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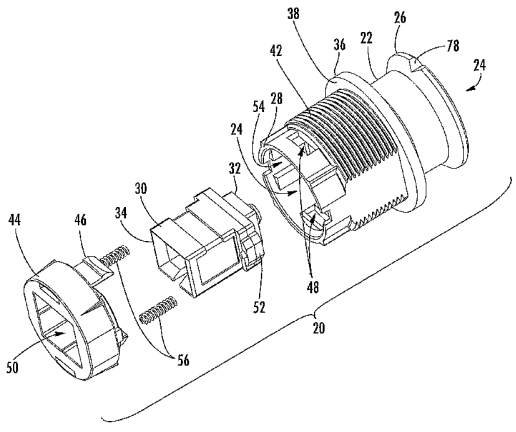
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(54) **Title:** ONE-PIECE FIBER OPTIC RECEPTACLE



(57) **Abstract:** A one-piece fiber optic receptacle (20) is provided for aligning and optically connecting a plug ferrule with a back-side ferrule of like configuration. The fiber optic receptacle (20) includes a receptacle housing (22) defining an internal cavity (24) opening through an external end (26) and an opposed internal end (28), an alignment sleeve (30) disposed within the internal cavity (24) and received within the internal end (28) of the receptacle housing (22), and a sleeve retainer (44) removably secured to the internal end (28) of the receptacle housing (22) and operable for providing access to the alignment sleeve (30) from the internal end (28) of the receptacle housing (22). The fiber optic receptacle further includes biasing member supports (52) that facilitate loading and ensure alignment of at least one biasing member (56) during assembly and use. Tapered posts (64, 62) may be provided on at least one of the alignment sleeve (30) and the sleeve retainer (44) for retaining and guiding the at least one biasing member (56) during assembly and use.

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ONE-PIECE FIBER OPTIC RECEPTACLE

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates generally to a fiber optic receptacle for interconnecting optical fibers within a communications network, and more specifically, to a fiber optic receptacle that provides improvements in freeze/thaw cycle performance, sealing and connector alignment.

2. Description of the Related Art

[0002] Fiber optic networks are currently revolutionizing the telecommunications industry due to their high bandwidth carrying capacity, low signal degradation and low power usage. As a result, fiber optic networks are being created and expanded to deliver "fiber-to-the-curb" (FTTC), "fiber-to-the-business" (FTTB), "fiber-to-the-home" (FTTH), "fiber-to-the-premises" (FTTP) and "fiber-to-the-subscriber" (FTTS), referred to generically as "FTTx." In order to provide services to one of these subscriber locations, fiber optic networks must include a large number of interconnection points in which optical fibers are optically connected or mated in the field. In the most recently developed fiber optic networks, communications service providers are demanding factory-prepared interconnection solutions, commonly referred to as "plug-and-play" systems, that are robust enough for use in field applications. Plug-and-play systems allow less skilled field technicians to readily perform optical interconnections, thereby reducing field labor costs and the time required to install and activate optical networks.

[0003] Factory-prepared interconnection solutions should not only properly align mating optical fibers, but should also protect the mating optical fibers against adverse environmental and mechanical influences, such as from moisture intrusion and tensile forces, and more particularly, protect the receptacle assembly (i.e., alignment sleeve,

etc.) at which the optical fibers are interconnected. Conventional fiber optic receptacles include a receptacle housing defining an internal cavity that houses an alignment sleeve for aligning opposing optical connectors or opposing ferrules. The alignment sleeve is typically inserted from the front-side of the receptacle and is designed to receive a pair of ferrules, each of which is mounted upon the end portions of one or more optical fibers. The alignment sleeve assists in gross alignment of the ferrules, and ferrule guide pins or other alignment means assist in detailed alignment of the optical fibers positioned on the end faces of the opposing ferrules. One of the ferrules is attached to the ends of one or more optical fibers extending from a cable, ribbon or optical fiber device and routed to the back-side of the receptacle, such as from the interior of a conventional optical connection terminal or closure. The other ferrule is mounted one or more optical fibers terminating in a fiber optic plug that is routed to the front-side of the receptacle, for example a connectorized drop cable leading to a subscriber of the optical network.

[0004] In the process of mating the opposing ferules within the receptacle, the plug ferrule is inserted into one end of the alignment sleeve. Original receptacle designs required that the plug ferrule be retained within the alignment sleeve by mechanical coupling, such as by means of a pair of latches. While the latches effectively secure the plug ferrule within the alignment sleeve, mechanical coupling disadvantageously limits float between the plug ferrule and the alignment sleeve. Recent receptacle designs include a biasing member, for example one or more linear springs, for providing float. In testing these receptacle designs, it has been determined that the biasing springs are subject to deformation during loading and ferrule insertion. To prevent this, structural design changes are needed to control spring travel and thereby prevent buckling. A new design is also needed to facilitate assembly by allowing for a "loose" fit between the biasing springs and the guide structures, and between the biasing springs and the bores into which the biasing springs are inserted. A receptacle design that controls spring travel, prevents buckling and provides for a loose fit would prevent damage to the biasing springs during assembly and use.

[0005] A possible advantage associated with existing receptacle designs is that they allow access to the alignment sleeve and the back-side (i.e., internal) ferrule from the outside of the connection terminal or enclosure without entering the connection

terminal or closure, referred to herein as "external access." To accomplish this, the receptacle is designed in two pieces as viewed from the front-side (i.e., external) side of the receptacle with the alignment sleeve held within the receptacle housing (first piece) by a second piece that is attached to the first piece and removable from outside the connection terminal or closure. An example of such an external two-piece design is the fiber optic receptacle described and shown in US Patent 6,579,014, which is assigned to the assignee of the present invention. However, such an external two-piece design requires an extra seal between the first piece and the second piece to prevent water ingress. Furthermore, the seal must be sufficiently strong to prevent connector failure due to freeze/thaw cycling that causes the second piece to separate from the first piece. In addition, an external two-piece design requires strict control and maintenance of high-quality molded surfaces. As previously mentioned, the external two-piece design provides a field technician with access to the alignment sleeve and the back-side ferrule. Accordingly, while it is advantageous to eliminate the external two-piece design and extra seal, an external one-piece design also eliminates the ability to access the alignment sleeve and back-side ferrule from the front-side of the receptacle. However, an external one-piece design permits the receptacle assembly to pass freeze/thaw cycle testing and provides further improvements with respect to ferrule and optical fiber alignment, which is especially important when mating angled physical contact (APC) connectors for low-loss requirements.

BRIEF SUMMARY OF THE INVENTION

[0006] To achieve the foregoing and other objects, and in accordance with the purposes of the invention as embodied and broadly described herein, the present invention provides various embodiments of a fiber optic receptacle assembly, and more particularly, a fiber optic receptacle having an improved alignment sleeve retainer and biasing member supports. Thus, the present invention provides a fiber optic receptacle designed to readily align and mate any like pair of opposed optical connectors or ferrules in a precise and secure manner, while providing strain relief against pulling forces of up to about 600 lb/ft.

[0007] In one embodiment, the invention provides a fiber optic receptacle including a receptacle housing defining an external end, an internal end and an internal cavity for

housing an alignment sleeve operable for interconnecting like optical connectors or ferrules. The receptacle housing permits insertion and removal of the alignment sleeve from the internal end, or back-side, of the housing only, thus eliminating removal of the alignment sleeve from the external end, or front-side, of the receptacle. The alignment sleeve is retained within the internal cavity via a sleeve retainer that is secured to the internal end of the receptacle housing. The alignment sleeve is removed from the internal cavity by completely removing the sleeve retainer.

[0008] In another embodiment, the invention provides a fiber optic receptacle including a receptacle housing, a sleeve retainer and an alignment sleeve for receiving and aligning like optical connectors or ferrules. The receptacle housing permits the alignment sleeve to be inserted and removed from the back-side of the receptacle only, as compared to a conventional external two-piece design in which the alignment sleeve is removed from the front-side of the receptacle to permit access to the alignment sleeve and the back-side ferrule. The fiber optic receptacle may be secured within a wall of an enclosure or may be used as a stand-alone receptacle assembly. The alignment sleeve defines a lengthwise, longitudinally extending passageway opening through opposed first and second ends that is adapted to receive a plug ferrule contained or partially contained within a first fiber optic connector and a second end adapted to receive a back-side ferrule contained or partially contained within a second fiber optic connector. The receptacle housing includes opposed external and internal ends, wherein the external end is adapted to receive the plug ferrule and the internal end is adapted to receive the alignment sleeve and the back-side ferrule. A sleeve retainer adjacent the internal end of the receptacle housing floatingly retains the alignment sleeve within an internal cavity of the receptacle. The sleeve retainer and the receptacle housing define tapered biasing member supports for supporting one or more linear biasing springs that operably engage the alignment sleeve so as to urge the alignment sleeve towards the external end of the receptacle housing. The alignment sleeve defines a chamfer on its second end as a means for guiding the back-side ferrule into the alignment sleeve. The sleeve retainer defines a plurality of internal alignment ribs that provide a loose fit for facilitating alignment of the back-side ferrule and the plug ferrule within the alignment sleeve.

[0009] Typically, the fiber optic receptacle provides strain relief to an optical connection terminal or closure so that one or more optical fibers of a fiber optic cable may be aligned and optically interconnected with one or more optical fibers routed to the receptacle from within the connection terminal or closure. In one embodiment, the fiber optic receptacle includes a receptacle housing having an internal end and an external end, and an alignment sleeve that is biased towards the external end of the housing. The alignment sleeve is biased so that when a fiber optic plug ferrule is inserted into the external end of the receptacle housing, the end face of the plug ferrule maintains physical contact with the end face of a back-side ferrule positioned within the alignment sleeve without requiring the plug ferrule to be latched to the alignment sleeve, thereby providing float between the respective ferrules. According to a further embodiment, a universal fiber optic receptacle is provided wherein an internal cavity defined by the receptacle housing and the associated sleeve retainer is sized to receive any alignment sleeve or optical connector, such as for example, alignment sleeves configured to receive and align a plurality of types of optical connectors or ferrules including MTP, MTRJ, SC-DC, SC, DC, LC, and the like.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] These and other features, aspects and advantages of the present invention are better understood when the following detailed description of the invention is read with reference to the accompanying drawings, in which:

[0011] FIG. 1 is an exploded perspective view of a fiber optic receptacle in accordance with an exemplary embodiment of the present invention illustrating the receptacle housing, the sleeve retainer, the alignment sleeve and a pair of biasing members;

[0012] FIG. 2 is a perspective view of the fiber optic receptacle of FIG. 1 shown in an assembled configuration;

[0013] FIG. 3 is a partial cross-sectional view of the assembled fiber optic receptacle of FIG. 2 taken along line 3-3;

[0014] FIG. 4 is a partial cross-sectional view of the assembled fiber optic receptacle of FIG. 2 taken along line 4-4;

[0015] FIG. 5 is a front-side perspective view of the sleeve retainer of the fiber optic receptacle of FIG. 1 illustrating the alignment ribs and the biasing member supports;

[0016] FIG. 6 is a back-side perspective view of the sleeve retainer of FIG. 5 further illustrating the alignment ribs;

[0017] FIG. 7 is a perspective view of the fiber optic receptacle of FIG. 2 showing a fiber optic plug having a plug ferrule mated to the receptacle; and

[0018] FIG. 8 is a cross-sectional view of the fiber optic receptacle of FIG. 7 taken along line 8-8.

DETAILED DESCRIPTION OF THE INVENTION

[0019] The present invention will now be described more fully hereinafter with reference to the accompanying drawings in which exemplary embodiments of the invention are shown. However, this invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. These exemplary embodiments are provided so that this disclosure will be both thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like reference numbers refer to like elements throughout the various drawings.

[0020] The various embodiments described below provide a fiber optic receptacle having an external one-piece design that eliminates the need for an internal seal, while permitting access to an alignment sleeve from only the back-side of the receptacle. The external one-piece design is an improvement over conventional external two-piece designs that permits the receptacle assembly to pass freeze/thaw cycle testing and provides further improvements with respect to ferrule and optical fiber alignment, which is especially important when mating angled physical contact (APC) connectors for low-loss requirements. The fiber optic receptacle of the present invention further provides an improved sleeve retainer, alignment sleeve and biasing member supports. Thus, the present invention provides a fiber optic receptacle designed to readily align and mate any like pair of opposed optical connectors or ferrules in a precise and sealed manner, while providing strain relief against pulling forces of up to about 600 lb/ft.

[0021] The fiber optic receptacle interconnects optical fibers within a communications network. The receptacle is designed such that it may be mounted within an optical connection terminal, closure or similar enclosure defining an opening or port in a wall through which one or more optical fibers are routed. The receptacle may also be mounted within an optical connection terminal, closure, pedestal, network interface device or like enclosure. In other embodiments, because of the robust (i.e., rugged) nature of its structure, the receptacle may be used in buried network installations. The fiber optic receptacle may also be used as a generic receptacle assembly and need not be mounted within any wall of any enclosure. If mounted within a wall, however, a rigid shoulder of the receptacle housing and a coupling nut secure the receptacle to the wall, thus providing superior strain relief for tensile forces, up to about 600 lb/ft, as compared to conventional receptacle assemblies.

[0022] In the exemplary embodiments shown and described herein, the fiber optic receptacle is adapted to receive a corresponding fiber optic plug having a plug ferrule mounted upon the end of a fiber optic cable comprising one or more optical fibers for optically connecting one or more optical fibers of a corresponding ferrule on the back-side of the receptacle (i.e., back-side ferrule). As used herein, the fiber optic cable associated with the fiber optic plug is referred to as a "drop cable" and is intended to include all types of fiber optic cables such as, but not limited to, a branch cable, a distribution cable, an extended distribution cable, a flat dielectric drop cable, a figure-eight drop cable or an armored drop cable. The drop cable typically comprises between one and about twelve optical fibers, depending on the type of cable and the number and type of optical connectors. The particular components of the fiber optic receptacle and fiber optic plug described herein may be modified to accommodate different cable types and optical connectors. As used herein, the term "optical fiber" is intended to include all types of single mode and multi-mode light waveguides, including one or more bare optical fibers, coated optical fibers, loose-tube optical fibers, tight-buffered optical fibers, ribbonized optical fibers or any other expedient for transmitting light signals.

[0023] The fiber optic receptacle of the present invention provides an external one-piece sealed design that prevents moisture and contaminates from reaching the end faces of the plug ferrule and back-side ferrule. In all embodiments in which the

receptacle is mounted in an opening or port within a wall, a sealing gasket provides a seal between the internal and external environments defined by the wall. Generally speaking, most of the components of the fiber optic receptacle and fiber optic plug are formed from a suitable polymer. Preferably, the polymer is a UV stabilized polymer such as ULTEM 2210 available from GE Plastics of Pittsfield, Massachusetts. However, other suitable materials made also be used. For example, stainless steel or any other suitable metal may be used for various components of the receptacle and/or plug.

[0024] Referring now to FIGS. 1 and 2, a fiber optic receptacle **20** in accordance with an exemplary embodiment of the invention is shown. FIG. 1 shows the fiber optic receptacle **20** in an exploded, or disassembled, configuration, while FIG. 2 shows the fiber optic receptacle **20** in an assembled configuration. The receptacle **20** is preferably mounted within an opening or port in a wall of an enclosure (not shown) to connect optical fibers from outside the enclosure with optical fibers from within the enclosure. The fiber optic receptacle **20** may be designed to accommodate and mate with any type of fiber optic plug (see FIGS. 7 and 8) that is mounted upon the end portion of a fiber optic cable (not shown). As shown, the receptacle **20** includes a receptacle housing **22** defining an internal cavity **24** opening through opposed ends, the opposed ends comprising a first, or external, end **26** and a second, or internal, end **28**. Typically, the opening through the external end **26** is sized to accommodate a corresponding fiber optic plug (not shown). Conversely, the opening through the internal end **28** is sized to accommodate an alignment sleeve **30** configured to be inserted into and retained within the internal cavity **24**. The relatively large opening of the external end **26** allows the alignment sleeve and the end face of a back-side ferrule to be cleaned with a cleaning tool, such as a cotton swap (e.g., Q-tip) or similar device. This is advantageous since the receptacle, in contrast to the fiber optic plug, may be exposed to adverse environmental conditions and possibly accumulate contaminants while not being used for a prolonged period of time. The various embodiments shown and described herein allow for easy cleaning and improved access without disassembly. In addition, the external end **26** of the receptacle **20** may be fitted with a dummy plug or dust cap when not in use to reduce the possibility of accumulating contaminants within the internal cavity **24**.

[0025] The alignment sleeve **30** defines a lengthwise, longitudinally extending passageway opening through opposed ends, the opposed ends comprising a first end **32** and a second end **34**. The alignment sleeve **30** receives and aligns a back-side ferrule (not shown) mounted upon the ends of one or more optical fibers routed to the receptacle **20** from inside the wall of the enclosure with a plug ferrule (not shown) of a fiber optic plug mounted upon the ends of one or more optical fibers of a fiber optic cable. In this regard, the plug ferrule of the fiber optic plug is inserted through the external end **26** of the receptacle **20** into the opening defined by the first end **32** of the alignment sleeve **30**, while the back-side ferrule is inserted through the internal end **28** of the receptacle **20** into the opening defined by the second end **34** of the alignment sleeve **30**.

[0026] The receptacle housing **22** may be sized and shaped in any suitable manner. In the embodiments shown, the receptacle housing **22** comprises a cylindrical portion defining the internal cavity **24** and a flanged portion **36** located medially along the length of the housing **22**, preferably nearer to the external end **26**. The flanged portion **36** extends radially outward from the receptacle housing **22** and defines a solid, generally flat surface **38** for receiving a sealing member. A generally flat elastomeric gasket (shown in FIGS. 7 and 8 at **39**) or conventional O-ring is preferably disposed between the surface **38** and the exterior surface of the wall in order to provide a seal against any adverse environmental conditions. The receptacle housing **22** is secured to the wall using an internally threaded coupling nut (shown in FIG. 7 at **40**) that is threaded onto an externally threaded surface **42** provided on the receptacle housing **22**. As the coupling nut **40** is tightened, the receptacle housing **22** is pulled towards the exterior surface of the wall, thus compressing the gasket and providing an effective seal.

[0027] The fiber optic receptacle **20** further includes a sleeve retainer **44** that is secured to the receptacle housing **22** adjacent the internal end **28** of the housing **22**. The sleeve retainer **44** may be secured to the receptacle housing **22** in any suitable manner. In the embodiments shown herein, the sleeve retainer **44** defines a plurality of retaining clips **46** that engage corresponding slots **48** defined by the receptacle housing **22**. As such, the sleeve retainer **44** is securely retained within the receptacle housing **22**. The sleeve retainer **44** secures the "floating" alignment sleeve **30** within

the receptacle housing **20** once the retaining clips **46** of the sleeve retainer **44** engage the slots **48** of the receptacle housing **22**. By inserting the alignment sleeve **30** from the internal end **28**, or back-side, of the receptacle housing **22** and retaining it in place with the sleeve retainer **44**, the alignment sleeve **30** may be removed from only the internal, or back-side, of the receptacle **20**. In embodiments in which the receptacle **20** is secured within a wall of an enclosure, the alignment sleeve **30** may only be accessed only from the internal, or back-side, of the receptacle **20**. In contrast, conventional receptacles include an external two-piece design that permits the alignment sleeve **30** to be removed from the external, or front-side, of the receptacle **20** (e.g., US Patent 6,579,014). In such a design, a field technician is able to remove the alignment sleeve **30** by removing an external second piece of the receptacle housing **22** to gain access to the alignment sleeve **30** from outside the enclosure without the need to enter the enclosure. As previously stated, however, external two-piece designs also require a seal between the first piece and the second piece of the receptacle housing **22** to prevent water ingress. In the present invention, the external one-piece design eliminates the need for an inner seal. Furthermore, freeze/thaw cycling will not cause the second piece to pull away or separate from the first piece and expose the optical fibers from inside the enclosure and the back-side ferrule to adverse environmental conditions, such as water ingress and dust, dirt and insect intrusion.

[0028] As shown in FIGS. 1 and 2, the sleeve retainer **44** engages the receptacle housing **22** so as to retain the alignment sleeve **30** within the receptacle housing **22**. The sleeve retainer **44** defines an opening **50** large enough to permit the back-side ferrule (not shown) that is mounted upon the ends of the optical fibers originating from inside the enclosure to pass through the sleeve retainer **44** into the alignment sleeve **30**. At the same time, the opening **50** is small enough to not permit the alignment sleeve **30** to be removed without removing the sleeve retainer **44** from the receptacle housing **22**. Once assembled, the sleeve retainer **44** must be removed from the receptacle housing **22** in order to access the alignment sleeve **30** or to access the back-side ferrule (not shown), such as for cleaning, replacement or the like. In an alternative embodiment, the sleeve retainer **44** may comprise threads that engage corresponding threads on the receptacle housing **22** to retain, access and remove the alignment sleeve **30** from the receptacle housing **22**. Once the alignment sleeve **30** or

the back-side ferrule has been cleaned, repaired or replaced, the alignment sleeve **30** is inserted into the internal cavity **24** defined by the receptacle housing **22** and the sleeve retainer **44** is secured to the receptacle housing **22**.

[0029] The alignment sleeve **30** defines a pair of biasing member supports **52** that extend laterally outward from opposed sides of the alignment sleeve **30**. While the supports **52** include spring support features, as described in detail below, the supports **52** are also used for aligning the alignment sleeve **30** within the internal cavity **24** of the receptacle housing **22**. The supports **52** extend laterally outward such that they seat within guide channels **54** defined within the internal cavity **24** of the receptacle housing **22**. The receptacle housing **22** is preferably sized to define the guide channels **54** extending lengthwise therethrough. Thus, the first end **32** of the alignment sleeve **30** can be positioned within the receptacle housing **22**. In addition, the supports **52** provide a "keying" function that prevents the alignment sleeve **30** from being improperly loaded into the receptacle housing **22**. The supports **52** further aid in preventing the alignment sleeve **30** from being withdrawn through the opening **50** defined by the sleeve retainer **44**.

[0030] The fiber optic receptacle **20** further includes at least one biasing member disposed within the receptacle housing **22**. In the embodiments shown, the biasing member comprises a pair of linear coil springs **56**, preferably having a low spring constant (k), that operably engage the alignment sleeve **30** to urge the alignment sleeve **30** toward the external end **26** of the receptacle housing **22** such that the alignment sleeve **30** is spring-loaded. However, the at least one biasing member may be any component, structure or material that biases the alignment sleeve **30** in the direction of the external end **26** of the receptacle housing **22**. The springs **56** are positioned between the supports **52** adjacent the first end **32** of the alignment sleeve **30** and the sleeve retainer **44** and are supported by posts, as shown and described in greater detail below. In addition to the spring-loading of the alignment sleeve **30**, the plug ferrule of the fiber optic plug that is inserted into the alignment sleeve **30** through the external end **26** if the receptacle housing **22** is also typically spring-loaded. Thus, the spring-loading of the alignment sleeve **30** and the plug ferrule urges the end face of the plug ferrule against the end face of the backside ferrule within the alignment sleeve **30**. In contrast to conventional alignment sleeves, connector sleeves

or adapter sleeves for coupling ferrules, the alignment sleeve **30** need not include latches to mechanically engage the plug ferrule since the spring-loading will bias the alignment sleeve **30** into engagement with the plug ferrule within the receptacle housing **22**. However, the second end **34** of the alignment sleeve **30** preferably includes a means for engaging the back-side ferrule, such as, for example, a latch mechanism that includes one or more latches. Thus, an advantageous alignment sleeve **30** according to an embodiment of this invention is also provided that may also be utilized in situations that do not involve a fiber optic receptacle **20**. In alternative embodiments, the fiber optic receptacle **20** may include other types of biasing members, in addition to or instead of one or more springs **56**.

[0031] Referring now to FIGS. 3 and 4, a cross-sectional view of the assembled fiber optic receptacle of FIG. 2 taken along line **3-3** is shown in FIG. 3, and a cross-sectional view of the assembled fiber optic receptacle of FIG. 2 taken along line **4-4** rotated 90 degrees to line **3-3** is shown in FIG. 4. The external end **26** of the receptacle housing **22** is internally threaded so as to threadably engage an externally threaded fiber optic plug (not shown). As previously described, the alignment sleeve **30** is received through the internal end **28** of the receptacle housing **22** and is retained within the internal cavity **24** by the sleeve retainer **44**. The alignment sleeve **30** may be shaped and designed to accommodate and mate with a variety of different types of fiber optic connectors mounted upon the end of a fiber optic cable. As shown, the alignment sleeve **30** defines a lengthwise extending passageway opening through the opposed first end **32** and second end **34** for receiving and aligning the ferrules of the fiber optic connectors. A first fiber optic connector (not shown) including a plug ferrule is inserted into the first end **32** of the alignment sleeve **30**. A second fiber optic connector (not shown) including a back-side ferrule that is mounted upon the ends of one or more optical fibers originating from inside the enclosure is inserted through the opening defined by the second end **34** of the alignment sleeve **30**. The alignment sleeve **30** preferably defines an alignment slot **58** for receiving a retaining clip (not shown) of the second fiber optic connector. The slot **58** is a keying feature used to align the second fiber optic connector within the alignment sleeve **30** and the retaining clip is used to plug/unplug the second fiber optic connector. The alignment sleeve **30** further defines an interior chamfer **60** for guiding the second fiber optic connector into the alignment sleeve **30**. The chamfer **60** helps to protect the end face

of the ferrule of the second fiber optic connector by guiding the connector housing during insertion into the alignment sleeve **30**.

[0032] In the embodiments of the fiber optic receptacle **20** in which the biasing member includes one or more springs **56**, the sleeve retainer **44** includes one or more tapered posts **62** extending in a lengthwise direction from the sleeve retainer **44** toward the internal end **28** of the receptacle housing **22**. The tapered posts **62** serve as supporting structures for the springs **56**. The sleeve retainer **44** includes the same number of posts **62** as the number of springs **56** such that each spring can be mounted upon a respective post as shown in FIG. 3. In addition, each spring **56** is preferably longer than the respective post **62**, even in the spring's compressed state. As such, the posts **62** serve to position the springs **56** that, in turn, bias the alignment sleeve **30** and, more particularly, spring posts **64** of the biasing member supports **52** of the alignment sleeve **30**. The spring posts **64** of the supports **52** are aligned with the posts **62** of the sleeve retainer **44**. Thus, each spring **56** contacts a respective biasing member support **52** of the alignment sleeve **30** and urges the alignment sleeve **30** toward the external end **26** of the receptacle housing **22**. The spring posts **64** of the biasing member supports **52** are preferably tapered, and more preferably, conical in shape. Both sets of posts **62**, **64** are preferably tapered in order to capture the springs **56** during assembly, thus facilitating loading and positioning the springs **56** between the alignment sleeve **30** and the sleeve retainer **44**. In other words, the tapered shape provides a feeding mechanism for seating springs **56** properly. Because the springs **56** have a low spring constant (k), they are subject to bowing, and even buckling, during assembly. Thus, improper spring **56** seating may result in poor or uneven biasing of the alignment sleeve **30**. The tapered shape of the posts **62**, **64** provides proper spring **56** seating and eliminates assembly errors.

[0033] Referring now to FIGS. 5 and 6, a front-side perspective view of the sleeve retainer **44** of the fiber optic receptacle **20** of FIG. 1 is shown in FIG. 5, and a back-side perspective view of the sleeve retainer **44** of the fiber optic receptacle **20** of FIG. 1 is shown in FIG. 6. The opening **50** through the sleeve retainer **44** is sized to accommodate the second end **34** of the alignment sleeve **30** such that an optical connector and/or ferrule can be inserted through the opening **50** into the alignment sleeve **30**. The sleeve retainer **44** may be sized and shaped in any suitable manner. In

the embodiments shown herein, the sleeve retainer **44** includes a cylindrical portion substantially similar in diameter to the internal end **28** of the receptacle housing **22**, thus it appears that the sleeve retainer **44** extends the length of the receptacle **20**. As is shown in FIG. 6, the back-side of the sleeve retainer **44** defines a generally flat surface.

[0034] The sleeve retainer **44** is secured to the receptacle housing **22** at the internal end **28** of the housing **22**. The sleeve retainer **44** may be secured to the housing **22** in various ways, but, in the embodiments shown, the sleeve retainer **44** defines a pair of retaining clips **46** that are received by slots **48** defined by the receptacle housing **22**. As such, the sleeve retainer **44** and the receptacle housing **22** of this embodiment are securely engaged. The alignment sleeve **30** may only be removed from the internal side of the receptacle **20** in embodiments in which the receptacle is positioned within a wall of an enclosure. The sleeve retainer **44** is removed from the receptacle housing **22** in order to access the alignment sleeve **30** or to access the back-side ferrule (not shown). In an alternative embodiment, the sleeve retainer **44** may be threadably attached to and removed from the receptacle housing **22**.

[0035] In the embodiment shown, the sleeve retainer **44** includes a pair of tapered posts **62** that serve as supports for the springs **56** such that each spring **56** is mounted upon a respective post **62**. The posts **62** are seated within recesses **66** defined by the sleeve retainer **44**. The recesses **66** are an additional means for retaining the springs **56** during receptacle assembly and use. As stated above, the posts **62** are tapered in order to capture the springs **56** during assembly, thus facilitating the loading of the springs **56**. The sleeve retainer **44** further defines a plurality of ribs **68** formed adjacent the opening **50** of the sleeve retainer **44**. Four ribs **68** are shown with each rib **68** being positioned medially on one of the four sidewalls that define the opening **50**. The ribs **68** are operable for guiding the alignment sleeve **30** to properly align with the first (i.e., plug) fiber optic connector and the second (i.e., receptacle) fiber optic connector. The ribs **68** are sized to permit the alignment sleeve **30** to rotate slightly within the opening **50**. In other words, the ribs **68** allow slight angular rotation without allowing axial movement of the alignment sleeve **30**, thus allowing the angles on a pair of opposed angled physical contact (APC) ferrules to line up

properly. The ribs **68**, along with the chamfer **60** of the alignment sleeve **30**, adequately provide for alignment of opposing APC ferrules.

[0036] Referring to FIG. 7, a fiber optic plug **70** of a fiber optic drop cable **72** is shown engaged with an external one-piece fiber optic receptacle **20** according to the invention. At the same time, the drop cable **72** associated with the plug **70** is strain relieved at the receptacle **20**. When a plug **70** has not yet engaged the receptacle **20**, the receptacle is preferably covered with some form or protective dust cap (not shown) operable for preventing water and contaminants, such as dust, dirt and insects, from reaching the internal cavity **24** of the receptacle **20**. When removed, the dust cap may be retained on the receptacle **20** using a tether and reused if the plug **70** is disengaged from the receptacle **20** at a later time. A dust cap may also be used to provide protection of the optical connector mounted on the drop cable **72** prior to installation until the plug **70** is engaged with the receptacle **20**. Although a wall of an enclosure is not shown, a threaded coupling nut **40** is used to secure the receptacle **20** within a through opening in the wall of the enclosure. An elastomeric gasket **39** is shown disposed between the coupling nut **40** and the flat surface **38** defined by the flanged portion **36** of the receptacle housing **22**. The wall of the enclosure is preferably disposed between the gasket **39** and the coupling nut **40** such that the gasket **39** is compressed against the wall as the coupling nut **40** is tightened. The gasket **39** is provided to prevent water and contaminants from penetrating through the opening in the wall of the enclosure. In alternative embodiments, a protective boot may be disposed on the internal portion of the receptacle **20** to allow the assembly to be installed in a breathable enclosure and may become obsolete if the receptacle is otherwise reliably sealed from the environment.

[0037] Referring to FIG. 8, a cross-sectional view of the fiber optic receptacle **20** of FIG. 7 taken along line 8-8 is shown. An O-ring **74** may be used to provide a seal between the plug **70** and the receptacle housing **22**. A plug ferrule **76** is mounted within the plug **70** such that the end face of the plug ferrule **76** extends somewhat beyond the forward end of the plug **70**. As with the corresponding receptacle **20**, the fiber optic plug **70** may include a variety of fiber optic connectors including SC, LC, MTRJ, MTP, SC-DC, and the like. The plug **70** of the particular embodiment is shown to include a single SC connector because a receptacle **20** can only receive a

back-side ferrule of the same configuration. The plug ferrule **76** is received within the lengthwise passageway of the alignment sleeve **30** for mating the plug ferrule **76** with the back-side ferrule (not shown). Referring again to FIGS. 1 and 2, the outer periphery of the receptacle housing **22** defines an alignment mark **78** for keying alignment of the fiber optic plug **70** with the receptacle **20**. The plug **70** and the corresponding receptacle **20** are configured to permit mating in only one orientation. In preferred embodiments, this orientation may also be marked on the plug **70** using alignment indicia so that a less skilled field technician can readily mate the plug **70** with the receptacle **20**. Any suitable indicia may be used. After alignment, the field technician engages the external threads on the plug **70** with the internal threads on the receptacle **20** to secure the plug **70** to the receptacle **20**. In an alternative embodiment, the plug **70** may define internal threads and the receptacle housing **22** may define external threads. Furthermore, any type of cooperating engagement means, such as bayonet, snap-fit or press fit may be utilized.

[0038] The receptacle housing **22** of the one-piece fiber optic receptacle **20** is mounted to a wall of an enclosure, holds the alignment sleeve **30** and aligns the plug ferrule with the back-side ferrule so that they engage in only one preferred orientation. This feature is especially advantageous for optical connections utilizing APC type ferrules where minimal angular offset is required, as well as multi-fiber ferrules that oftentimes are not centric. Additionally, the optical connection may be easily connected or disconnected by merely mating or un-mating the fiber optic plug **70** with the receptacle **20,** as previously described.

[0039] The foregoing is a description of various embodiments of the invention that are given here by way of example only. Although the one-piece fiber optic receptacle has been described with reference to preferred embodiments and examples thereof, other embodiments and examples may perform similar functions and/or achieve similar results. All such equivalent embodiments and examples are within the spirit and scope of the present invention and are intended to be covered by the appended claims.

That which is claimed is:

1. A fiber optic receptacle comprising:

a receptacle housing defining an internal cavity opening through an external end and an opposed internal end, the external end configured to receive a corresponding fiber optic plug;

an alignment sleeve disposed within the internal cavity and received by the internal end of the receptacle housing, the alignment sleeve defining a lengthwise extending passageway between first end and an opposed second end, the first end receiving and aligning a plug ferrule and the second end receiving and aligning a back-side ferrule; and

a sleeve retainer removably secured to the receptacle housing and operable for providing access to the alignment sleeve through the internal end of the receptacle housing.

2. The fiber optic receptacle of claim 1, further comprising at least one biasing member disposed within the internal cavity of the receptacle housing and positioned between the sleeve retainer and the alignment sleeve, the biasing member operably engaging the alignment sleeve so as to urge the alignment sleeve towards the external end of the receptacle housing.

3. The fiber optic receptacle of claim 2, wherein the biasing member comprises at least one linear spring.

4. The fiber optic receptacle of claim 2, further comprising at least one biasing member support defined by the alignment sleeve for supporting the at least one biasing member within the internal cavity of the receptacle housing.

5. The fiber optic receptacle of claim 4, wherein the biasing member support comprises at least one tapered post for retaining and guiding the at least one biasing member during assembly of the fiber optic receptacle.

6. The fiber optic receptacle of claim 1, wherein the alignment sleeve is inserted into and removed from the internal cavity of the receptacle housing when the sleeve retainer is not secured to the receptacle housing.

7. The fiber optic receptacle of claim 1, wherein the sleeve retainer defines means for securing the sleeve retainer to the internal end of the receptacle housing.

8. The fiber optic receptacle of claim 1, wherein the fiber optic receptacle is secured within an opening in a wall of an enclosure and wherein the wall of the enclosure is secured between a flange defined by the receptacle housing and a coupling nut secured to the receptacle housing opposite the flange.

9. The fiber optic receptacle of claim 8, further comprising an elastomeric gasket disposed between the flange and an exterior surface of the wall for preventing water ingress and dirt, dust and insect intrusion from entering the enclosure through the opening in the wall.

10. A fiber optic receptacle comprising:

a receptacle housing defining an internal end, an opposed external end and an internal cavity extending between the internal end and the external end;

an alignment sleeve received within the internal cavity through the internal end of the receptacle housing, the alignment sleeve defining a first end and an opposed second end, the first end receiving and aligning a plug ferrule and the second end receiving and aligning a back-side ferrule;

a removable sleeve retainer secured to the internal end of the receptacle housing adjacent the second end of the alignment sleeve, the sleeve retainer providing access to and retaining the alignment sleeve within the internal cavity of the receptacle housing;

a biasing member disposed within the receptacle housing, the biasing member engaging the alignment sleeve so as to urge the alignment sleeve in the direction of the external end of the receptacle housing; and

a biasing member support defined by at least one of the sleeve retainer and the alignment sleeve for retaining and guiding the biasing member within the receptacle housing.

11. The fiber optic receptacle of claim 10, wherein the biasing member is configured to floatingly align the plug ferrule with the back-side ferrule.

12. The fiber optic receptacle of claim 10, wherein the biasing member comprises at least one linear spring.

13. The fiber optic receptacle of claim 10, wherein the biasing member support comprises at least one tapered post that retains and guides the biasing member during assembly of the fiber optic receptacle.

14. The fiber optic receptacle of claim 10, wherein the alignment sleeve is inserted into and removed from the internal cavity through the internal end of the receptacle housing when the sleeve retainer is removed from the receptacle housing.

15. The fiber optic receptacle of claim 10, wherein the sleeve retainer defines means for securing the sleeve retainer to the internal end of the receptacle housing.

16. The fiber optic receptacle of claim 15, wherein the securing means comprise at least one retaining clip that is received within a corresponding slot defined by the receptacle housing to secure the sleeve retainer to the receptacle housing.

17. The fiber optic receptacle of claim 10, wherein the sleeve retainer has at least one recess formed therein adjacent the biasing member support for further retaining the biasing member during assembly of the fiber optic receptacle.

18. The fiber optic receptacle of claim 10, wherein the receptacle housing is disposed within an opening in a wall of an enclosure and wherein the receptacle housing is secured to the wall of the enclosure through the opening by a flange defined by the receptacle housing adjacent an exterior surface of the wall and a coupling secured to the receptacle housing opposite the flange adjacent an interior surface of the wall.

19. The fiber optic receptacle of claim 18, further comprising an elastomeric gasket disposed between the flange and the exterior surface of the wall for preventing water ingress and dirt, dust and insect intrusion through the opening into the enclosure.

20. A fiber optic receptacle comprising:

a receptacle housing defining an internal cavity opening through opposed external and internal ends, the receptacle housing comprising means for securing the fiber optic receptacle to a wall of an enclosure;

an alignment sleeve disposed within the internal cavity defined by the receptacle housing and received through the internal end, the alignment sleeve defining a lengthwise extending passageway opening through the external end for receiving and aligning a plug ferrule and opening through the internal end for receiving and aligning a back-side ferrule;

a sleeve retainer removably secured to receptacle housing and operable for retaining the alignment sleeve within the internal cavity defined by the receptacle housing; and

at least one biasing member positioned between and supported by the sleeve retainer and the alignment sleeve, the biasing member operably engaging the alignment sleeve so as to urge the alignment sleeve in the direction of the external end of the receptacle housing, the biasing member configured to floatingly align the plug ferrule with the back-side ferrule.

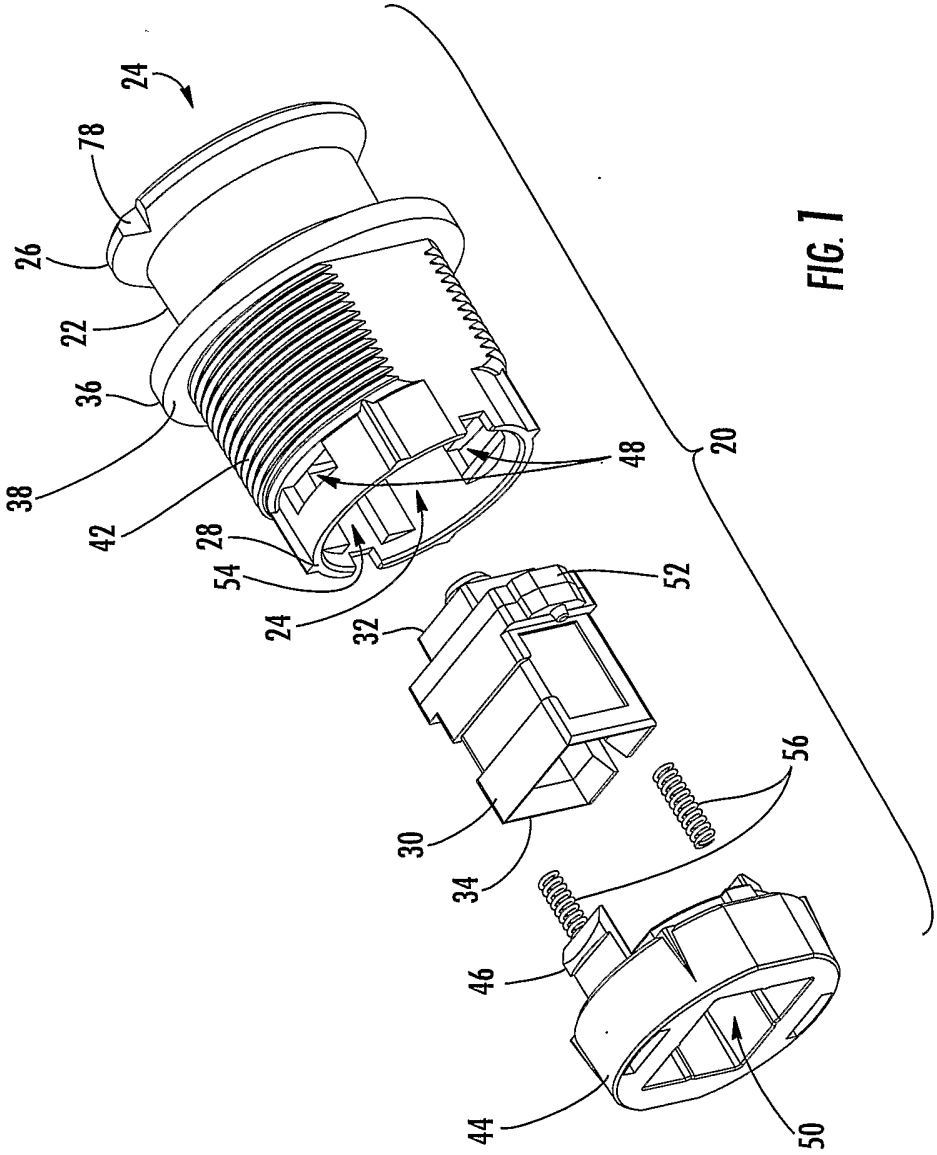


FIG. 1

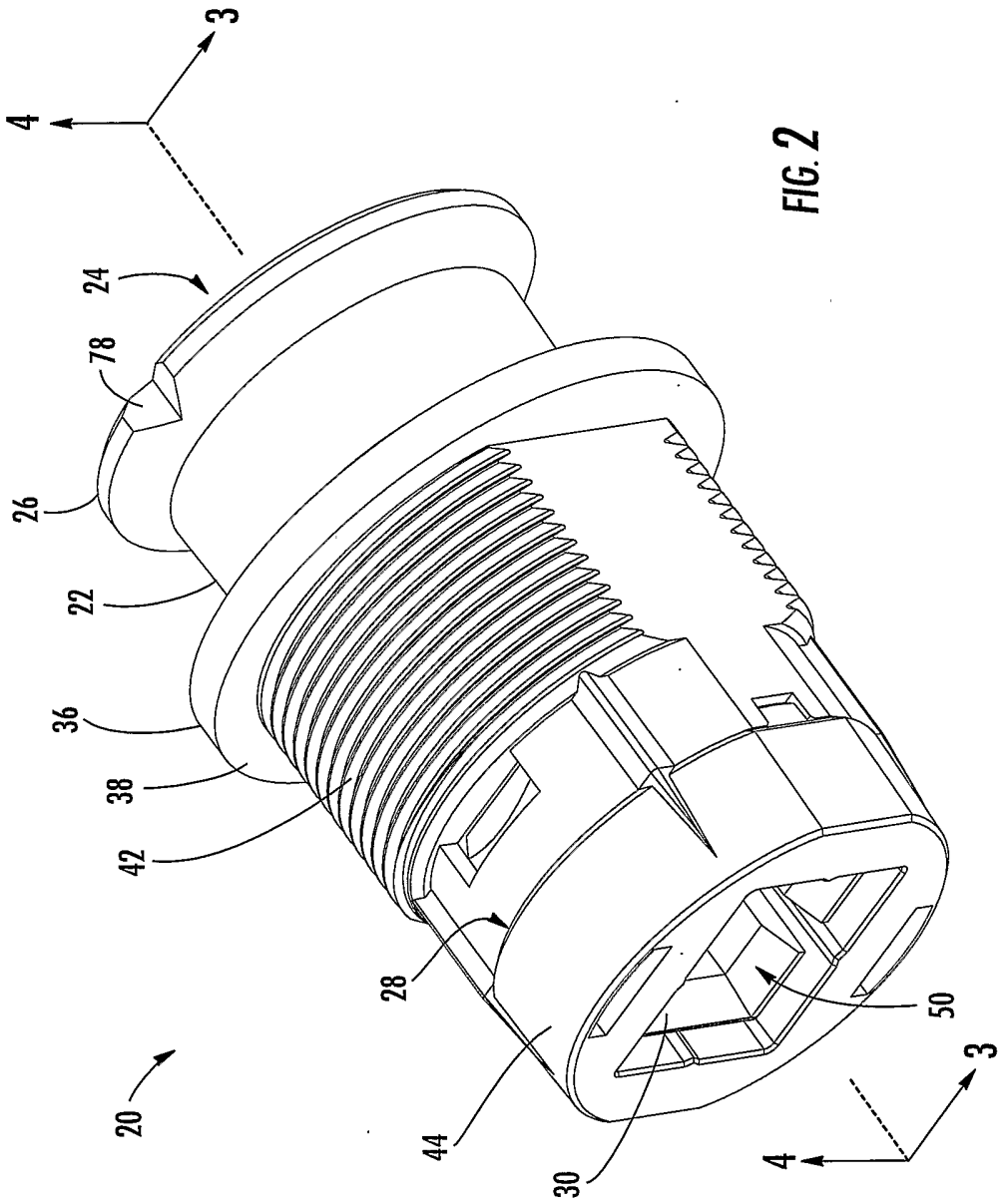


FIG. 2

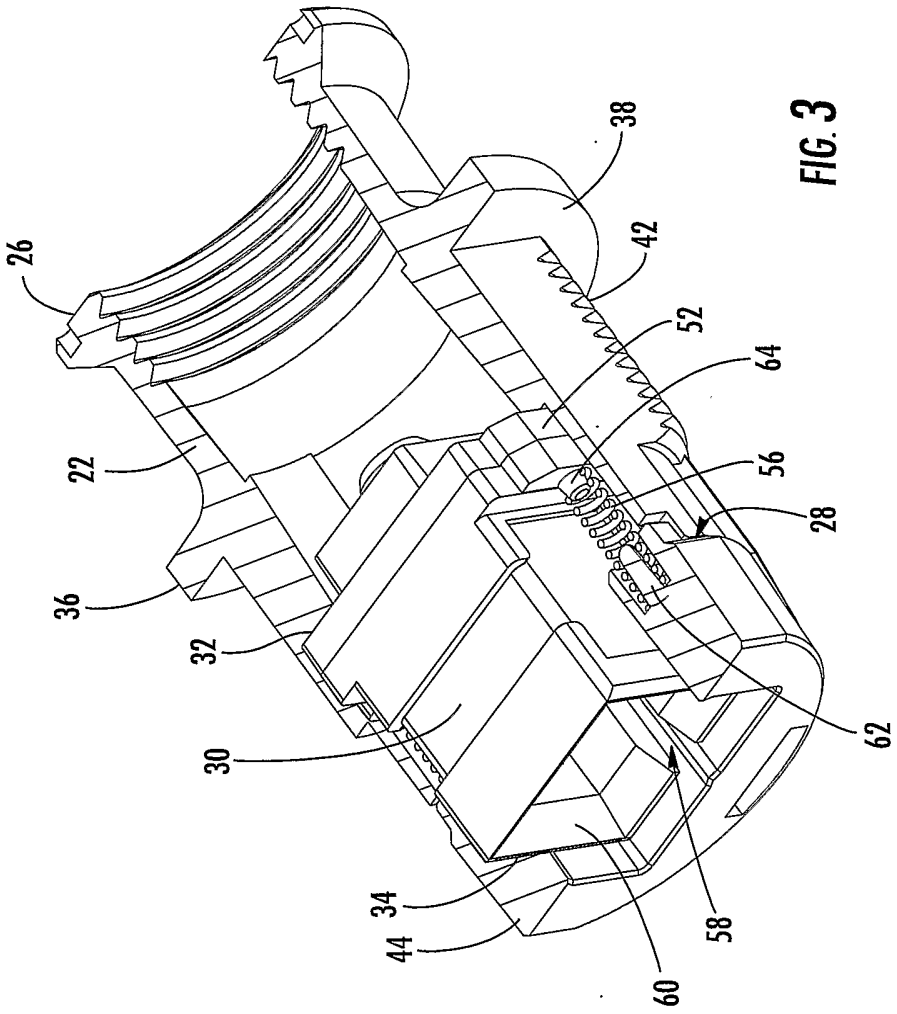


FIG. 3

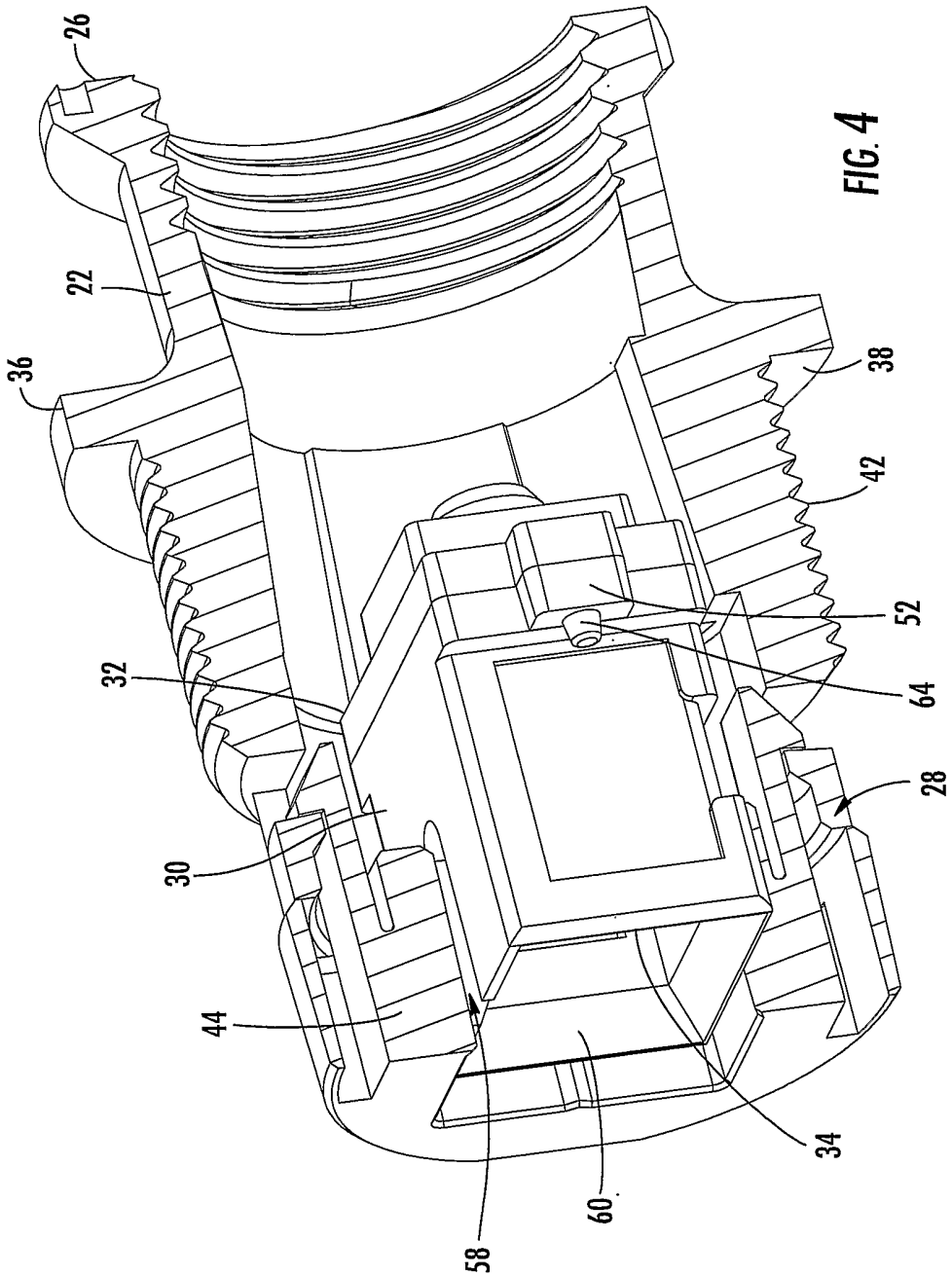


FIG. 4

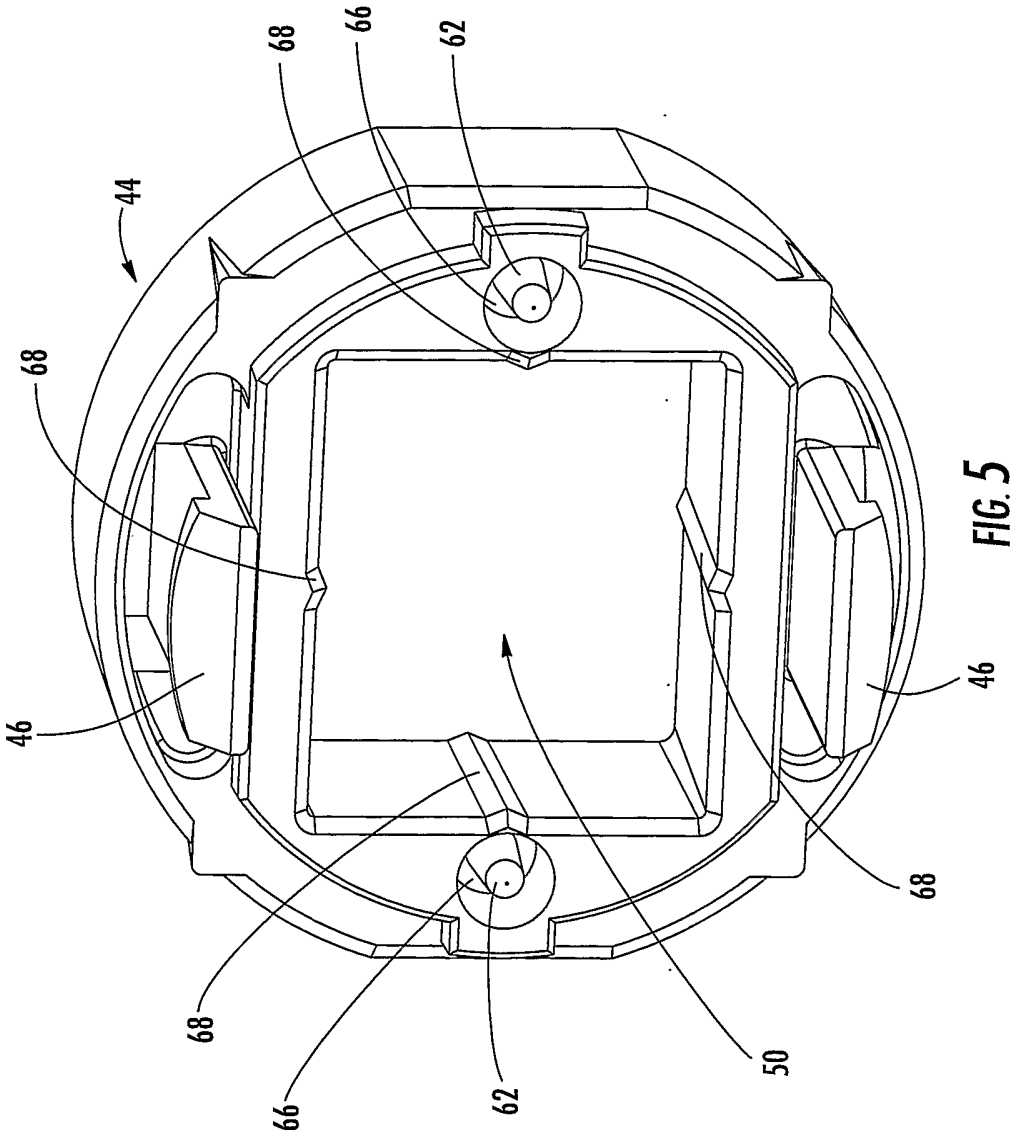


FIG. 5

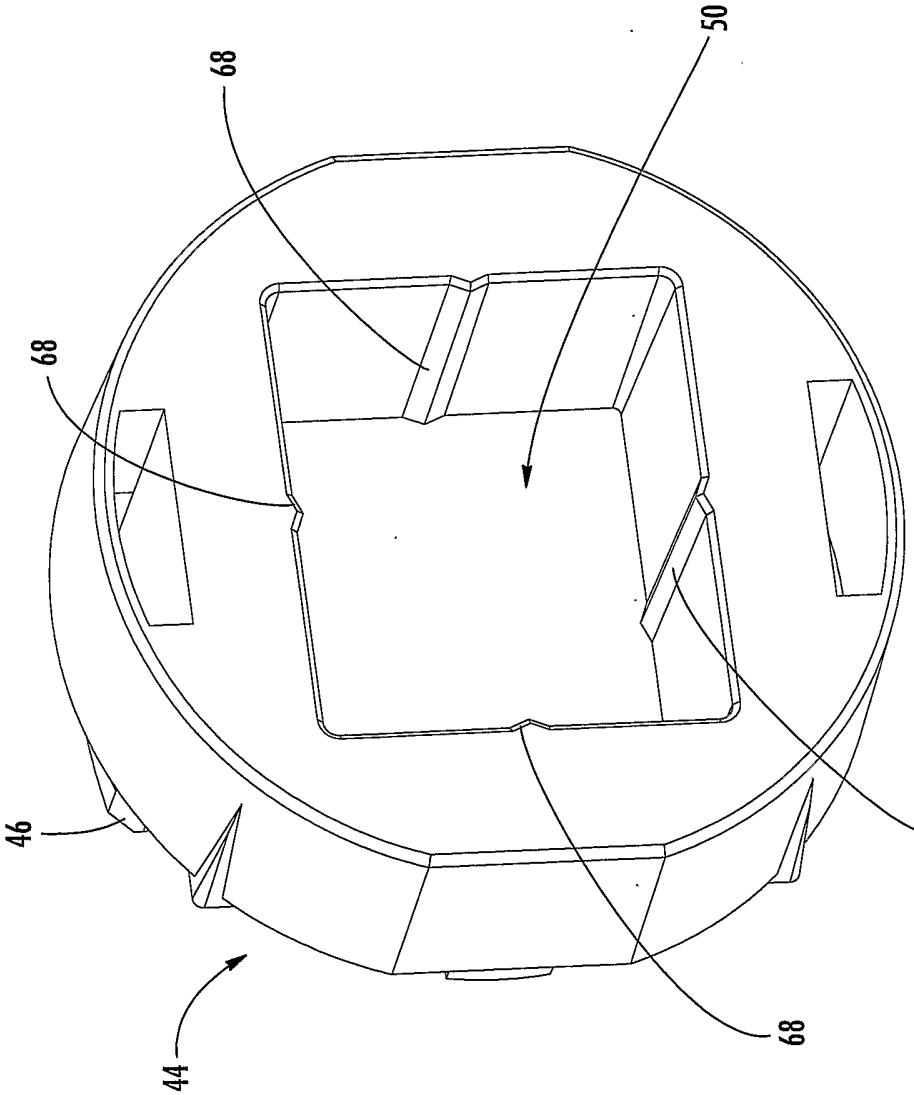


FIG. 6

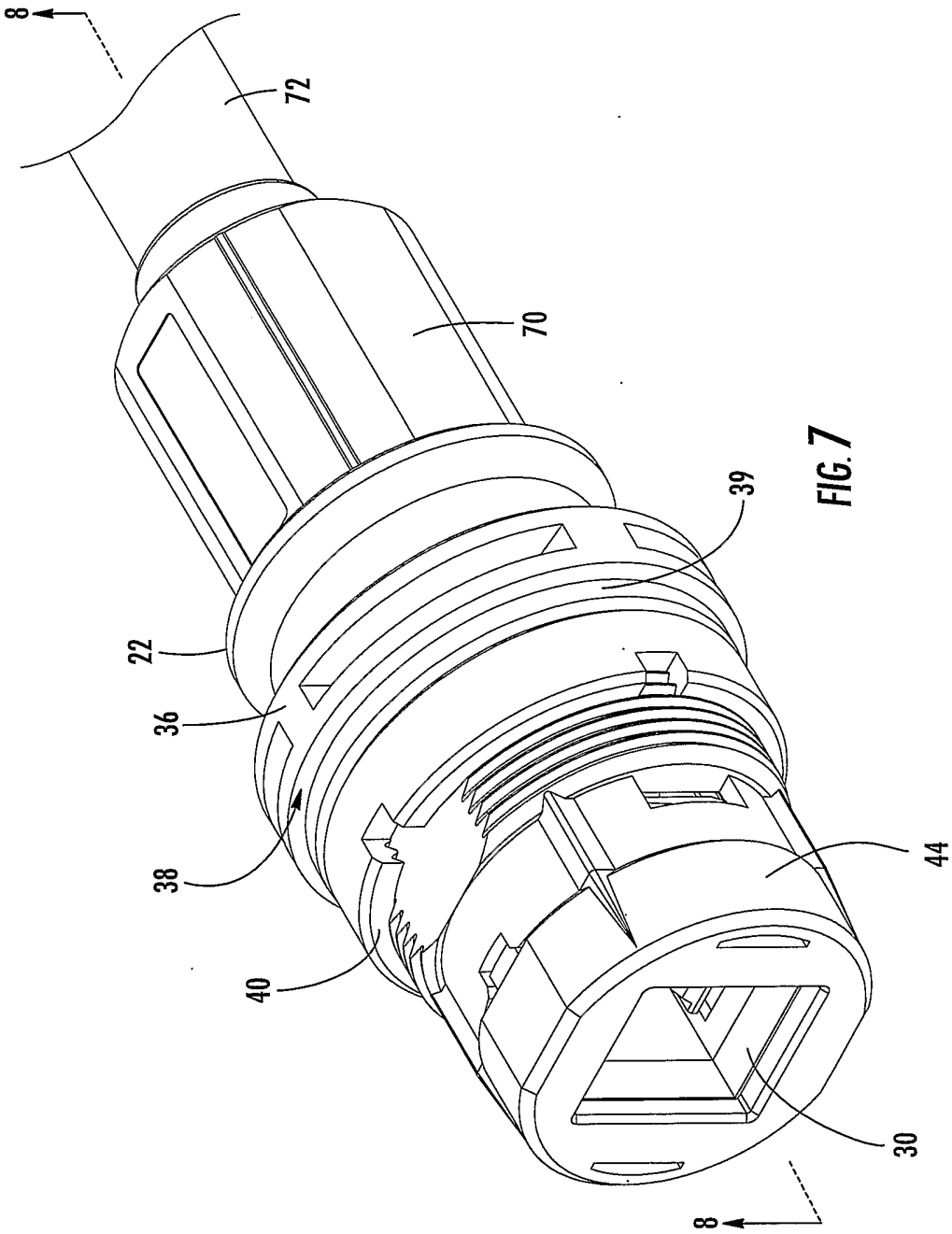


FIG. 7

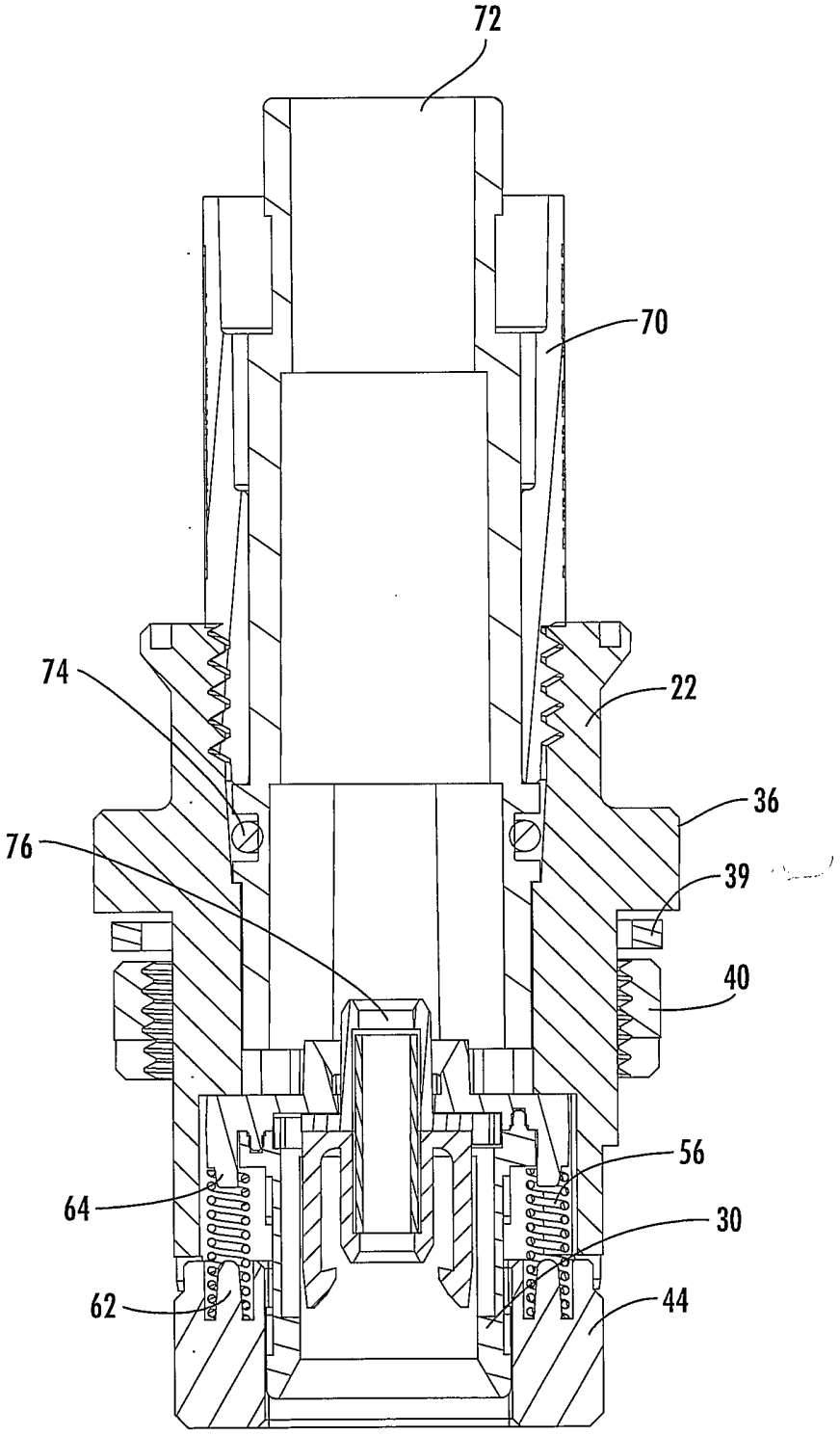


FIG. 8

INTERNATIONAL SEARCH REPORT

PCT/US2005/034539

A. CLASSIFICATION OF SUBJECT MATTER
G02B6/38

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

B. FIELDS SEARCHED

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

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 579 014 B2 (MELTON STUART R ET AL) 17 June 2003 (2003-06-17) cited in the application column 6, lines 27-51; figures column 7, lines 18-33 column 7, line 61 - column 8, line 57	1-20
X	US 5 452 390 A (BECHTEL ET AL) 19 September 1995 (1995-09-19) column 8, lines 3-11; figure 9	1
X	EP 0 375 669 A (AMP INCORPORATED) 27 June 1990 (1990-06-27) column 5, lines 33,34; figure 5	1

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

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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"&" 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 January 2006	26/01/2006

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, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Riblet, P

INTERNATIONAL SEARCH REPORT

PCT/US2005/034539

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 99/32914 A (KRONE AKTIENGESELLSCHAFT; LEES, KENNETH, LESLIE) 1 July 1999 (1999-07-01) page 5, line 21 - page 7, line 18; figures 1,4-7	1-20
A	US 5 751 874 A (CHUDOBA ET AL) 12 May 1998 (1998-05-12) figures	1-20
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