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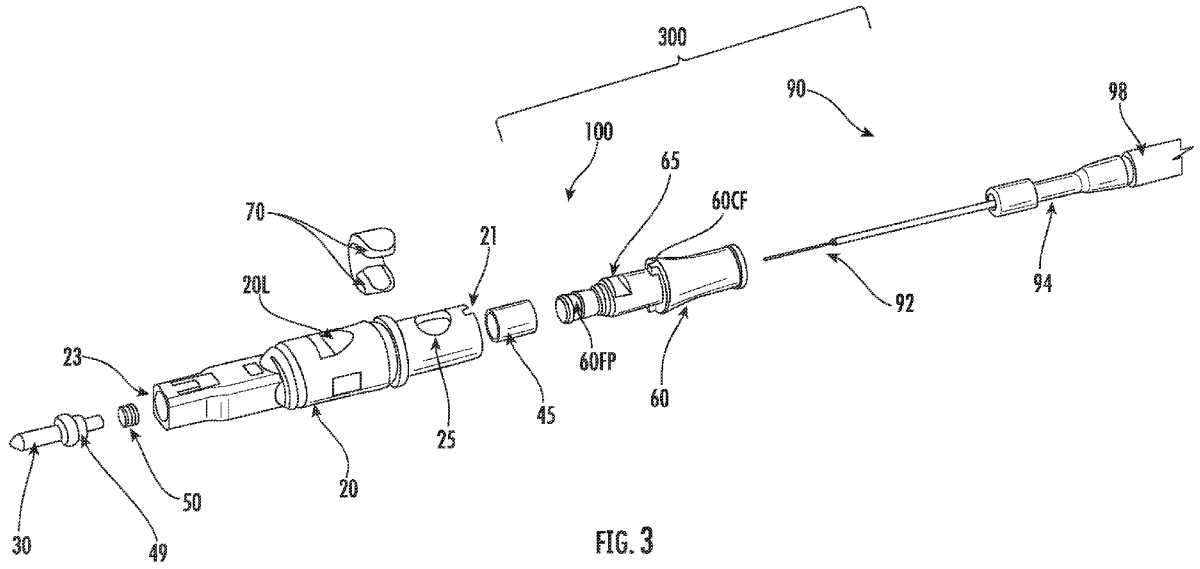

FIG. 3

(57) Abstract: Fiber optic connectors and cable assemblies comprising a retention body with a portion that fits a connector housing when assembled and is secured to the connector housing using one or more securing buttons are disclosed. The connector housing comprises at least one connector housing aperture and the retention body comprises at least one retention body securing portion for cooperating with the one or more securing buttons when aligned for assembly. The fiber optic connectors disclosed advantageously allow for the termination of a wide variety of fiber optic cables of various shapes and/or construction for different requirements of preferences. Methods for securing the fiber optic connector to a cable for forming a cable assembly are also disclosed.

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FIBER OPTIC CONNECTORS HAVING ONE OR MORE SECURING BUTTONS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority of U.S. Provisional Application Serial No. 63/082,036 filed on September 23, 2020, and U.S. Provisional Application Serial No. 63/029,991 filed on May 26, 2020, the content of both of which is relied upon and incorporated herein by reference in its entirety.

FIELD

[0002] The disclosure is directed to fiber optic connectors and cable assemblies comprising a retention body with a portion that fits within a connector housing and is secured to the connector housing using one or more securing buttons along with methods for making fiber optic cable assemblies by terminating the fiber optic cable with the fiber optic connector.

BACKGROUND

[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 extends deeper into communication networks there exist a need for building more complex and flexible fiber optic networks using fiber optic connectors in a quick and easy manner.

[0004] Fiber optic connectors were developed for making plug and play optical connections at links or devices in the communication network such as terminals, cabinets, patch panels, and like. The fiber optic connectors allow the distribution of optical signals within an optical network and provide the flexibility of locating the devices in convenient locations for efficient network design and deployment and also deferring connectivity and the associated expense until needed in the communication network. Certain network operators have a preference for the type of fiber optical cables they deploy in their communication network. Consequently, the fiber optic connectors that terminate many different types of cables advantageously provide manufacturing synergies.

[0005] Consequently, there exists an unresolved need for fiber optic connector designs that provide quick and easy manufacturing in a flexible manner.

SUMMARY

[0006] The disclosure is directed to fiber optic connectors (hereinafter "connectors") and fiber optic cable assemblies (hereinafter "cable assemblies") comprising a retention body and a connector housing where the retention body may be secured to connector housing using one or more securing buttons. Specifically, the one or more securing buttons are sized to fit into respective connector housing apertures and retention body securing portions when aligned, thereby securing the retention body to the connector housing. Methods of making cable assemblies are also disclosed.

[0007] One aspect of the disclosure is directed to a fiber optic connector comprising a retention body, a connector housing and one or more securing buttons. The retention body comprises a rear end and a front end with a passageway from the rear end to the front end, and at least one retention body securing portion in the retention body. The connector housing comprises a rear end and a front end with a longitudinal passageway extending from the rear end to the front end, and at least one connector housing aperture in the connector housing. One or more securing buttons are sized to fit into the at least one connector housing aperture and the at least one retention body securing portion for securing a portion of the retention body within the connector housing when assembled.

[0008] Another aspect of the disclosure is directed to a fiber optic connector comprising a retention body, a connector housing and one or more securing buttons. The retention body comprises a rear end and a front end with a passageway from the rear end to the front end, and at least one retention body securing portion in the retention body. The connector housing comprises a rear end and a front end with a longitudinal passageway extending from the rear end to the front end, and at least one connector housing aperture in the connector housing. One or more securing buttons are sized to fit into the at least one connector housing aperture and the at least one retention body securing portion for securing a portion of the retention body within the connector housing when assembled. Where the at least one retention body securing portion in the retention body may be aligned with the at least one connector housing aperture when a portion of the retention body is inserted into an opening at the rear end of the connector housing so that the one or more securing buttons may be inserted

into the at least one retention body securing portion and the at least one connector housing aperture.

[0009] Yet another aspect of the disclosure is directed to a fiber optic connector comprising a retention body, a connector housing and one or more securing buttons. The retention body comprises a rear end and a front end with a passageway from the rear end to the front end, and at least one retention body securing portion in the retention body. The connector housing comprises a rear end and a front end with a longitudinal passageway extending from the rear end to the front end, and at least one connector housing aperture in the connector housing. One or more securing buttons are sized to fit into the at least one connector housing aperture and the at least one retention body securing portion for securing a portion of the retention body within the connector housing when assembled. Where the one or more securing buttons comprise a larger portion and a smaller portion with the larger portion sized for the at least one connector housing aperture and the smaller portion sized for the at least one retention body securing portion.

[0010] A further aspect of the disclosure is directed to a fiber optic cable assembly comprising a fiber optic cable having an optical fiber and a fiber optic connector. The fiber optic connector comprises a retention body, a connector housing and one or more securing buttons. The retention body comprises a rear end and a front end with a passageway from the rear end to the front end, and at least one retention body securing portion in the retention body. The connector housing comprises a rear end and a front end with a longitudinal passageway extending from the rear end to the front end, and at least one connector housing aperture in the connector housing. One or more securing buttons are sized to fit into the at least one connector housing aperture and the at least one retention body securing portion for securing a portion of the retention body within the connector housing.

[0011] The disclosure is also directed to methods of making a fiber optic cable assembly. The method comprises inserting a fiber optic cable having an optical fiber into a passageway of a retention body comprising at least one retention body securing portion in the retention body and securing the fiber optic cable to the retention body. The method also comprises inserting a portion of the retention body into a connector housing comprising a longitudinal passageway extending from a rear end to a front end, and at least one connector housing aperture so that the at least one connector

housing aperture is aligned with the at least one retention body securing portion of the retention body, and then inserting one or more securing buttons into the at least one connector housing aperture and the at least one retention body securing portion for securing a portion of the retention body within the connector housing.

[0012] The fiber connector concepts disclosed may be varied for use with any suitable components or cables desired for termination. For instance, any suitable connector housing may benefit from the concepts disclosed by providing flexibility and adaptability for manufacturing.

[0013] 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.

[0014] 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

[0015] **FIGS. 1 and 2** are top and bottom perspective views of an explanatory fiber optic cable assembly having a fiber optic connector that terminates a fiber optic cable according to the present application;

[0016] **FIG. 3** is a partially exploded view of the fiber optic cable assembly of **FIG. 1**;

[0017] **FIG. 4** is a partial cross-sectional view of the fiber optic cable assembly of **FIG. 1** taken in a vertical plane 9-9;

[0018] **FIG. 5** is a perspective view of securing buttons of explanatory fiber optic connector of **FIG. 1**;

[0019] **FIGS. 6 and 7** are perspective views of the retention body of the explanatory fiber optic connector of **FIG. 1**;

[0020] **FIG. 8** is a perspective view of the connector housing of the explanatory fiber optic connector of **FIG. 1**;

[0021] **FIG. 9** is a longitudinal cross-sectional view of the fiber optic cable assembly of **FIG. 1** taken respectively along plane 9-9;

[0022] **FIGS. 10-18** shows various explanatory methods for making the fiber optic cable assemblies disclosed herein;

[0023] **FIGS. 19 and 20** are an exploded view and a partial cross-sectional view of another explanatory fiber optic connector having a retention body with the securing portion configured as an aperture according to the concepts disclosed;

[0024] **FIGS. 21-24** are various views showing details for another fiber optic connector similar to the fiber optic connector of **FIGS. 19 and 20**;

[0025] **FIGS. 25-28** are various views showing details of another securing button concept disclosed for explanatory fiber optic connectors;

[0026] **FIGS. 29-32** are various views showing details of another securing button concept disclosed for explanatory fiber optic connectors; and

[0027] **FIG. 33** depicts a fiber optic connector that comprises a multi-fiber ferrule using the securing button concepts disclosed herein; and

[0028] **FIG. 34** depicts an enlarged view of the multi-fiber ferrule of the connector of **FIG. 33**.

DETAILED DESCRIPTION

[0029] 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.

[0030] The concepts disclosed are related to fiber optic connectors, cable assemblies and methods of making comprising a retention body used for securing a fiber optic cable along with a connector housing secured to the retention body using one or more securing buttons. During assembly, a portion of the retention body is inserted into the connector housing for aligning at least one retention body securing portion with at least one connector housing aperture before the one or more securing buttons are inserted, thereby allowing a compact fiber optic connector design with quick, easy and repeatable assembly to the connector housing. Moreover, the

concepts may be used with single-fiber or multi-fiber connectors and cable assemblies.

[0031] Cable assemblies may be formed by securing the fiber optic cable to the retention body in any suitable fashion such as using an adhesive and/or a crimp as desired. Consequently, the fiber optic connector design is highly-adaptable to a wide variety of fiber optic cables of various shapes and/or construction for different customer requirements or preferences. For instance, the connector may be terminated to cables comprising a round cross-section or a non-round cross-section as desired. Likewise, the connector may be terminated to cables having rigid strength members such as GRPs or yarn-like strength members such as aramid. In other embodiments, the fiber optic connectors and cable assemblies disclosed may have a conventional connector construction or a connector construction with push-to-lock retention feature in the connector housing as further disclosed.

[0032] The concepts disclosed advantageously provide flexibility for the cable type used with the fiber optic connector. The concepts may be used with any suitable cables and may be especially advantageous with compact cable form-factors along with enabling terminals with relatively high-density arrays of optical connections with an organized layout. The connector concepts are scalable to any suitable count of optical fibers on a ferrule in a variety of arrangements or constructions for building fiber optic networks.

[0033] The concepts disclosed herein are suitable for fiber optic networks such as for Fiber-to-the-location (FTTx), densification, 5G applications, and are equally applicable to other optical applications as well including indoor, industrial, wireless, or other desired application. Additionally, the concepts disclosed may be used with other devices having any suitable footprint or construction. Various designs, constructions, or features for fiber optic connectors and cable assemblies are disclosed in more detail as discussed herein and may be modified or varied as desired.

[0034] **FIGS. 1-9** depict a first explanatory connector 100 and **FIGS. 10-18** disclose methods of making cable assemblies 300 according to the concepts disclosed. **FIGS. 19-24** depict another explanatory connector 100 and cable assembly 300, and **FIGS. 25-32** show other concepts of the disclosure. Explanatory cable assemblies 300 comprise a fiber optic cable 90 terminated to connector 100 such as shown in **FIGS. 1-3 and 19**.

[0035] The first explanatory connector 100 is depicted in top and bottom assembled perspective views in **FIGS. 1 and 2** as a portion of cable assembly 300. Connectors 100 disclosed herein comprise one or more securing buttons 70 that cooperate with connector housing 20 and retention body 60. Illustratively, **FIG. 3** is a partially exploded view of connector 100 of cable assembly 300, and **FIG. 4** is a partial cross-sectional view of cable assembly 300 taken in a vertical plane showing fiber optic connector 100 comprising one or more securing buttons 70 (**FIG. 5**) cooperating with the connector housing 20 (**FIG. 8**) and retention body 60 (**FIGS. 6 and 7**) for securing a portion of the retention body 60 within the connector housing 20 when assembled.

[0036] As depicted, connector 100 uses a retention body 60 comprising a rear end 61 and a front end 63 with a passageway 62 from the rear end 61 to the front end 63. Retention body 60 also comprises at least one retention body securing portion 60SP. Connector 100 also has a connector housing 20 comprising a rear end 21 and a front end 23 with a longitudinal passageway 22 extending from the rear end 21 to the front end 23, and at least one connector housing aperture 25 in the connector housing 20. When aligned, the at least one retention body securing portion 60SP of retention body 60 and at least one connector housing aperture 25 in the connector housing 20 allow the insertion of securing button 70. This assembly of inserting one or more securing buttons 70 when parts are aligned secures a portion of the retention body 60 inside connector housing 20 of connector 100.

[0037] One or more securing buttons 70 are sized to cooperate with both the at least one connector housing aperture 25 and the at least one retention body securing portion 60SP for securing a portion of the retention body 60 within the connector housing 20 when assembled. To assemble connector 100, the at least one retention body securing portion 60SP is aligned with the at least one connector housing aperture 25 when a portion of the retention body 60 is inserted into an opening at the rear end 21 of the connector housing 20 so that the one or more securing buttons 70 may be inserted into the at least one retention body securing portion and the at least one connector housing aperture 25. As best shown in **FIG. 4,** the one or more securing buttons 70 depicted in **FIG. 5** secure a portion of the retention body 60 within the connector housing 20 when assembled.

[0038] Retention body 60 may be secured to cable 90 in a number of suitable manners for enabling the termination of a variety of cable types or constructions. For instance, a crimp may be used for securing retention body 60 to cable 90. The crimp may be a dedicated component like a crimp band to secure one or more strength members or the retention body 60 may be crimped (i.e., deformed) to the cable 90 if the retention body 60 was formed from a suitable material. Cable 90 may also be attached to retention body 60 using an adhesive or the like. The adhesive or the like can be inserted into an aperture in the retention body 60 for securing the cable 90 to the retention body 60. Retention bodies 60 may be also be designed with features allowing multiple ways for securing cable 90 to retention body 60 for accommodating several cable types or constructions.

[0039] **FIGS. 6 and 7** depict perspective views of an explanatory retention body 60 and **FIG. 8** shows an explanatory connector housing 20 for connector 100. Connector 100 or cable assembly 300 may also include other features or components that are not shown for the sake of simplicity. For instance, connector 100 may also include one or more O-rings for sealing, one or more heat shrinks for securing or sealing components, boot supports, boots, or the like.

[0040] The connector concepts presented allow flexibility for connector termination and the assembly process. Connectors 100 may include a retention body 60 with one or more retention body securing portions 60SP with the geometry configured as desired. For instance, retention body securing portion 60SP need not extend through a wall of the retention body 60, but the retention body securing portion 60SP may extend through the wall of the retention body if desired. Further, the number or spacing of securing buttons 70 may be varied if desired.

[0041] As depicted in **FIGS. 6 and 7**, connector 100 may comprise retention body 60 with a first retention body securing portion 60SP and a second retention body securing portion 60SP disposed on opposing portions of retention body 60. Likewise, the explanatory connector housing 20 may comprise a first connector housing aperture 25 and a second connector housing aperture 25 disposed on opposing portions of connector housing 20 that may be aligned with the first and second retention body securing portions 60SP.

[0042] As shown in **FIG. 4**, the securing buttons 70 are disposed about 180 degrees apart like the connector housing apertures 25 and securing portions 60SP, but

other spacings or counts for the one or more securing buttons 70 are possible. When inserted, securing buttons 70 cooperate with both the connector housing 20 and retention body 60. One way of cooperating is by the securing buttons 70 having a snap-feature or detent that cooperates with the connector housing or retention body for a friction-fit. Another way of cooperating is when the securing button 70 is sized for an interference fit with the at least one connector housing aperture 25 or the at least one retention body securing portions 60SP. In one embodiment, the geometry for retention body securing portion 60SP does not extend thru the sidewall of the retention body 60. This geometry for the securing portion 60SP provides a continuous wall for passageway 62 to inhibit snagging during insertion of optical fibers 92 or strength members 94 from the rear portion 60RP through the passageway 62 to the front portion 60FP of retention body 60.

[0043] As depicted, the two securing portions 60SP are slots formed in retention body 60 that do not extend through the sidewall of retention body 60, but other suitable geometries are possible for retention body securing portions 60SP. For instance, the retention body securing portions 60SP may be apertures or even have other suitable geometry for the securing portion.

[0044] If an aperture is used as the retention body securing portion 60SP, then it is possible to use an adhesive such as epoxy, glue, resin, radiation-curable, polymer (cured using an ultrasonic or induction welding process) or other such materials for securing cable 90 within the retention body 60 if desired, by placing the adhesive or the like inside the passageway 62 and curing for securing cable 90. Still other geometry is possible for use as retention body securing portions 60SP besides the aperture. By way of explanation, retention body securing portions 60SP on retention body 60 may be a slot, a groove, a pocket, or the like. The retention body 60 may be secured to cable 90 or a portion of cable 90 in any suitable fashion. For instance, retention body 60 may be terminated or secured to strength members 94 of cable 90 using adhesive, crimp, or other desired processes. Other variations of the cable assembly concepts include terminating or securing the retention body 60 to a portion of the cable jacket 98 of cable 90 using adhesive, crimp, or other desired processes.

[0045] As shown in **FIGS 6 and 7**, retention body 60 may have other geometry as desired or not. For instance, the retention body 60 may comprise a front portion forward of the at least one retention body securing portion 60SP and a medial portion

with a medial cross-section that is greater than a cross-section of the forward portion 60FP, and the retention body securing portion 60SP is disposed in the medial portion 60M.

[0046] In further variations, the forward portion 60FP of the retention body 60 may have a plurality of ridges (not numbered) for securing one or more strength members such as tensile yarns 94 of cable 90 to retention body 60. Tensile yarns lack significant anti-buckling strength and are typically are aramids, fiberglass, and the like. As best depicted in **FIG. 4**, tensile yarns 94 of cable 90 may pass through the passageway 62 of retention body 60 and exit to the front end 63 of retention body 60. Thereafter, the one or more strength members 94 may be folded over a front portion 60FP of the retention body 60. Then crimp band 45 may be positioned over the front portion 60FP to sandwich the one or more strength members 94 between the deformed crimp band 45 and the front portion 60FP. Thus, one or more strength members 94 are secured to the retention body 60 with crimp band 45. Additionally, the front portion 60FP may have a rounded or radiused end 60RE for inhibiting a sharp edge at the front portion 60FP from damaging the one or more strength members 94 as they are folder over the front portion 60FP of the retention body 60.

[0047] Retention body 60 may be formed from any suitable materials such as a polymer, metal, composite, etc. The material of the retention body may depend on the method used for securing the cable 90 to the retention body 60. For instance, if retention body 60 was intended to receive an adhesive for securing the cable 90, then the retention body 60 would be made from a suitable material to cooperate with the adhesive. In other embodiments, retention body may be formed from materials with other desired properties such as if the retention body 60 was intended for use with a crimp band 45 for securing the cable 90 to the retention body 60. For instance, a material for retention body 60 may be selected so that it has a higher modulus of elasticity compared with the crimp band (e.g., aluminum, brass or the like) for proper attachment of the crimp band (45). However, the material for the retention body 60 could also be selected so that it is also deformable such as to the cable 90 if desired. One such material for retention body 60 having a higher modulus of elasticity than a brass crimp band 45 could be an aluminum such as AL 6082, but other suitable materials are possible according to the concepts disclosed. If retention body 60 is

metal or the like, then a rear portion of the retention body 60 could also be crimped to the cable 90 for additional strain-relief if desired.

[0048] **FIG. 5** is an isolated perspective view of one or more securing buttons 70 used with connector 100. Securing buttons 70 may have any suitable geometry or features for cooperating with the retention body 60 and connector housing 20 and several explanatory examples are discussed herein.

[0049] As shown by **FIG. 5**, a first securing button 70 is connected to a second securing button 70, thereby allowing installation of both securing buttons in a single component operation and making the part easier to handle. As depicted, the first securing button 70 is attached to the second securing button 70 by a connecting arm 78. Connector housing may be shaped to accommodate the connector arm 78 if desired or not. The securing buttons 70 may comprise any suitable shape to cooperate with the connector housing aperture 25 and the retention body securing portion 60SP for securing a portion of the retention body 60 within the connector housing 20 when assembled.

[0050] By way of explanation, one or more securing buttons 70 may comprise any suitable shapes or features for cooperation with the retention body 60 and connector housing 20. As depicted for this embodiment, securing button 70 may also comprise a larger portion 70L and a smaller portion 70S. For instance, the larger portion 70L may be sized for the at least one connector housing aperture 25 and the smaller portion 70S may be sized for the at least one retention body securing portion 60SP as shown. As best depicted in **FIG. 4**, the smaller portion 70S of securing button 70 is shaped to cooperate with retention body securing portion 60SP and the larger portion 70L of securing button 70 is shaped and sized to cooperate with the connector housing aperture 25. Securing button 70 may also comprise one or more chamfers 70C to help aid alignment and insertion of the securing buttons 70 into position during assembly. Securing buttons 70 may be formed from any suitable material as desired. Further, the securing buttons 70 may be flush or protrude from the retention body 60 when installed. Securing buttons 70 can have other features and other embodiments of securing buttons 70 are disclosed.

[0051] In this embodiment, the smaller portion 70S of securing button 70 has a rectangular shape, and the larger portion 70L of securing button 70 has a round shape with one or more chambers 70C. The rectangular shape of the smaller portion 70S

cooperates with the slot-shaped retention body securing portion 60SP of retention body 60.

[0052] Other features for connector 100 are possible for quick alignment of the components for assembly. As depicted in **FIG. 4**. the at least one retention body securing portion 60SP in the retention body 60 is aligned with the at least one connector housing aperture 25 when a portion of the at least one retention body 60 is inserted into an opening at the rear end 21 of the connector housing 20 so that the one or more securing buttons 70 may be inserted into the at least one retention body securing portion 60SP and the at least one connector housing aperture 25. Features may be formed into components for aligning the components so that the one or more securing buttons may be inserted.

[0053] By way of explanation, connector 100 may also include an interface between the connector housing 20 and retention body 60 with one or more clocking features to guide rotational alignment of parts for assembly and insertion of the one or more securing buttons 70. **FIGS. 7 and 8** show clocking features 60CF of retention body 60 that cooperate with clocking features 20CF on connector body 20. As shown, the clocking features may be one or more protrusions and complimentary slots. Further, the clocking features may be configured to allow assembly only in a single orientation if desired.

[0054] **FIG. 8** is a top perspective view of the connector housing 20 of explanatory connector 100 comprising a rear end 21 and a front end 23 with a longitudinal passageway 22 extending from the rear end 21 to the front end 23 with at least one connector housing aperture 25. Connector housing aperture 25 is used for securing the retention body 60 to the connector housing 20 using one or more securing buttons 70.

[0055] Connector housing 20 may have other geometry or features or not as desired. Connector housing 20 may have any suitable outer profile using the concepts disclosed. The explanatory connector housing 20 depicted in **FIG. 8** comprises a connector housing with a specific outer profile using primitive geometry with the desired features formed in the primitive geometry (e.g., the round and non-round primitive portions). Examples of explanatory features in the connector housing 20 include locking features for securing the connector 100 in a port, features for keying

connector 100, features for securing a dust cap or converting the connector footprint, or other suitable features.

[0056] With reference to **FIG. 8**, the primitive geometry for connector housing 20 shown may comprise a part of a rear portion (RP) comprises a round cross-section (RCS), and a part of the front portion (FP) of the connector housing 20 comprise a non-round cross-section (NRCS). A transition region (TR) may be disposed between the rear portion (RP) and the front portion (FP). The transition region (TR) may comprise an asymmetric portion if desired. As an example, the transition region (TR) may comprise a threaded portion (TP) as shown, but other geometry for the transition region (TR) is possible as well. The connector housing aperture 25 may have any suitable location on the connector housing 20, and as shown the connector housing aperture 25 is disposed in the rear portion (RP) of the connector housing 20. **FIG. 9** shows connector housing 20 in cross-section with the explanatory features formed on primitive geometry of the connector housing 20.

[0057] In one advantageous connector housing design, a locking feature 20L is integrally-formed in the material of the connector housing 20 such as a negative cutout from the primitive round geometry at a rear portion (RP) of the connector housing 20 as shown. The negative cutout from the primitive round geometry for locking feature 20L allows a relatively small connector footprint while retaining the connector 100 in a complimentary device or port. For instance, the locking feature 20L may cooperate with a translating securing member of the device or port that engages the negative cutout for securing connector 100. Other embodiments of connector housing 20 may omit the locking feature 20L or use a conventional connector attachment such as a coupling nut, bayonet, etc.

[0058] The locking feature 20L may have any suitable geometry. The locking feature 20L cooperates with a suitable device or optical port to secure the connector 100 for optical connection. In this explanatory example, locking feature 20L of connector housing 20 may be configured as a ramp (20R) with a ledge (20LD) as the retaining feature for connector 100. The ramp 20R and ledge 20LD may have geometry that allows a push and lock feature for securing the connector 100 to a suitable optical port or other device. The locking feature 20L may also comprise a flat portion disposed between the ramp 20R and ledge (20LD) if desired. Of course,

other locking features or configurations are possible for connector housing 20 using the concepts disclosed herein.

[0059] Connector housing 20 may include still other features if desired. For instance, connector housing may further comprise a suitable keying portion. By way of example, connector housing 20 comprises a female key (20FK). Female key 20FK may extend into a portion of the transition region (TR) if desired. One arrangement may have the locking feature 20L integrally formed in the rear portion (RP) of connector housing 20 with the female key 20FK that extends into a portion of the transition region (TR), and the locking feature 20L is disposed about 180 degrees apart from the female key 20FK.

[0060] In this configuration, connector housing 20 also comprises a transition region (TR) disposed between the rear portion (RP) and the front portion (FP). Transition region (TR) of connector housing 20 comprises a threaded portion (TP). Threaded portion (TP) may secure a dust cap and/or be used for adding a convertor to connector 100.

[0061] Still other features are possible with connector housings 20 for connectors 100 depending on the ferrule used. Ferrules for connectors 100 comprise one or more fiber bores 32 for receiving one or more optical fibers. Additionally, the ferrule of the connector could use a ferrule holder or not. Connector housings may load the ferrule from the rear or the front as desired. By way of explanation, connector housing 20 further comprises one or more latch arms 20LA for securing ferrule holder 49. Latch arms 20LA may be disposed in a front portion (FP) of connector housing 20 as depicted. Moreover, the front opening of passageway 22 of connector housing 20 is sized for allowing the insertion of ferrule holder 49 from the front end 23 such as shown in the cross-section of **FIG. 8**. Latch arms 20LA are connected at the front end and cantilevered at the rear end so they can be deflected when ferrule holder 49 is inserted and then the latch arms 20LA spring back to retain the ferrule holder 49 once it is fully-inserted as shown in **FIG. 9**.

[0062] **FIG. 9** shows a cross-section of the ferrule holder 49 and ferrule 30 disposed in housing 20 and retained by latch arms 20LA. As depicted, latch arms 20LA have ramp portions for aiding portions of ferrule holder 49 to deflect the latch arms 20LA outward as the ferrule holder 49 is inserted into housing 20 and then the latch arms 20 LA spring back over ferrule holder 49 for retaining the same. Ferrule

holder 49 and ferrule 30 may be biased to a forward position using resilient member 50 if desired. The use of other ferrules or ferrule assemblies are possible and may have other ways of being assembled in connector 100.

[0063] Cable assemblies 300 may include other connector structures or components. For instance, connector 100 may comprise one or more O-rings that may be disposed on groove 20G of connector housing 20. Likewise, the cable assembly may comprise one or more heat shrinks for assembling the connector 100 to cable 90. Dust caps for connector 100 and other components may be used as well. Further variations of connectors are also discussed below.

[0064] **FIGS. 10-18** show explanatory methods of making cable assemblies 300 by terminating cable 92 with connector 100**. FIG. 10** depicts cable 90 having an optical fiber 92. Cable 90 may be prepared in any suitable manner for insertion into passageway 62 of retention body 60 having at least one retention body securing portion 60SP as depicted in **FIG. 11**. Preparation of cable 90 typically comprises exposing the optical fiber 92 and prepping any other cable components as desired for termination such as strength members 94 or cable jacket 98. As best shown in **FIG. 10**, cable 90 is prepared so that strength members 94 extend beyond cable jacket 98. Strength members 94 may be any suitable type such as rigid glass-reinforced plastic (GRPs) or flexible yarns such as aramid or fiberglass. Cable construction may influence how the cable 90 is secured to the retention body 60, and may be accomplished in a variety of manners using the concepts disclosed herein.

[0065] **FIGS. 11 and 12** show the cable 90 inserted into the passageway 62 of retention body 60. Cable 90 may be secured to retention body 60 in any suitable fashion. For instance, a crimp may be used for securing a portion of cable 90 to retention body 60. In other methods, a portion of cable 90 is secured to the retention body 60 using an adhesive or the like. Still other variations are possible for securing cable 90 to retention body 60.

[0066] **FIG. 12** shows one explanatory cable 90 being secured to retention body 60 using a crimp band 45 that is slid over a portion of the retention body 60. In this termination, the strength members 94 are flexible yarns such as aramid that are routed through the passageway 62 of retention body 60 past the front end 63 and then folded rearward over the front portion 60FP of retention body 60 as shown. Thereafter, crimp band 45 is slid over strength members 94 and the front portion 60FP of

retention body 60 as represented by the arrow in **FIG. 12**, and then crimped to secure the cable 90 to the retention body 60. **FIG. 13** depicts the ends of the strength members 94 sandwiched between the front portion 60FP and the deformed crimp band 45. Other methods of securing cable 90 to retention body may be used in addition to crimp band 45 or independently of crimping. Illustratively, **FIGS. 17 and 18** show a method of using an adhesive or the like for securing cable 90 to retention body 60.

[0067] **FIG. 14** depicts the inserting a portion of the retention body 60 into connector housing 20 that comprises a longitudinal passageway 22 extending from the rear end 21 to the front end 23. The connector housing 20 comprises at least one connector housing aperture 25 that may be aligned with the at least one retention body securing portion 60SP of retention body 60 as shown. When assembled, the rotational alignment interface between the connector housing 20 and retention body 60 comprises one or more clocking features 20CF,60CF that cooperate when aligned to aid assembly. By way of example, retention body 60 may include a protrusion or recess as a clocking feature that fits with a complimentary recess or protrusion on connector housing 20 to align connector housing apertures 25 with retention body securing portions 60SP as shown in **FIG. 14**.

[0068] Once the components and geometry are aligned and assembled, then the one or more securing buttons 70 may be installed for securing the connector housing 20 with the retention body 60. **FIG. 15** depicts the one or more securing buttons 70 inserted into the at least one connector housing aperture 25 and the at least one retention body securing portion 60SP for securing a portion of the retention body 60 within the connector housing 20.

[0069] **FIG. 15** also depicts the ferrule 30 before being installed onto one or more optical fibers. The concepts disclosed may be used with any suitable connector having a ferrule comprising one or more fiber bores. For instance, connectors for cable assemblies disclosed may comprise single-fiber counts or multi-fiber counts.

[0070] Other components are possible for with ferrule 30 for connector 100. For instance, ferrule holder 49 and resilient member 50 may also be used. From the front end 23, resilient member 50 is placed about optical fiber 92 and then the ferrule holder 49 and ferrule 30 are threaded onto optical fiber 92 for assembly as known. Optical fiber 92 may be clamped in a suitable manner through bores (not numbered)

disposed on opposite sides of connector housing 20 when ferrule holder 49 is being inserted into housing 20. Clamping optical fiber 92 inhibits the optical fiber 92 from pushing rearward or buckling as ferrule 30 and ferrule holder 49 are inserted. Ferrule holder 49 is aligned to a suitable rotational position and pushed rearward into housing 20 until retained by latch arms 20LA. Optical fiber 92 is secured to ferrule 30 in a suitable fashion such as adhesive like a UV or heat curable material, but other processes are possible. Thereafter, the end face of ferrule 30 is polished.

[0071] Additionally, ferrule holder 49 may be configured for tuning ferrule 30 relative to housing 20. Additionally, a portion of the passageway 22 is sized to cooperate with a flange of the ferrule holder to allow different rotational positions. Consequently, after measurement of the end face profile of the ferrule 30 or measurement of the insertion loss, the ferrule 30 may be tuned if desired for improving performance such as to a Grade B standard. By way of explanation, the latch arms 20LA may be deflected outward to release the ferrule holder 49 and then the ferrule holder 49 is rotated to the desired position and inserted back into the housing 20 until it is retained by latch arms 20LA. Other embodiments of ferrule holder 49 may have other suitable numbers of rotational positions as desired. **FIG. 16** is a perspective view of the ferrule 30 attached to optical fiber 92 for cable assembly 300.

[0072] **FIGS. 17 and 18** show an explanatory method of using an adhesive or the like for securing cable 90 to retention body 60. The retention body 60 depict has retention body securing portion 60SP configured as an aperture for use with connector housing 20. Using the aperture for the retention body securing portion 60SP allows the placement of adhesive or the like into the retention body as represented by the arrow. However, the use of adhesive is possible without the aperture for the retention body securing portion 60SP.

[0073] Using an adhesive or the like for securing the retention body 60 to cable 90 allows for the use of many different types or constructions of cables with the retention body 60. By way of explanation, the cable 90 is prepared and adhesive may be inserted into a passageway 62 of retention body 60. The adhesive may be inserted through the retention body securing portion 60SP configured as an aperture or it could be placed from the passageway 62. Any suitable adhesive or other like material could be used such as a heat curable, UV curable, or other curing and the adhesive or

material may be placed before, during or after the cable 90 is placed into the retention body 60 as desired. In other variations, the outer jacket or strength members could be shaved to fit inside the passageway 62 of retention body 60 to fit an oversized cable or shaping the cable to the passageway 62. Moreover, shaving the cable 90 may improve the adhesion to the cable 90. **FIG. 18** depicts the one or more securing buttons 70 inserted for securing a portion of the retention body 60 within the connector housing 20.

[0074] Other constructions or methods of assembly are possible with the connector and cable assembly concepts disclosed. By way of explanation, the retention body 60 may secured to cable 90 in other ways such as being crimped directly to the cable 90.

[0075] After inserting the one or more securing buttons 70, one or more heat shrinks 99 may be installed over the one or more securing buttons such as shown in **FIG. 20**. Likewise, one or more heat shrinks may be used about a portion of the optical fiber or other places in the cable connector 100 or cable assembly 300. Any suitable size or type of heat shrink such as an adhesive lined heat shrink may be used for sealing or securing components as desired.

[0076] **FIGS. 19 and 20** are an exploded view and a partial cross-sectional view of another explanatory connector 100 having retention body 60 with the retention body securing portion 60SP configured as an aperture for use with connector housing 20 as disclosed herein. Connector 100 of **FIGS. 19 and 20** has a similar construction and operation as disclosed herein and is shown as cable assembly 300. Using an aperture for retention body securing portion 60SP allows securing of the retention body 60 to cable 90 using an adhesive, epoxy, glue or the like. Additionally, the other securing concepts disclosed can also be used for securing the retention body 60 to cable 90 as well when retention body securing portion 60SP is configured as an aperture. As depicted in **FIG. 20**, one or more securing buttons 70 may extend thru the wall of retention body 60 when retention body securing portion 60SP is the aperture. Further, the one or more securing buttons 70 may be sized so that the optical fiber 92 may still pass through the passageway 62 of retention body 60 freely.

[0077] In this embodiment, one or more securing buttons 70 snap-fit into retention body 60 as shown. Securing buttons 70 may have a symmetric shape or asymmetric shape as desired. Further, securing buttons 70 may have one or more detents 70D on

securing buttons 70 for securing the retention body 60 and connector housing 20 for creating an interference fit when assembled. As in **FIG. 20**, the strength members 94 of cable 90 may be secured to the retention body 60 such as by using a crimp band 45 if desired or not. Other geometry or versions of the securing button 70 may be sized for other interference fits with the connector housing aperture 25 or retention body securing portion 65 as desired.

[0078] Connector 100 and cable assembly 300 of **FIGS. 19 and 20** have other differences in construction or components as well. For instance, heat shrink 99 can inhibit securing buttons 70 from coming out of the retention body 60 or connector housing 20 along with sealing the connector housing 20 to cable 90. Also, a boot may be used if desired, and a support 80 may also be used for supporting a heat shrink or boot. The use of other heat shrinks is also possible. By way of explanation, the cable assembly 300 may use an appropriately sized heat shrink placed over a portion of the optical fiber 92 and a portion of cable 90 for protecting or inhibiting movement of the optical fiber 92 relative to the end of cable 90.

[0079] **FIGS. 21-24** are various views showing details of another connector 100 and cable assembly 300. As depicted, securing buttons 70 may have larger portion 70L and smaller portion 70S sized and shaped for the respective retention body 60 and connector housing 20. In this variation, securing buttons 70 comprise a rectangular smaller portion 70S and a round larger portion 70L that cooperate with retention body 60 and connector housing 20. Again, securing buttons 70 extend through a wall in retention body 60, but allow optical fiber 92 to pass toward the ferrule 30.

[0080] **FIGS. 25-28** are various views showing details of another securing button concept disclosed for explanatory connectors 100. In this embodiment, a portion of the securing button 70 interacts with the connector housing 20 to snap into position. **FIG. 26** depicts securing button 70 with one or more detents 70D. The geometry of detents 70D may be tailored for the features desired. As depicted, detents 70D are disposed on an outer facing portion of securing button 70 so they can interact with the sidewall shape of connector housing 20 as best shown in **FIG. 28**. Further, securing buttons 70 may be used with adhesive or the like if desired.

[0081] **FIGS. 29-32** are various views of yet another securing button concept disclosed for explanatory connectors 100. As depicted, securing buttons 70 may have

larger portion 70L and smaller portion 70S sized and shaped for the respective retention body 60 and connector housing 20. In this variation, securing buttons 70 comprise a round smaller portion 70S and a round larger portion 70L that cooperate with retention body 60 and connector housing 20. Again, securing buttons 70 extend through a wall in retention body 60, but allow optical fiber 92 to pass toward the ferrule 30. Still other variations are possible with the concepts disclosed.

[0082] For instance, the concepts for connectors disclosed herein may also be used with multifiber connectors and cable assemblies as depicted in **FIGS. 33 and 343**. By way of example, **FIG. 33** is a perspective view of a cable assembly 300 comprising a connector 100 having a multi-fiber ferrule 33 that has a plurality of fiber bores 32 for supporting a plurality of optical fibers for mating. Multifiber connector 100 has a construction that is similar to single-fiber connector 100, but is adapted to support multifiber ferrule 33. The connector housing used for a multifiber connector may have any suitable shape or construction as desired. Ferrule 33 may support any suitable fiber count in one or more rows of optical fibers or any other arrangement as desired. **FIG. 34** depicts an enlarged view of the multi-fiber ferrule 33 of connector 100. Ferrule 33 may comprise a plurality of fiber bores 32 for receiving a plurality of optical fibers 92 of cable 90. Ferrule 33 may also have one or more guide pin bores 33A for aligning the ferrule with a mating ferrule or device as known in the art.

[0083] This connector housing 20 is similar to other connector housings disclosed herein comprising at least one connector housing apertures 25 for receiving a portion of one or more securing buttons 70. The connector housing 20 also comprises rear end (21) and a front end (23) with a longitudinal passageway (22) extending from the rear end (21) to the front end (23). Multi-fiber ferrule 33 may be a MT, MTP or other suitable multi-fiber ferrule for use with the securing button concepts disclosed herein. The concepts disclosed may also be used with connectors comprising multi-ferrule designs for making multi-fiber connectors.

[0084] The concepts disclosed also enable small connector footprints. By way of example, connector 100 may have a diameter of 12 millimeters or smaller, but other sizes are possible. The small connector footprint allows relatively smaller terminals using ports with the locking features for securing connector 100. Of course the concepts disclosed may be used with any suitable connector having a threaded, bayonet, push-pull or other suitable mating structure.

[0085] Explanatory connectors 100 avoid bulky mating structures such as a coupling nut or bayonet used with conventional connectors. In other words, conventional connectors have threaded, bayonet, or push-pull connections that require finger access for connection and disconnecting. By eliminating the structures such as threaded coupling nuts or bayonets (which is a separate component that must rotate about the connector) the spacing between conventional connectors disposed in a terminal may be greatly reduced. Also eliminating the dedicated coupling nut from the conventional connectors also allows the footprint of the connectors to be smaller, and arrays of connectors to likewise be more compact.

[0086] 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 fiber optic connector (100) comprising:

a retention body (60) comprising a rear end (61) and a front end (63) with a passageway (62) from the rear end (61) to the front end (63), and at least one retention body securing portion (60SP) in the retention body (60);

a connector housing (20) comprising a rear end (21) and a front end (23) with a longitudinal passageway (22) extending from the rear end (21) to the front end (23), and at least one connector housing aperture (25) in the connector housing (20); and

one or more securing buttons (70), wherein the one or more securing buttons (70) are sized to fit into the at least one connector housing aperture (25) and the at least one retention body securing portion (60SP) for securing a portion of the retention body (60) within the connector housing (20) when assembled.

2. The fiber optic connector of claim 1, wherein the at least one retention body securing portion in the retention body (60) may be aligned with the at least one connector housing aperture when a portion of the retention body is inserted into an opening at the rear end (21) of the connector housing (20) so that the one or more securing buttons (70) may be inserted into the at least one retention body securing portion (60SP) and the at least one connector housing aperture (25).

3. A fiber optic connector (100) comprising:

a retention body (60) comprising a rear end (61) and a front end (63) with a passageway (62) from the rear end (61) to the front end (63), and at least one retention body securing portion (60SP) in the retention body (60);

a connector housing (20) comprising a rear end (21) and a front end (23) with a longitudinal passageway (22) extending from the rear end (21) to the front end (23), and at least one connector housing aperture (25) in the connector housing (20), wherein the at least one connector housing aperture (25); and

one or more securing buttons (70), wherein the one or more securing buttons (70) are sized to fit into the at least one connector housing aperture (25) and the at least one retention body securing portion (60SP) for securing a portion of the

retention body (60) within the connector housing (20) when assembled, wherein the at least one retention body securing portion in the retention body (60) may be aligned with the at least one connector housing aperture when a portion of the retention body is inserted into an opening at the rear end (21) of the connector housing (20) so that the one or more securing buttons (70) may be inserted into the at least one retention body securing portion (60SP) and the at least one connector housing aperture (25).

4. The fiber optic connector of any one of claims 1-3, wherein the at least one retention body securing portion (60SP) comprises a first retention body securing portion and a second retention body securing portion disposed on opposing portions of the retention body (60), and the at least one connector housing aperture (25) comprises a first connector housing aperture and a second connector housing aperture disposed on opposing portions of the connector housing (20).

5. The fiber optic connector of claim 4, wherein the first retention body securing portion and the second retention body securing portion are disposed about 180 degrees apart.

6. The fiber optic connector of claim 5, wherein the first connector housing aperture and the second connector housing aperture are disposed about 180 degrees apart.

7. The fiber optic connector of any one of claims 1-6, wherein the one or more securing buttons (70) comprises a larger portion (70L) and a smaller portion (70S) with the larger portion (70L) sized for the at least one connector housing aperture (25) and the smaller portion (70S) sized for the at least one retention body securing portion (60SP).

8. A fiber optic connector (100) comprising:

a retention body (60) comprising a rear end (61) and a front end (63) with a passageway (62) from the rear end (61) to the front end (63), and at least one retention body securing portion (60SP) in the retention body (60);

a connector housing (20) comprising a rear end (21) and a front end (23) with a longitudinal passageway (22) extending from the rear end (21) to the front end

(23), and at least one connector housing aperture (25) in the connector housing (20); and

one or more securing buttons (70), wherein the one or more securing buttons (70) are sized to fit into the at least one connector housing aperture (25) and the at least one retention body securing portion (60SP) for securing a portion of the retention body (60) within the connector housing (20) when assembled, wherein the one or more securing buttons (70) comprises a larger portion (70L) and a smaller portion (70S) with the larger portion (70L) sized for the at least one connector housing aperture (25) and the smaller portion (70S) sized for the at least one retention body securing portion (60SP).

9. The fiber optic connector of claim 8, wherein the at least one retention body securing portion (60SP) in the retention body (60) may be aligned with the at least one connector housing aperture (25) when a portion of the at least one retention body (60) is inserted into an opening at the rear end (21) of the connector housing (20) so that the one or more securing buttons (70) may be inserted into the at least one retention body securing portion (60SP) and at least one connector housing aperture (25).

10. The fiber optic connector of any one of claims 1-9, wherein the one or more securing buttons (70) comprises a snap-feature.

11. The fiber optic connector of any one of claims 1-10, wherein the retention body (60) comprises a front portion (60F) forward of the at least one retention body securing portion (60SP) and a medial portion (60M) with medial cross-section greater than a cross-section of the forward portion (60F), wherein the at least one retention body securing portion (60SP) is disposed in the medial portion (60M).

12. The fiber optic connector of any one of claims 1-11, wherein the one or more securing buttons (70) comprises a first securing button connected to a second securing button.

13. The fiber optic connector of any one of claims 1-12, further comprising a crimp band (45) or the retention body securing portion (60SP) comprising an aperture.

14. The fiber optic connector of any one of claims 1-13, wherein the connector housing (20), wherein a part of the rear portion (RP) of the housing (20) comprises a round cross-section (RCS) and a part of the front portion (FP) of the housing (20) comprises a non-round cross-section (NRCS) with a transition region (TR) disposed between the rear portion (RP) and the front portion (FP), wherein the transition region (TR) comprises an asymmetric portion (AT).

15. The fiber optic connector of claim 14, wherein the connector housing (20) comprises a locking feature (20L) integrally formed in the rear portion (RP) of the housing (20) for retaining the fiber optic connector in a complimentary device.

16. The fiber optic connector of claim 15, wherein the locking feature (20L) comprises a ramp with a ledge.

17. The fiber optic connector of any one of claims 14-16, the connector housing further comprising a female key (20FK) that extends into a portion of the transition region (TR).

18. The fiber optic connector of claim 14, the connector housing (20) further comprising a locking feature (20L) integrally formed in the rear portion (RP) of the housing (20), and a female key (20FK) that extends into a portion of the transition region (TR), wherein the locking feature (20L) is disposed about 180 degrees apart from the female key (20FK).

19. The fiber optic connector of any one of claims 1-18, further comprising a ferrule (30) having one or more fiber bores (32).

20. The fiber optic connector of claim 19, further comprising a ferrule holder (49).

21. The fiber optic connector of claim 20, wherein the housing (20) further comprises one or more latch arms (20LA) for securing the ferrule holder (49).

22. The fiber optic connector of claims 20 or 21, further comprising a resilient member (50) for biasing the ferrule holder (49) to a forward position.

23. The fiber optic connector of any one of claims 1-22, wherein the retention body securing portion comprises a slot, a groove, a pocket, or an aperture for cooperating with the one or more securing buttons.

24. The fiber optic connector of any one of claims 1-22, wherein the retention body securing portion comprises a slot.

25. The fiber optic connector of any one of claims 1-24, wherein the at least one securing button (70) is sized for an interference fit with the at least one connector housing aperture (25) or the at least one retention body securing portion (60SP).

26. The fiber optic connector of any one of claims 1-25, wherein the interface between the connector housing (20) and the retention body (60) comprises one or more clocking features for rotational alignment.

27. The fiber optic connector of any one of claims 1-26, wherein the at least one connector housing aperture (25) is disposed in a rear portion (RP) of the connector housing (20).

28. The fiber optic connector of any one of claims 1-27, wherein the fiber optic connector (100) is a portion of a cable assembly (300) comprising a fiber optic cable (90).

29. The fiber optic connector of claim 27, wherein the fiber optic cable (90) is secured to the retention body (60) with an adhesive, epoxy, or glue.

30. The fiber optic connector of any one of claims 28 or 29, wherein the fiber optic cable (90) comprises one or more tensile yarns (94) that are secured to the retention body (60).

31. The fiber optic connector of any one of claims 28-30, wherein the fiber optic cable (90) comprises a round cross-section or a non-round cross-section.

32. The fiber optic connector of any one of claims 1-31, further comprising one or more heat shrinks (99).

33. The fiber optic connector of any one of claims 1-32, further comprising a boot support.

34. A fiber optic cable assembly (300) comprising:

a fiber optic cable (90) having an optical fiber (92) and a fiber optic connector (100), wherein the fiber optic connector (100) comprises:

a retention body (60) comprising a rear end (61) and a front end (63) with a passageway (62) from the rear end (61) to the front end (63), and at least one retention body securing portion (60SP) in the retention body (60);

a connector housing (20) comprising a rear end (21) and a front end (23) with a longitudinal passageway (22) extending from the rear end (21) to the front end (23), and at least one connector housing aperture (25) in the connector housing (20); and

one or more securing buttons (70), wherein the one or more securing buttons (70) are sized to fit into the at least one connector housing aperture (25) and the at least one retention body securing portion (60SP) for securing a portion of the retention body (60) within the connector housing (20).

35. The fiber optic cable assembly of claim 34, wherein the at least one retention body aperture in the retention body (60) is aligned with the at least one connector housing aperture when a portion of the at least one retention body is inserted into an opening at the rear end (21) of the connector housing (20) and the one or more securing buttons (70) are disposed in the at least one retention body securing portion (60SP) and at least one connector housing aperture (25).

36. The fiber optic connector of claim 34 or 35, wherein the fiber optic cable (90) is secured to the retention body (60) with an adhesive, epoxy, or glue.

37. The fiber optic cable assembly of claim 34 or 35, the fiber optic cable (90) further comprising one or more strength members (94) secured to the retention body (60).

38. The fiber optic cable assembly of claim 34, wherein the one or more strength members (94) are secured to the retention body (60) with a crimp band (45).

39. The fiber optic cable assembly of claim 34, further comprising the one or more strength members (94) being folded over a front portion of the retention body (60).

40. The fiber optic cable assembly of any one of claims 34-39, further comprising a rear portion of the retention body (60) being crimped to the fiber optic cable (90).

41. The fiber optic cable assembly of any one of claims 34-40, wherein the at least one retention body securing portion (60SP) comprises a first retention body aperture and a second retention body aperture disposed on opposing portions of the retention body (60), and the at least one connector housing aperture (25) comprises a first connector housing aperture and a second connector housing aperture disposed on opposing portions of the connector housing (20).

42. The fiber optic cable assembly of claim 41, wherein the first retention body securing portion and the second retention body securing portion are disposed about 180 degrees apart.

43. The fiber optic cable assembly of claims 41 or 42, wherein the first connector housing aperture and the second connector housing aperture are disposed about 180 degrees apart.

44. The fiber optic cable assembly of any one of claims 34-43, wherein the one or more securing buttons (70) comprises a larger portion (70L) and a smaller portion (70S) with the larger portion (70L) sized for the at least one connector housing aperture (25) and the smaller portion (70S) sized for the at least one retention body securing portion (60SP).

45. The fiber optic cable assembly of any one of claims 34-44, wherein the at least one connector housing aperture (25) is disposed in a rear portion (RP) of the connector housing (20).

46. The fiber optic cable assembly of any one of claims 34-45, wherein the at least one retention body securing portion (60SP) in the retention body (60) may be aligned with the at least one connector housing aperture (25) when a portion of the at least one retention body is inserted into an opening at the rear end (21) of the connector housing (20) so that the one or more securing buttons (70) comprises an interference fit with the at least one retention body securing portion (60SP) or the at least one connector housing aperture (25).

47. The fiber optic cable assembly of any one of claims 34-46, wherein the retention body securing portion comprises a slot, a groove, a pocket, or an aperture for cooperating with the one or more securing buttons.

48. The fiber optic cable assembly of any one of claims 34-46, wherein the retention body securing portion comprises a slot.

49. The fiber optic cable assembly of any one of claims 34-48, wherein the interface between the connector housing (20) and the retention body (60) comprises one or more clocking features for rotational alignment.

50. The fiber optic cable assembly of any one of claims 34-49, wherein the retention body (60) comprises a front portion (60F) forward of the at least one retention body securing portion (60SP) and a medial portion (60M) with medial cross-section greater than a cross-section of the forward portion (60F), wherein the at least one retention body securing portion (60SP) is disposed in the medial portion (60M).

51. The fiber optic cable assembly of any one of claims 34-50, wherein the one or more securing buttons (70) comprises a first securing button connected to a second securing button with a connecting arm (78).

52. The fiber optic cable assembly of any one of claims 34-51, wherein the connector housing (20), wherein a part of the rear portion (RP) of the housing (20) comprises a round cross-section (RCS) and a part of the front portion (FP) of the housing (20) comprises a non-round cross-section (NRCS) with a transition region (TR) disposed between the rear portion (RP) and the front portion (FP), wherein the transition region (TR) comprises an asymmetric portion (AT).

53. The fiber optic cable assembly of claim 52, wherein the connector housing (20) comprises a locking feature (20L) integrally formed in the rear portion (RP) of the housing (20) for retaining the fiber optic connector in a complimentary device.

54. The fiber optic cable assembly of claim 53, wherein the locking feature (20L) comprises a ramp with a ledge.

55. The fiber optic cable assembly of any one of claims 52-54, further comprising a female key (20FK) that extends into a portion of the transition region (TR).

56. The fiber optic cable assembly of claim 55, the connector housing (20) further comprising a locking feature (20L) integrally formed in the rear portion (RP) of the housing (20), and a female key (20FK) that extends into a portion of the transition region (TR), wherein the locking feature (20L) is disposed about 180 degrees apart from the female key (20FK).

57. The fiber optic cable assembly of any one of claims 34-56, further comprising a ferrule (30) having one or more fiber bores (32).

58. The fiber optic cable assembly of claim 57, further comprising a ferrule holder (49).

59. The fiber optic cable assembly of claim 58, wherein the housing (20) further comprises one or more latch arms (20LA) for securing the ferrule holder (49).

60. The fiber optic cable assembly of claims 58 or 59, further comprising a resilient member (50) for biasing the ferrule holder (49) to a forward position.

61. The fiber optic cable assembly of any one of claims 34-60, wherein the fiber optic cable (90) comprises a round cross-section or a non-round cross-section.

62. The fiber optic cable assembly of any one of claims 34-61, further comprising one or more heat shrinks (99).

63. The fiber optic cable assembly of any one of claims 34-62, further comprising a boot support.

64. A method of making a fiber optic cable assembly (300) comprising:

inserting a fiber optic cable (90) having an optical fiber (92) into a passageway (62) of a retention body (60) comprising at least one retention body securing portion (60SP) in the retention body (60);

securing the fiber optic cable (90) to the retention body (60);

inserting a portion of the retention body (60) into a connector housing (20) comprising a longitudinal passageway (22) extending from a rear end (21) to a front end (23), and at least one connector housing aperture (25) so that the at least one connector housing aperture (25) is aligned with the at least one retention body securing portion (60SP) of the retention body (60); and

inserting one or more securing buttons (70) into the at least one connector housing aperture (25) and the at least one retention body securing portion (60SP) for securing a portion of the retention body (60) within the connector housing (20).

65. The method of claim 64, further comprising securing the retention body (60) to the fiber optic cable (90) using an adhesive, epoxy, or glue.

66. The method of claim 64, further comprising securing the retention body (60) to the fiber optic cable (90) using a crimp band (45).

67. The method of any one of claims 64-66, wherein the connector housing (20) further comprises a locking feature (20L) integrally formed in the rear portion

(RP) of the housing (20) for retaining the fiber optic connector in a complimentary device.

68. The method of claim 67, wherein the locking feature (20L) comprises a ramp with a ledge.

69. The method of any one of claims 64-68, the connector housing further comprising a female key (20FK) that extends into a portion of a transition region (TR).

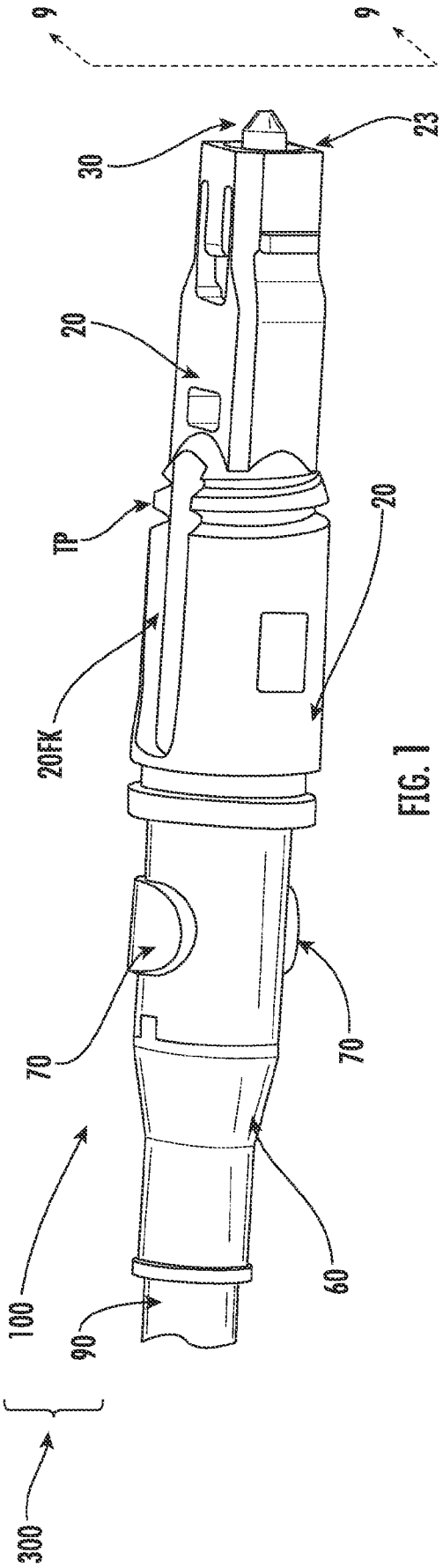

9
9
30
23
20
TP
20
20FK
70
70
100
90
60
300

FIG. 1

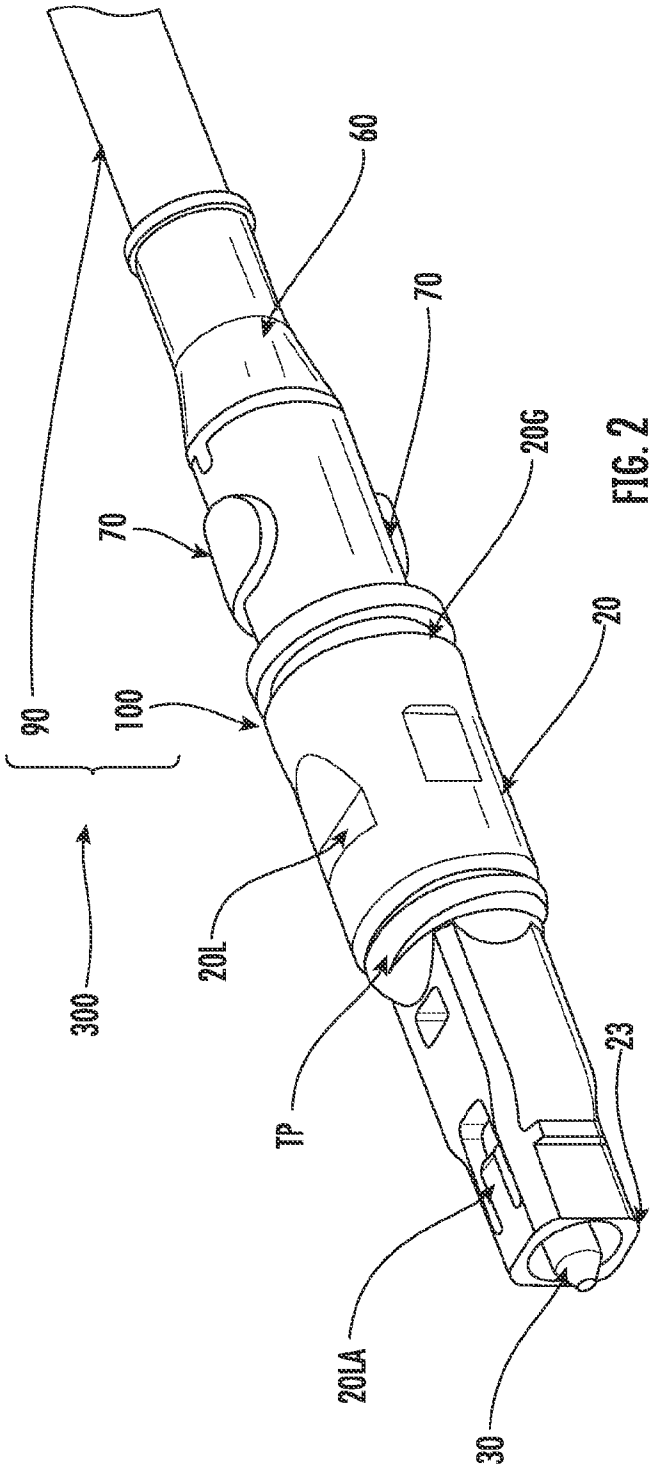

60
70
70
20G
20
90
100
300
20L
TP
23
20LA
30

FIG. 2

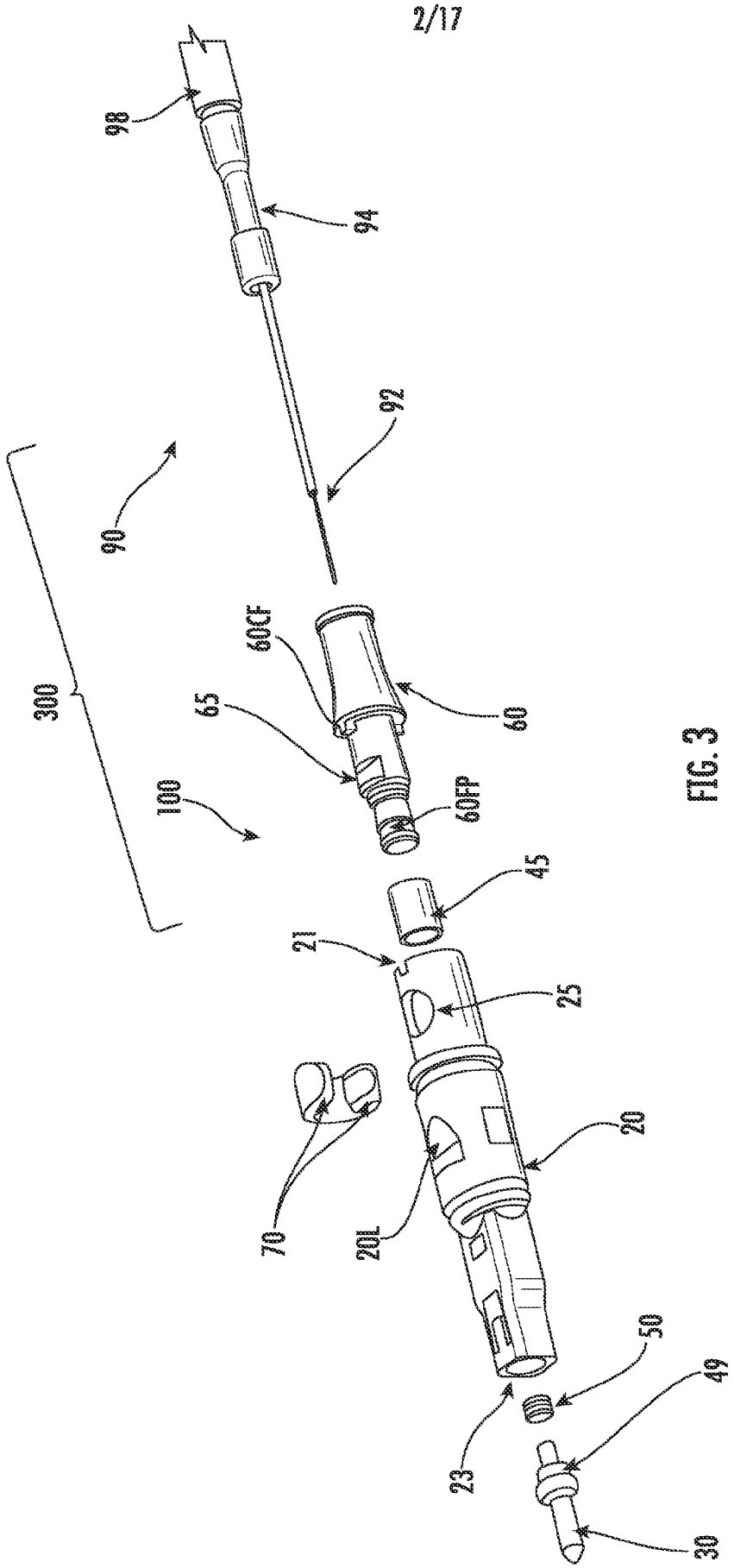
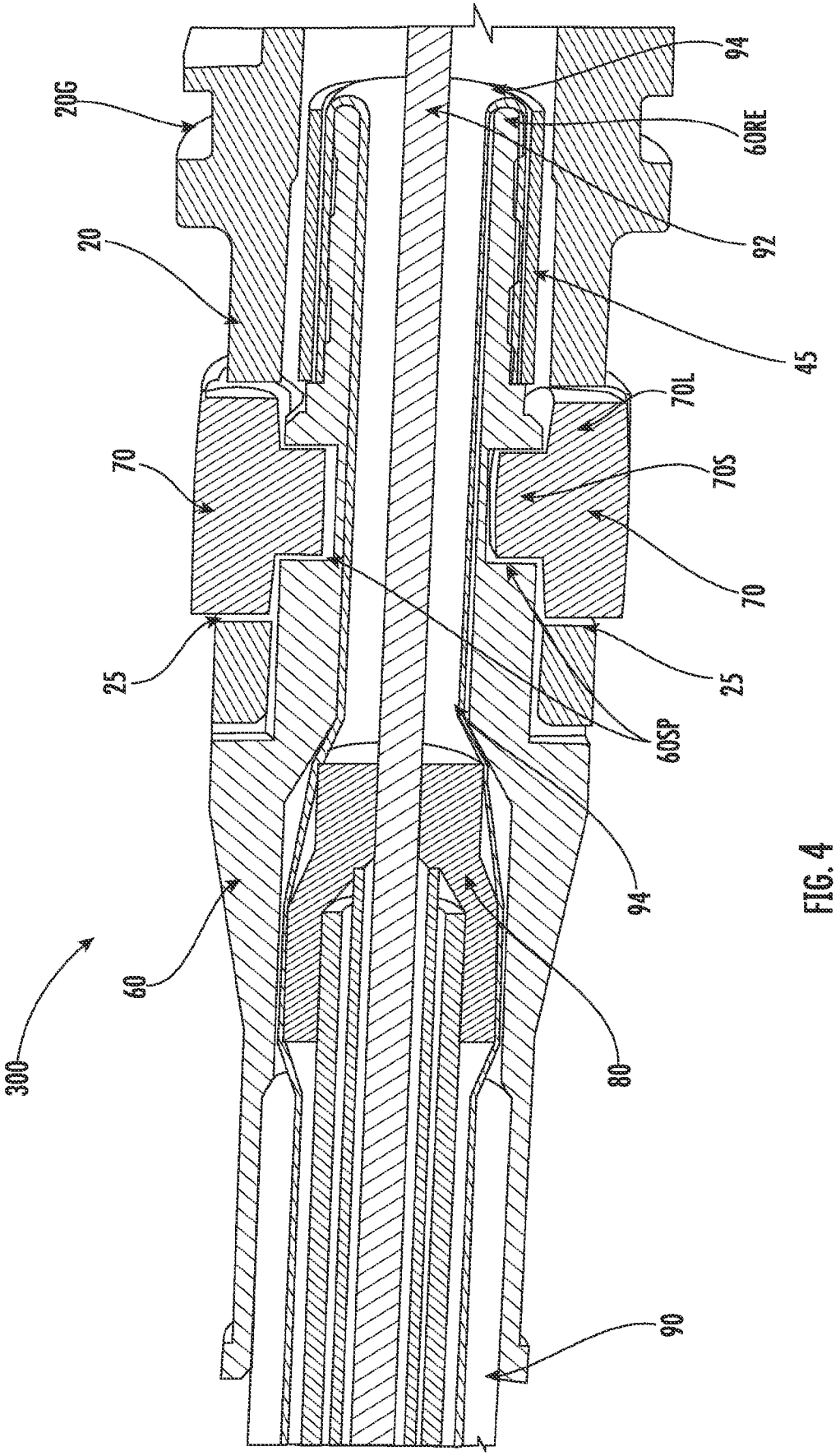


FIG. 3



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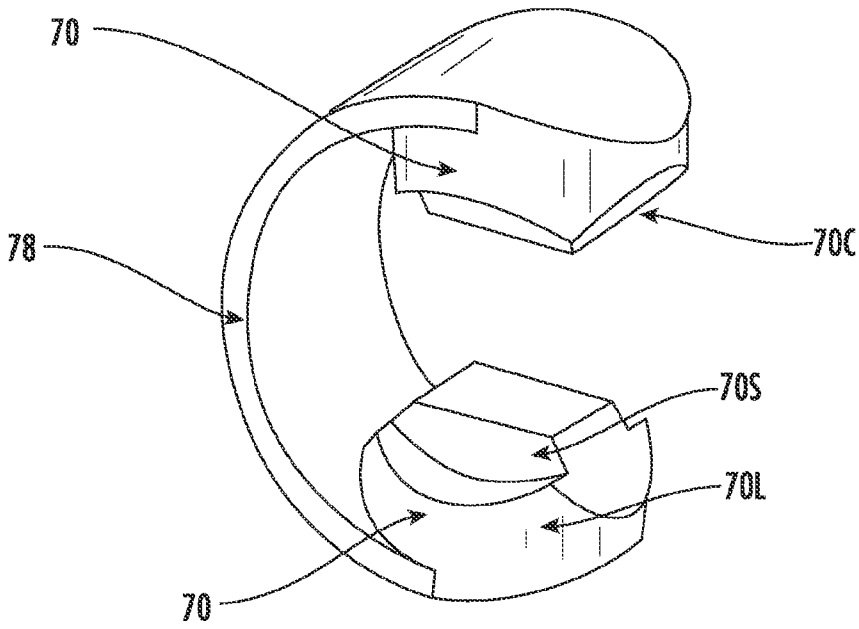
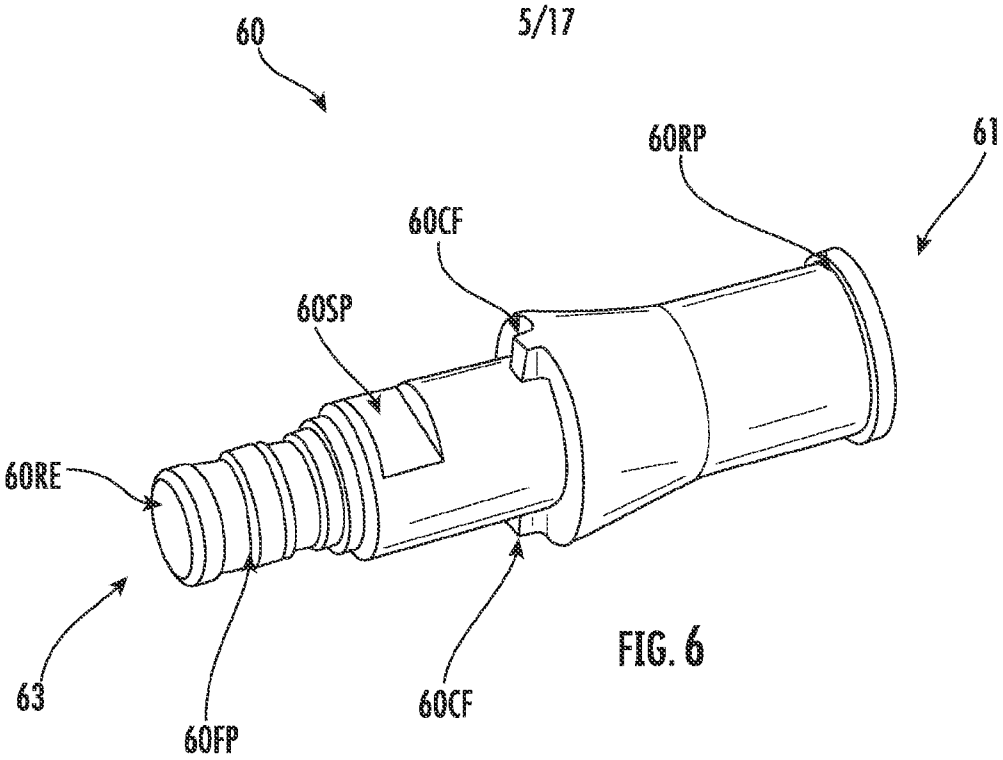


FIG. 5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60RP
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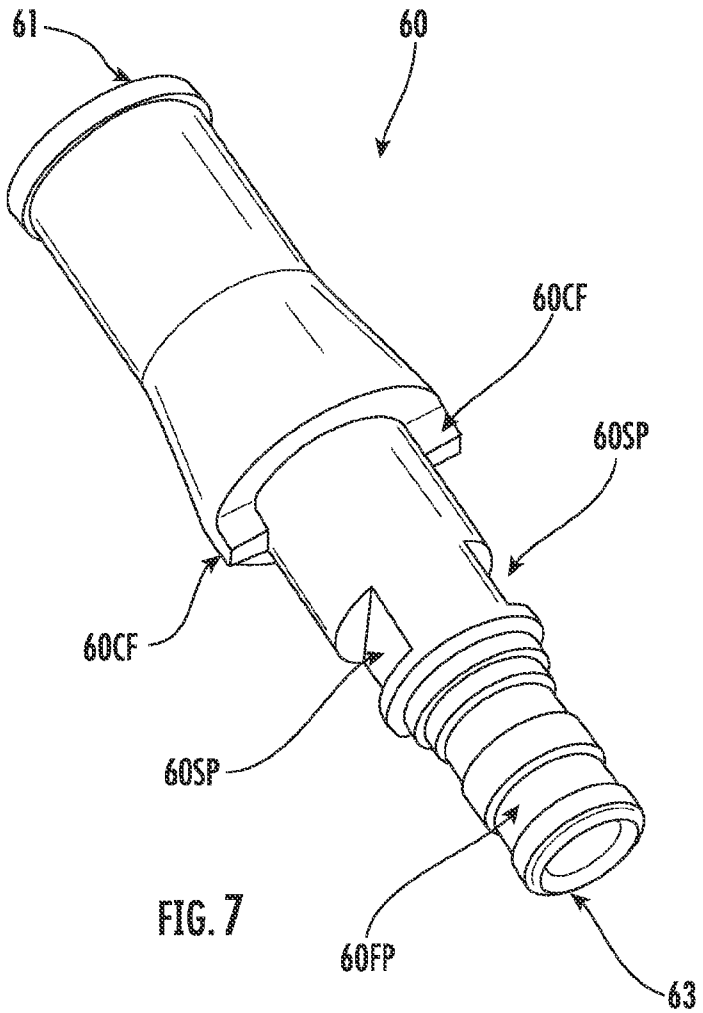
60RE
63
60FP
60CF

FIG. 6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60
60CF
60SP
60CF
60SP
60FP
63

FIG. 7

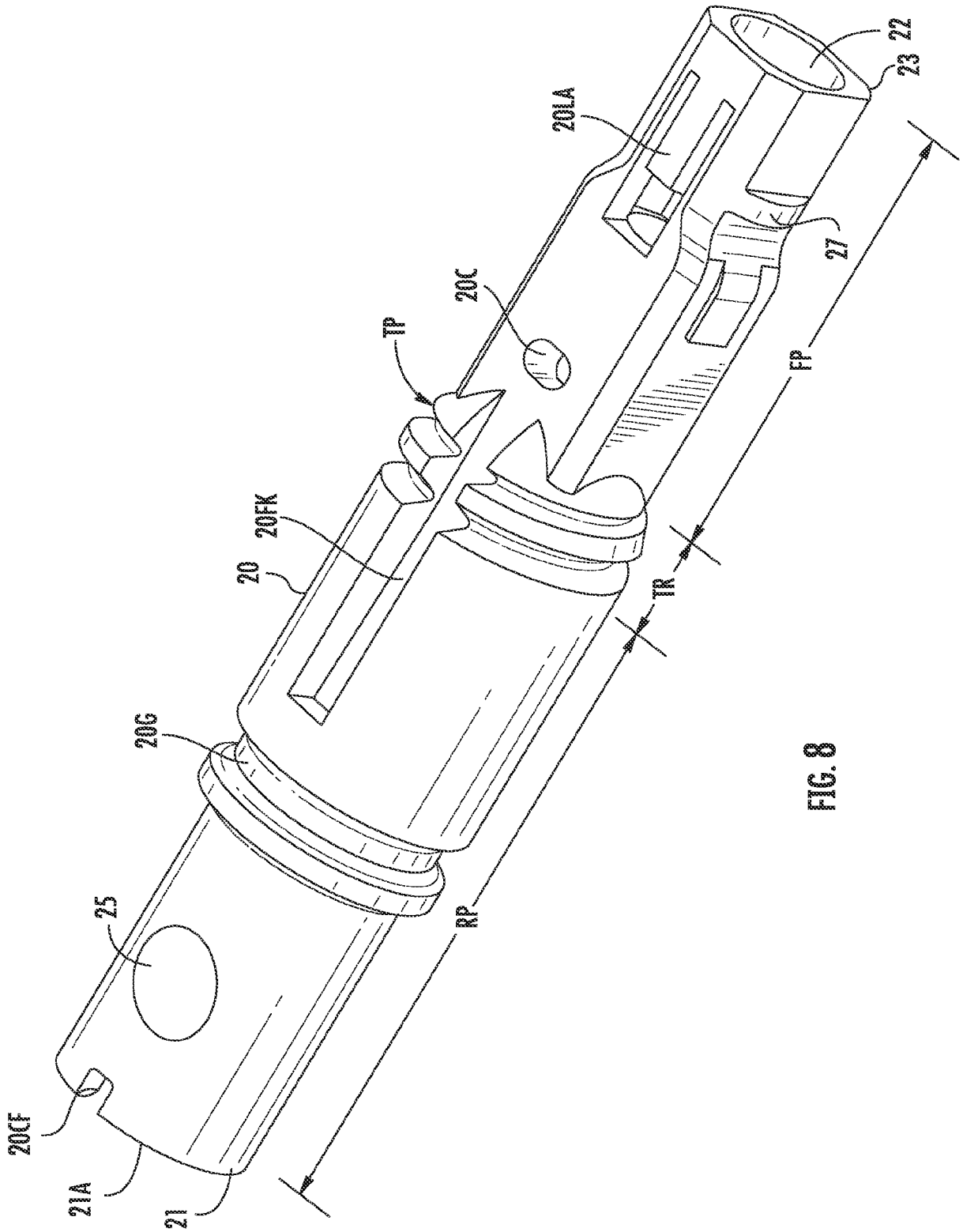
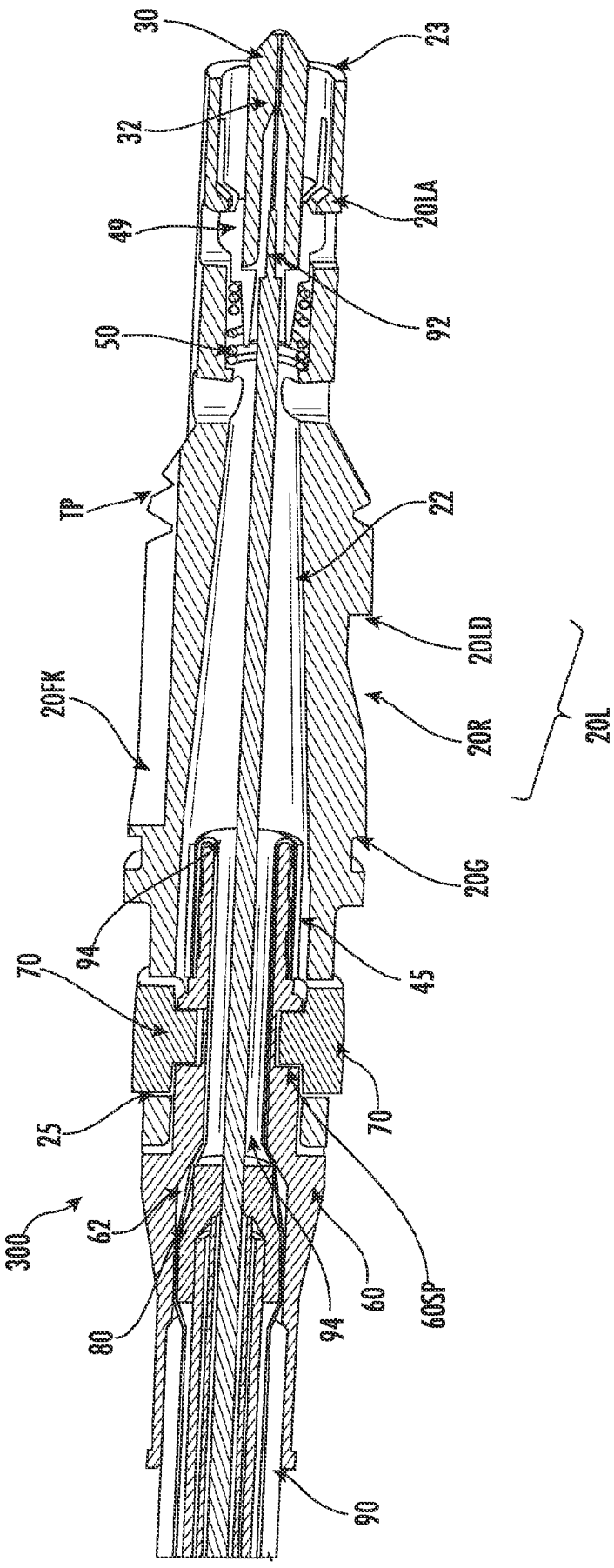


FIG. 8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60
60SP
80
94
90

FIG. 9

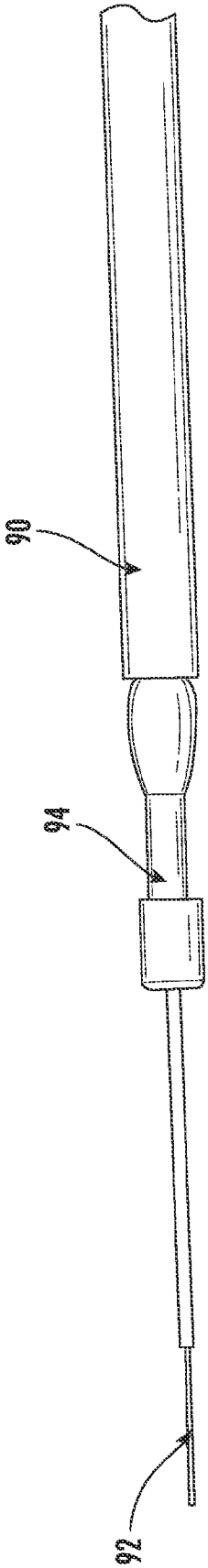
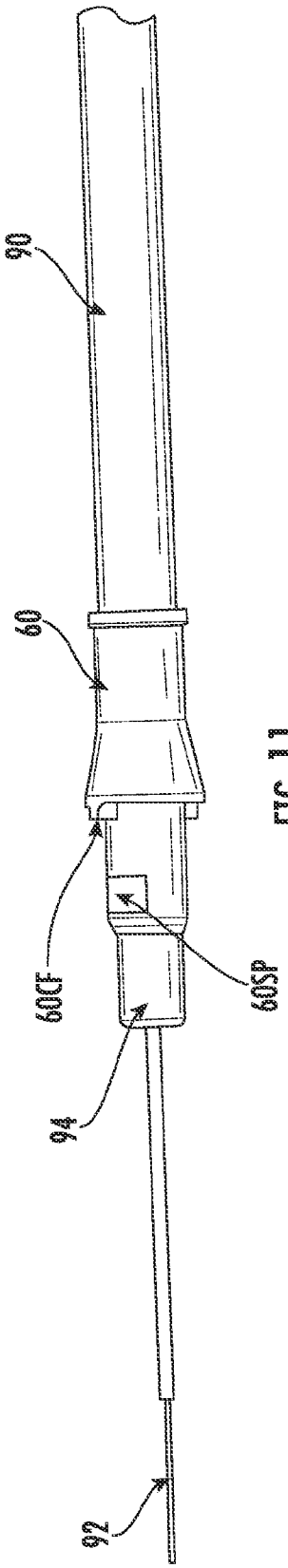


FIG. 10



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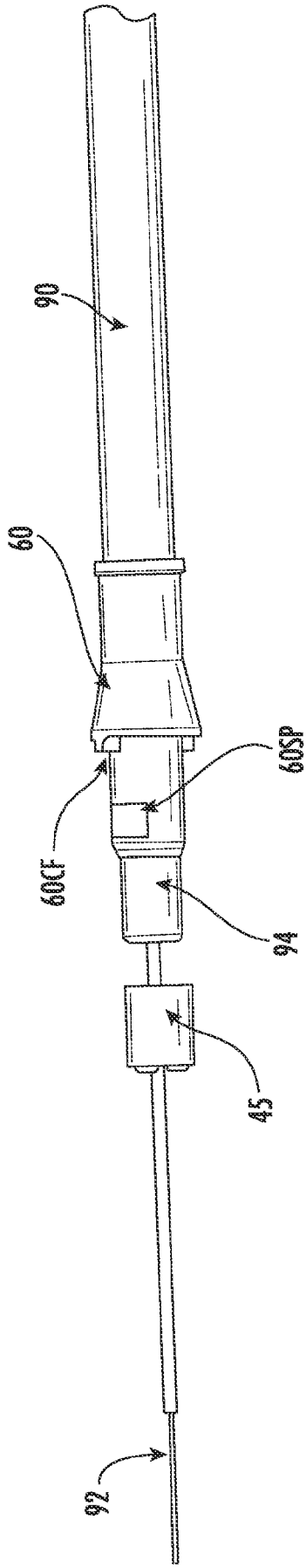

FIG. 12

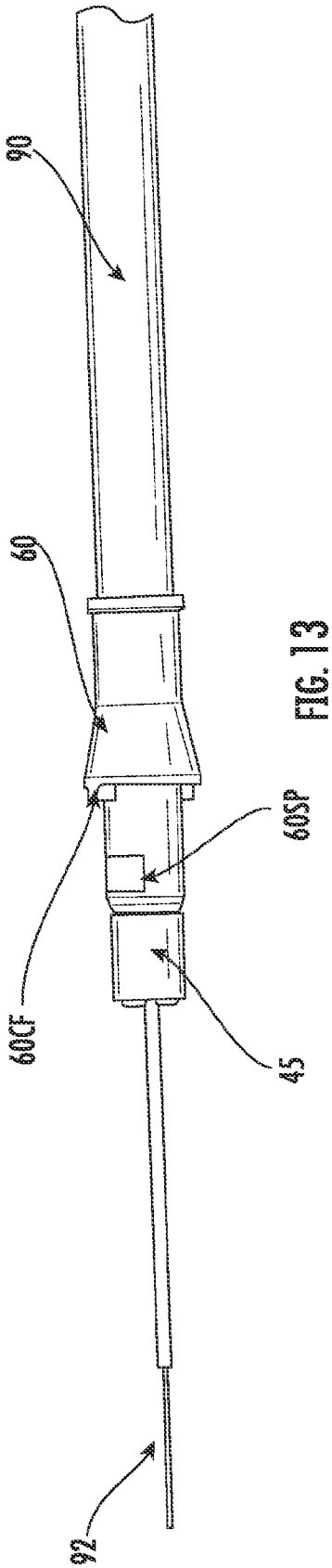

FIG. 13

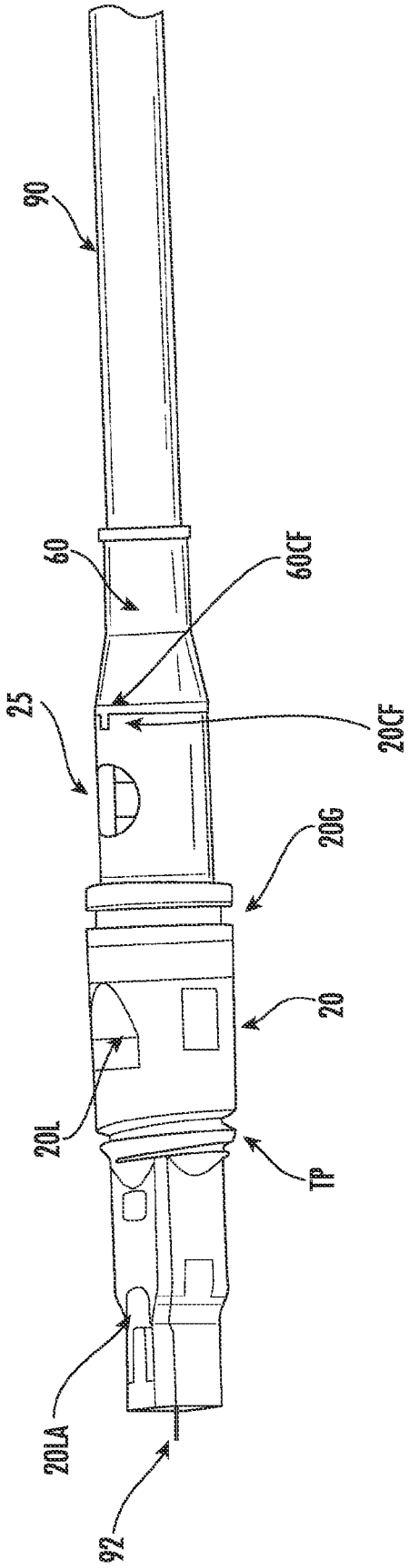

FIG. 14

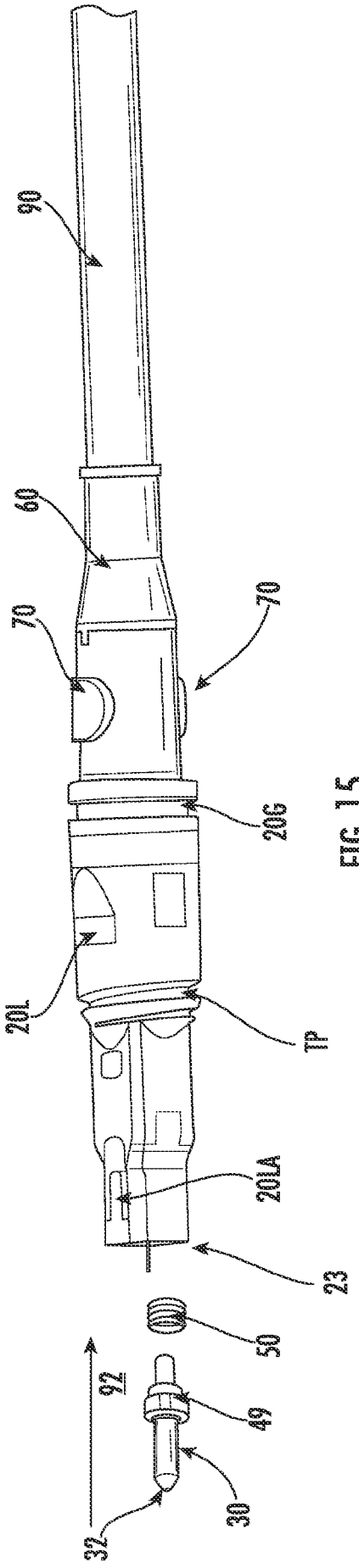
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FIG. 15

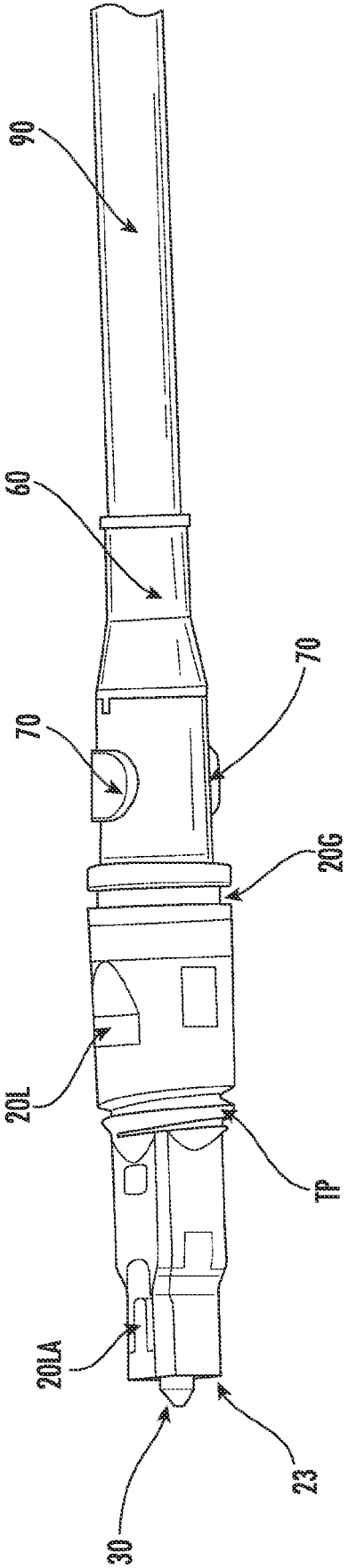
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FIG. 16

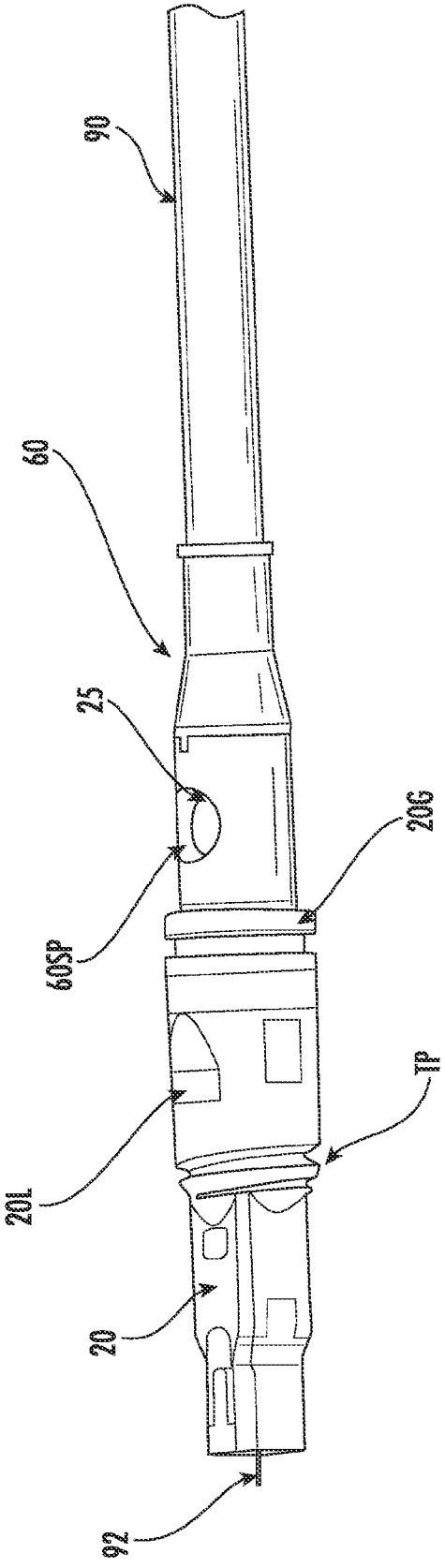

FIG. 17

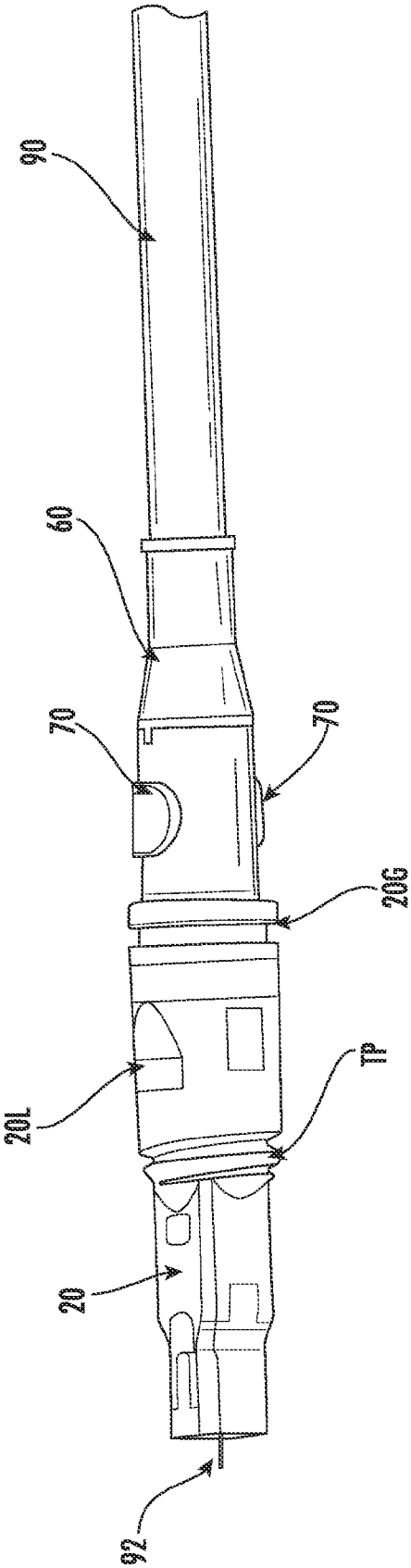

FIG. 18

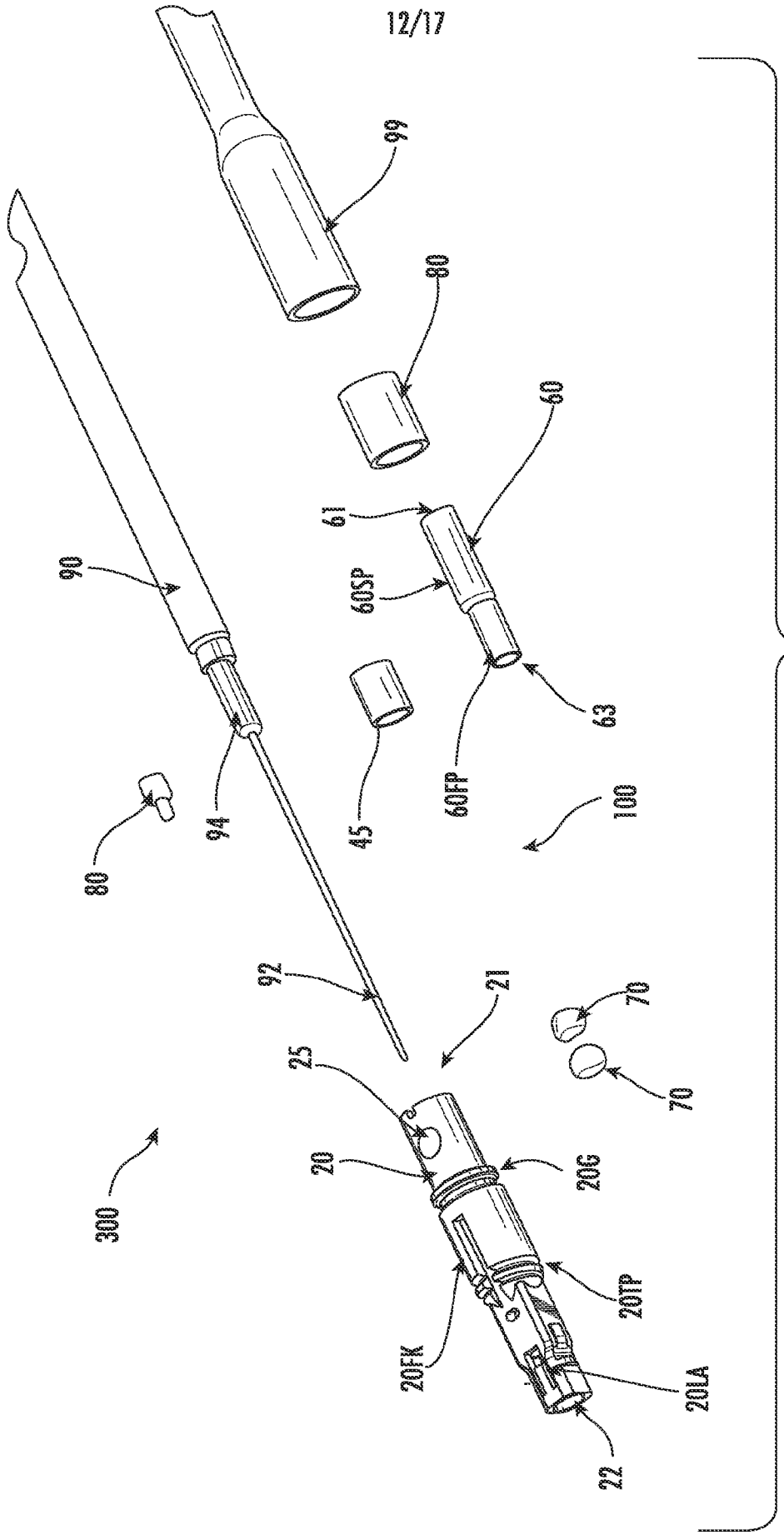
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FIG. 19

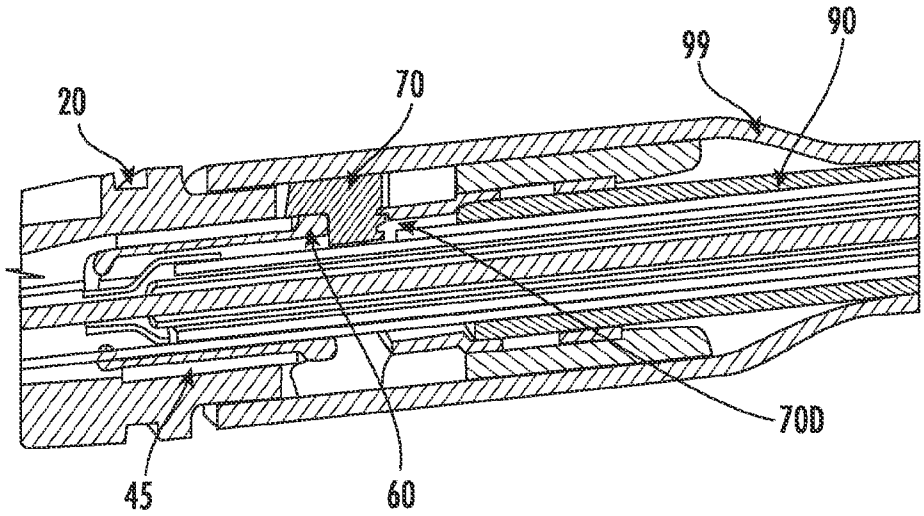


FIG. 20

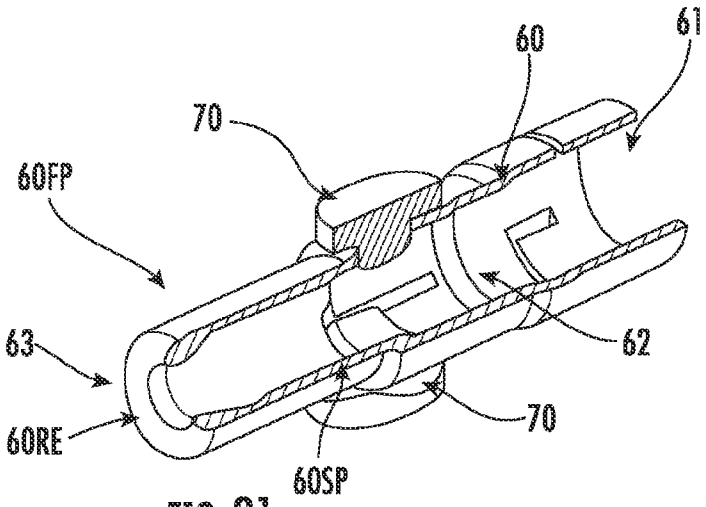


FIG. 21

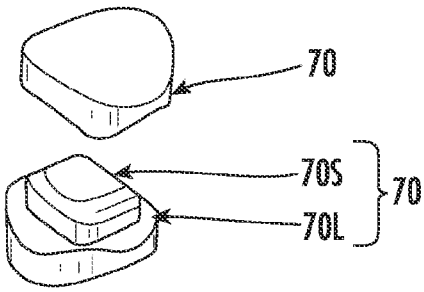


FIG. 22

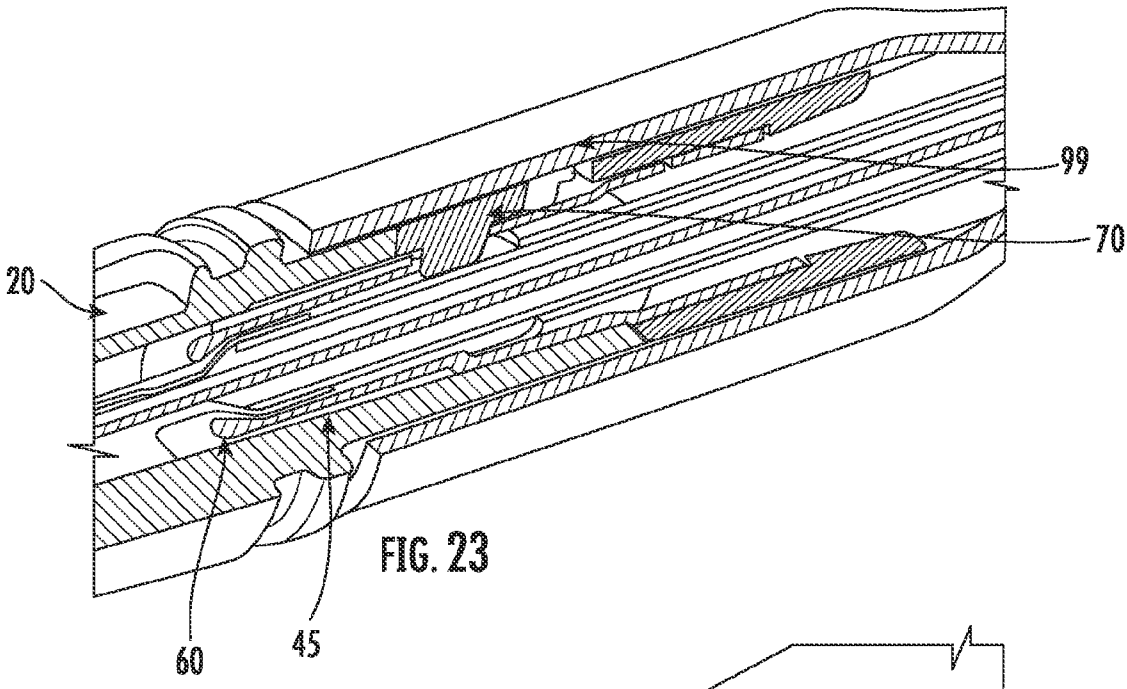


FIG. 23

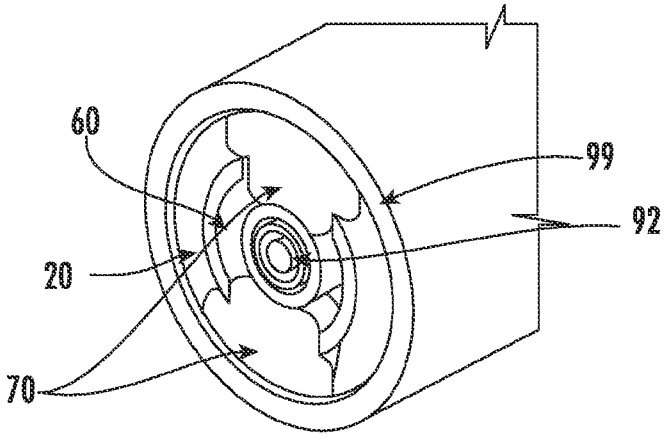


FIG. 24

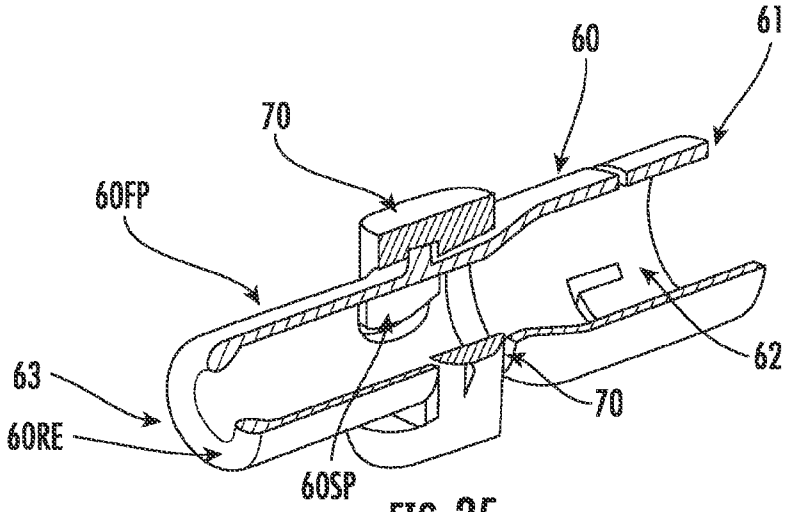


FIG. 25

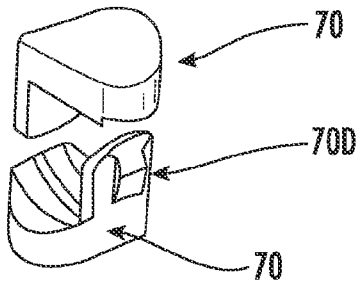


FIG. 26

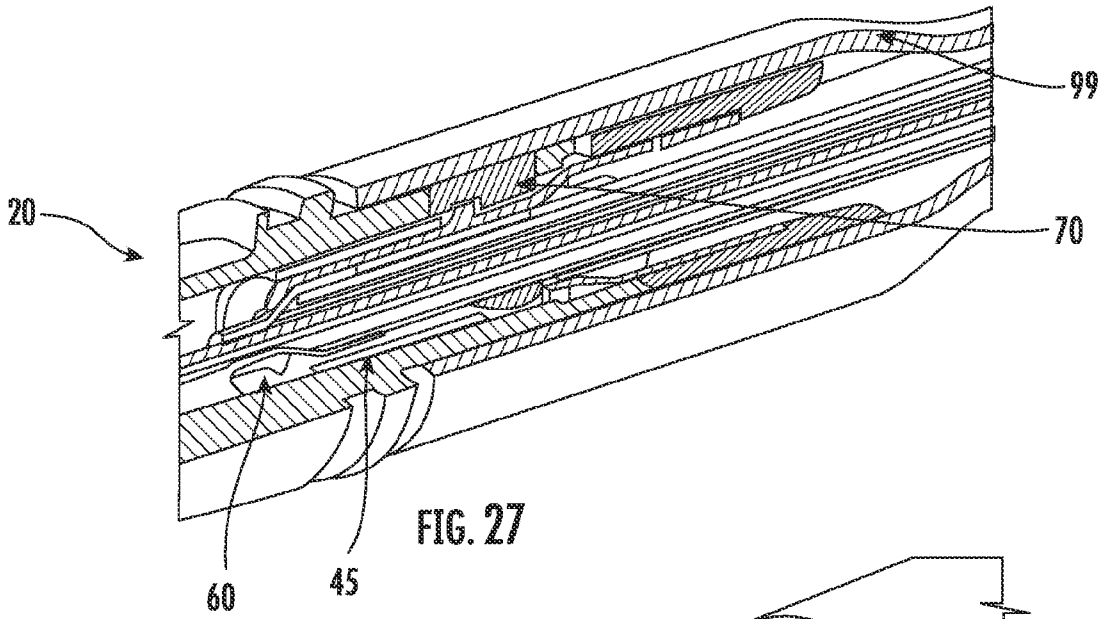


FIG. 27

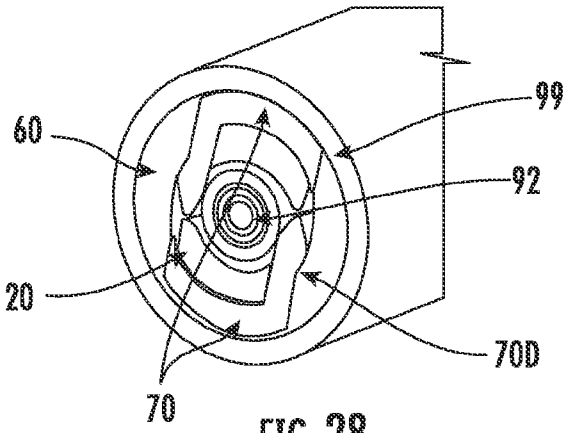


FIG. 28

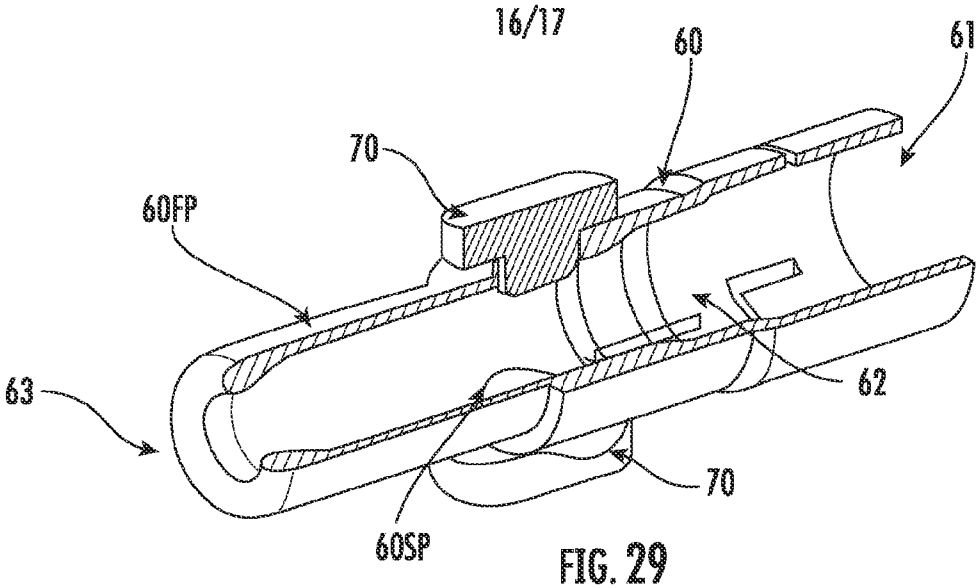


FIG. 29

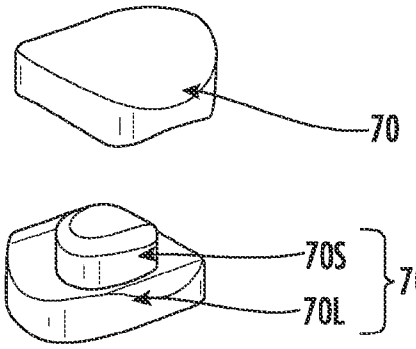


FIG. 30

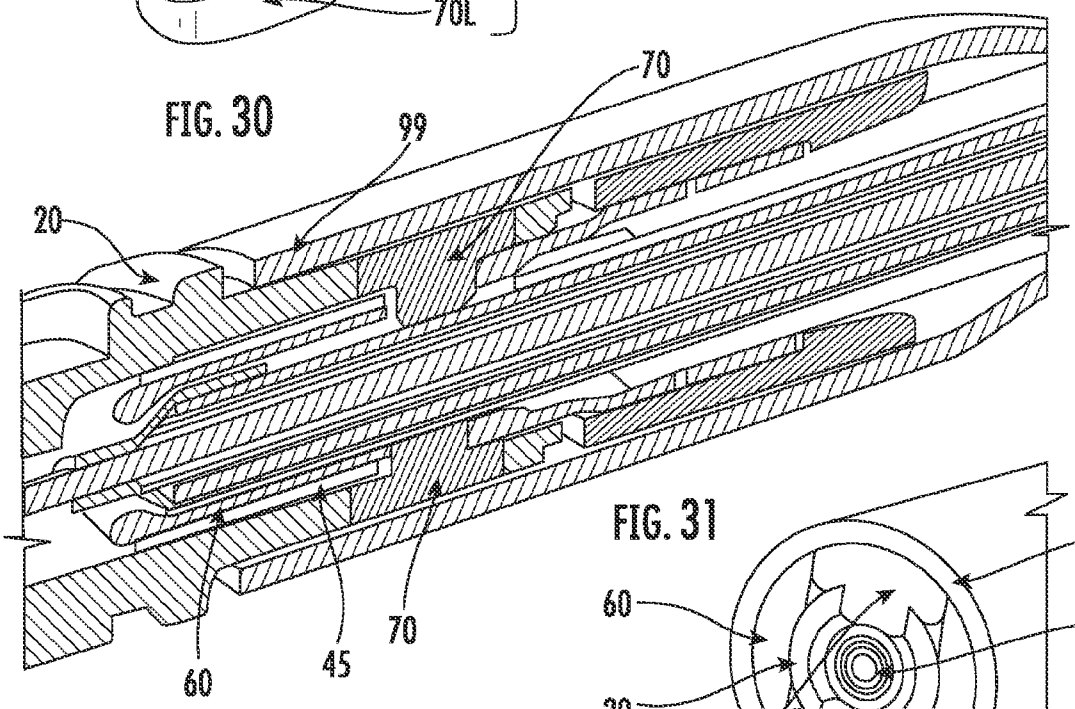
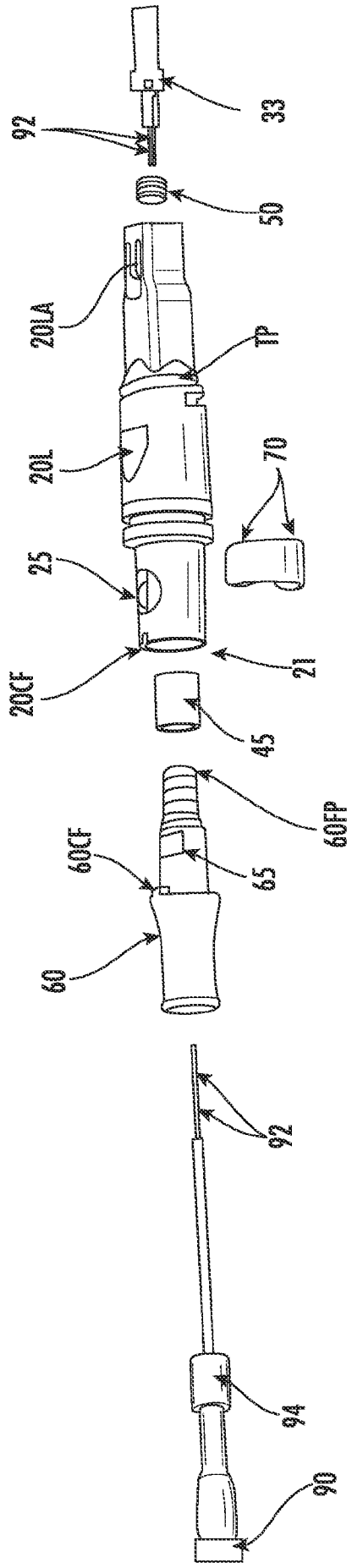


FIG. 31

FIG. 32


92
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60FP
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FIG. 33

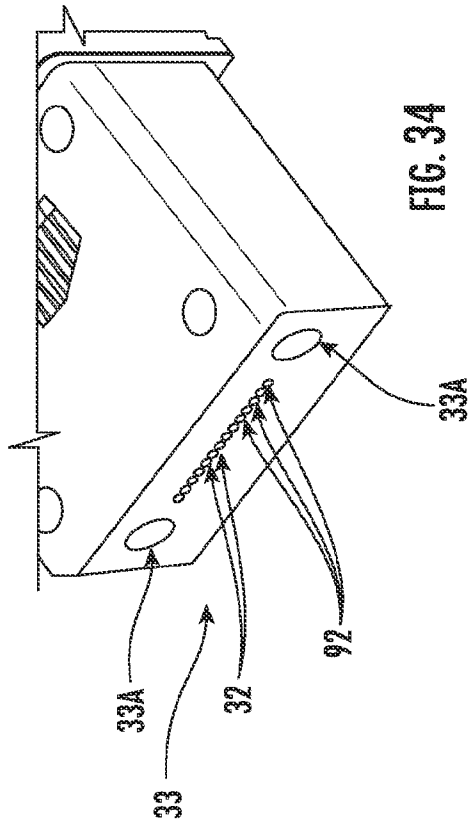
33A
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FIG. 34

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2021/032904

A. CLASSIFICATION OF SUBJECT MATTER
INV. G02B6/38
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	CN 110 954 996 A (AVIC JONHON OPTRONIC TECH CO LTD) 3 April 2020 (2020-04-03) paragraphs [0051] - [0056] figures 1-7	1-69
X	US 2004/052474 A1 (LAMPERT NORMAN R [US] ET AL) 18 March 2004 (2004-03-18) paragraphs [0036] - [0037] figures 5-11	1-69
A	US 2020/124805 A1 (ROSSON JOEL CHRISTOPHER [US] ET AL) 23 April 2020 (2020-04-23) figure 2	1-69

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

☒ See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 August 2021	25/08/2021

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

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2021/032904

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 110954996 A	03-04-2020	NONE	
US 2004052474 A1	18-03-2004	NONE	
US 2020124805 A1	23-04-2020	NONE	