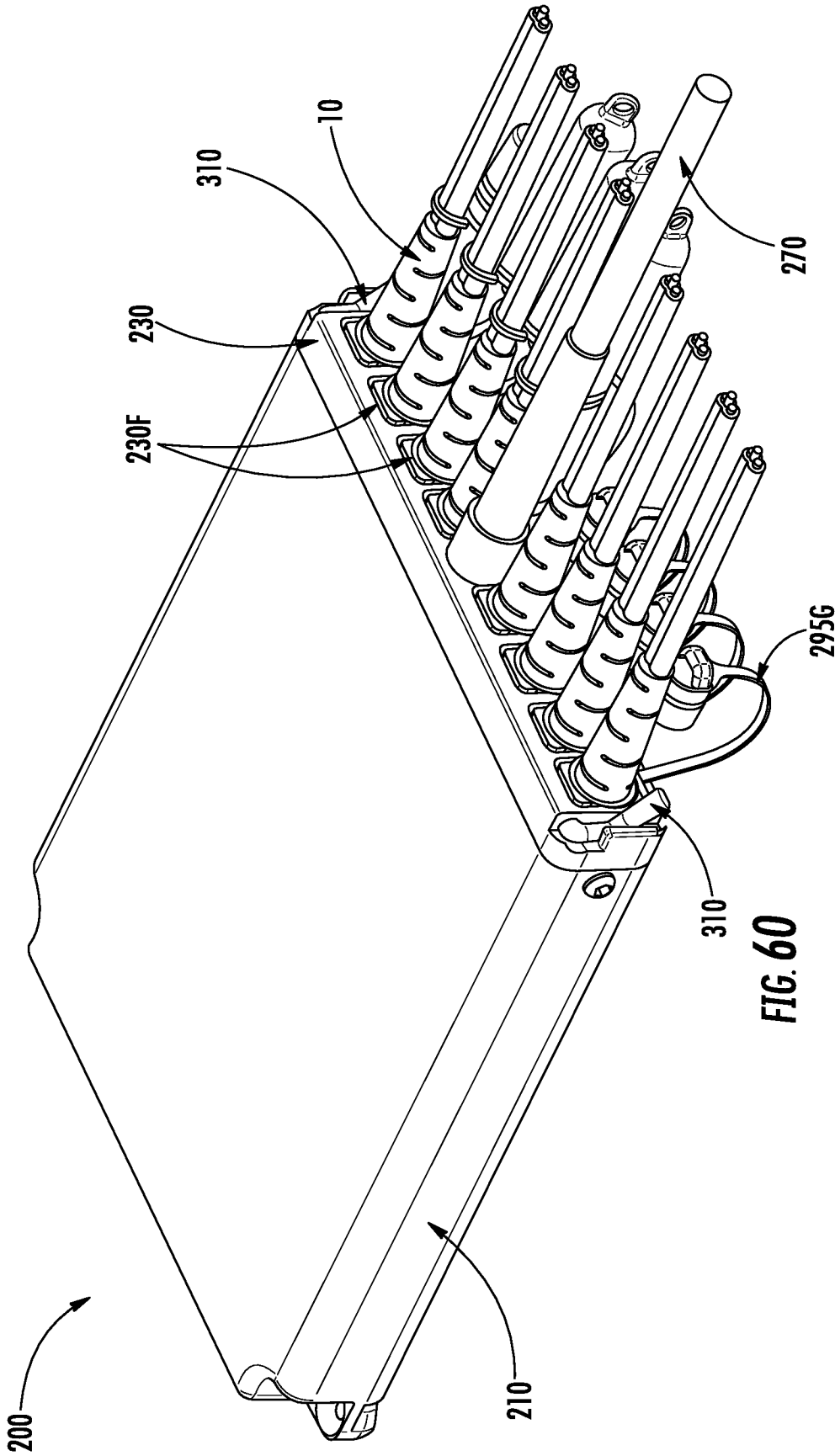
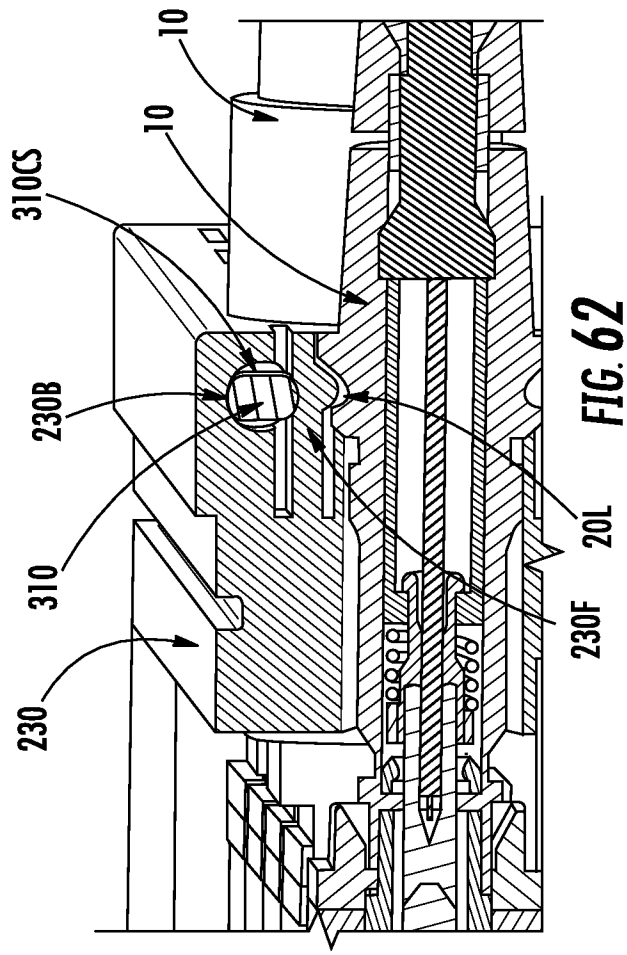
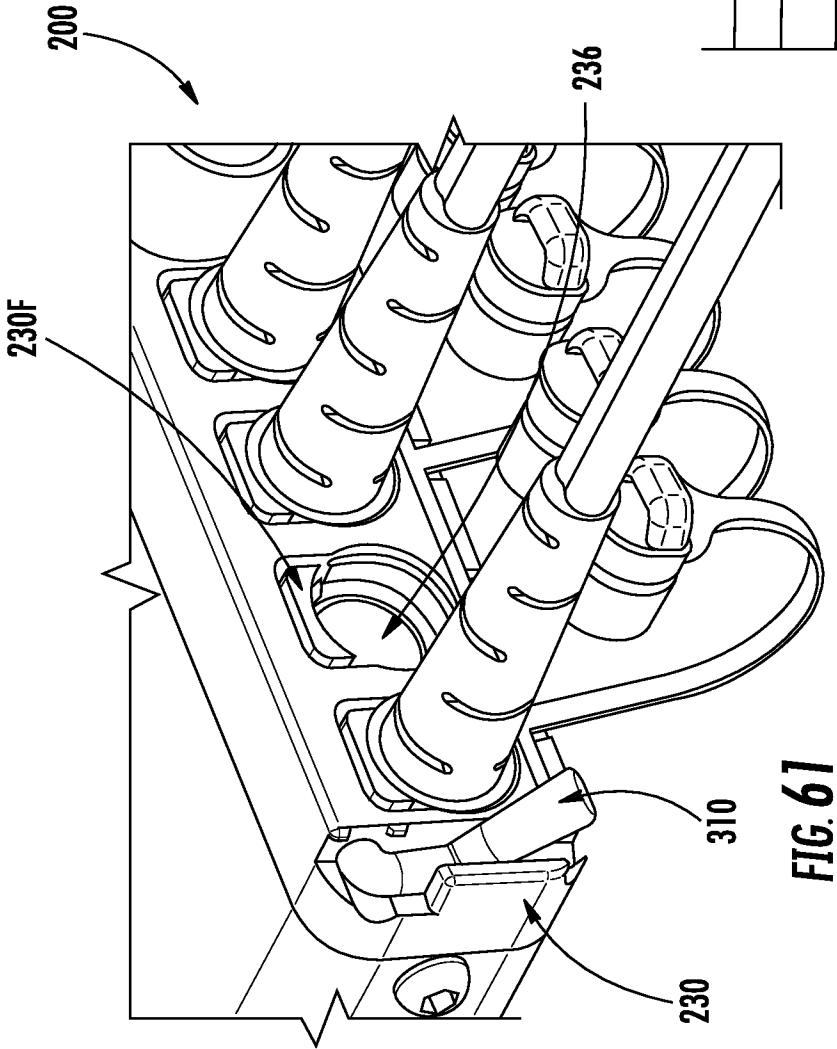


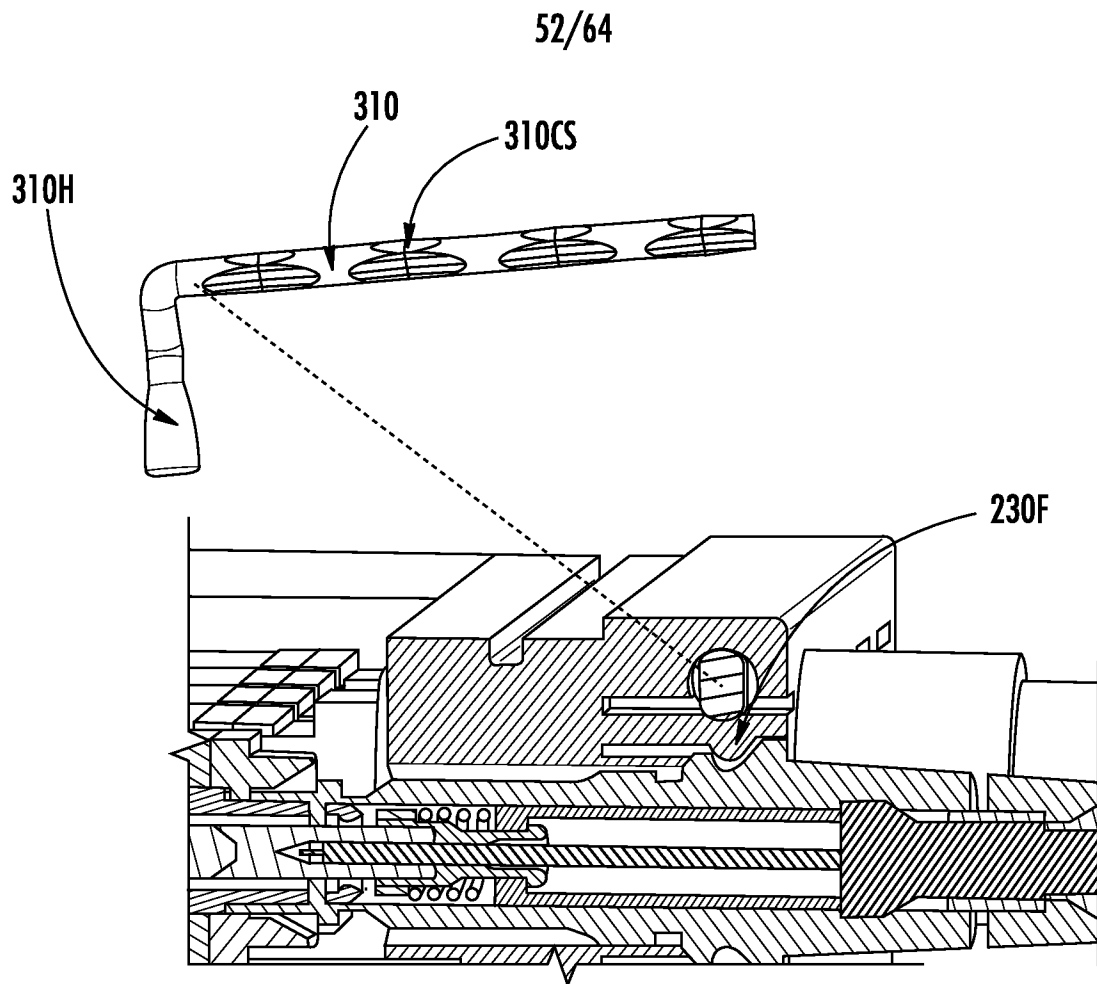
FIG. 57



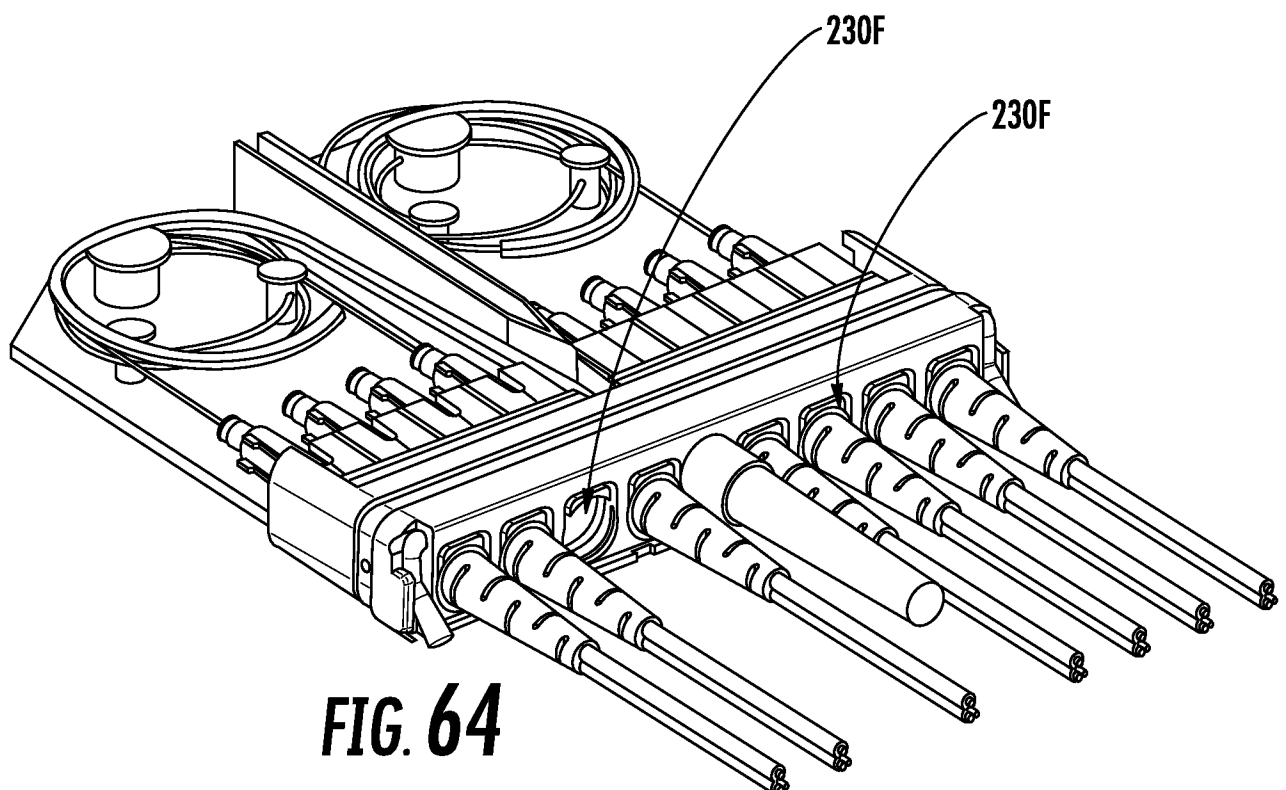




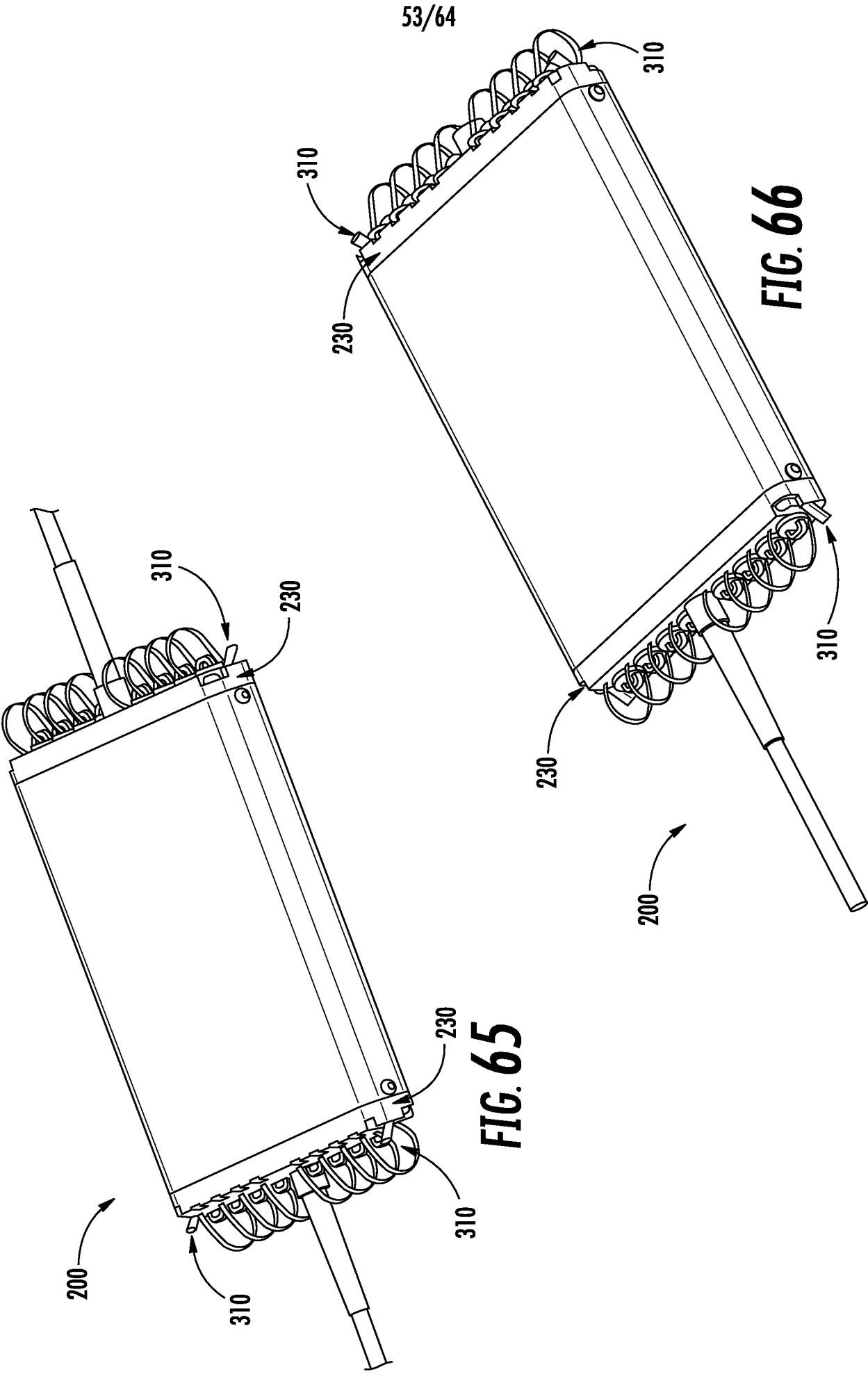




**FIG. 63**



**FIG. 64**



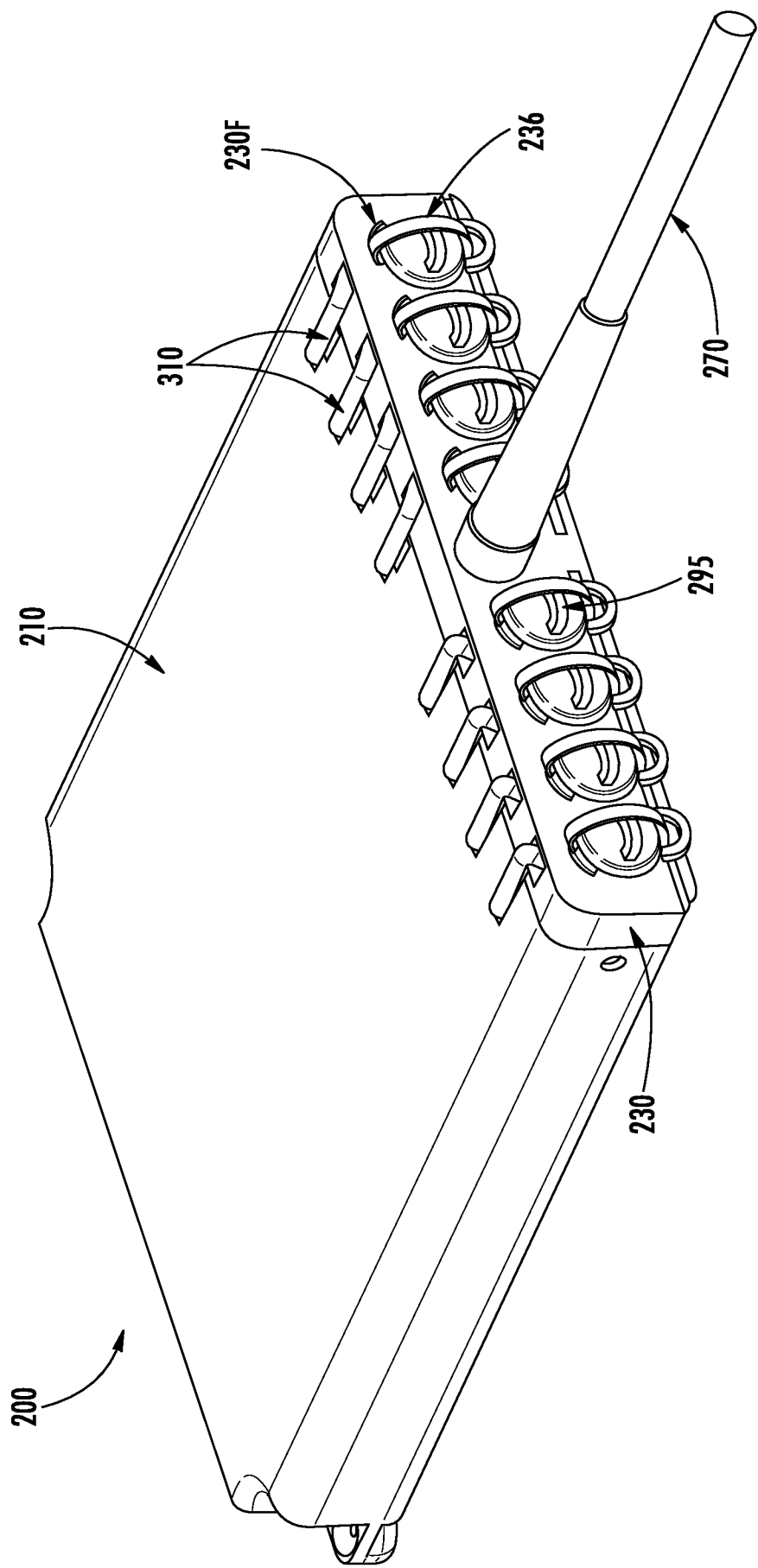
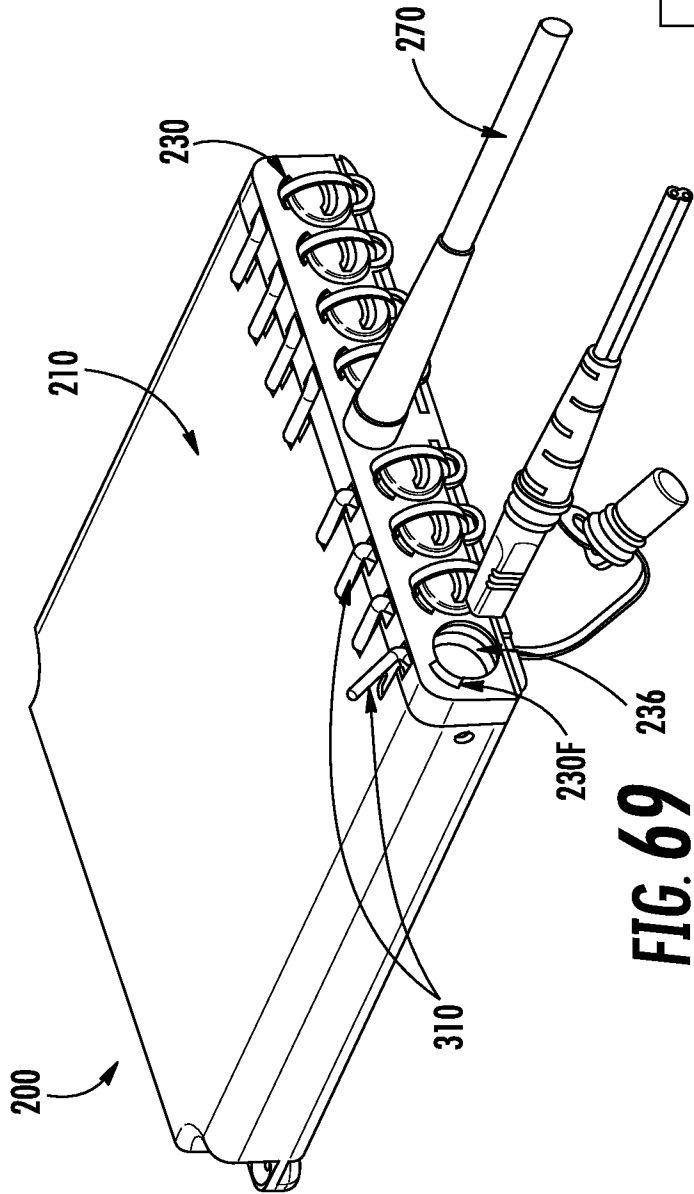
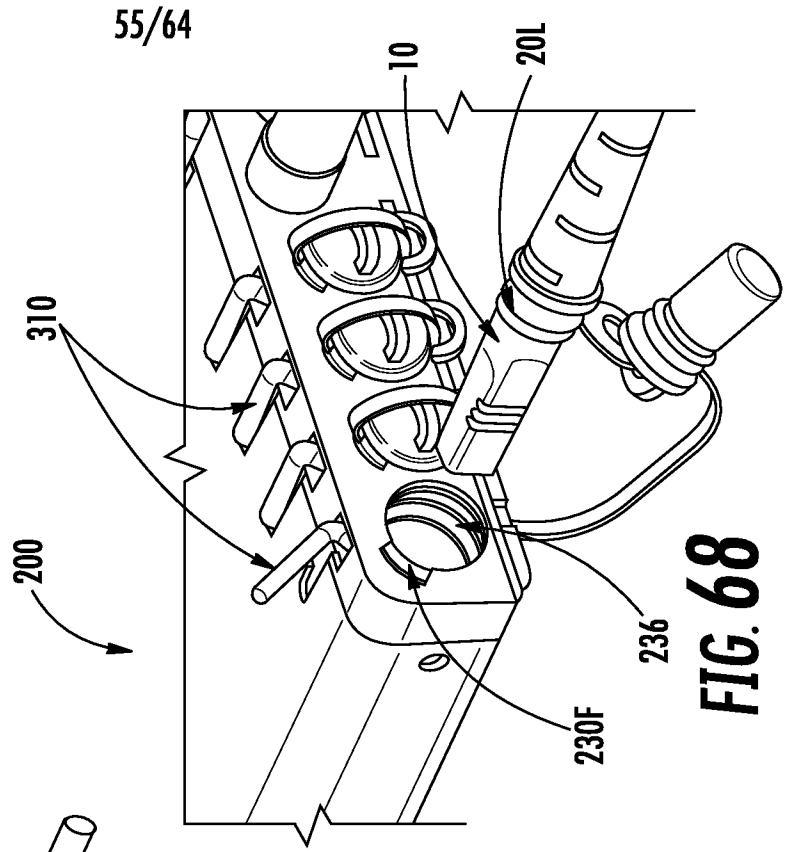


FIG. 67





**FIG. 69**



**FIG. 68**

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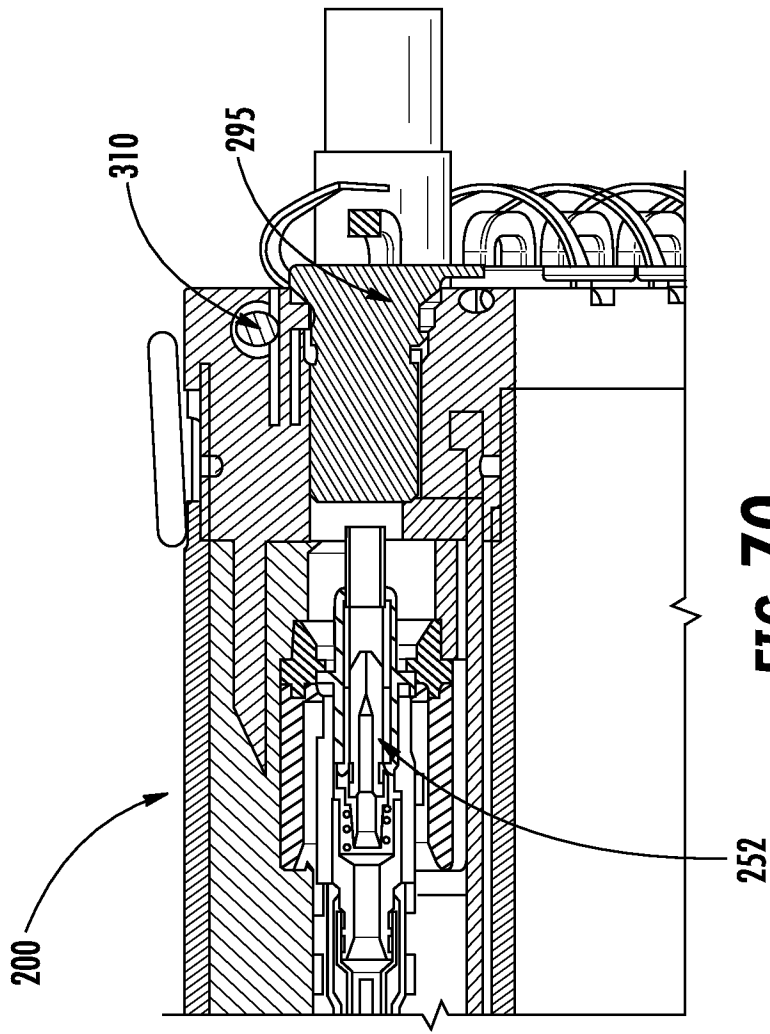


FIG. 70

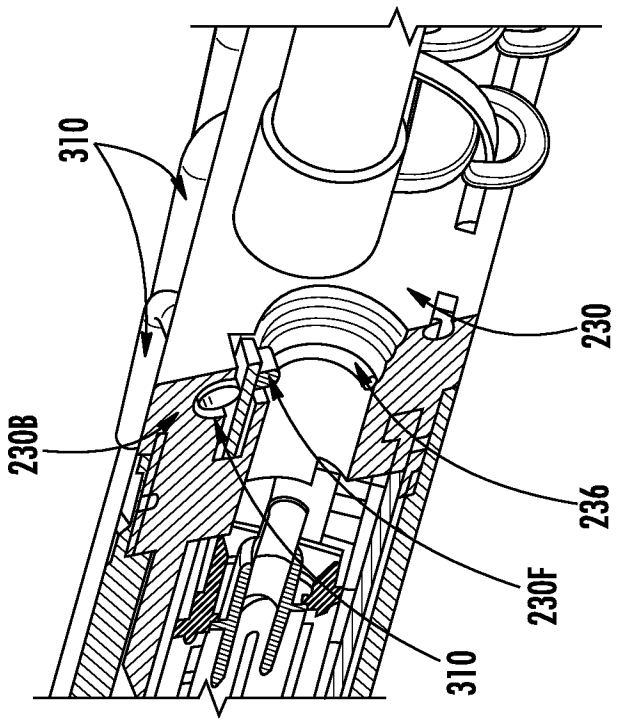


FIG. 71

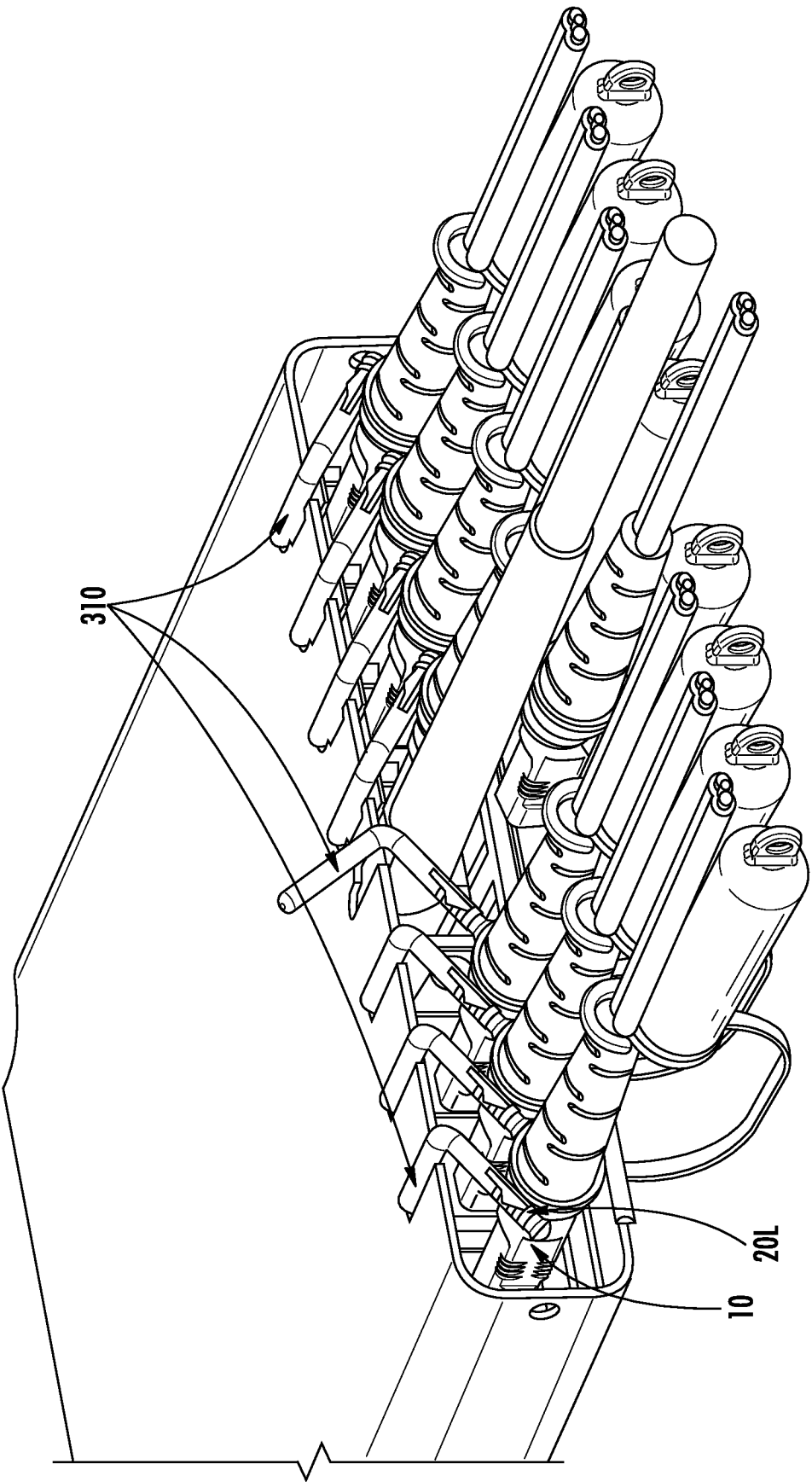


FIG. 72

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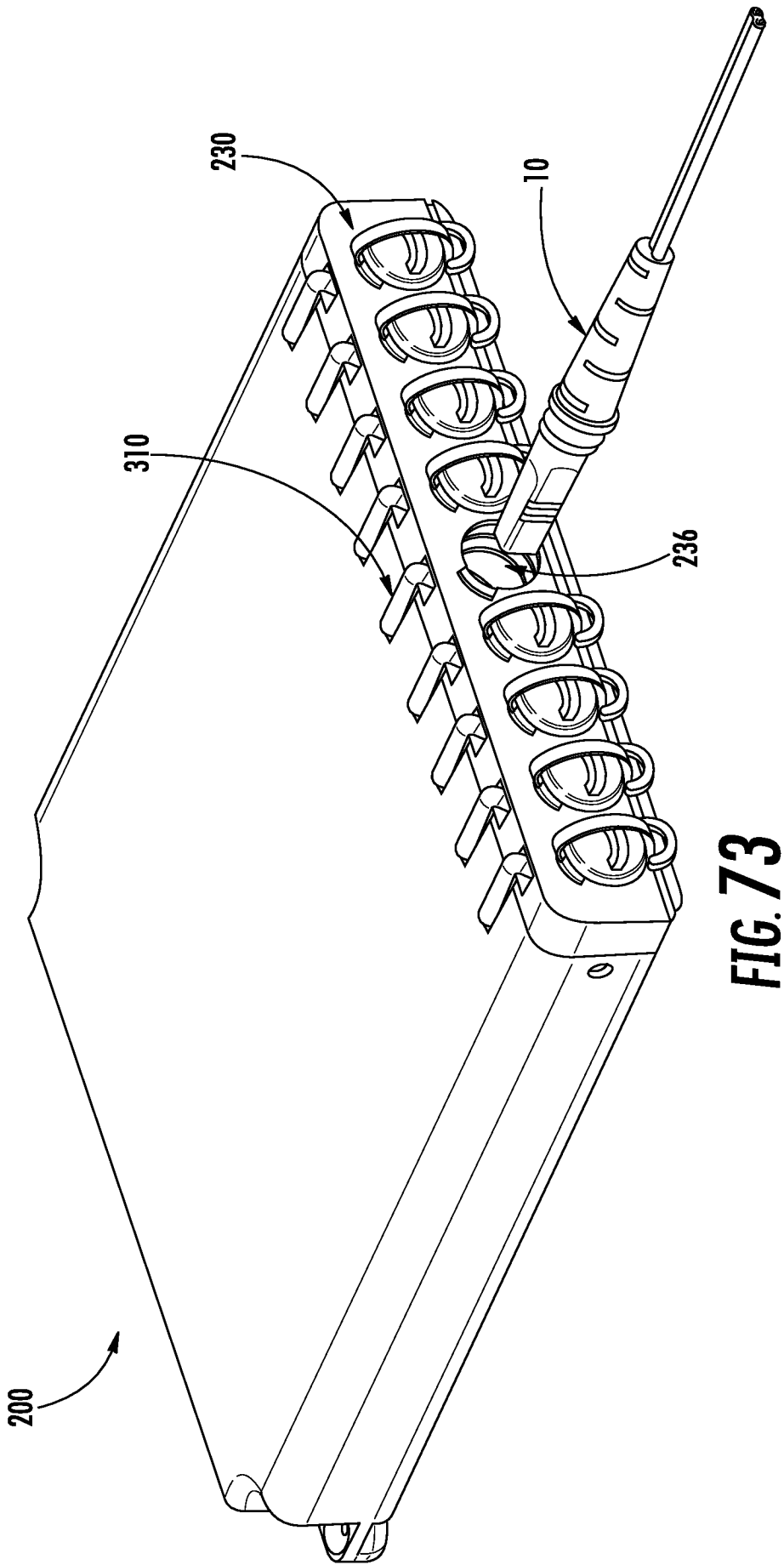
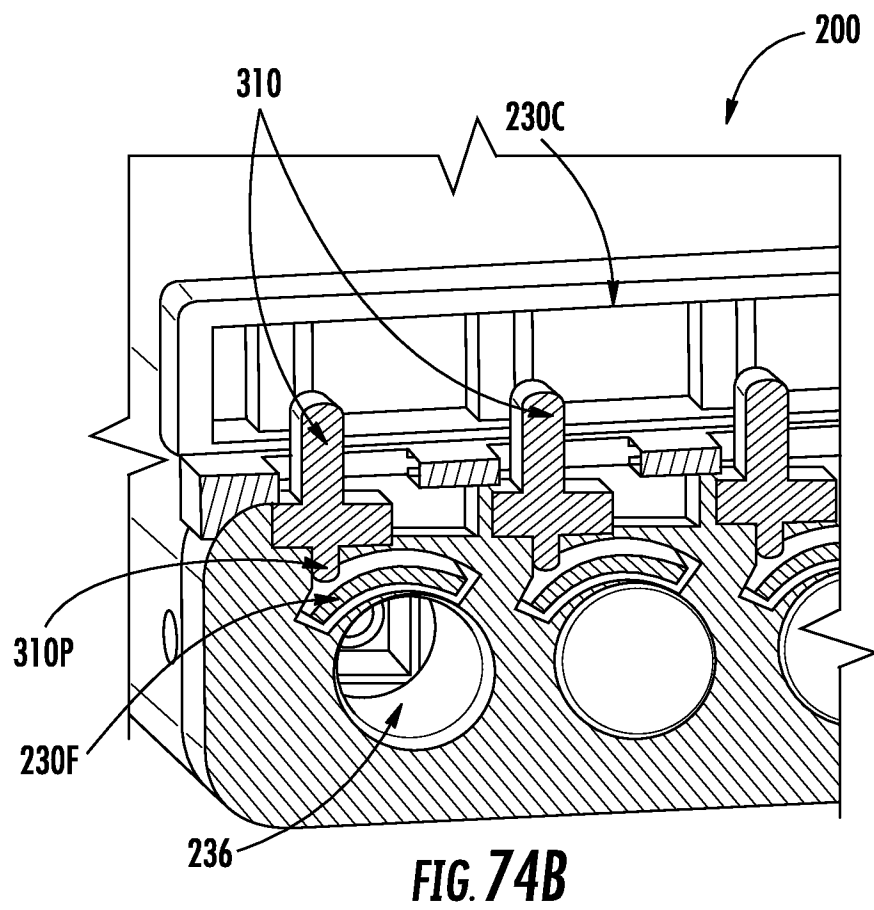
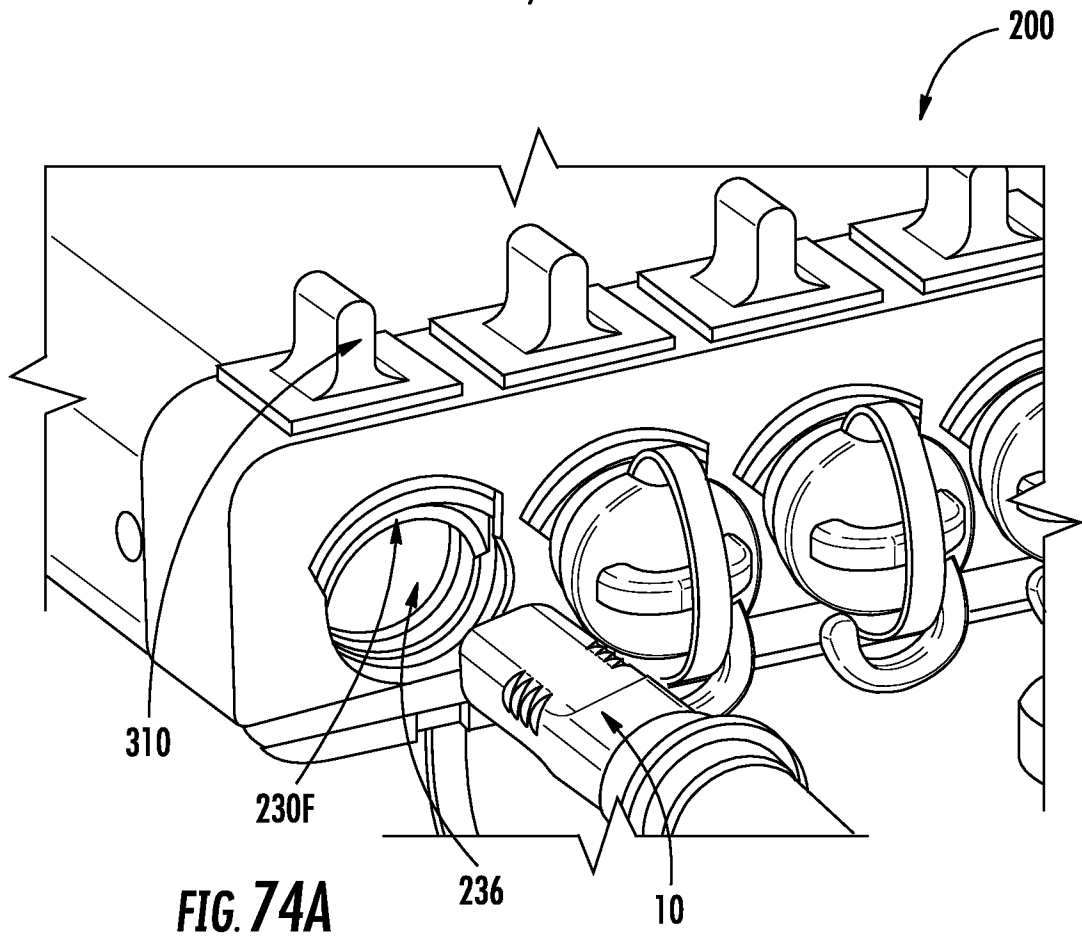
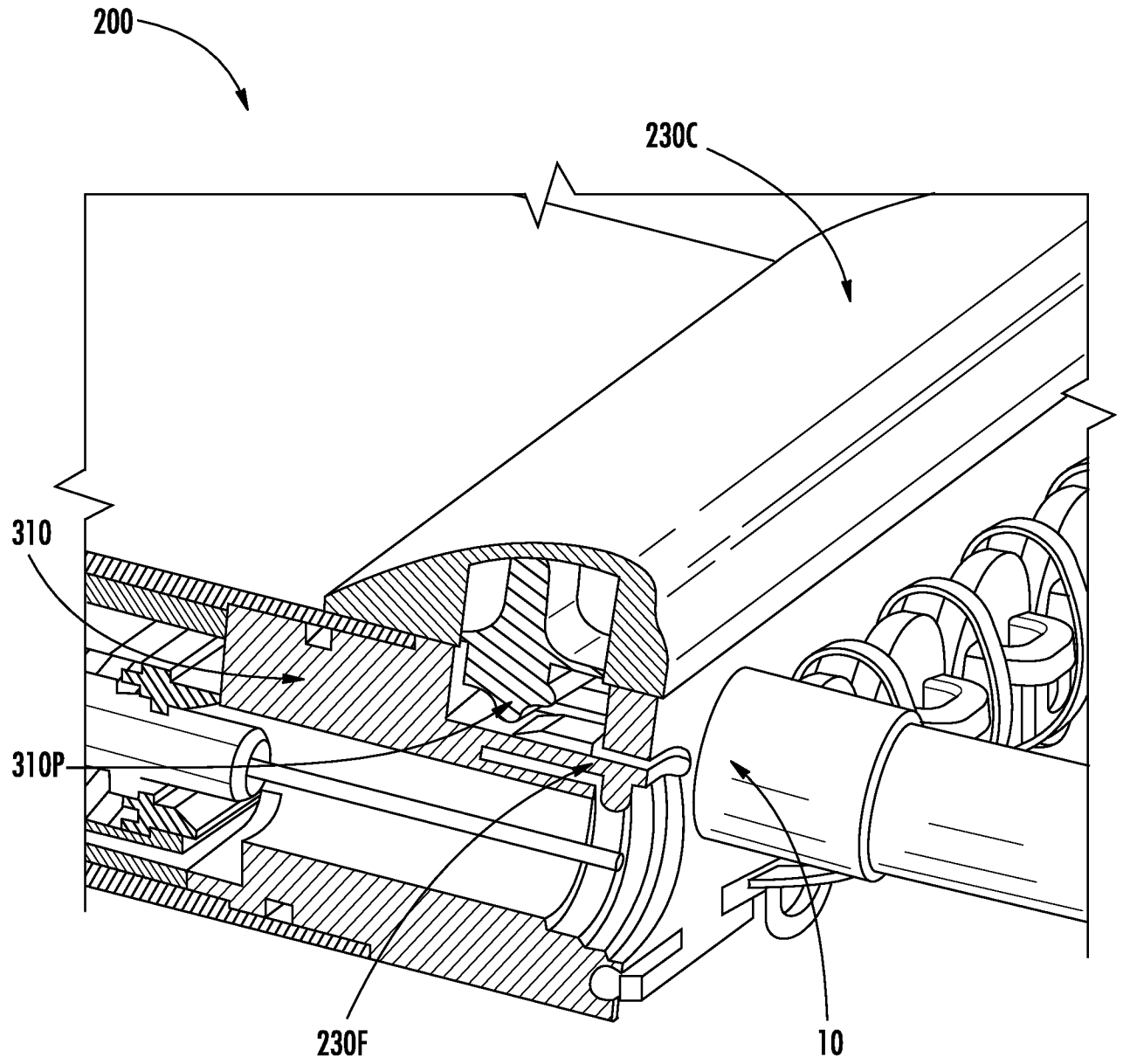


FIG. 73

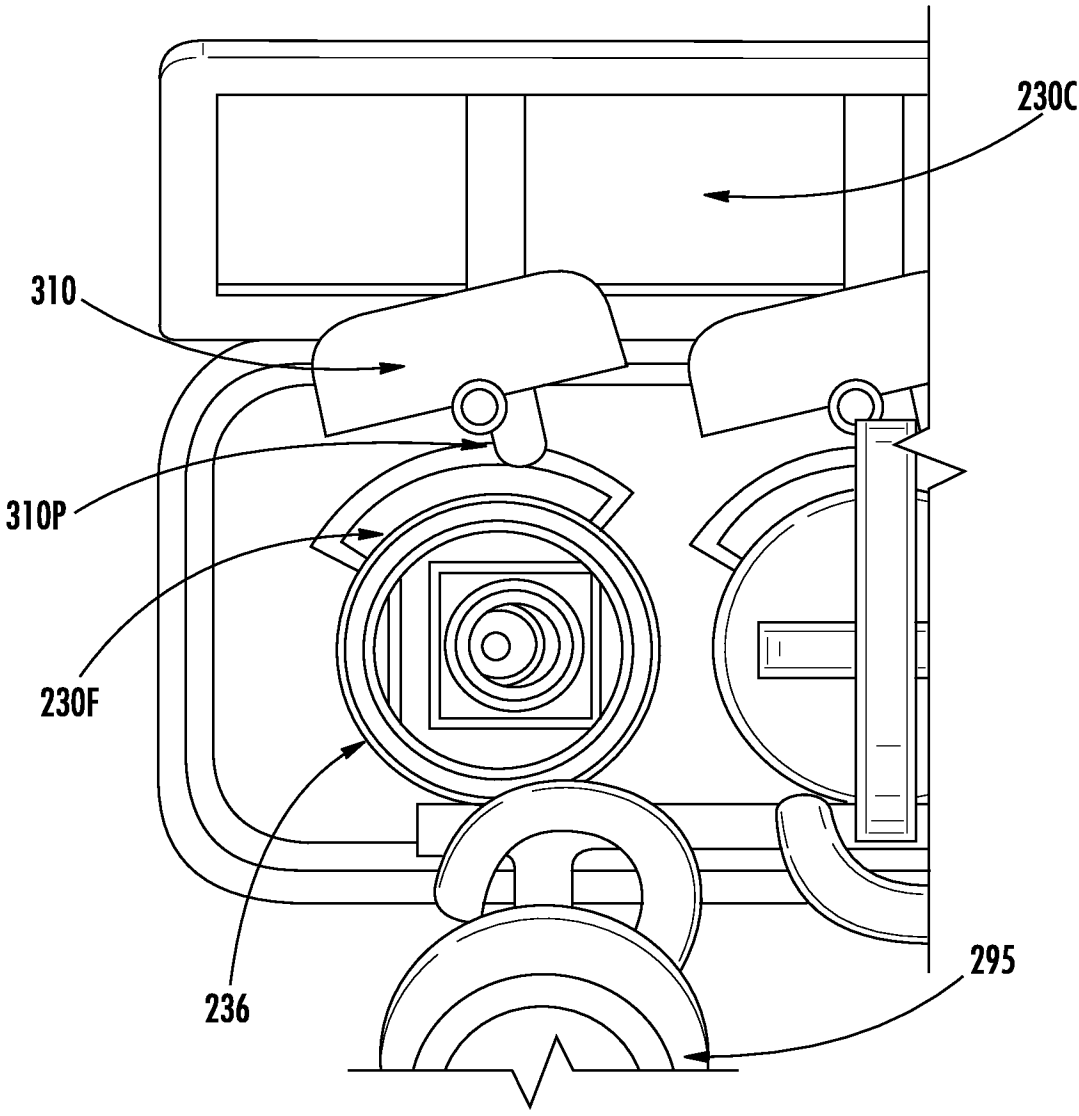
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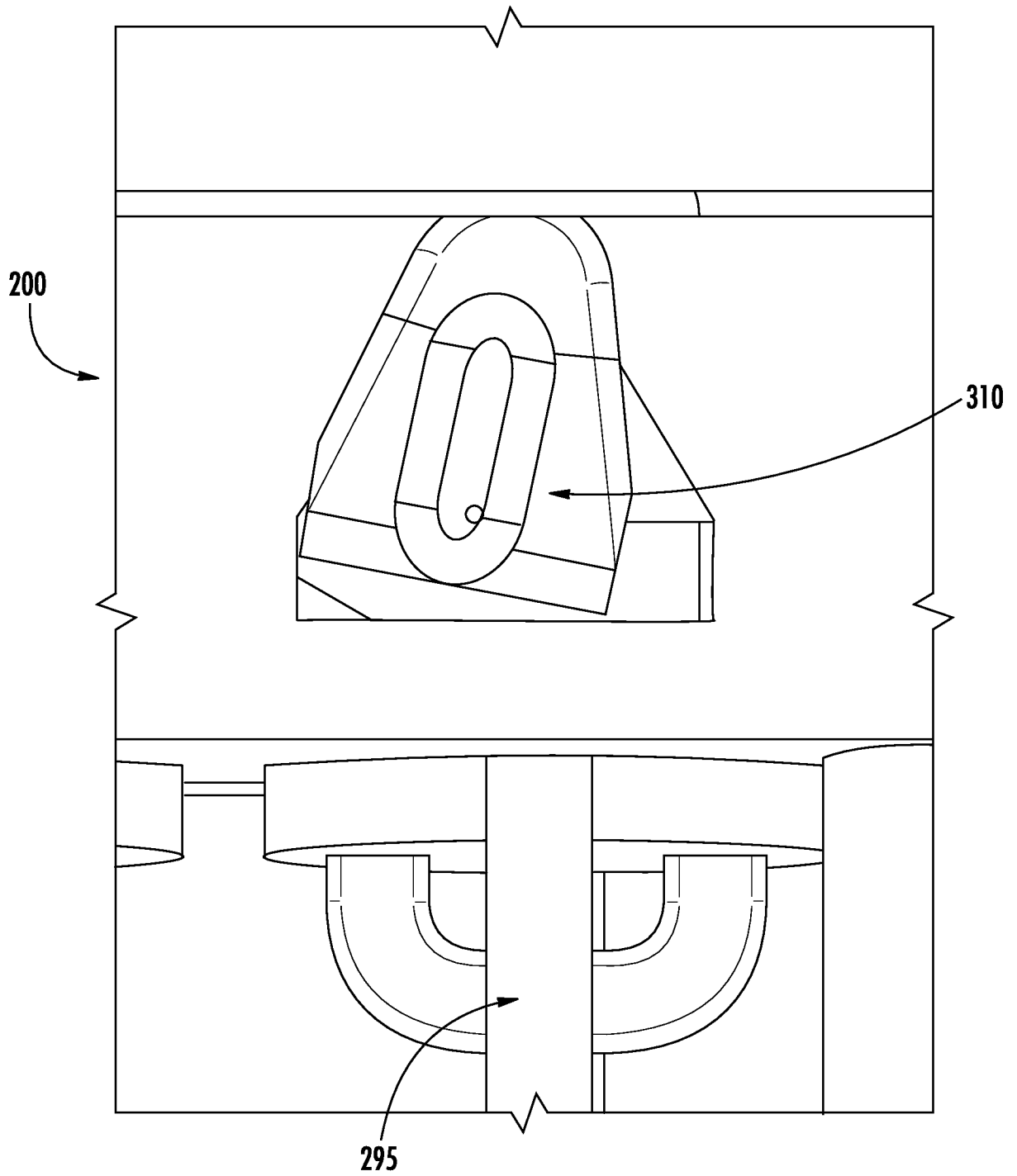


**FIG. 75**



**FIG. 76**

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**FIG. 77**



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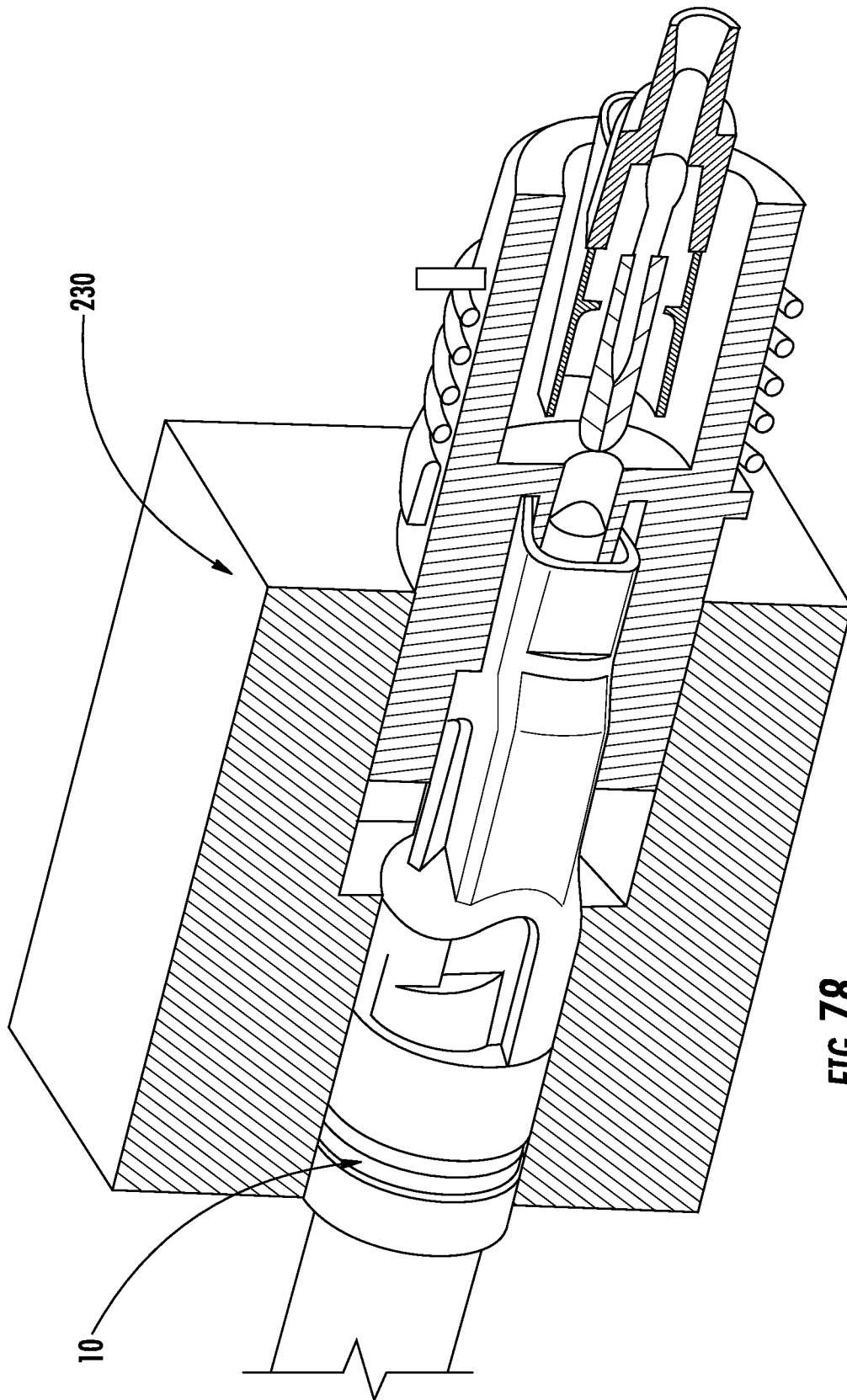
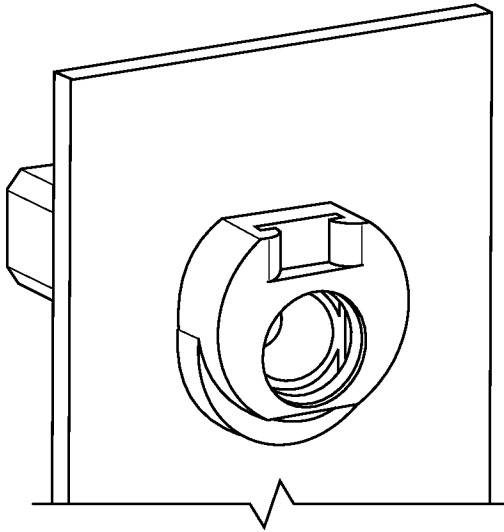
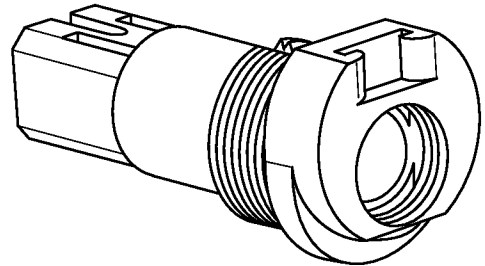


FIG. 78

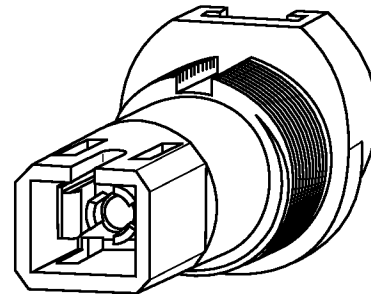
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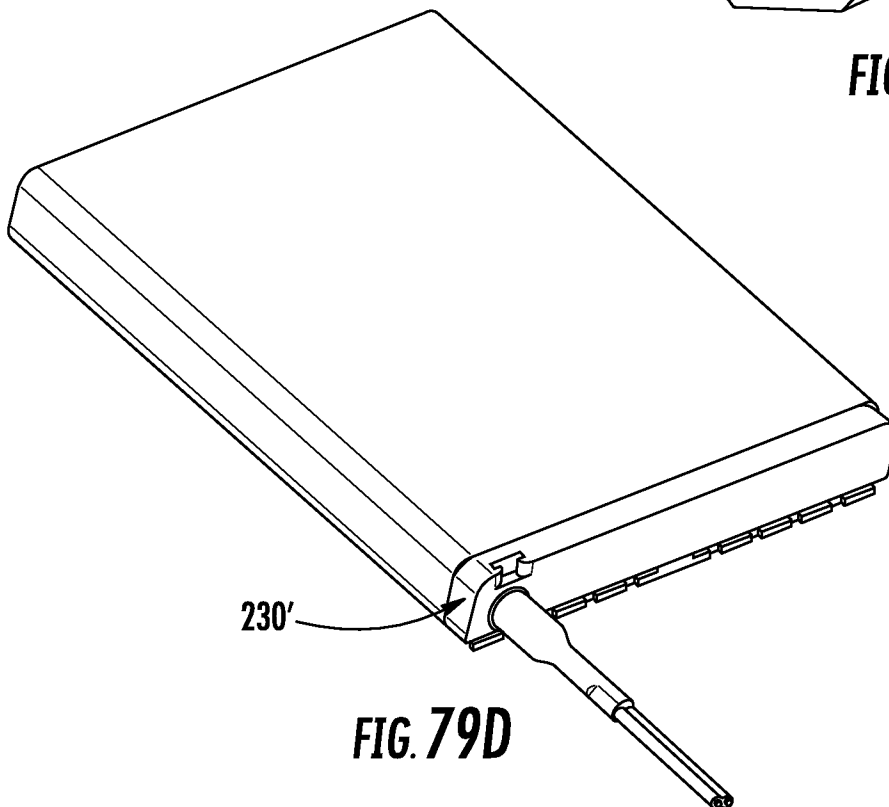
**FIG. 79A**



**FIG. 79B**



**FIG. 79C**



**FIG. 79D**

## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2017/064087

## A. CLASSIFICATION OF SUBJECT MATTER

INV. G02B6/38 G02B6/44  
ADD.

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

## B. FIELDS SEARCHED

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

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No. |
|-----------|---|-----------------------|
| X         | WO 2016/156610 A1 (COMMSCOPE CONNECTIVITY BELGIUM BVBA [BE])<br>6 October 2016 (2016-10-06)<br>pages 2-8<br>figures 1, 2, 2A, 3, 5<br>-----               | 1-58,<br>60-64        |
| X         | US 2015/253528 A1 (CORBILLE CHRISTOPHE [FR] ET AL) 10 September 2015 (2015-09-10)<br>paragraphs [0040] - [0043], [0066] - [0068]<br>figures 1, 6<br>----- | 1-58,<br>60-64        |
| A         | US 5 631 993 A (CLOUD RANDY G [US] ET AL)<br>20 May 1997 (1997-05-20)<br>column 3 - column 6<br>figure 2<br>-----<br>-/-                                  | 1-64                  |



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

19 February 2018

Date of mailing of the international search report

26/02/2018

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Authorized officer

Hohmann, Leander

## INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

International application No

PCT/US2017/064087

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)   | Publication<br>date  |
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