



- (51) **International Patent Classification:**
G02B 6/36 (2006.01) *G02B 6/38* (2006.01)
- (21) **International Application Number:**
PCT/US2019/025944
- (22) **International Filing Date:**
05 April 2019 (05.04.2019)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
62/653,706 06 April 2018 (06.04.2018) US
62/793,198 16 January 2019 (16.01.2019) US
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(81) **Designated States** (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

(54) **Title:** FLEXIBLE PUSH-PULL BOOT AND CRIMP BODY FOR FIBER OPTIC CONNECTOR

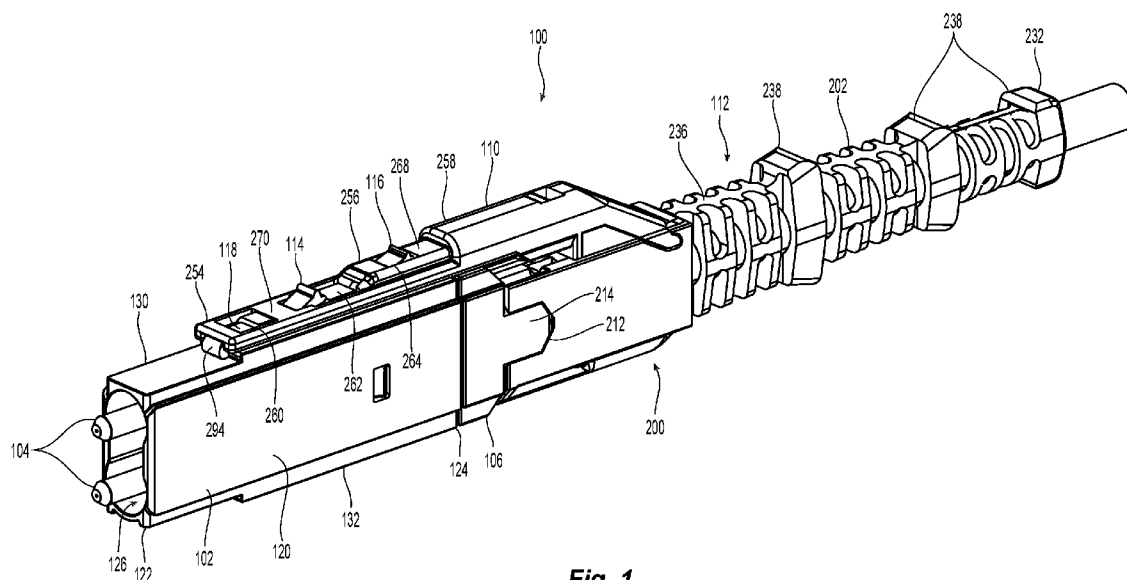


Fig. 1

(57) **Abstract:** A new boot for a fiber optic connector has a ribbed back portion, a center portion, and a forward extending portion that can be used to insert and remove the fiber optic connector to receptacle. The ribbed back portion has grasping elements and is connected to the center portion. The center portion is removably connected to a crimp body that is in turn connected to the connector housing. The front extension is connected to the fiber optic connector and also provides a keying feature depending on the side of the fiber optic connector on which it is installed.



TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

- *with international search report (Art. 21(3))*

FLEXIBLE PUSH-PULL BOOT AND CRIMP BODY FOR FIBER OPTIC CONNECTOR**BACKGROUND OF THE INVENTION**

[0001] This application claims priority of U.S. Provisional Patent Application serial numbers 62/653,706, filed on April 6, 2018, and 62/793,198, filed on January 16, 2019, the contents of both of which are incorporated by reference.

FIELD OF THE INVENTION

[0002] Fiber optic connectors, and the locations where they are installed, are becoming smaller, requiring a higher density application. The fiber optic connectors have been reduced in size such that a person can not easily grasp individual fiber optic connectors mounted in a receptacle in the high density areas. Thus, it can be very difficult to install a fiber optic connector in, and uninstall from, its respective receptacle. Adjacent fiber optic connectors are generally located too close to allow manual insertion and removal of a single fiber optic connector using the connector's outer housing as intended, particularly, when used in higher density applications. Some solutions to the smaller areas include push-pull tabs or projections connected to the fiber optic connector, either as an additional component or as an integral part of the fiber optic connector, usually the outer housing.

[0003] While these push-pull tabs provide a solution to the insertion and removal of some fiber optic connectors, there is still an issue with the optical fibers and optical cables getting tangled around the tabs. This could lead to the push-pull tabs being removed or broken, providing the user with no real options for removing the fiber optic connectors. Additionally, in a high density environment, there may be some confusion as to which fiber optic connector a particular push-pull tab belongs.

[0004] While a boot may be used for pushing a fiber optic connector into a receptacle, they are generally not intended to be used to remove a fiber optic connector. The boot is generally used for strain relief of the optical fibers secured within the fiber optic connectors. In many connectors, the boot simply cannot be used for fiber optic connector removal as the boot is not attached to the appropriate structures, such as the outer housing.

[0005] Additionally, the typical boot on a fiber optic connector can not convey the polarity of the fiber optic connector to which it is attached.

[0006] The present invention is therefore directed to a boot that can be used with a fiber optic connector to insert into and remove from a receptacle. The boot can also be detached from a portion of the fiber optic connector and reinstalled in a different configuration to identify a polarity of the fiber optic connector.

SUMMARY OF THE INVENTION

[0007] The present invention is directed to a boot for a fiber optic connector, the fiber optic connector having a housing, at least two fiber optic ferrules, and a crimp body, the boot that includes a center portion having a front end and a back end, a first longitudinal opening extending between the front end and the back end to receive a portion of the crimp body and a fiber optic cable, a back portion attached to the center portion and extending away from the front end of the center portion, the back portion defining a second longitudinal opening that is in communication with the first longitudinal opening, the back portion having grasping portions to allow a user to push and pull on the boot, and a front extension portion connected to the center portion and engageable with the fiber optic connector, the front extension portion extending forward and beyond the front end of the center portion and having at least one latch to engage a receptacle.

[0008] In some embodiments, the the boot is connectable to one of a first side and a second side of the fiber optic connector to determine a polarity of the fiber optic connector.

[0009] In some embodiments, the boot further includes a first engagement member to cooperate with a corresponding second engagement member on the crimp body to removably attach the boot to the crimp body.

[0010] In some embodiments, pulling on the boot causes the first engagement member to slide relative to the second engagement member thereby pulling the front extension rearwardly releasing the fiber optic connector from the receptacle.

[0011] In another aspect, the invention is directed to a combination of a boot and a crimp body for a fiber optic connector, the fiber optic connector having a housing, at least two fiber optic ferrules, and a spring push, the combination that includes a boot that further includes a center portion having a front end and a back end, a first longitudinal opening extending between the front end and the back end to receive a portion of the crimp body and a fiber optic cable, a back portion attached to the center portion and extending away from the front end of the center portion, the back portion defining a second longitudinal opening that is in

communication with the first longitudinal opening, the back portion having grasping portions to allow a user to push and pull on the boot, a front extension portion connected to the center portion and engageable with the fiber optic connector, the front extension portion extending forward and beyond the front end of the center portion and having at least one latch to engage a receptacle, and a crimp body that additionally includes a front portion configured to be disposed at least partially in the housing, a rear portion that extends rearwardly away from the front portion and provides an outer surface to receive a crimp band therearound, and a central portion disposed between the front and rear portions, wherein the boot has a first engagement member to cooperate with a corresponding second engagement member on the crimp body to removably attach the boot to the crimp body, the second engagement member being disposed on the central portion of the crimp body.

[0012] Additional features and advantages of the invention will be set forth in the detailed description which follows, and in part will be readily apparent to those skilled in the art from that description or recognized by practicing the invention as described herein, including the detailed description which follows, the claims, as well as the appended drawings.

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

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 is a top perspective view of one embodiment of a fiber optic connector with a crimp body, a boot, and a front extension according to the present invention;

[0015] FIG. 2 is a bottom perspective view of the fiber optic connector in FIG. 1;

[0016] FIG. 3 is a top plan view of the fiber optic connector in FIG. 1;

[0017] FIG. 4 is a side elevation view of the fiber optic connector in FIG. 1;

[0018] FIG. 5 is a bottom plan view of the fiber optic connector in FIG. 1;

[0019] FIG. 6 is a front perspective view of the fiber optic connector in FIG. 1 with the boot and front extension detached from the crimp body and the connector housing;

- [0020] FIG. 7 is a cross sectional view of the front extension, latch body, and connector housing;
- [0021] FIG. 8 is bottom perspective view of the front extension, crimp body, and boot from the fiber optic connector in FIG. 1;
- [0022] FIG. 9 is a partial cross section of the crimp body and boot at the connection of these two components;
- [0023] FIG. 10 is perspective view of the crimp body of the fiber optic connector in FIG. 1;
- [0024] FIG. 11 is a bottom perspective view from the front of the boot and the front extension of the fiber optic connector in FIG. 1 down the opening therein;
- [0025] FIG. 12 is a rear and bottom perspective view of the boot and the front extension of the fiber optic connector in FIG. 1 down the opening therein;
- [0026] FIG. 13 is an enlarged view of a portion of the bottom portion of the boot;
- [0027] FIG. 14 is a side perspective view of the boot and front extension being attached to the crimp body;
- [0028] FIG. 15 is a side view of the boot and the front extension being pulled rearwardly to disengage the fiber optic connector from a receptacle;
- [0029] FIG. 16 is a second embodiment of a fiber optic connector with a crimp body, a boot, and a front extension according to the present invention;
- [0030] FIG. 17 is a third embodiment of fiber optic connector with a crimp body, a boot, and a front extension according to the present invention; and
- [0031] FIG. 18 is an enlarged view of the connection between the boot and the crimp body in the fiber optic connector of FIG. 16.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0032] Reference will now be made in detail to the present preferred embodiment(s) of the invention, examples of which are illustrated in the accompanying drawings. Whenever possible, the same reference numerals will be used throughout the drawings to refer to the same or like parts.

[0033] Applicant notes that the term “front” or “forward” means that direction where the fiber optic connector would meet with another fiber optic connector or device, while the term “rear” or “rearward” is used to mean the direction from which the optical fibers enter into the

fiber-optic ferrule or fiber optic connector. Thus, “front” is that part of the fiber optic connector on the left side of FIG. 1 and “forward” is out and to the left. “Rear” or “back” is that part of the fiber optic connector that is on the right side of the page and “rearward” and “backward” is toward the right.

[0034] One embodiment of a fiber optic connector **100** according to the present invention is illustrated in FIGS 1-15. The fiber optic connector **100**, as illustrated in FIGS. 1 - 6, may include a housing **102**, fiber optic ferrules **104** (which may be included in a ferrule assembly as disclosed in PCT/2018/066523), a crimp body **106**, a crimp ring and heat shrink tube **108**, a front extension **110** that is a part of strain relief boot **112**. As discussed in more detail below, the crimp body **106**, the front extension **110**, and a strain relief boot **112** are the focus of this application. The front extension **110** also functions as a push-pull mechanism or latch component, whereby the front extension **110** has at least one latch and more preferably two latches **114**, **116** on a latch body **118** that engage a receptacle (such as an adapter and/or a carrier) if used with the present invention. The front extension **110** also functions as a polarity key for the fiber optic connector **100**. As described in more detail below, the fiber optic connector **100** can only be inserted into a receptacle in one orientation with the front extension **110** installed on the fiber optic connector **100**. The housing **102** is symmetric about a longitudinal axis A through the fiber optic connector **100**. Thus, without the front extension **110**, the fiber optic connector **100** could be inserted into a receptacle in at least two ways. The front extension **110** prevents the fiber optic connector **100** from being inserted in all but one way - thereby giving it a polarity function.

[0035] Turning to the housing **102**, the housing **102** has a main body **120** extending between a front end **122** and a rear end **124**, and has an opening **126** extending therebetween. See also FIGS. 6 and 7. The fiber optic ferrules **104** are disposed within the opening **126** and have their front faces (for mating with other fiber optic ferrules) adjacent the front end **122**. The crimp body **106** is also at least partially disposed within the opening **126** at the rear end **124** of the housing **102**.

[0036] The outside of the housing **102** has many features that are integral to its use. First are the top surface **130** and the bottom surface **132**. The top and bottom surfaces **130**, **132** are preferably the same. Extending from the rear end **124** towards the front end **122** of the housing **102** on both the top surface **130** and the bottom surface **132** is a rail receiving portion **134**. The rail receiving portion **134** as illustrated does not extend the entire length of

the housing **102**, but it could extend farther along the length of the housing **102** than shown in the figures if so desired. The rail receiving portion **134** has a stop surface **136** at the end of the rail receiving portion **134**. The front extension **110** will make use of the stop surface **136** when the fiber optic connector **100** is inserted into or removed from various structures as discussed in more detail below.

[0037] The rail receiving portion **134** has a central portion **138** and two lobe sections **140**, one lobe on each side of the central portion **138**. As a result, the rail receiving portion **134** looks like part of a profile of a dog bone. This configuration matches that of the bottom surface of the front extension **110** (latch component or push-pull mechanism) to form a sliding dove-tail configuration. See FIG. 7. Other configurations are possible, such as, for example, a cap with undercuts (essentially an umbrella or a T-shape configuration).

[0038] The fiber optic connector **100** also includes a crimp body **106**. The crimp body **106** has a front portion **150** that is designed to interact and connect with the housing **102** and a spring push (not shown) that is used in conjunction with the fiber optic ferrules **104** in the opening **126** thereof. The crimp body **106** has a central portion **152** that fits against the rear end **124** of the housing **102**. The central portion **152** has a first portion **154** that includes a rail receiving portion **158** on both a top side **154** and a bottom side **156**. The rail receiving portion **158** has a central portion **160** and two lobe sections **162**, one lobe on each side of the central portion **160** that matches the same structure **134** on the housing **102** to engage the front extension **110**.

[0039] The central portion **152** has a second, more rearward portion **170** that include two notches **172** on both the top side **154** and the bottom side **156**. At a rearward end **174** of each of the four notches **172** (two on the top side **154** and two on the bottom side **156**) are forward facing surfaces **176** to engage latches on the boot **112**. The notches **172** and the forward facing surfaces **176** are involved in the connection of the boot **112** (and the front extension **110**) to the crimp body **106** and the housing **102** as explained below.

[0040] The crimp body **106** has a rear portion **180** that extends behind the central portion **152** and the housing **102** and provides an outer surface **182** to receive a crimp band (e.g., crimp ring and heat shrink tube) therearound. Extending through the crimp body **106** is an opening **184** through which optical fibers/optical fiber cable can pass between the fiber optic ferrules **104** and the boot **112**. Although the design will allow for the use of a crimp band to attach the aramid yarn from a fiber optic cable, the crimp band is optional and the fiber optic

connector will work without a crimp band when the aramid yarn is not present. Further, when the crimp band is not used, the crimp body would require the outer surface **182**.

[0041] Turning now to the boot **112**, the boot **112** includes the front extension **110**, a center portion **200** that is disposed between the front extension **110** and a ribbed back portion **202**. It should be noted that the front extension **110** is preferably an integral part of the center portion **200**, but it could be removably attached to the center portion **200** and still fall within the scope of the present invention.

[0042] The center portion **200** has a front end **204** and a back end **206** with a first longitudinal opening **208** extending throughout the center portion **200**. The first longitudinal opening **208** receives at least a portion of the crimp body **106**, including at least the rear portion **180** that extends behind the central portion **152** and the outer surface **182** with the crimp band. The first longitudinal opening **208** also receives the rearward portion **170** of the central portion **152** of the crimp body **106** as well as the notches **172** and the forward facing surfaces **176**. See FIG. 9.

[0043] The center portion **200** also has sides **210** that help to define the first longitudinal opening **208**. The sides **210** may also have cut-outs **212** that receive a portion **214** of the crimp body **106**. The cooperation between the cut-outs **212** and the portion **214** of the crimp body **106** assist in alignment and the integrity of the combination of the crimp body **106** and the center portion **200**. However, it should be noted that the sides **210** could be solid and cover the overlapping portion of the crimp body **106**. See, e.g., FIG. 16.

[0044] Within the first longitudinal opening **208** and extending from the sides **210** are two projections or latches **220** that extend into the first longitudinal opening **208**. When the boot **112** is attached to the crimp body **106**, the projections or latches **220** are disposed within the two notches **172** on one of the top side **154** or bottom side **156**, depending on the orientation of the boot **112**. In the fully engaged position, the projections or latches **220** are farthest from the forward facing surfaces **176** that at least partially define the two notches **172**. See FIG. 9. At this position, the front end **204** of the center portion **200** should be touching the first portion **154** of the central portion **152** of the crimp body **106**. See FIGS. 1, 8, and 9. The center portion **200** also has a bridge portion **222** that connects the sides **210** with the projections or latches **220**. This bridge portion **222** performs two functions. First, as seen in FIGS. 2 and 8, the bridge portion **222** blocks the rail receiving portion **158** when the front extension **110** is oriented on the other side of the fiber optic connector **100**. See FIG. 8. This

bridge portion **222** assists in preventing the rail receiving portion **158** from snagging optical fibers and optical fiber cables when the fiber optic connector **100** is installed. Second, when a user pushes on the bridge portion **222** toward the first longitudinal opening **208**, the projections or latches **220** (and the sides **210**) are pushed outward and clear of the notches **172** and the forward facing surfaces **176**. This allows the boot **112** (and center portion **200**) to be removed from the crimp body **106** and from the fiber optic connector **100** if so desired.

[0045] It should be noted that while there are two projections or latches **220** and two notches **172** on each side, there may be more or fewer. For example, there may just be one latch and one corresponding notch. Alternatively, the latching of the boot **112** to the crimp body **106** may not be on an outside surface of the crimp body **106**. Instead, such latching may occur on an inside surface of the crimp body **106**, and may not be visible from the outside. For example, the notches **172** and the forward facing surfaces **176** may be inside the rearward portion **170** such that from outside, the rearward portion **170** will have a smooth continuous surface merging with the portion **214** of the crimp body. In another example, latches **220** may be extending from the bridge portion **222** into an internal groove inside or underneath the top surface of the rearward portion **170** (i.e., the portion between the forward facing surfaces **176**). In this scenario, the latches **220** would be facing upward or downward rather than sideways as shown in FIG. 11, for example.

[0046] The ribbed back portion **202** extends between a front end **230** and a back end **232** and is made of a plurality of rib members **234**. The ribbed back portion **202** is attached to the back end **206** of the center portion **200** and extends away from the front end **204**. Thus, the ribbed back portion **202** makes the boot **112** longer. The ribbed back portion **202** also has a spine **236** that joins the plurality of rib members **234** together. Along the spine **236** are a number of grasping portions **238** that provide surfaces for the user to grasp. The user can then use the ribbed back portion **202** to either push the fiber optic connector **100** into a receptacle or to pull on the ribbed back portion **202**, and the grasping portions **238** in particular, to pull the fiber optic connector **100** from a receptacle. The grasping portions **238** are illustrated as three annular members that are disposed along a length of the spine **236** and together with the plurality of rib members **234** form a second longitudinal opening **240** through the ribbed back portion **202**. The first longitudinal opening **208** and the second longitudinal opening **240** are in communication with one another and form a pathway for the optical fibers/fiber optic cable to be inserted from back end **232** to the opening **126** in the

housing so they can be fixed within the fiber optic ferrules **102** in the fiber optic connector **100**.

[0047] The construction of the ribbed back portion **202** with the plurality of rib members **234** and the spine **236** provides sufficient strength to allow it to be used to install and remove the fiber optic connector while at the same time being flexible to provide strain relief to the optical fibers. The ribbed back portion **202** is illustrated as being asymmetrical about the second longitudinal opening **240**, but could be of any appropriate shape and still fall within the scope of the present invention. Additionally, there could be different rib structures and grasping portions such as those illustrated in FIGS. 16 and 17 that also fall within the scope of the present invention.

[0048] The front extension **110** has a main body **250** and a latch body **118** that attaches to the main body **250**. See FIGS. 6, 7, and 14. The main body **250** has a front portion **254**, a middle portion **256**, and a rear portion **258**. Generally, the front portion **254** is where the latch body **252** attaches to the main body **250** and provides for the latching of the fiber optic connector **100** to a first receptacle such as an adapter. The middle portion **256** provides an area for the latching of the fiber optic connector **100** to a second receptacle such as a ganged carrier. The rear portion **258** has an area for a return element associated with the latch body **252** and also connects the front extension **110** to the center portion **200** of the boot **112**.

[0049] The front portion **254** has two windows **260** and **262** and the middle portion **256** has a window **264**. The window **262** of the front portion **254** and window **264** are to receive a latch **114**, **116** from the latch body **118** therethrough. The first window **260** is to receive a latch pad **266** on the latch body **118**. There are two latch **266** pads on the latch body **118** that cooperate with a groove **266a** in the main body **250** to secure the latch body to the main body **250**. The latch pads slide within the grooves to allow for the latching and unlatching of the fiber optic connector **100**. A more detailed discussion of this feature is disclosed in PCT/2018/066523, which is incorporated by reference herein.

[0050] The middle portion **256** has an upper surface **268** that is higher than an upper surface **270** of the front portion **254**. This allows for the latching of a carrier and an adapter with the same device. On the bottom side **272** of the middle portion **256** are two extensions **274,276** that are a complementary configuration of a rail receiving portion **134** of the housing **102**. See FIG. 13. The latch body **118** also has the same rail portion configuration of two extensions **280,282** on the bottom thereof. This allows the main body **250** and the

latch body **118** to be slidably attached to the rail receiving portion **134** of the housing **102** and the rail receiving portion **158** of the crimp body **106**. When the latch body **118** is inserted into the front portion **254**, a front surface **284** of the two extensions **274,276** provides a pushing surface by which the main body **250** can push the latch body **118** in the rail receiving portion **134**. See also FIGS. 11 and 14. The front surface **286** of the two extensions **280,282** also provides a pushing surface to be used against the stop surface **136** of the housing **102**. See FIGS. 11 and 14. This allows for the user to exert a force on the boot **112** which is transferred through the main body **250** to the latch body **118** and to the housing **102** to insert the fiber optic connector **100** into a carrier and/or adapter.

[0051] Turning to FIGS. 1, 7, and 14, the latch body **118** has two latches for receptacles such as an adapter latch **114** and a carrier latch **116**. The latch body **118** may only have one of the latches, depending upon its uses and the needs of the user and the receptacles into which the fiber optic connector **100** is going to be inserted. The adapter latch **290** extends from a forward portion of the latch body **118** and protrudes through window **262** of the main body **250**. The carrier latch **116** also extends from the latch body **118**, from a rear portion thereof, and protrudes through the window **264** of the main body **250**. As is recognized from FIG. 4, the adapter latch **114** does not rise as high as the carrier latch **116**. The latch body **118** has a connector latch **294** as well. The connector latch **294** extends forward beyond the front surface **286** of the two extensions **280,282** to engage the stop surface **136**. The connector latch **294** has a downward curling portion **296** that provides a surface to engage the stop surface **136** to prevent the latch body **118** from moving rearwardly relative to the housing **102** as the boot **112** is pulled to disengage the fiber optic connector **100** from a receptacle as will now be explained.

[0052] Referring in particular to FIGS. 1, 6, 9, 14, and 15, the attachment, use, and the removal of the boot **112** on the fiber optic connector **100** will be explained. As is generally known in the art, a fiber optic connector would need to have the optical fibers terminated in the fiber optic ferrules before a strain-relief boot can be attached to the fiber optic connector. In this case, the boot **112** with the center portion **200** and the front extension **110** are put onto the optical fibers/fiber optic cable as illustrated in Fig 6. The optical fibers/fiber optic cable pass through the first longitudinal opening **208** and the second longitudinal opening **240** of the boot **112** and are secured in the fiber optic ferrules **104**. The jacket or covering on the optical fibers/fiber optic cable is then secured to the crimp body **106** with a crimp ring and

heat shrink tube **108** or in any other manner that is appropriate. As seen in FIG. 6, the boot **112** is disposed on the optical fibers/fiber optic cable and the fiber optic connector has been assembled. As the boot **112** is moved to the fiber optic connector (to the left in FIG. 6), it is apparent that the front extension **110** will engage the rail receiving portion **158** of the crimp body **106** first and then the rail receiving portion **134** of the housing **102**. As the boot **112** is further pushed to the left in the figure, the rear portion **180** of the crimp body **106** enters the first longitudinal opening **208** followed by the rearward portion **170** of the central portion **152** of the crimp body **106**. As the connector latch **294** starts to engage the stop surface **136** of the housing **102**, the notches **172** and the forward facing surfaces **176** of the central portion **152** of the crimp body **106** also enter the first longitudinal opening **208**. See FIG. 1. FIG. 14 also illustrates (with the connector housing **102** removed for clarity) how the crimp body **106** engages the boot **112** and the latches **220** moving past the forward facing surfaces **176**. With the front end **204** of the center portion **200** disposed against the crimp body **106**, the cut-outs **212** receive the portion **214** of the crimp body **106**. As seen in FIG. 9, the projections or latches **220** are disposed within the two notches **172** and are at the front end of the notches **172**. At this point, the fiber optic connector **100** is as illustrated in FIGS. 1-5 and ready to be inserted into a receptacle. The user could push on the ribbed back portion **202**, the grasping portions **238**, the front extension **110**, or the center portion **200** to insert the fiber optic connector **100** into the receptacle.

[0053] To remove the fiber optic connector **100** from the receptacle, the user could pull on the ribbed back portion **202**, the grasping portions **238**, the front extension **110**, or the center portion **200**. Referring to FIG. 15, when the user pulls on one of those structures, the front extension **110**, the center portion **200**, and ribbed back portion **202** move relative to the crimp body **106** and the housing **102**, the projections or latches **220** sliding rearwardly within the two notches **172**. It is important to note that the frictional force between the boot and the connector housing and crimp body should be low. It is desirable to have clearance between the boot and the crimp band, crimp body, housing, and the cable. It is also desirable to have a boot material that has a low coefficient of friction, such as polypropylene. Furthermore, an elastomeric boot material is not preferred because the user could deform the internal surface of the boot and cause added friction due to squeezing or pinching the boot while pulling. A material with a Young's Modulus greater than 500 MPa or possibly greater than 1 GPa has been shown not to deform easily. See the arrows in FIG. 15. It is important to note that the

latch body **118** (and the adapter latch **114** and carrier latch **116**) also does not move because the connector latch **294** has engaged the stop surface **136** of the housing **102**. As the front extension **110** moves rearwardly, the main body **250** slides relative to the latch body **118** (and housing **102**), pushing the adapter latch **114** and carrier latch **116** downward out of the windows and disengaging them from their respective receptacle.

[0054] At this point the fiber optic connector **100** could be simply removed from the receptacle by pulling on the ribbed back portion **202**, the grasping portions **238**, the front extension **110**, or the center portion **200**. The engagement of the projections or latches **220** with the forward facing surfaces **176** prevents the boot **112** from being disengaged from the crimp body **106** and the housing **102**. However, as noted above, the user could push on the bridge portion **222**, which allows the boot **112** to be disengaged from the crimp body **106** and the housing **102**. At this point the boot **112** could be rotated about the optical fibers/fiber optic cable and reattached on the opposite side, thereby changing the polarity of the fiber optic connector **100**.

[0055] FIGS. 16-18 illustrates another embodiment of a boot **500** for use with a fiber optic connector. The boot **500** has a front extension **502**, a center portion **504**, and a ribbed back portion **506**. The front extension **502** of this embodiment is the same as that described above and will not be addressed any further. The ribbed back portion **506** functions in the same way as ribbed back portion **202** in that it can be used to push and pull on the fiber optic connector. It does have a different configuration with regard to the plurality of rib members **508** and the spine **510**, but still provides sufficient strength to allow it to be used to install and remove the fiber optic connector while at the same time being flexible to provide strain relief to the optical fibers. The ribbed back portion **506** has only a single grasping portion **512** at the back end **514**, although more grasping portions could be added. As can be seen in the figures, the spine **510** connects the plurality of rib members **508** from the center portion **504** to the grasping portion **512**.

[0056] The center portion **504** of the boot **500** is similar to the embodiment above, but with a few differences. First, the sides **516** that help to define the longitudinal opening therein do not have cut-outs. The sides of a crimp body **520** to be used with the boot **500** would not have to extend as far into the center portion with the engagement member noted below.

[0057] Second, the way of engagement between the center portion **500** and the crimp body **520** has changed. See FIG. 18. In this figure, the top and bottom of the center portion **500** have a single engagement member, a single element **522** that replaces the two projections or latches **220** in the prior embodiment. The single element **522** has a shape that is rounded at the front **524** and then has two rearward facing surfaces **526** to engage two inward facing latches **528**, **530** in the crimp body **520**. The interaction between the center portion **504** and the crimp body **520** is the same as discussed above. The boot **500** is advanced toward the crimp body **520** and the rounded front portion **524** causes the two inward facing latches **528**, **530** in the crimp body **520** to spread apart, allowing the engagement member **522** to be disposed between them. As the user pulls on the boot **500** to remove the fiber optic connector from a receptacle, the engagement member **522** moves relative to the two inward facing latches **528**, **530**. As discussed above, this movement causes the front extension **502** to release the latches and the engagement member **522** contacts the two inward facing latches **528**, **530** to pull the fiber optic connector from the receptacle. Once the fiber optic ferrule is removed from the receptacle, the user can pull of the center portion **504** while holding the crimp body or housing and disengage the boot **500** from the crimp body with a little more force than was necessary to disengage the fiber optic connector from the receptacle.

[0058] One other alternative in this embodiment that can be used on the other embodiment is the rail receiving portion **540** on both sides. The rail receiving portion **540** has a central portion **542** and two lobe sections **544** to engage the front extension **502**. However, the lobe sections **542** not as closed as the two lobe sections **162**. This allows the rail receiving portion **540** to act more as an alignment feature allowing the front extension **502** to be aligned with and then inserted in to the rail receiving portion **540** from above it, rather than being inserted from the rear side as in the prior embodiment.

[0059] It will be apparent to those skilled in the art that various modifications and variations can be made to the present invention without departing from the spirit and scope of the invention. Thus it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed:

1. A boot for a fiber optic connector, the fiber optic connector having a housing, at least two fiber optic ferrules, and a crimp body, the boot comprising:
 - a center portion having a front end and a back end, a first longitudinal opening extending between the front end and the back end to receive a portion of the crimp body and a fiber optic cable;
 - a back portion attached to the center portion and extending away from the front end of the center portion, the back portion defining a second longitudinal opening that is in communication with the first longitudinal opening, the back portion having grasping portions to allow a user to push and pull on the boot; and
 - a front extension portion connected to the center portion and engageable with the fiber optic connector, the front extension portion extending forward and beyond the front end of the center portion and having at least one latch to engage a receptacle.
2. The boot according to claim 1, wherein the boot is connectable to one of a first side and a second side of the fiber optic connector to determine a polarity of the fiber optic connector.
3. The boot according to claim 1, further comprising a first engagement member to cooperate with a corresponding second engagement member on the crimp body to removably attach the boot to the crimp body.
4. The boot according to claim 3, wherein the first engagement member comprises one of at least one projection and at least one notch and the second engagement member comprises the other of at least one projection and at least one notch, the at least one notch has a length to allow for movement of the at least one projection within the at least one notch without becoming unattached.
5. The boot according to claim 4, wherein pulling on the boot causes the first engagement member to slide relative to the second engagement member thereby pulling the front extension rearwardly releasing the fiber optic connector from the receptacle.

6. The boot according to claim 4, wherein the at least one projection includes two projections and the at least one notch comprises two notches.
7. The boot according to claim 4, wherein the at least one notch includes a forward facing surface and the at least one projection includes a rearward facing surface such that pulling on the boot causes the rearward facing surface to engage the forward facing surface.
8. The boot according to claim 3, wherein the first engagement member is disengaged from the second engagement member when the front portion of the boot is pressed inward toward the first longitudinal opening.
9. A combination of a boot and a crimp body for a fiber optic connector, the fiber optic connector having a housing, at least two fiber optic ferrules, and a spring push, the combination comprising:
 - a boot comprising:
 - a center portion having a front end and a back end, a first longitudinal opening extending between the front end and the back end to receive a portion of the crimp body and a fiber optic cable;
 - a back portion attached to the center portion and extending away from the front end of the center portion, the back portion defining a second longitudinal opening that is in communication with the first longitudinal opening, the back portion having grasping portions to allow a user to push and pull on the boot;
 - a front extension portion connected to the center portion and engageable with the fiber optic connector, the front extension portion extending forward and beyond the front end of the center portion and having at least one latch to engage a receptacle; and
 - a crimp body comprising
 - a front portion configured to be disposed at least partially in the housing;
 - a rear portion that extends rearwardly away from the front portion and provides an outer surface to receive a crimp band therearound; and
 - a central portion disposed between the front and rear portions,wherein the boot has a first engagement member to cooperate with a corresponding second engagement member on the crimp body to removably attach the boot to the crimp

body, the second engagement member being disposed on the central portion of the crimp body.

10. The combination of a boot and a crimp body according to claim 9, wherein the first engagement member comprises one of at least one projection and at least one notch and the second engagement member comprises the other of at least one projection and at least one notch, the at least one notch has a length to allow for movement of the at least one projection within the at least one notch without becoming unattached.

11. The combination of a boot and a crimp body according to claim 10, wherein the at least one projection includes two projections and the at least one notch comprises two notches.

12. The combination of a boot and a crimp body according to claim 10, wherein the at least one notch includes a forward facing surface and the at least one projection includes a rearward facing surface such that pulling on the boot causes the rearward facing surface to engage the forward facing surface.

13. The combination of a boot and a crimp body according to claim 9, wherein the first engagement member is disengaged from the second engagement member when the front portion of the boot is pressed inward toward the first longitudinal opening.

14. The combination of a boot and a crimp body according to claim 9, wherein pulling on the boot causes the first engagement member to slide relative to the second engagement member thereby pulling the front extension rearwardly releasing the fiber optic connector from the receptacle.

15. The combination of a boot and a crimp body according to claim 9, wherein the central portion of the crimp body has top and bottom surfaces with a rail receiving portion, the rail receiving portion has a central portion and two lobe sections, one lobe on each side of the central portion.

16. A fiber optic connector having a boot, a crimp body, and a housing having at least two ferrules to hold optical fibers therein, the fiber optic connector comprising:

a front end opening in the housing for the at least two ferrules;

the crimp body attached to the housing rearward of the front end, the crimp body having a front portion, a central portion and a rear portion; and

the boot attached to the crimp body and having a front extension, the front extension extending towards the front end of the housing and is attached to one of the crimp body at the central portion or the housing and also has at least one latch to engage a receptacle, and the boot having a back portion having at least one grasping portion to allow a user to push and pull on the boot,

wherein the crimp body and the boot each have a longitudinal opening to accommodate at least two optical fibers.

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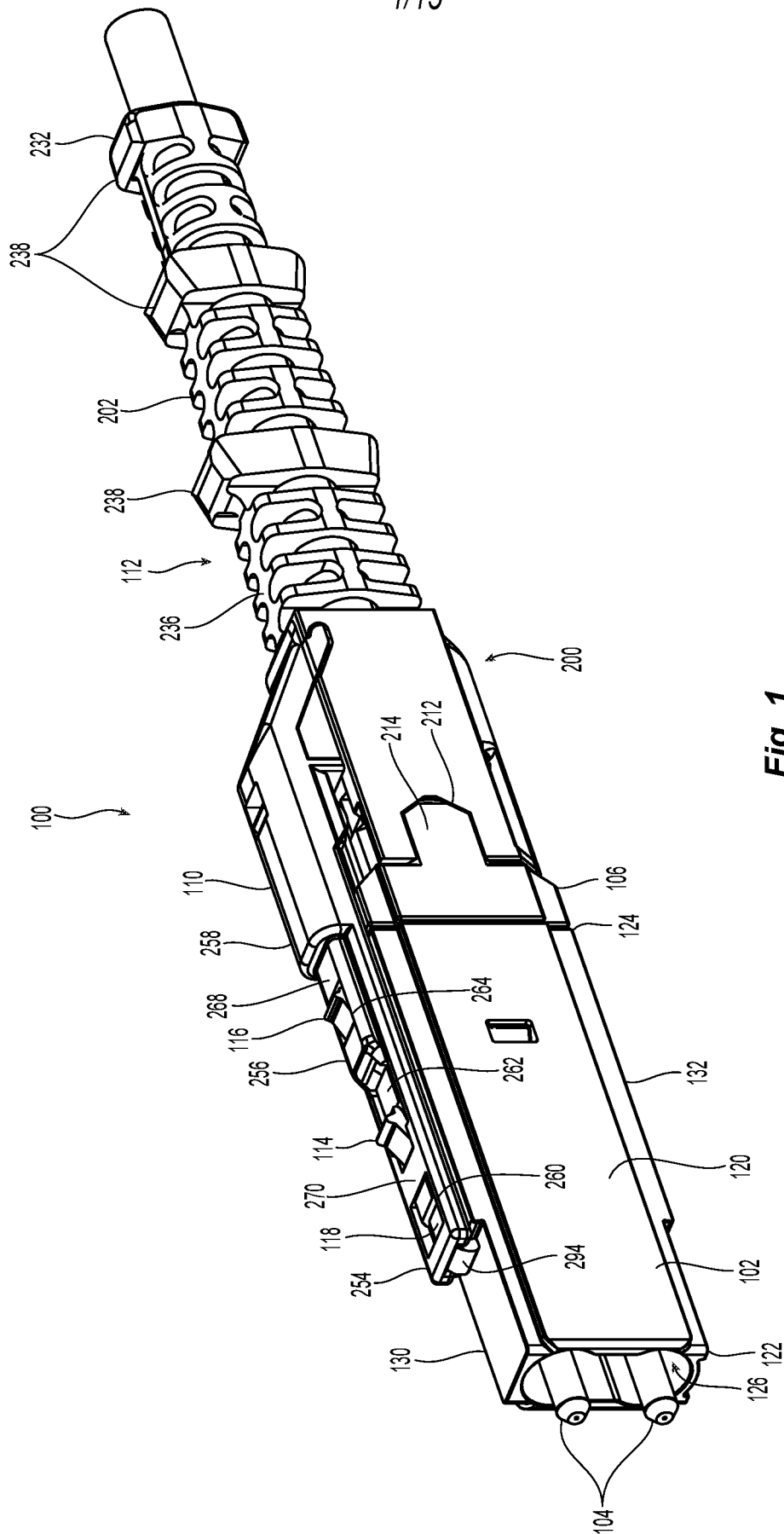
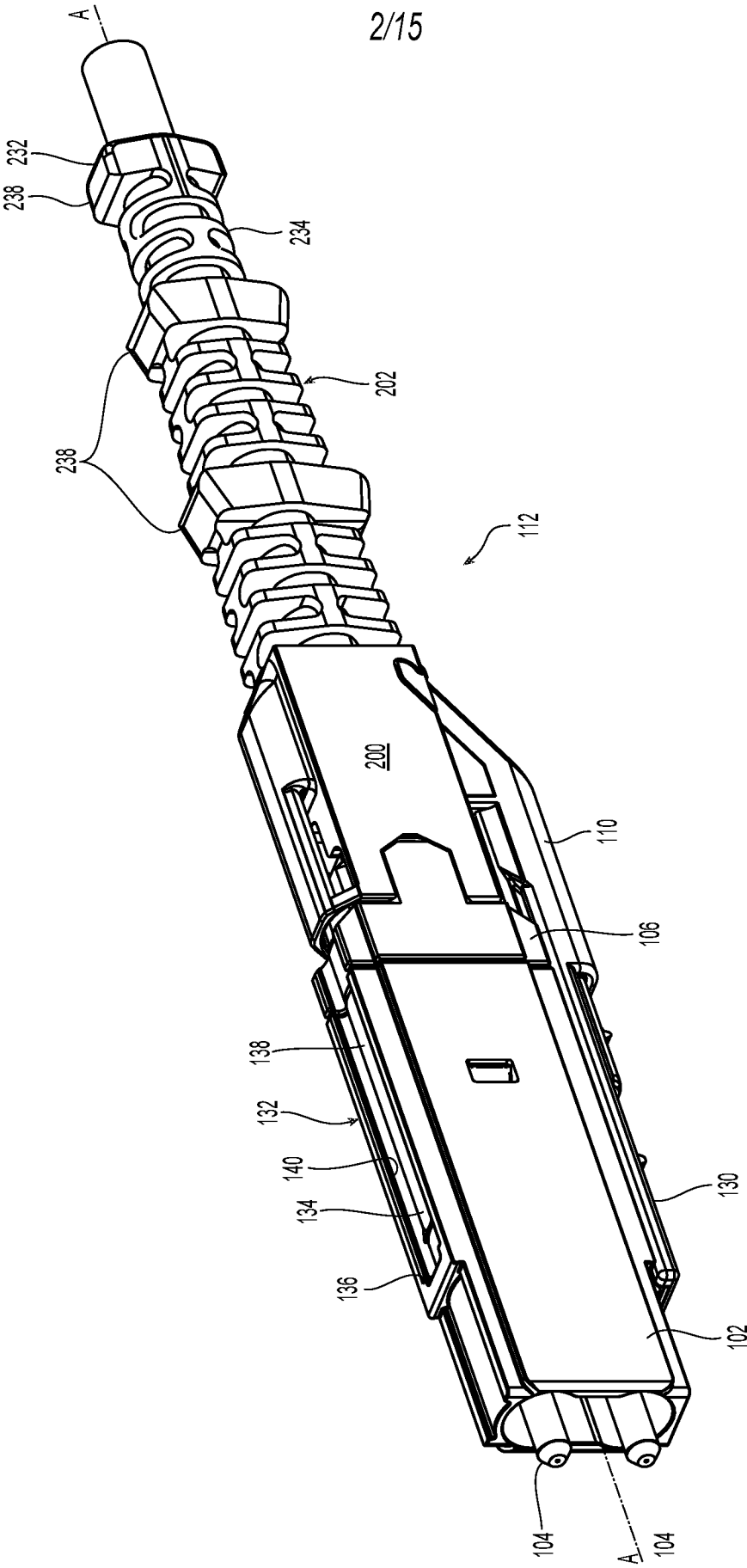


Fig. 1



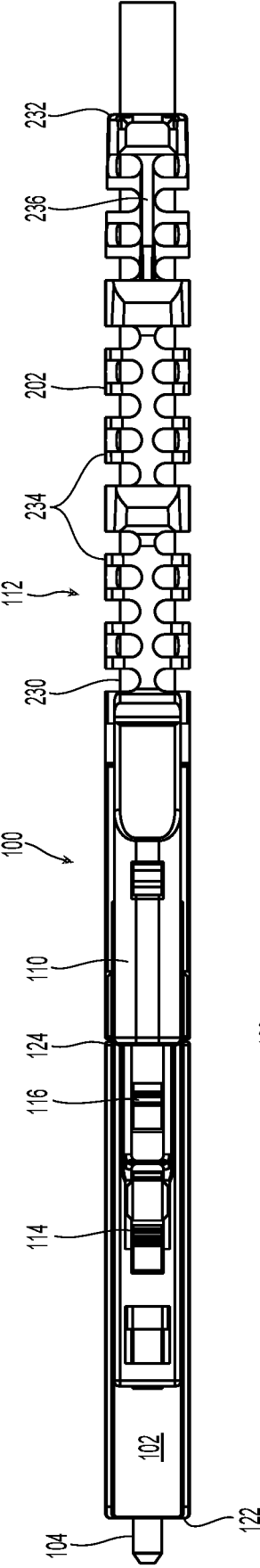


Fig. 3

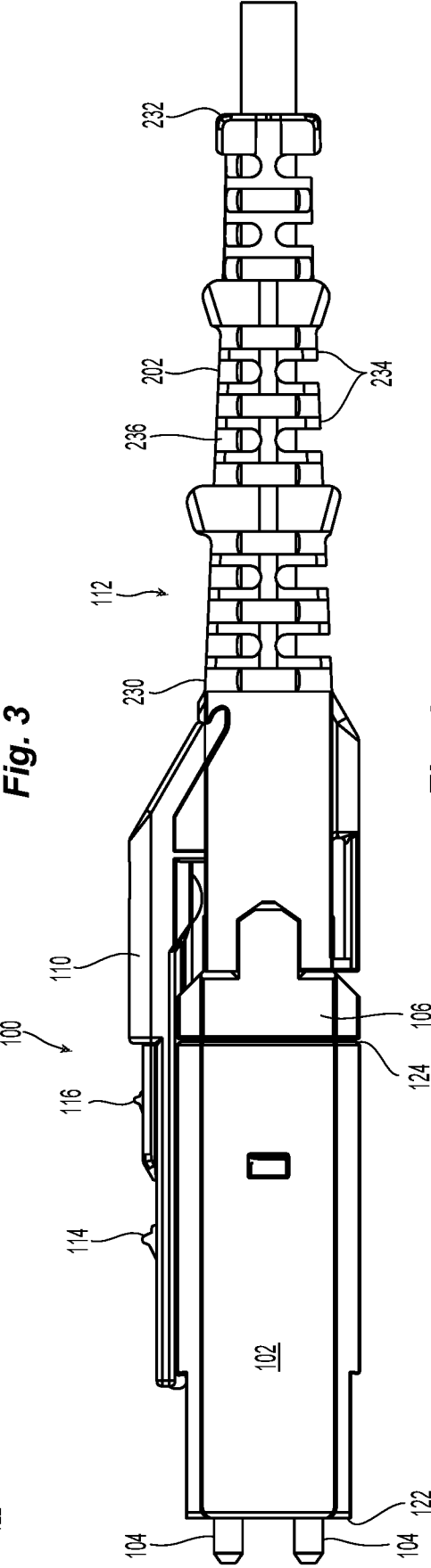


Fig. 4

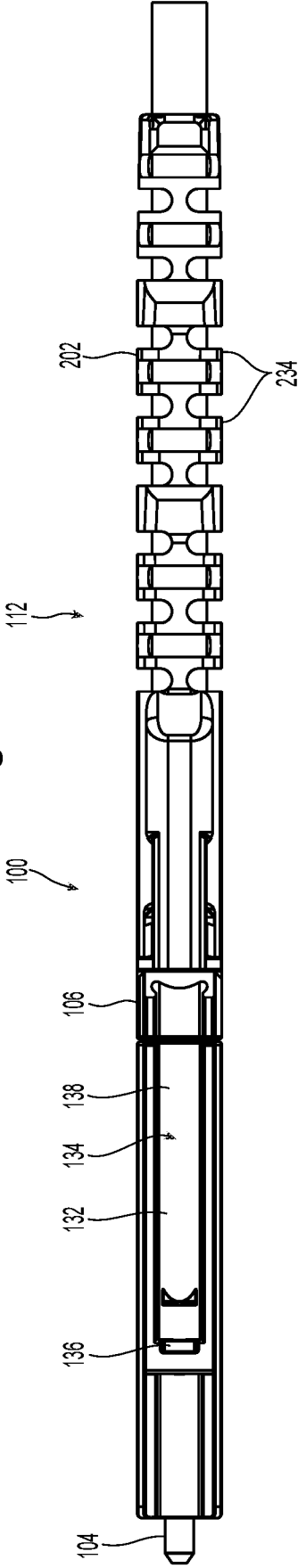


Fig. 5

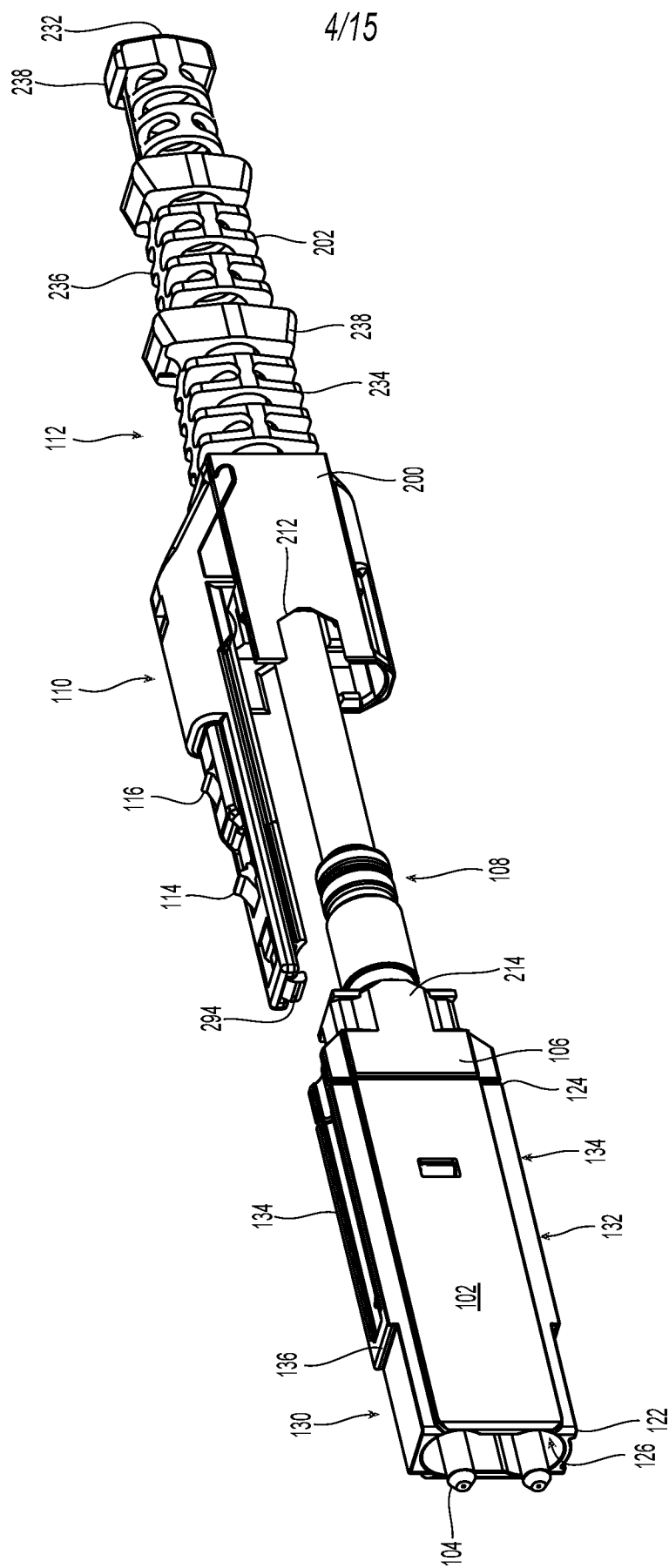


Fig. 6

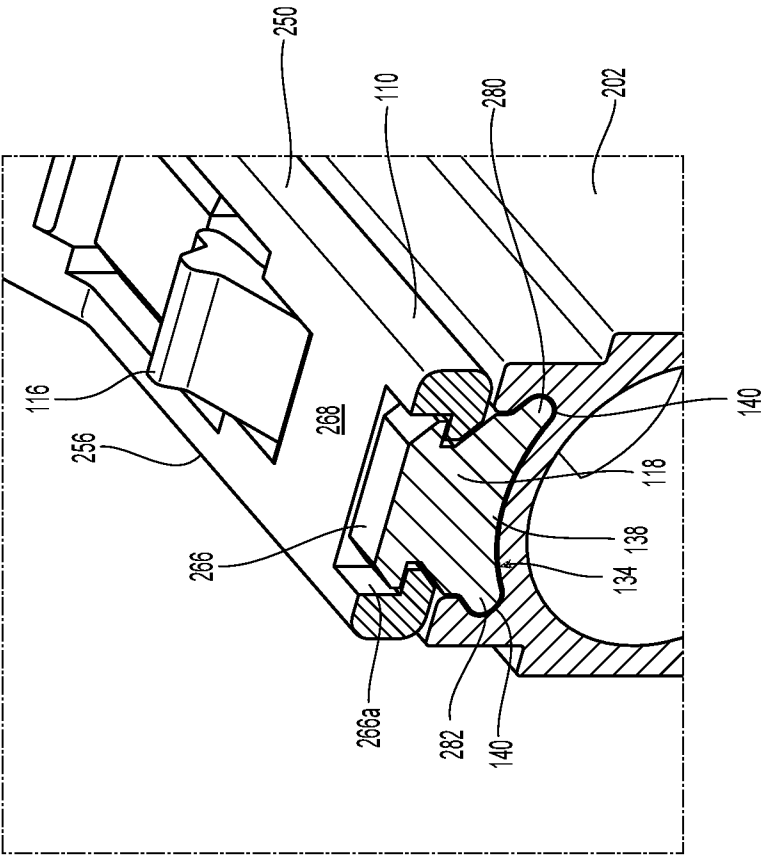
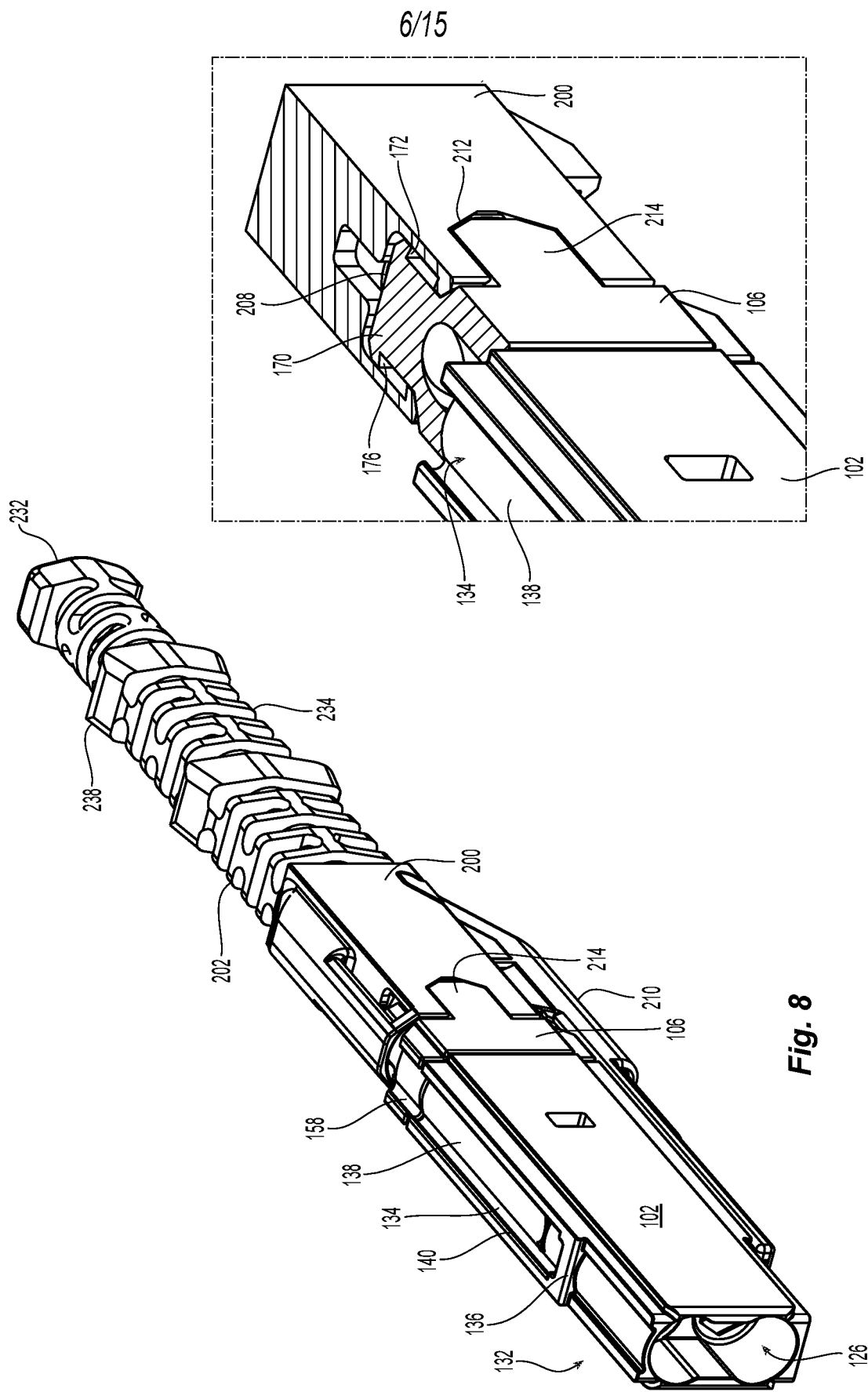


Fig. 7



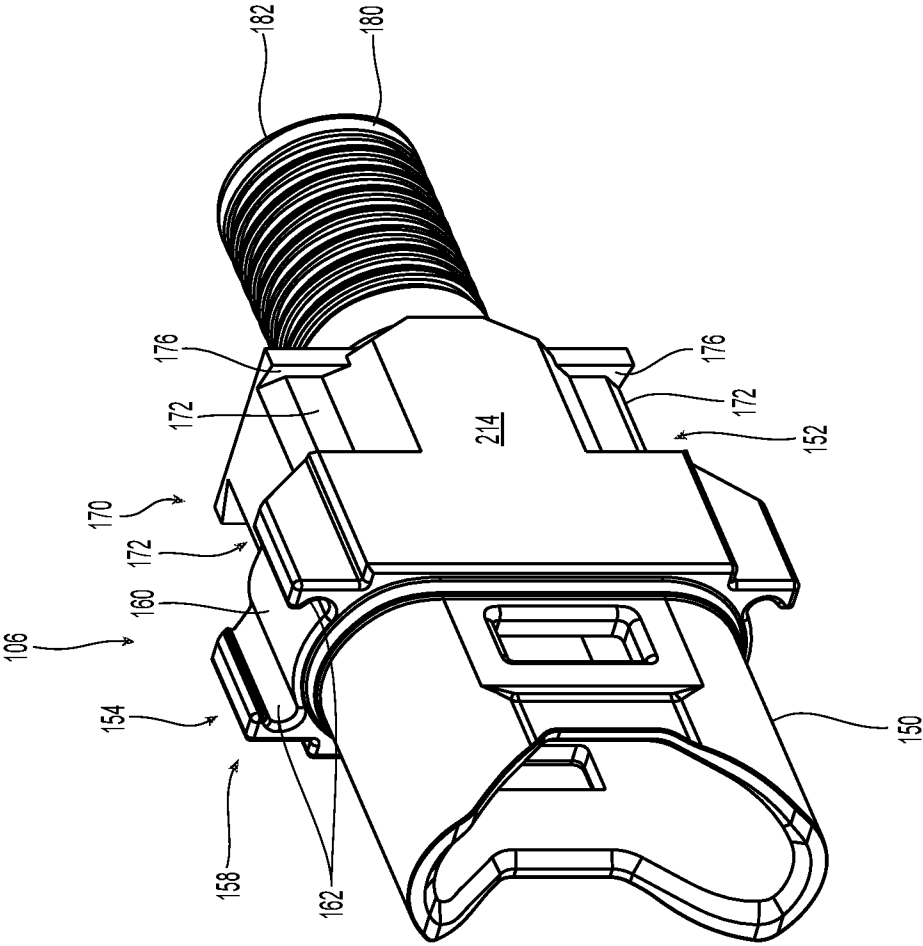


Fig. 10

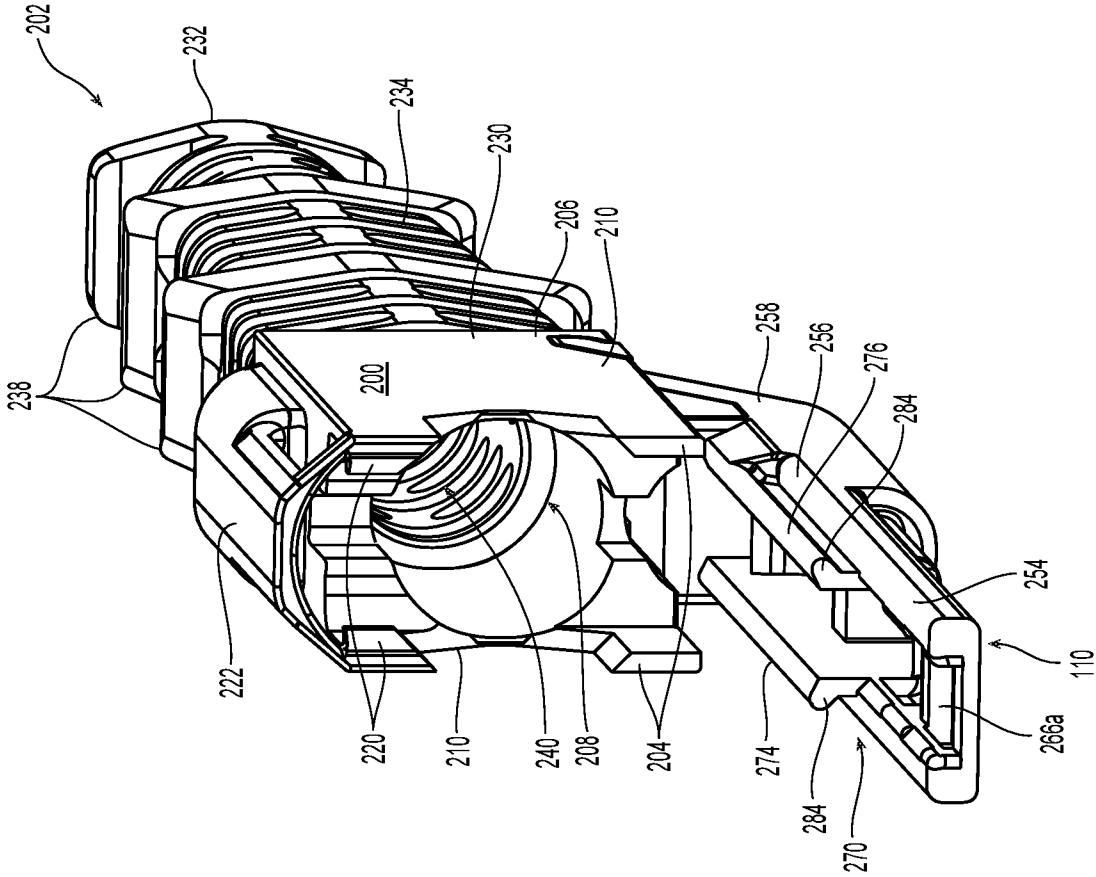


Fig. 11

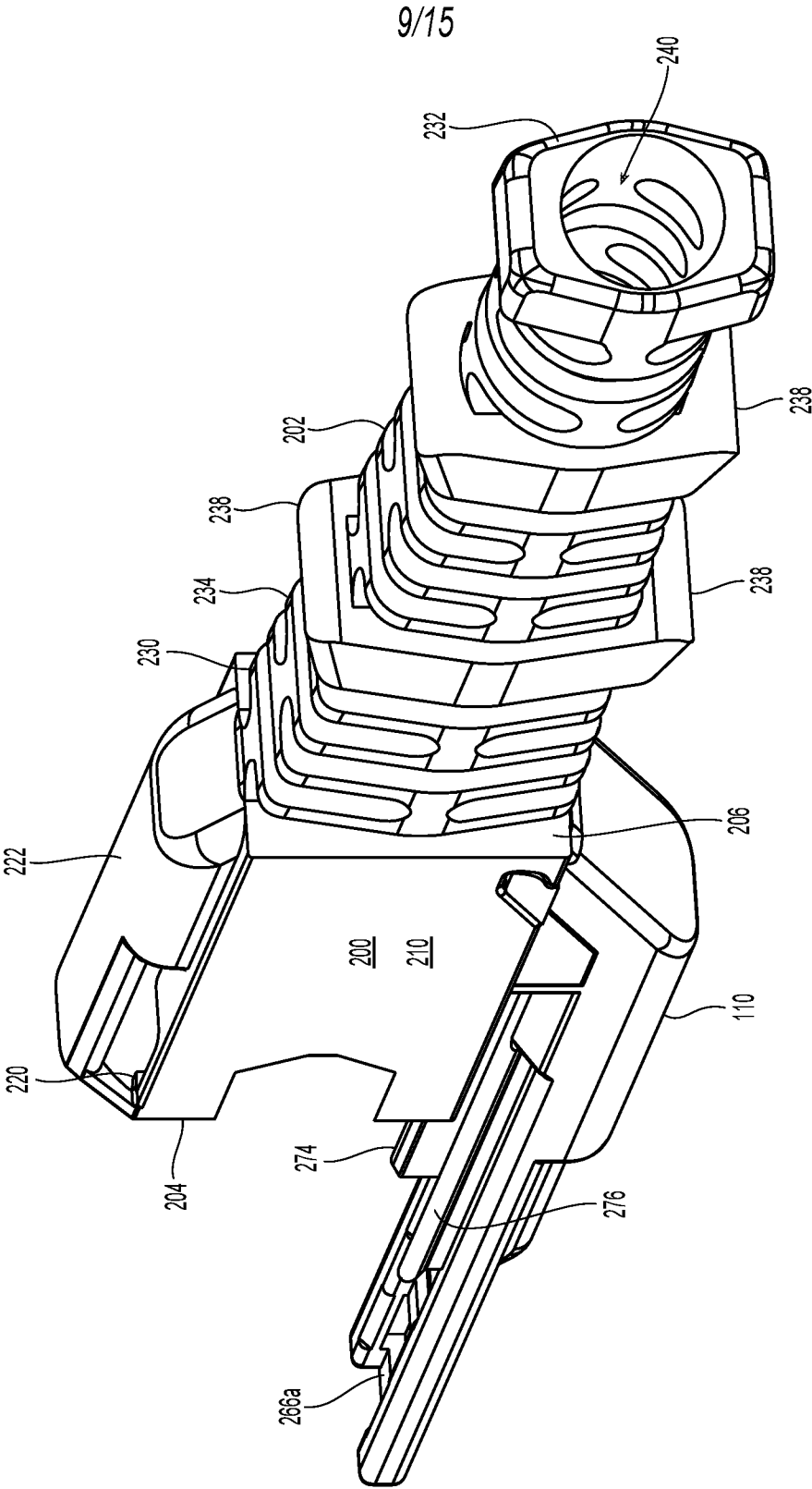


Fig. 12

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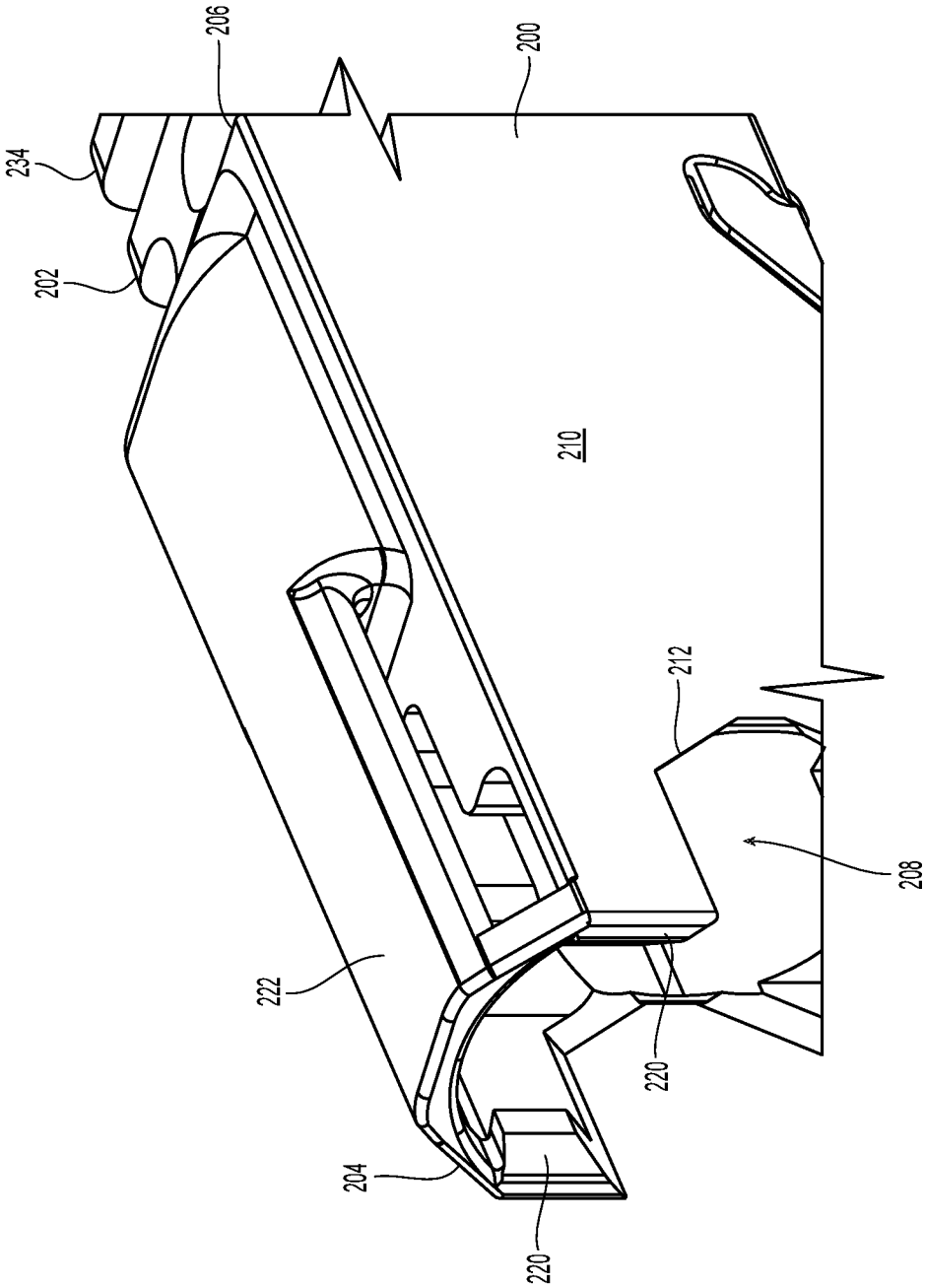


Fig. 13

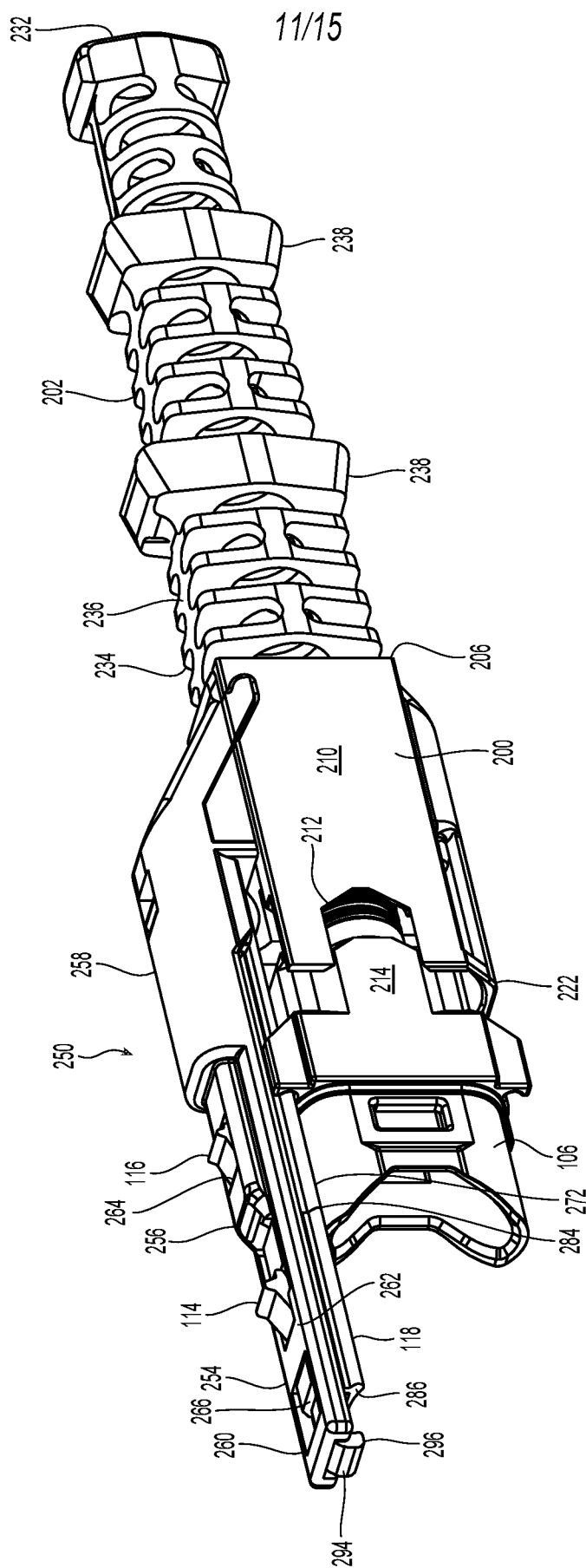


Fig. 14

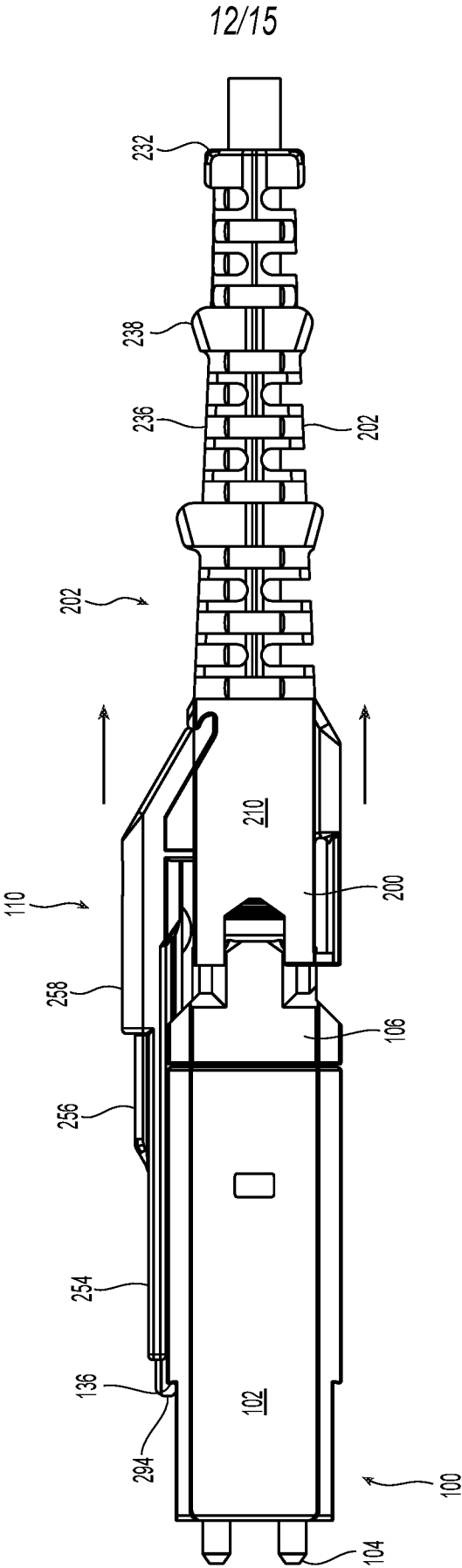


Fig. 15

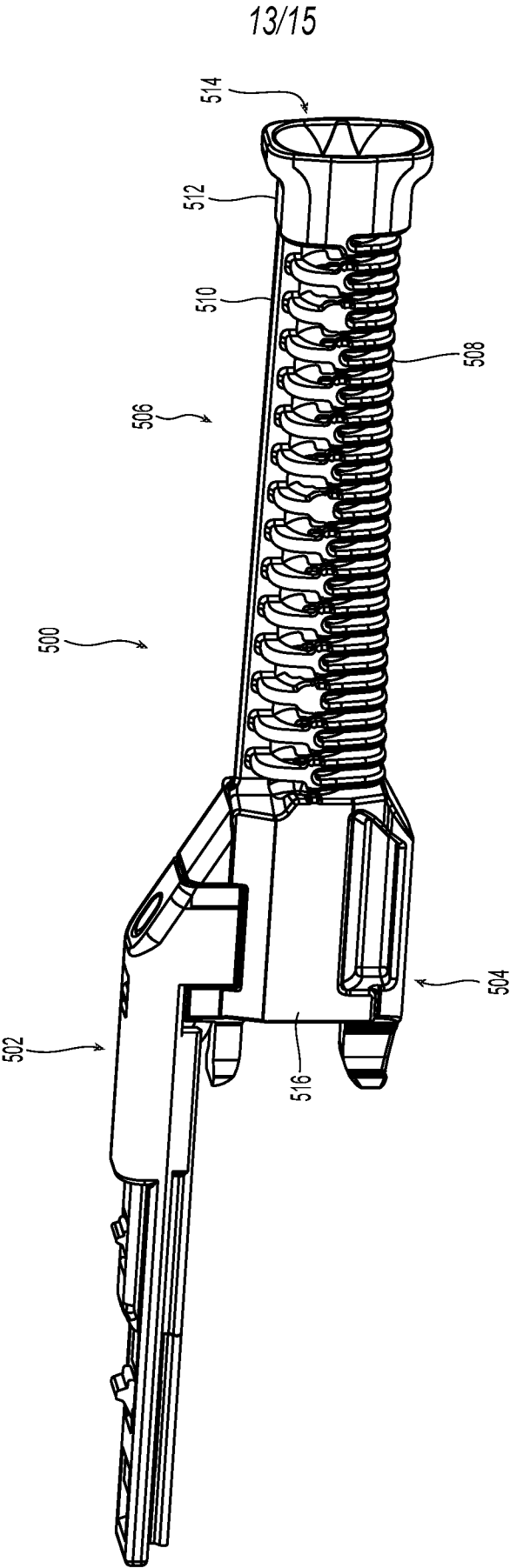
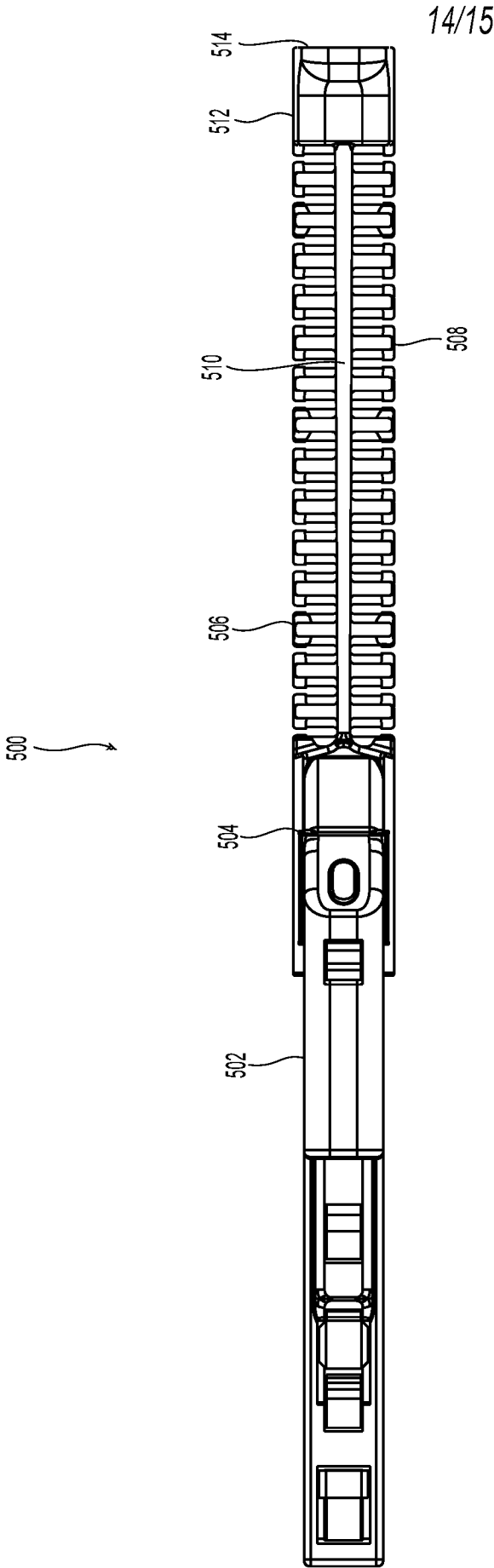


Fig. 16



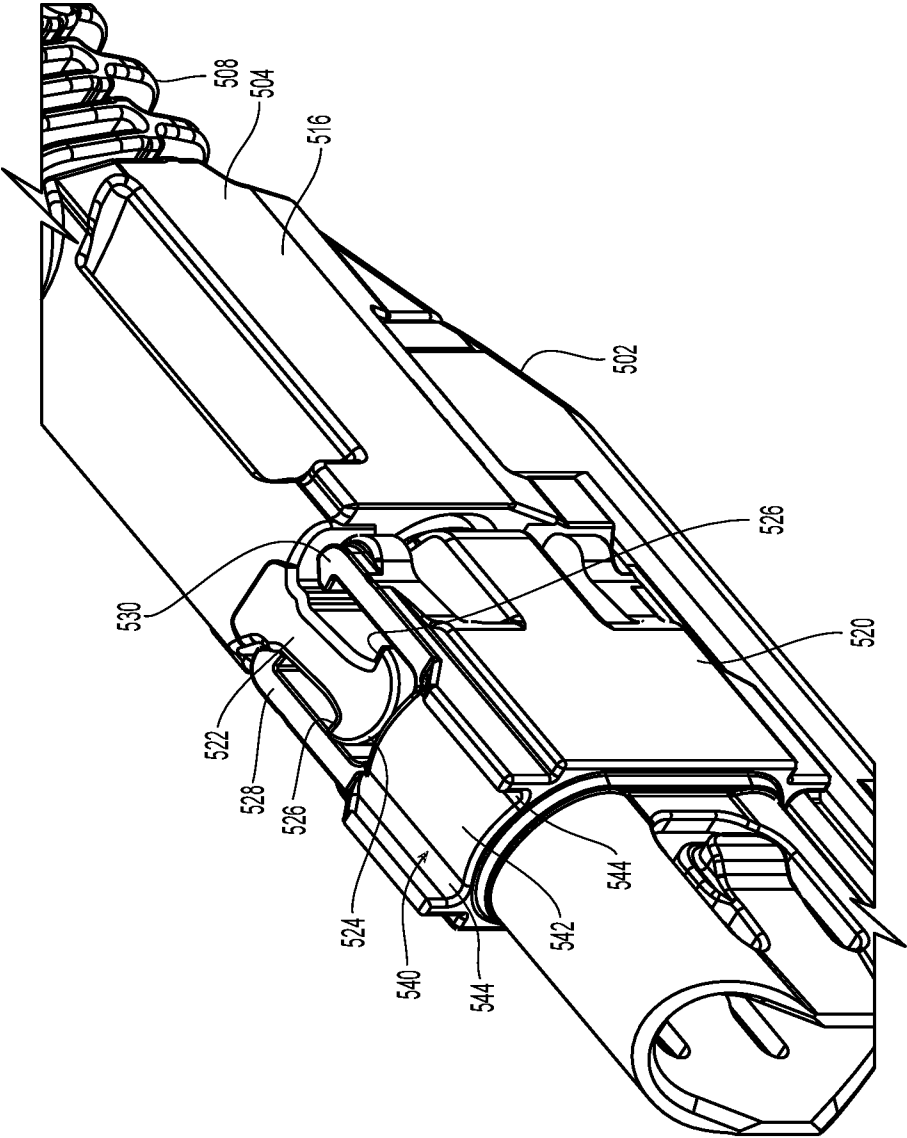


Fig. 18

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 19/25944

A. CLASSIFICATION OF SUBJECT MATTER
 IPC(8) - G02B 6/36, G02B 6/38 (2019.01)
 CPC - G02B 6/3807, G02B 6/3893

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)

See Search History Document

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

See Search History Document

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

See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y --- A	US 2016/0209602 A1 (CORNING OPTICAL COMMUNICATIONS LLC) 21 July 2016 (21.07.2016), entire document especially Figs 5-6; paras [0021], [0023], [0024], [0029]	1, 2, 16 ----- 3-15
Y --- A	US 2017/0205588 A1 (ALLIANCE FIBER OPTIC PRODUCTS, INC.) 20 July 2017 (20.07.2017), entire document especially para [0006]	1, 2, 16 ----- 3-15
Y --- A	US 2017/0192180 A1 (CORNING OPTICAL COMMUNICATIONS LLC) 06 July 2017 (06.07.2017), entire document especially para [0023]	1, 2, 16 ----- 3-15
Y	US 2014/0169727 A1 (VEATCH et al.) 19 June 2014 (19.06.2014), entire document especially Figs 7-10; paras [0028]-[0030]	2
A	US 2017/0160496 A1 (CORNING OPTICAL COMMUNICATIONS LLC) 08 June 2017 (08.06.2017), entire document	1-16

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

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

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

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

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

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

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Date of the actual completion of the international search

10 June 2019

Date of mailing of the international search report

03 JUL 2019

Name and mailing address of the ISA/US

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