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(71) Applicant: QUICK FITTING, INC. [US/US]; 30 Plan Way, Warwick, Rhode Island 02886 (US).

(72) Inventors: CROMPTON, David B.; David B. Crompton, 12 Lambs Way, Stonington, Connecticut 06378 (US). DIAS, Libardo Ochoa; Libardo Ochoa Dias, 30 Barnold St., West Warwick, Rhode Island 02893 (US). BOUCHARD, Herbert J.; Herbert J. Bouchard, 390 Plain Road, West Greenwich, Rhode Island 02817 (US).

(74) Agent: BERGERT, Thomas F.; Thomas F. Bergert, Williams Mullen, 321 E. Main Street, Suite 400, Charlottesville, Virginia 22902 (US).

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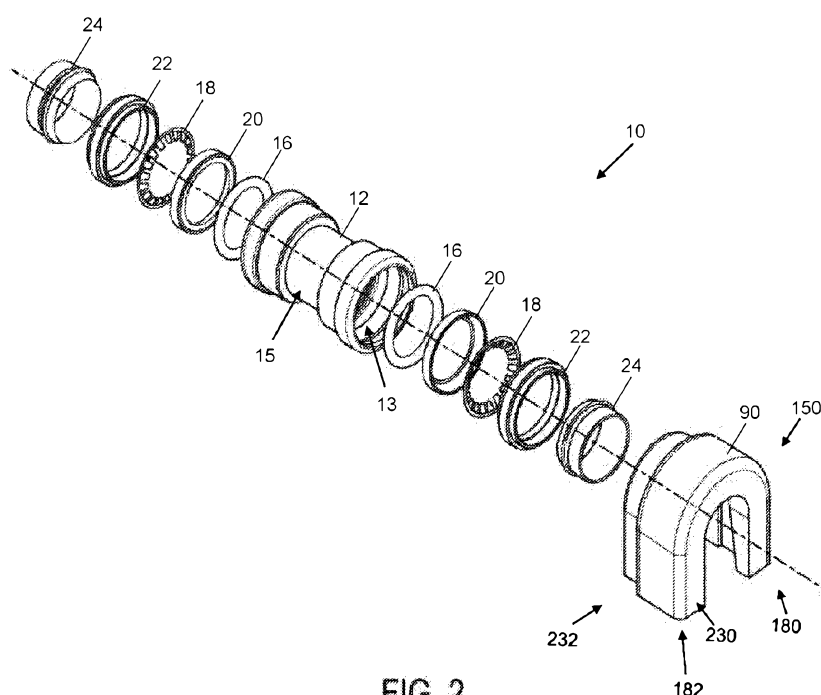


FIG. 2

(57) Abstract: A push-to-connect fitting assembly and device allows for visual inspection of proper connection through, among other things, a formed main body component that is at least partially transparent or translucent. In various embodiments, a sleeve member is movably secured around the main body component and provided with one or more transparent or translucent windows through which to confirm proper fitting connections during use.

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PUSH-TO-CONNECT FITTING ASSEMBLY AND DEVICE

TECHNICAL FIELD

The present disclosure relates to fluid flow systems, and more particularly to a push-to-connect fitting release assistance assembly and device that facilitates the simple connection, disconnection, inspection, repair and re-use of piping and tubing system parts.

BACKGROUND ART

Piping systems exist to facilitate the flow of fluids (e.g., liquid, gas (such as air) or plasma). For example, homes, schools, medical facilities, commercial buildings and other occupied structures generally require integrated piping systems so that water and/or other fluids can be circulated for a variety of uses. Liquids and/or gases such as cold and hot water, breathable air, glycol, compressed air, inert gases, cleaning chemicals, waste water, plant cooling water and paint and coatings are just some examples of the types of fluids and gases that can be deployed through piping systems. Tubing and piping types can include, for example, copper, stainless steel, CPVC (chlorinated polyvinyl chloride) and PEX (cross-linked polyethylene). For purposes of the present disclosure, the term “pipe” or “piping” will be understood to encompass one or more pipes, tubes, piping elements and/or tubing elements.

Piping connections are necessary to join various pieces of pipe and must be versatile in order to adapt to changes of pipe direction required in particular piping system implementations. For example, fittings and valves may be employed at the ends of open pieces of pipe that enable two pieces of pipe to fit together in a particular configuration. Among fitting types there are elbows, “tees”, couplings adapted for various purposes such as pipe size changes, ends, ball valves, stop valves, and partial angle connectors, for example.

In the past, pipe elements have been traditionally connected by welding and/or soldering them together using a torch. Soldering pipe fittings can be time-consuming, unsafe, and labor intensive. Soldering also requires employing numerous materials, such as copper pipes and fittings, emery cloths or pipe-cleaning brushes, flux, silver solder, a soldering torch and striker, a tubing cutter and safety glasses, for example. The process for soldering pipes can proceed by first preparing the pipe to be soldered, as the copper surface must be clean in order to form a good joint. The end of the pipe can be cleaned on the outside with emery cloth or a specially made wire brush. The inside of the fitting must be cleaned as well. Next, flux (a type of paste) can be applied to remove oxides and draw molten solder into the joint where the surfaces will be joined. The brush can be used to coat the inside of the fitting and the outside of the pipe with

the flux. Next, the two pipes are pushed together firmly into place so that they "bottom out" -- i.e., meet flush inside the fitting. The tip of the solder can be bent to the size of the pipe in order to avoid over-soldering. With the pipes and fitting in place, the torch is then ignited with the striker or by an auto-strike mechanism to initiate soldering. After heating for a few moments, if the copper surface is hot enough such that it melts when touched by the end of the solder, the solder can then be applied to the joint seam so that it runs around the joint and bonds the pipe and fitting together.

In recent years, push-fit technology has been employed with piping systems to reduce the dangers and time involved in soldering joints. Push-fit methods require minimal knowledge of pipe fittings and involve far fewer materials than soldering. For example, one may only need the pipes, quick-connect fittings, a chamfer/de-burring tool and tubing cutter in order to connect pipes using push-fit technology.

The steps involved in connecting piping systems using push-fit technology can be outlined as follows. First, the pipe is cut to the appropriate length and the end of the pipe is cleaned with the de-burring tool. Then the pipe and fitting are pushed together for connection. The fitting is provided with a fastening ring (also called a collet, grip ring or grab ring) having teeth that grip the pipe as it is inserted. The fastening ring device is employed to provide opposing energy, preventing the device from disconnection while creating a positive seal. Accordingly, no wrenches, clamping, gluing or soldering is involved. Push-fit and/or quick-connect technology for piping systems can be obtained, for example, through Quick Fitting, Inc. of Warwick, Rhode Island, USA, suppliers of the CoPro®, ProBite®, LocJaw™, BlueHawk™, CopperHead® and Push Connect® lines of push fittings and related products. Also, such technology is described, for example, in U.S. Pat. No. 7,862,089, U.S. Pat. No. 7,942,161, U.S. Pat. No. 8,205,915, U.S. Pat. No. 8,210,576, U.S. Pat. No. 8,398,122, U.S. Pat. No. 8,480,134, U.S. Pat. No. 8,844,974, U.S. Pat. No. 8,844,981, U.S. Pat. No. 9,115,833, U.S. Pat. No. 9,322,446, U.S. Pat. No. 9,416,897, U.S. Pat. No. 9,574,691 and U.S. Pat. No. 9,664,316, the disclosures of which are incorporated herein by reference in their entireties.

In past pipe coupling technology, the fastening ring is inserted into the fitting body along with a plastic grip ring support that typically fails under extensive tensile testing. Further, the coupling must then be either coin rolled, glued or receive a threaded cap member to retain the fastening ring inside the fitting body. In addition to the added steps for the manufacture and assembly of the coupling, the strength of the plumbing joint is determined by the retaining cap member. The additional steps and components add significant labor and manufacturing costs to

the final product cost and reduce the overall production capability due to the extensive time required for proper assembly.

In addition to the above, when using a threaded retaining cap method, the process of cutting threads into the fitting body and the retaining cap elevates the cost of machining the fitting components. Further, the threaded end cap method requires mechanical assembly as well as the added cost and application of a thread sealant to the threads. In prior efforts that employ a coined retaining cap method, the process of coining the fitting body as the retaining cap significantly increases the cost of final assembly of the fitting. Additionally, the coining process permanently encapsulates the fastening ring inside the fitting, whereby the fastening ring cannot be removed without complete destruction of the ring and fitting.

Along with additional assembly steps and increased manufacturing costs, past pipe fittings and connection methods do not allow visual inspection of internal seals. In some cases, fittings can be improperly sealed or only partially sealed. If an installer has not properly pushed the fitting to provide a permanent seal, fluid can leak, causing great damage and cost. Imperfections or scarring in the tubing being inserted also presents an opportunity for the connection to leak following compression. In many installation environments, installers take work breaks or otherwise become distracted as to which fittings within a group of press fittings have been properly compressed and which have been either improperly compressed or not at all. When this happens, there has been no simple and fast way (other than catastrophic failure or leakage) to determine which fittings have been properly pushed, which can result in lost time spent determining which fittings need to be pushed or in damage in the application environment.

Past pipe fittings and connection methods further do not allow repair for various reasons. In some cases, this is because they are factory sealed, for example. In other cases, it is because the separation of the fitting from the pipe can damage or induce wear on the parts. For example, some push-to-connect fittings provide permanently fixed demounting rings for removing the fittings. The demounting rings can be depressed axially to lift the fastening ring teeth off of the surface of the inserted pipe, such that the pipe can then be withdrawn. This arrangement, however, can subject the fittings to tampering and shorter life. In addition, while fastening ring devices work effectively as an opposing retaining member, their functionality makes them nearly impossible to dismount, remove or detach for re-use. The fastening rings are thus permanently affixed unless they are cut and removed, which then destroys the fastening ring.

Whether connected by traditional soldering methods or with push-fit methods, past efforts have been specifically provided for the connection of like materials and lack the ability to connect two unlike materials, such as copper with CPVC, PEX or stainless steel, or any other

combination of unlike materials. Past methods further invariably require the replacement of fittings and valves, and do not allow re-use of the fittings or valves in instances where only a small internal component needs to be repaired or replaced.

SUMMARY

5 The present disclosure relates to, in part, a push fitting assembly package that facilitates the inspection and re-use of push fittings without damage to the fitting elements or the pipe. Piping can be connected according to the present disclosure using no tools, clamps, solder or glues, while creating a leak-free seal at the connected joining area, and permitting visual inspection through the main body component.

10 The quick connection pipe joint assembly package provided as part of the present disclosure employs a release pusher member that, when removed, exposes the clamping, sealing and fastening mechanisms of the fitting. The release pusher member, also called the “release pusher” moves axially and can push the fastening ring of the present invention in order to facilitate the release of a cylindrical object such as a piping element held within the fitting.

15 The device and assembly of the present disclosure, in part, assists in permitting visual inspection to assist an individual in determining whether a piping element such as a fitting has been pushed to a proper seal. In embodiments described herein, a fitting is provided having a main body component which can be fully or partially transparent or translucent. In
20 embodiments, the main body component can be fully transparent or translucent, and a rotatable, generally opaque outer sleeve provided to permit visual inspection of one or more windows to the main body component. In these ways, an installer, inspector or other individual can visually determine very quickly whether a fitting has been properly pushed, and whether there is a proper and complete seal.

25 For purposes of the present disclosure, a fitting (also referred to as a body member) can encompass a valve member and other piping elements including, but not limited to: a coupling joint, an elbow joint, a tee joint, a stop end, a ball valve member, tubing and other objects with cylindrical openings. In various embodiments disclosed herein, one or more sealing member gasket inserts (e.g., O-ring members) fits within a first sealing ring compartment defined in the interior wall of the fitting. In addition, at each pipe receiving end of the fitting, a tube support
30 member compartment is machined into the interior wall to retain at least a portion of the body of the fastening ring. The interior compartments provide integrated support for the sealing member(s) and fastening ring when opposing force is applied to piping elements that have been inserted into the fitting. In various embodiments, a tube support member is employed to provide

additional support for the fastening ring and to cooperate with the release pusher to facilitate connection and disconnection of piping elements with less required force.

The release pusher provided as part of the present disclosure is employed to facilitate the release of tubing, piping and other cylindrical objects inserted into a fitting. In various
5 embodiments, a clip device acts to push and release the release pusher into/from the cavity
formed by the tube support member within the fitting body. When it is desired to release an
inserted pipe, for example, from the fitting, the release pusher can be forced in the direction of
the fastening ring such that its angular surfaces depress the fastening ring teeth off of the surface
of the inserted pipe, thereby allowing the pipe to be removed. The clip is provided with a body
10 portion and leg portions adapted to provide increasing pressure on the axially outer edge of the
release pusher as the clip is secured in place around the outside of the fitting. Similarly, when
the clip is removed, pressure on the release pusher is gradually decreased, thereby releasing the
pusher from the fastening ring teeth to allow the teeth to securely retain any inserted pipe within
the fitting. The fitting body is adapted for optimal mechanical connection with the clip device
15 while maintaining proper functioning of internal components maintained within different
interior portions of the fitting as described in more detail hereinafter. In various embodiments,
the clip member can be operated by a user so as to be able to manipulate the release pusher
within the fitting with one hand, while the other hand can insert and/or remove a pipe element.

BRIEF DESCRIPTION OF THE DRAWINGS

20 Fig. 1 is an exploded front perspective view of one embodiment of a fitting assembly in
accordance with the present disclosure.

Fig. 2 is an exploded front perspective view of an embodiment of a fitting assembly in
accordance of the present disclosure with inserted package elements in one portion of the fitting.

Fig. 3 is a front cross-sectional view of one embodiment of a fitting assembly in
25 accordance with the present disclosure with inserted fitting elements.

Fig. 4 is a view similar to Fig. 3 with no inserted fitting elements.

Fig. 5 is an end view of a tube support member in accordance with embodiments of the
present disclosure.

Fig. 6 is a right side cross-sectional view taken along the line 6-6 of Fig. 5.

30 Fig. 7 is a detailed cross-sectional view of encircled portion 7-7 of Fig. 6.

Fig. 8 is an end view of a release pusher in accordance with embodiments of the present
disclosure.

Fig. 9 is a right side cross-sectional view taken along the line 9-9 of Fig. 8.

Fig. 10 is a detailed cross-sectional view of encircled portion 10-10 of Fig. 9.

Figs. 11 through 13 are front cross-sectional views of different stages of advancement of a clip device in accordance with embodiments of the present disclosure as it is secured around a fitting end and engages a release pusher in accordance with embodiments of the present disclosure.

5 Fig. 14 is a front view of a clip device in accordance with embodiments of the present disclosure.

 Fig. 15 is a right side cross-sectional view taken along line 15-15 of Fig. 14.

 Fig. 16 is a right side cross-sectional view of an alternative embodiment of the clip member of the present disclosure.

10 Fig. 17 is a perspective view of the embodiment of the clip member of Fig. 16.

 Fig. 18 is an exploded front perspective view of another embodiment of a fitting assembly in accordance with the present disclosure.

 Fig. 19 is an exploded front perspective view of the embodiment of Fig. 18 with inserted packing elements in one portion of the fitting.

15 Fig. 20 is a front cross-sectional view of one embodiment of a fitting assembly in accordance with the present disclosure with inserted fitting elements.

 Fig. 21 is a front photographic view of another embodiment of a fitting assembly in accordance with the present disclosure with inserted fitting elements and an inserted pipe or tubing element.

20 Fig. 22 is a view similar to Fig. 21, with a sleeve member around the fitting in accordance with embodiments disclosed herein.

MODES FOR CARRYING OUT THE INVENTION

 In the push-to-connect fitting assembly 10 according to embodiments of the present disclosure as shown in Figs. 1 and 2, elements of the assembly as shown include: a fitting (i.e.,
25 fitting body member or main body component) 12 having an interior wall 13 and exterior wall 15, a fastening ring 18, one or more sealing members 16 (which can be optionally lubricated), a sealing ring support member 20, a tube support member 22 and a release pusher 24. The fastening ring 18 and sealing member 16 together provide one embodiment of a packing arrangement for the present disclosure, and each has an internal diameter that allows for smooth
30 and snug engagement of a piping or tubing element external surface (not shown) when inserted into the opening 55. The fitting 12 inner wall defines a pipe receiving opening 55 extending axially therethrough along axis 25. In one embodiment, the interior diameters of the fastening ring 18 (as measured to the teeth 19 and not the ring cylindrical base 17) and sealing member 16 are substantially the same, and the interior diameters of the fitting 12 and the release pusher 24

are substantially the same. Further, the interior diameters of the fastening ring 18 and sealing member 16 are slightly less than that of the fitting 12 and release pusher 24 so as to facilitate proper operation of the present disclosure. The release pusher 24 is substantially cylindrical and includes an external tip 26 at the fastening ring engaging end thereof, as shown in Figs. 9 and

10, for example.

As further shown in Figs. 3 and 4, the main body component 12 includes first 30 and second 31 segments, divided by a tube stop 29. The tube stop 29 extends radially inwardly of the inner surface 13 in order to provide a stopping surface for inserted tubes and pipes. Each of the first 30 and second 31 segments includes an axially inner portion 32, an axially intermediate portion 34 and an axially outer portion 36, with the axially inner portion 32, axially intermediate portion 34 and axially outer portion 36 being monolithically formed and each having a respective interior wall 42, 44, 46, exterior wall 52, 54, 56, interior radius **R2**, **R3** and/or **R4**, **R5** and an exterior radius **R6**, **R7**, **R8**, wherein the exterior radius **R7** of the axially intermediate portion 34 is larger than the exterior radius **R6** of the axially inner portion 32, and wherein the exterior radius **R8** of the axially outer portion 36 is larger than the exterior radius **R6** of the axially inner portion 32 and the exterior radius **R7** of the axially intermediate portion 34. In this way, and among other things, the present disclosure provides a greater sized opening at the pipe or tubing entry area 55 on the fitting 12 and a tighter opening within the axially inner portion 32. In addition, the sizing and spacing of the axially inner 32, intermediate 34 and outer 36 portions provides greater surface area and resistance and/or gripping surfaces for the clip device 90 as described in greater detail hereinafter. As shown in Fig. 4, a first ridge 51 extends radially outwardly from the outer wall 15 from a wall segment 60 forming a boundary for the axially inner portion 32 to a wall segment 62 forming a boundary for the axially intermediate portion 34. A second ridge 53 extends radially outwardly from wall segment 62 to a wall segment 64 forming a boundary for the axially outer portion 36. The first ridge 51 and the wall segment 62 form a first exterior wall portion 250 of the fitting, and the second ridge 53 and the wall segment 64 form a second exterior wall portion 252 of the fitting, as shown in Figs. 3, 4, 10 and 11, for example. It will be appreciated that the main body component 12 can be formed without the first 51 and second 53 ridges, thereby providing a main body component having a substantially even outer surface of substantially constant external radius from the axis 25.

As further shown in Figs. 3 and 4, the axially outer portion 36 of the first segment 30 terminates in an axially outer rim 38 that extends radially inwardly of the interior wall 13. In various embodiments, the axially outer rim 38 has an internal radius **R1** that is substantially the same as the axially intermediate portion internal radius **R3** or **R4**. In various other

embodiments, the radially inner edge 39 of the axially outer rim 38 is sloped such that the radius varies from a shorter size at the axially inner edge 40 of the radially inner edge 39 to a longer size at the axially outer edge 41 of the radially inner edge 39 of the axially outer rim 38. In this way, the opening formed by the inner edge 39 for a pipe or tubing element to be inserted is more receptive to insertion angles of a pipe or tubing element that may not be perfectly aligned with the axis 25.

As further shown in Figs. 3 and 4, the interior radius **R3** or **R4** of the axially intermediate portion 34 is larger than the interior radius **R2** of the axially inner portion 32, and the interior radius **R5** of the axially outer portion 36 is larger than the interior radius **R2** of the axially inner portion 32 and the interior radius **R3** or **R4** of the axially intermediate portion 34. Additionally, the axially intermediate portion 34 can be provided with a radial step 43 extending radially inwardly such that the axially intermediate portion 34 includes a first interior wall portion 44A having an internal radius **R3** and a second interior wall portion 44B having an internal radius **R4**, where the portions 44A and 44B are separated by the radial step 43. As described elsewhere herein, the radial step 43 assists in providing an engaging surface for the sealing ring support member 20 as part of the packing arrangement provided in accordance with aspects of the present disclosure.

As shown in Figs. 3 and 4, a sealing ring 16 is maintained against ridge 51 and within the first interior wall portion 44A of the axially intermediate portion 34 of the main body component 12, and a sealing ring support member 20 is maintained partially within the first interior wall portion 44A and partially within the second interior wall portion 44B of the axially intermediate portion 34 of the main body component 12. In one embodiment of the present disclosure, a second O-ring or sealing ring can be positioned adjacent the first sealing ring.

As shown in Fig. 3, for example, the tube support member 22 is maintained against rim 38 and partially within the interior wall 46 of the axially outer portion 36 of the main body component 12 and partially within the second interior wall portion 44B of the axially intermediate portion 34 of the main body component 12. As shown in Figs. 5 through 7, the tube support member 22 has a radially interior surface 80, against which the release pusher 24 is slidably maintained during operation. The tube support member 22 includes an axially inner edge 82, a retaining lip 111, an axially inner wall segment 112 as part of the radially interior surface 80, and an axially outer wall segment 113 as part of the radially interior surface. The tube support member 22 further includes a radially outer surface 84 comprising an axially inner segment 87, an axially intermediate segment 88 and an axially outer segment 86. As shown in Fig. 7, the axially intermediate segment 88 extends radially outward further than the radial

outward extension of the axially inner 87 and outer 86 segments. Further, the axially inner segment 87 extends radially outward further than the radial outward extension of the axially outer segment 86. In this way, the tube support member outer surface 84 can substantially mate with the inner surface 13 of the fitting 12, as the axially outer segment 86 lies in substantially flush engagement with the radially inner edge 39 of the axially outer rim 38, the axially intermediate segment 88 lies in substantially flush engagement with the interior wall 46 of the axially outer portion 36 of the fitting, and the axially inner segment 87 lies in substantially flush engagement with the interior wall portion 44B of the axially intermediate portion 34 of the fitting 12, as shown in Fig. 3. The tube support member 22 further includes a first wall member 89 extending from the axially inner segment 87 to the axially intermediate segment 88, and a second wall member 91 extending from the axially outer segment 86 to the axially intermediate segment 88. In embodiments of the present disclosure, the tube support member 22 can comprise a spring steel formulation, and can be provided as a unitary, unsplit member or can be provided with a split similar to the embodiment of the fastening ring described elsewhere herein.

A fastening ring 18 is maintained within the second interior wall portion 44B of the axially intermediate portion 34 of the main body component 12, with the fastening ring base 17 being held between an axially inner edge 82 of the tube support member 22 and an axially outer edge 85 of the sealing ring support member 20. The fastening ring 18, which can be an integral, unsplit ring or can be a split ring member, has a substantially circumferential base 17 with teeth 19 extending radially inwardly therefrom. In the embodiments where the fastening ring is a split ring, the fastening ring can include two circumferential end points (not shown) that do not connect, with fixture points for handling and compressing the fastening ring, such that a tool designed to hold the fastening ring at the fixture points can more easily handle and compress the fastening ring in order to assist with assembly or disassembly of embodiments of the present disclosure. In this embodiment, and once compressed, the fastening ring is easily insertable into the fitting 12 by releasing the hold on the fixture points, thereby allowing the fastening ring to expand such that the circumferential base engages the walls of the second radial housing element. The fastening can be removed from the second radial housing element in similar manner. No wrenches, solder, welding, glue and/or twisting and turning the elements are required to form or disengage a connection.

The fastening ring 18 can comprise a spring steel formulation, for example, that enables the fastening ring to be malformed during installation, while springing back into its originally manufactured position once installed. The fastening ring is capable of grabbing an inserted pipe's surface via two or more teeth 19 to ensure connections cannot be pulled apart. The

fastening ring teeth are angled downward from the substantially cylindrical perimeter of the ring, toward the axially inner portion 32 and away from the axially external portion 36, such that when a pipe is inserted, the teeth exert a pressure against the pipe to discourage the pipe from slipping or moving back out of the fitting. No wrenches, solder, welding, glue and/or twisting and turning the elements are required to form a connection. Specifically, the combination of the fastening ring, an O-ring support member, a tube support member and release pusher provide a push-fit piping assembly when inserted into any cylindrical pipe fitting in accordance with one embodiment of the present disclosure. As shown in Figs. 1 through 4, the fastening ring 18 includes a substantially cylindrical base 17 that has a plurality of bifurcated or square edged teeth 19 extending inwardly from and along the base 17. The teeth 19 of the fastening ring 18 can extend at various angles from the base axis as measured when the teeth are at rest position and are not stressed by the insertion of a pipe, for example. The number of teeth can readily vary in number and size.

In one embodiment, the fitting 12 can be forged CW617N brass, with full porting and full flow fitting, for example. The lubricant for the sealing members 16 can be a food grade lubricant, for example. It will be appreciated that the sealing members 16 can comprise a flat ring or washer-type seal member in addition or as an alternative to a circular member of substantially circular cross-section. As shown in Figs. 1 and 3, the sealing ring support member 20 has a circumferential base 92, an axially inner edge 93 that acts as a sealing member-engaging surface and an axially outer edge 85 that acts as a fastening ring-engaging surface. The sealing ring support member 20 can be comprised of metal or plastic, for example.

As shown in Figs. 8 through 10, for example, the release pusher 24 is substantially cylindrical and includes an outer wall 65, an inner wall 66, a back edge 67 and a leading tip 26. In various embodiments, the outer wall 65 comprises a leading segment 68, a recessed segment 69 and a trailing segment 70. In various embodiments of the release pusher 24 of the present disclosure, the leading segment 68 comprises a single linear segment from a radially outer ledge 71 to the leading tip 26. In various other embodiments, as shown in Fig. 10, a first leading outer wall segment 72 extends linearly at a first angle from the radially outer ledge 71 to a leading outer wall intermediate point 73, and a second leading outer wall segment 774 extends linearly from the outer wall intermediate point 73 to the leading tip 26 at a second angle. Further, in various embodiments, the release pusher recessed segment 69 lies radially inwardly of the trailing segment 70 and the radially outer ledge 71, with an outer ledge back wall 74 extending from the outer ledge 71 to the recessed segment 69, and with a trailing segment front wall 75

extending from the trailing segment 70 to the recessed segment 69, as shown in Fig. 10, for example.

The release pusher 24 can comprise an injection-molded plastic material or a metal material such as brass, for example. When pressure is applied on the back edge 67 of the release pusher 24, the leading tip 26 can engage the inside surface of the fastening ring teeth 19, and the outer ledge back wall 74 can removably engage a retaining lip 111 of the tube support member 22, as shown in Fig. 3. As the release pusher 24 is inserted into the fitting 12, the radially outer ledge 71 is crimped somewhat as it slides along the axially outer wall segment 113 of the tube support member 22. The recessed segment 69 provides sufficient resilience to allow the outer ledge 71 to flex backwardly and away from tip 26 as the release pusher is inserted into the fitting. Once the outer ledge 71 passes the retaining lip 111 of the tube support member, the outer ledge 71 expands such that the outer ledge back wall 74 lies in substantially flush engagement with the retaining lip 111 and the outer ledge 71 lies in substantially flush engagement with the axially inner wall segment 112 of the tube support member 22. In this way, the release pusher 24 is held in place against the tube support member 22 within the fitting 12, as shown in Fig. 3. The acute angle formed between the retaining lip 111 and the axially inner wall segment 112 of the tube support member 22 assists in retaining the release pusher 24 with a stronger retaining force and much higher “failure pressure”, meaning the release pusher requires a much higher pulling pressure before it will fail and/or break out of the retained position during testing.

The trailing segment 70 of the release pusher 24 is slidably engaged with the axially outer wall segment 113 once the release pusher 24 is inserted, and this slidable engagement assists the release pusher 24 in traveling substantially along the axis 25 of the fitting during operation. During removal, a tool such as a specially adapted wrench, for example, can be applied to the outer top surface of the release pusher so as to exert a pushing and lifting force that causes the release pusher outer ledge 71 to disengage the retaining lip 111. Once the release pusher is removed, the internal packing arrangement components are exposed for removal and/or replacement as necessary or desired.

As shown in Figs. 1, 2 and 11 through 15, the clip device 90 in accordance with embodiments of the present disclosure includes a base portion 150 having a substantially semi-circular body portion 151 that is provided with a first body portion end 152, a second body portion end 154 and a body wall 156. The body wall 156 has an interior surface 158 and an exterior surface 160, with the body wall interior surface 158 defining a cavity 161 extending axially through the base portion 150. The body portion 151 further has an end wall 164

extending radially inwardly of the interior surface of the body wall 156, with the end wall 164 having an outer surface 165, an inner surface 168 and a medial surface 170. As shown in Figs. 11 through 15, the clip device 90 also includes a first leg portion 180 extending from the first body portion end 152 and having a radially outer surface 173, a radially inner surface 174, a posterior axially outer surface 171, a posterior axially inner surface 172, a posterior medial surface 175, a first leg portion top portion 176 and a first leg portion bottom portion 178, wherein the posterior medial surface 175 has a width that tapers from a first width **W1** at the first leg portion top portion 176 to a second width **W2** at the first leg portion bottom portion 178, such that the first width **W1** is greater than the second width **W2**. As shown in Figs. 1 and 11 through 15, the second leg portion 182 extends from the second body portion end 154 and has a radially outer surface 184, a radially inner surface 186, a posterior axially outer surface 188, a posterior axially inner surface (shown at 772 in Fig. 17), a posterior medial surface 190, a second leg portion top portion 192 and a second leg portion bottom portion 194, wherein the posterior medial surface 190 has a width that tapers from a wider dimension at the second leg portion top portion 192 to a smaller dimension at the second leg portion bottom portion 194, similar to that shown for the first leg portion 180 in Fig. 15.

The base portion 150, first leg portion 180 and second leg portion 182 are of unitary construction, and thereby form a monolithic device. The first leg portion posterior axially outer surface 171, posterior axially inner surface 172 and posterior medial surface 175 extend from the end wall 164 of the body portion 151, and the second leg portion posterior axially outer surface 188, posterior axially inner surface (shown at 772 in Fig. 17) and posterior medial surface 190 extend from the end wall 164 of the body portion 151. In various embodiments, as shown in Figs. 1 through 2, the first leg portion 180 and second leg portion 182 extend from the base portion 150 in substantially parallel relation. As such, the leg portions 180, 182 are substantially mirror images of one another.

In various embodiments, as shown in Fig. 11, for example, the body wall interior surface 158 and the end wall inner surface 168 help define a clip axially outer end engaging compartment 200. As shown in Fig. 13, the body wall 156 includes a posterior portion 210 and an anterior portion 212, the first leg portion 180 includes a posterior portion 220 and an anterior portion 222, and, as shown in Fig. 2, the second leg portion 182 includes a posterior portion 230 and an anterior portion 232. As shown in Fig. 13, the body wall anterior portion 212 extends radially inwardly of the body wall posterior portion 210. The body wall anterior portion 212 further includes a radially inner surface 214 and an axially outer wall 216, wherein the body wall

anterior portion radially inner surface 214 helps define a fitting axially interior engaging compartment 218.

As further shown in Figs. 11 and 12, the body wall 156 includes a lead wall 211 extending radially inwardly of the axially interior portion of the body wall anterior portion radially inner surface 214, with the lead wall 211 including an outer surface 215, an inner surface 217 and a medial surface 219, and wherein the lead wall inner surface 217 and the body wall anterior portion radially inner surface 214 further define the fitting axially interior engaging compartment 218. The axially outer wall 216 of the body wall anterior portion 212 further defines the fitting axially outer end engaging compartment 200, along with the body wall interior surface 158 and the end wall inner surface 168.

As shown in Fig. 13, the first leg portion 180 includes an anterior axially outer surface 223, an anterior axially inner surface 224, and an anterior medial surface 225 extending from the lead wall 211. The second leg portion 182 includes an anterior axially outer surface 523, an anterior axially inner surface 524, and an anterior medial surface 525 (all shown in Fig. 17) extending from the lead wall 211, and these elements are substantially mirrored versions of their counterparts 223, 224 and 225, respectively, of the first leg portion 180. As shown in Fig. 13, the first leg portion anterior medial surface 225 and the lead wall 211 have a width **W3**, and this width **W3** is less than the widths **W1** and **W2** of the first leg portion posterior medial surface 175 shown in Fig. 15, in various embodiments of the present disclosure. The second leg portion 182 includes an anterior medial surface of similar width such that the leg portions are substantially uniform and mirror images of one another. It will be appreciated that the width dimension **W3** is sufficient to provide locking and/or retaining force when the leg portions 180, 182 are positioned downwardly about a main body component 12, as shown in Figs. 11 through 13, for example. It will also be appreciated that the widths **W1** and **W2** are of sufficient dimension to provide an axially inward pushing force to the end 67 of the release pusher 24 as external force is applied to the clip 90 along the outer surface 160 of the body wall 156, as illustrated by the sequence in Figs. 11 through 13.

As shown in Figs. 11 through 13, the interior surfaces 217, 214, 158 and 168 are adapted to engage the first 250 and second 252 exterior wall portions of the main body component 12. As force is applied to the outer surface 160 of the body wall 156, the posterior axially inner surfaces (e.g., 172 of first leg portion 180) contacts the end 67 of the release pusher member 24 so as to influence axial sliding movement of the release pusher member 24 within the cavity 55. As shown in Figs. 11 through 15, the release device base portion 150 has a substantially semi-circular body portion 151 having a first body portion end 152, a second body portion end 154

and a body wall 156, wherein the end wall 164 has an outer surface 165, an inner surface 168 and a medial surface 170. In various embodiments, the interior surface 217 extends radially inwardly of the body wall anterior portion radially inner surface 214 at a substantially perpendicular angle, as shown in Figs. 11 through 13. In various other embodiments, as shown in Fig. 16, for example, the interior surface 217 extends radially inwardly of the body wall anterior portion radially inner surface 214 at a substantially obtuse angle, such that the interior surface 217 engages and directly abuts ridge 51 substantially along the entire external surface of the ridge 51 when engaged with the fitting.

In operation, the main body component 12 of the present disclosure is provided and one or more sealing members 16 are inserted into the axially intermediate portion 34 of the main body component 12 and retained against the first interior wall portion 44A thereof. Next, the sealing ring support member 20 is inserted so as to fit snugly within the axially intermediate portion 34 of the main body component 12, and retained against the first 44A and second 44B interior wall portions. The support member 20 abuts the sealing ring member 16, as shown in Fig. 3, for example. The fastening ring 18 is then inserted such that its base 17 is securely retained against the second interior wall portion 44B of the axially intermediate portion 34 of the main body component 12, and the base is further securely retained between the sealing ring support member 20 and the tube support member 22. The tube support member is inserted so as to be retained in the axially outer portion 36 and the second interior wall portion 44B of the axially intermediate portion 34 of the main body component, as well as against the inner wall of the outer rim 38 of the main body component 12. The release pusher is then inserted as described above. The clip 90 is then positioned around the external surfaces 250, 252 of the main body component 12, and as force is applied, the leg posterior axially inner surfaces (e.g., 172) push the edge 67 of the release pusher 24 axially inwardly so as to slide inwardly along the inner surface of the tube support member 22 and thereby push the teeth 19 of the fastening ring 18 axially inwardly. In this way, sufficient room is created for a pipe member to be inserted.

In an alternative embodiment of the clip 90, as shown in Figs. 16 and 17, the leg posterior axially inner surface 172 does not extend to the inner wall 244 of the axially outer end engaging compartment 200 of the clip 90, as it does in the embodiment shown in Figs. 11 through 15. Rather, it extends towards wall 244 and meets a leg platform 255 which extends radially inwardly of wall 244. Thus, in this embodiment, the end wall 164 of the body portion 151 of the clip 90 extends to the top portion 176 of leg portions 180 and 182, and then the radially exterior portion 259 of the end wall 164 extends in the form of leg platforms 255 to the bottom portion 178 of leg portions 180, 182. Further, the radially interior portion 258 of the end

wall 164 extends to the top portion 176 of leg portions 180, 182, and then the leg portions 180, 182 extend to respective bottom portions 178 in sloped fashion, as shown and described with regard to Fig. 15 above and in connection with widths **W1** and **W2** shown therein. Leg platforms 255 include a rim engaging surface 270 and a riser surface 272 extending from the posterior axially inner surfaces 172 of the legs 180, 182 to the rim engaging surface 270. As shown in Figs. 16 and 17, the rim engaging surface 270 is coplanar with the interior surface 168 of the wall 164.

In this way, as the clip 90 is positioned around the main body component 12, and as force is applied, the leg posterior axially inner surfaces 172 push the edge 67 of the release pusher 24 axially inwardly while the rim engaging surfaces 270 of the leg platforms 255 engage the axially outer rim 38 of the main body component 12. The extra engagement of the leg platforms 255 with the main body component 12 enhances stability and effectiveness of the clip 90 during operation. It will be appreciated that the action of the clip 90 in pushing the edge 67 of the release pusher 24 creates room for a pipe member to be inserted similar to that described above.

When a pipe is inserted, it travels through the release pusher 24 into the pipe receiving cavity 55 of the main body component 12, engaging the fastening ring 18 and the sealing member 16. When the pipe is fully inserted (i.e., when the leading edge of the pipe contacts tube stop 29), the clip 90 can be raised away from the main body component 12, allowing the release pusher 24 to return to its relaxed and engaged position with the retaining lip 111 of the tube support member 22. In this position, the teeth 19 of the fastening ring 18 engage the side walls of the inserted pipe in order to retain the pipe securely within the main body component 12. The sealing members provide a strong, leak-free seal and the combination of the sealing ring support member 20, the fastening ring 18 and the tube support member 22 prohibits any inclination an inserted pipe may have to slide out of position. It will be appreciated that the elements of the present disclosure permit a user to manually hold the clip 90 and the fitting 12 in one hand, apply pressure to the clip 90 with the same hand, such that the pressure is transferred to the release pusher 24 and thus the fastening ring teeth 19. A pipe held in the user's other hand can then be inserted or withdrawn while the fastening ring teeth 19 are in the extended position caused by the release pusher pressure. Once the pipe is either inserted or removed, the user can release the pressure being applied to the clip 90 using the same hand that has been holding the clip and fitting, to thereby release the pressure being applied by the release pusher on the fastening ring teeth 19.

The angles, dimensions and materials described herein will be understood to be exemplary and provided as embodiments associated with proper working operation of the present disclosure. Further, it will be appreciated that, in one embodiment of the present disclosure, the members of the push connect joint assembly can be formed through

5 hydroforming processes. Additionally, embodiments of the present disclosure can be provided whereby the fitting and/or main body component includes independent packing arrangements on both sides of the tube stop 29, where the packing arrangements comprise at least two of the following: sealing ring, sealing ring support member, fastening ring, tube support member, release pusher, as shown in Figs. 2 and 3, for example.

10 In various embodiments, tube support member 22 can comprise a single piece construction or a multi-piece construction. Figs. 2 and 3 show a single piece construction for tube support member 22. In the push-to-connect fitting assembly 400 according to Figs. 18 through 20, a multi-piece tube support member is shown, including o-ring support member 22A and pusher support member 22B.

15 In the push-to-connect fitting assembly 400 according to Figs. 21 and 22, the main body component 12 is shown as a fully translucent body. In various embodiments, this translucent body is formed of a polymer, such as a plastic resin. An exemplary material for fabrication of this embodiment of the main body component is the polysulfone material, particularly such material marketed under the Udel® brand, commercially available from Solvay Specialty
20 Polymers USA, L.L.C. of Alpharetta, Georgia, USA. Such materials offer a superior combination of high-performance properties that include: excellent thermal stability, high toughness and strength, good environmental stress cracking resistance, high heat deflection temperature (e.g., 345°F), combustion resistance, transparency or translucency, approved for food contact and potable water, and low creep. The transparent and/or translucent aspect of the
25 main body component permits visual confirmation that the fitting has been properly connected. In various embodiments, the main body component 12 can be formed by extrusion or through injection molding.

As can be seen in Figs. 21 and 22, the inserted tubing 440 is colored or shaded, and can be seen through the main body component 12 as at 442, wherein it abuts the tube stop element
30 indicated at 29 in Fig. 21. By permitting visual inspection of a proper seal, the present disclosure assists in the initial connection operation as well as in later inspection of connections to confirm the fitting and inserted tubing are properly sealed.

In the embodiment of the assembly 400 shown in Figs. 18 through 20, the main body component 12 can be provided as partially translucent or transparent, with windows 412 being

translucent or transparent, and opaque sections 414 not being translucent or transparent. As shown in Fig. 22, a sleeve member 488 can also be provided that fits over the main body component 12, wherein the sleeve 488 can be rotated about the common axis so as to provide for inspection of the seal at one or more sections at a time, as at 482 and 484. The sleeve member 488 is thus movably secured about the exterior wall of the main body component 12. In such embodiments, the main body component 12 can be fully transparent, fully translucent, partially transparent or partially translucent.

In various embodiments, the sleeve 488 can be formed of a plastic material, and can have an opaque cylindrical wall 485 formed with a connecting strip 487 so as to provide one or more open windows therein, as at 482 and 484. In some embodiments, the strip 487 divides two windows formed of a transparent or translucent material.

In various embodiments, whether the main body component 12 is transparent or translucent, the packing arrangement is visible through the interior and exterior walls of the main body component 12. In various embodiments, the packing arrangement is not visible through the interior and exterior walls of the main body component 12, but the axially inner portion 32 of the main body component 12 is either partially or fully transparent or translucent. In such cases, the axially inner portion 32 of the main body component 12 is opaque, as shown at 414 in Fig. 19. In this way, the user can view an inserted tube through the main body component 12 to assess whether it has been inserted properly.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the claims of the application rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

CLAIMS:

1. A fitting, comprising:

a main body component having an interior wall and an exterior wall, wherein the interior wall defines a cavity extending along an axis through the main body component, wherein the main body component includes a first segment having an axially inner portion, an axially intermediate portion and an axially outer portion, with the axially inner portion, axially intermediate portion and axially outer portion being monolithically formed and each having a respective interior radius from the axis to the interior wall, with the interior radius of the axially inner portion being less than the interior radius of the axially intermediate and axially outer portions, wherein the main body component is at least partially translucent or transparent;

a packing arrangement inserted into the cavity so as to engage the axially intermediate and axially outer portions of the first segment.

2. The fitting of claim 1, wherein the axially inner portion of the main body component is entirely translucent.

3. The fitting of claim 1, wherein the main body component is entirely translucent, and wherein the packing arrangement is visible through the interior and exterior walls of the main body component.

4. The fitting of claim 1, wherein the axially inner portion of the main body component is entirely transparent.

5. The fitting of claim 1, wherein the main body component is entirely transparent, and wherein the packing arrangement is visible through the interior and exterior walls of the main body component.

6. The fitting of claim 1, wherein the axially inner portion of the main body component is partially translucent.

7. The fitting of claim 6, wherein the axially inner portion of the main body portion is partially opaque.

8. The fitting of claim 1, wherein the axially inner portion of the main body component is partially transparent.

9. The fitting of claim 8, wherein the axially inner portion of the main body portion is partially opaque.

10. The fitting of claim 1, wherein the main body component is formed of a polymer material.

11. The fitting of claim 1, wherein the main body component is formed of a polysulfone material.

12. The fitting of claim 1, further comprising a sleeve member movably secured about the exterior wall of the main body component.

13. The fitting of claim 12, wherein the main body component is entirely transparent or translucent, and wherein the sleeve member is opaque.

5 14. The fitting of claim 13, wherein the sleeve member is formed with at least one window permitting a tubing member inserted into the main body component to be visible through the main body component.

15. The fitting of claim 1, wherein the packing arrangement comprises at least one sealing ring maintained within the axially intermediate portion of the main body component, a tube support
10 member having a radially interior surface, wherein the tube support member is maintained within the axially outer portion of the main body component, and a fastening ring maintained within the axially intermediate portion of the main body component.

16. A fitting, comprising:

15 a main body component comprising an interior wall, an exterior wall and a first end wall, wherein the interior wall defines a cavity extending along an axis through the main body component, wherein the main body component further comprises a tube stop extending radially inwardly of the interior wall and a first segment extending axially outwardly from the tube stop to the first end wall;

20 at least one sealing ring maintained within the first segment, wherein the at least one sealing ring is visible through the interior and exterior walls of the main body component;

a tube support member maintained within the first segment, wherein the tube support member is visible through the interior and exterior walls of the main body component; and

25 a fastening ring maintained within the first segment, wherein the fastening ring is visible through the interior and exterior walls of the main body component.

17. The fitting of claim 16, wherein the main body component is translucent.

18. The fitting of claim 16, wherein the main body component is transparent.

30 19. A push-to-connect fitting assembly, comprising:

a fitting having an interior wall and an exterior wall, wherein the interior wall defines a cavity extending axially through the fitting and includes first and second interior wall portions separated by a tube stop element extending radially into the cavity from the interior wall;

a first packing arrangement inserted into the cavity so as to engage the first interior wall portion of the fitting;

a second packing arrangement inserted into the cavity so as to engage the second interior wall portion of the fitting; and

5 wherein the first and second packing arrangements are visible through the interior and exterior walls of the fitting.

20. The assembly of claim 19, wherein the first and second packing arrangements each comprise at least one sealing ring being substantially circular in cross-section, a fastening ring and a tube
10 support member.

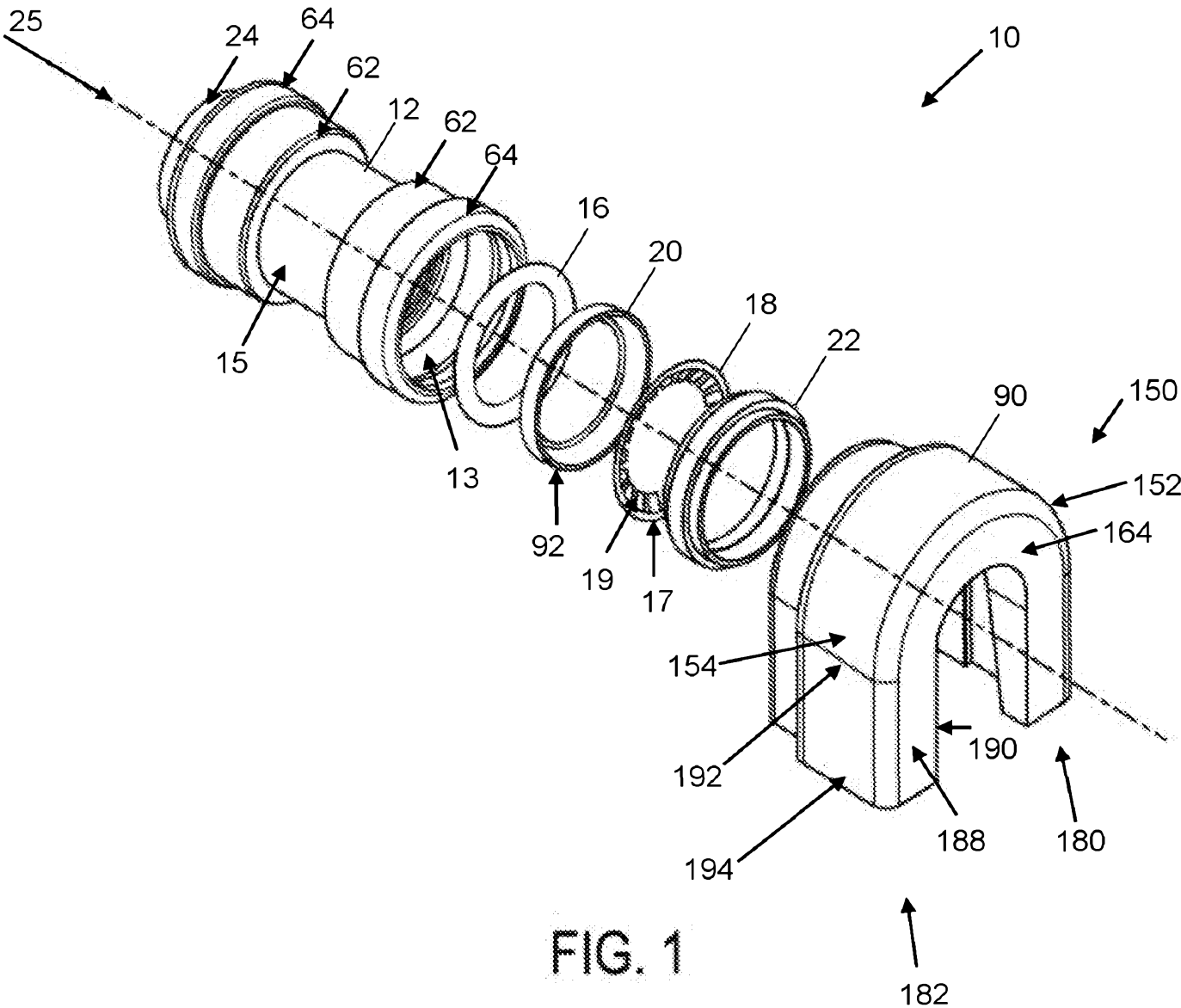


FIG. 1

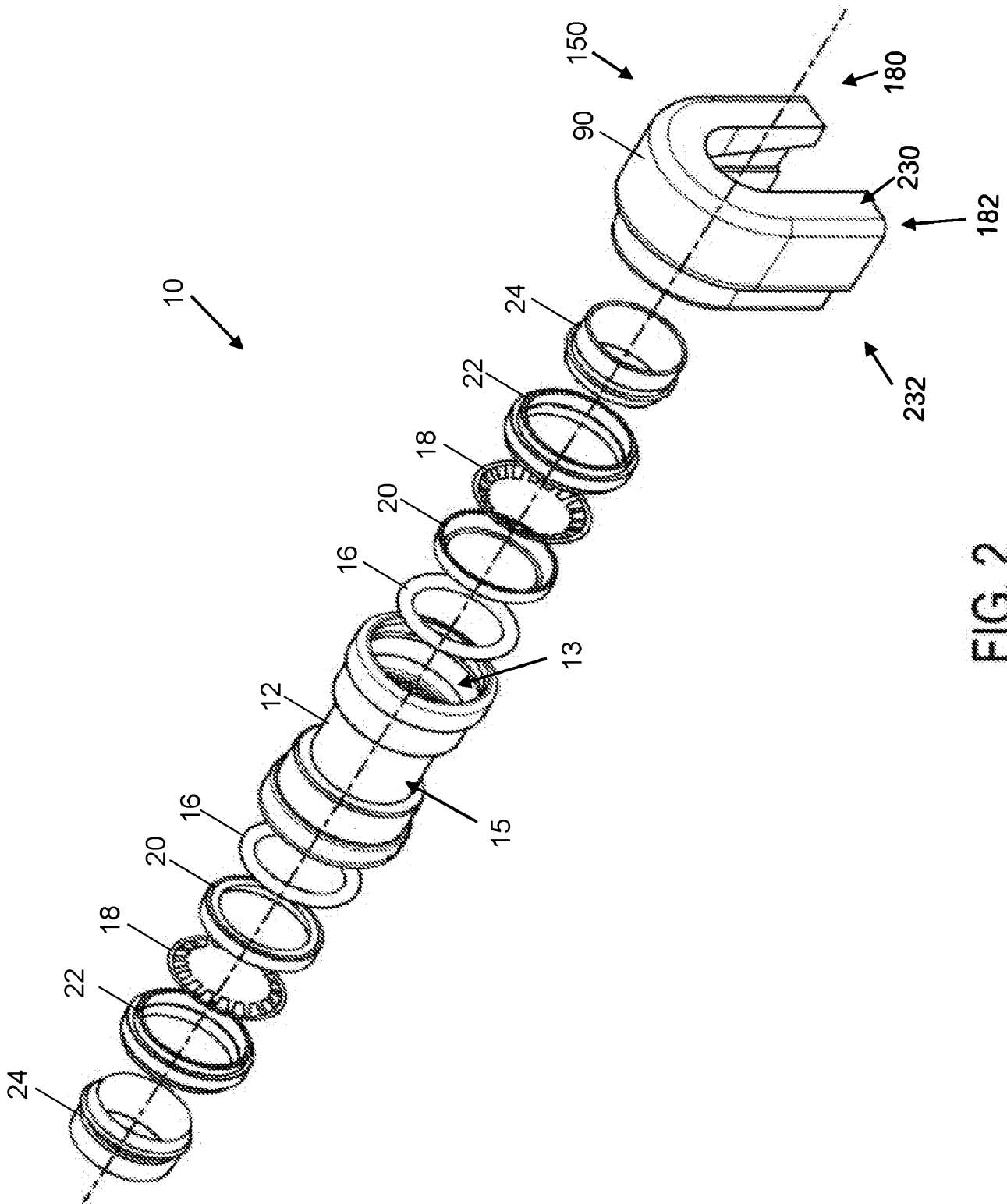
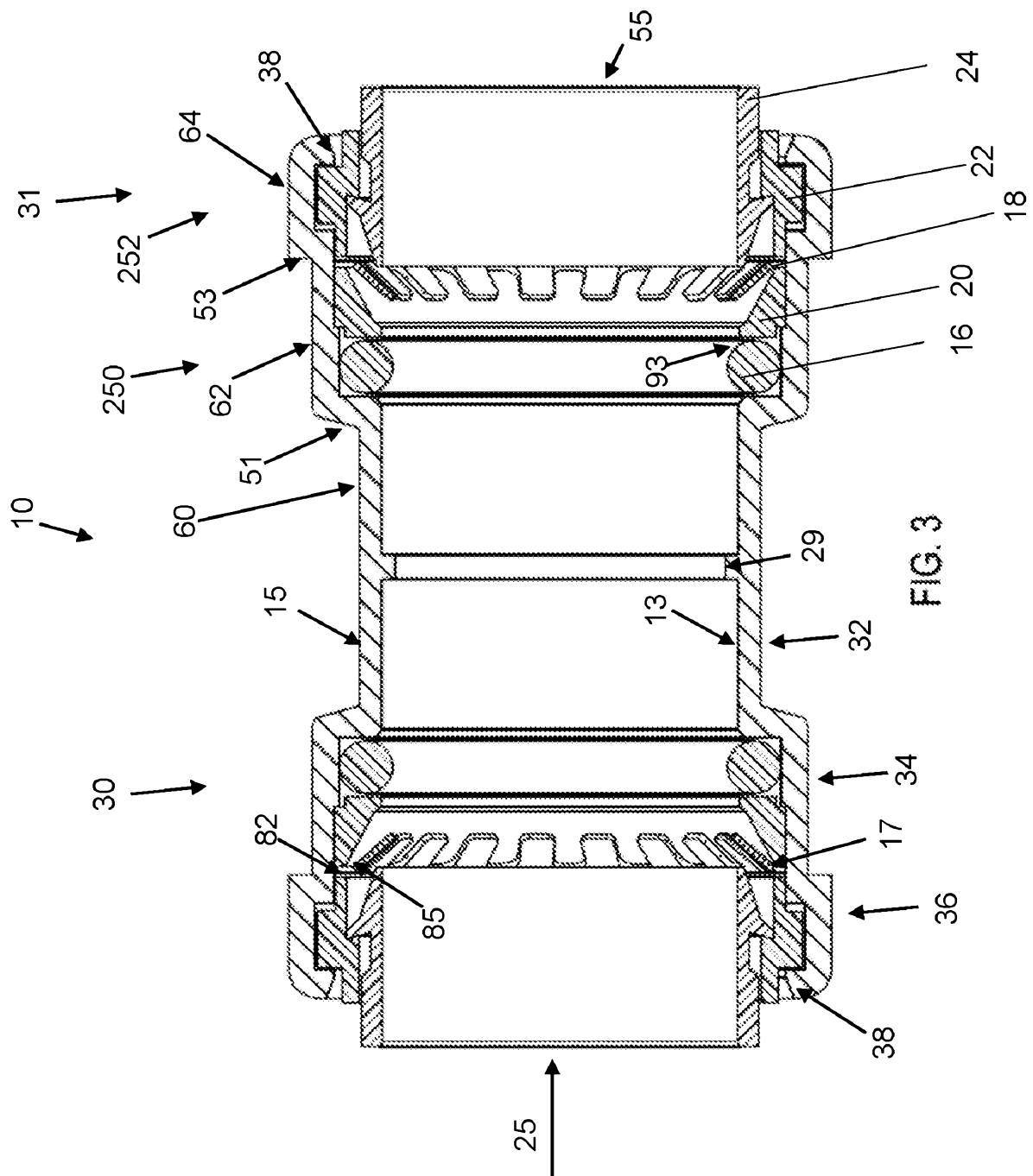


FIG. 2



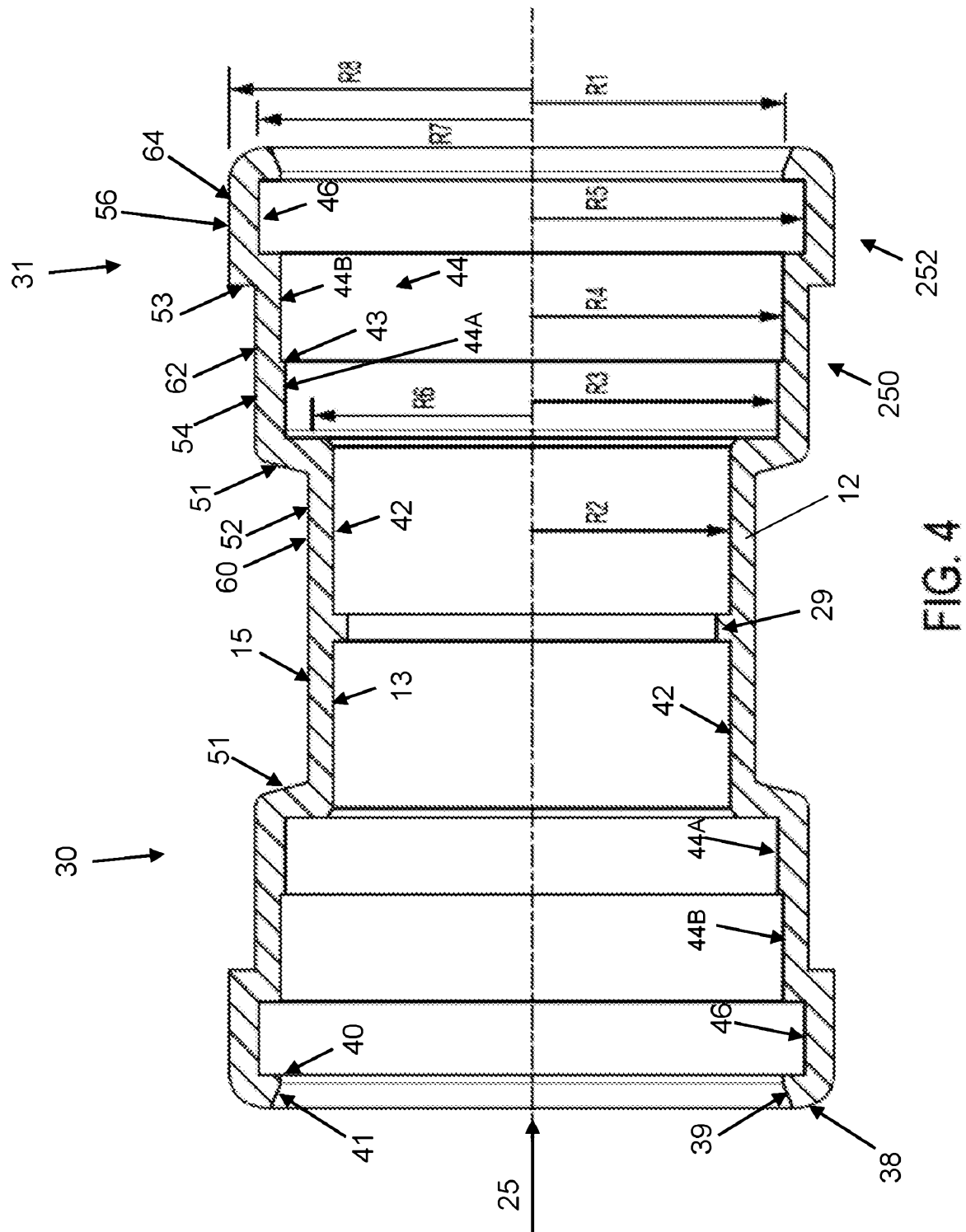


FIG. 4

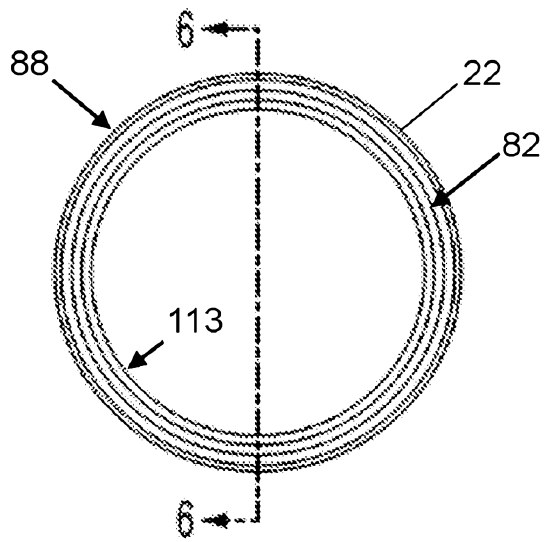


FIG. 5

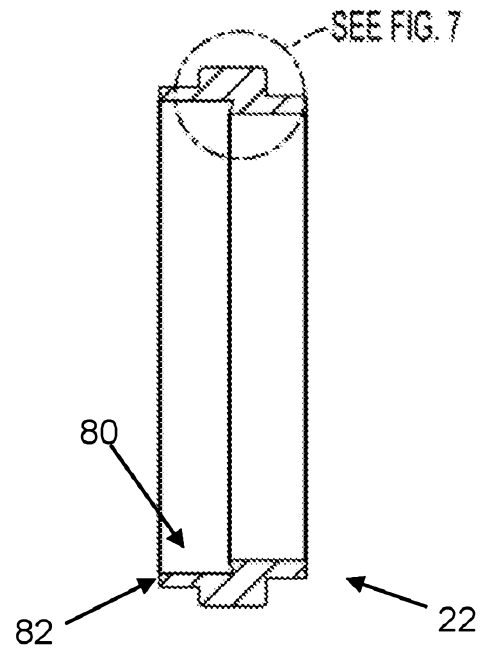


FIG. 6

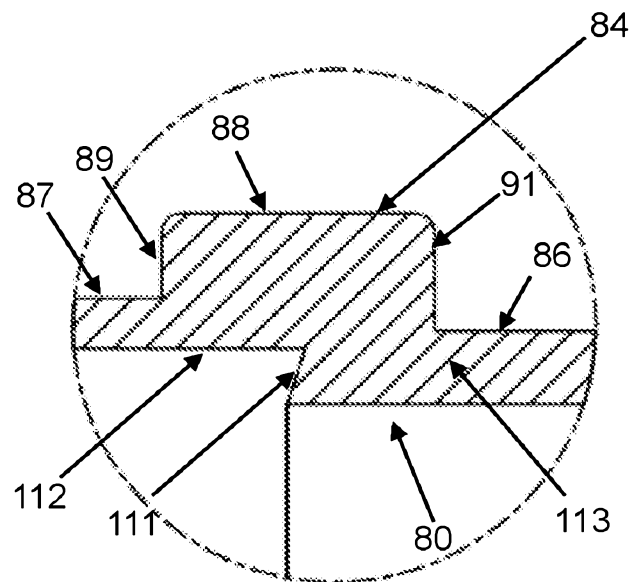


FIG. 7

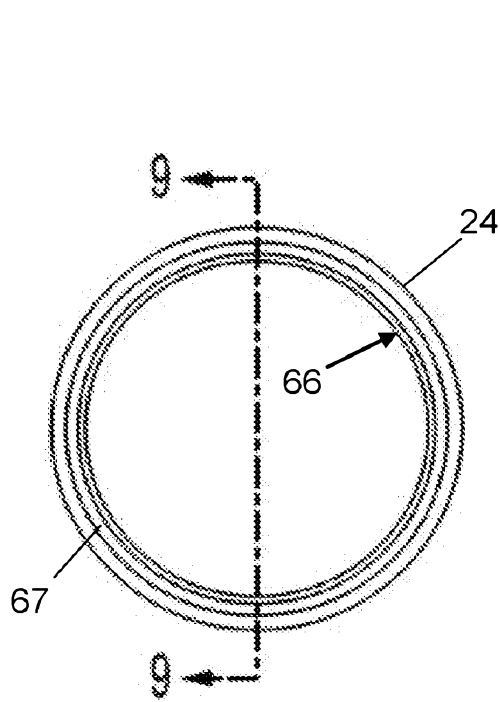


FIG. 8

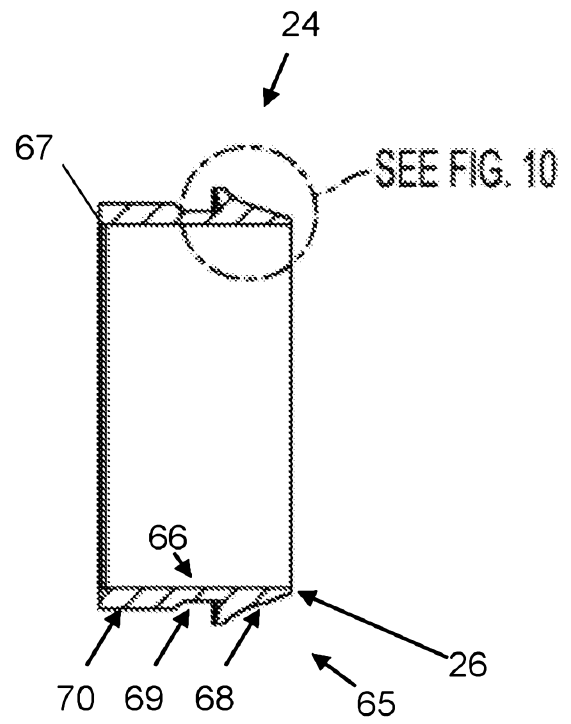


FIG. 9

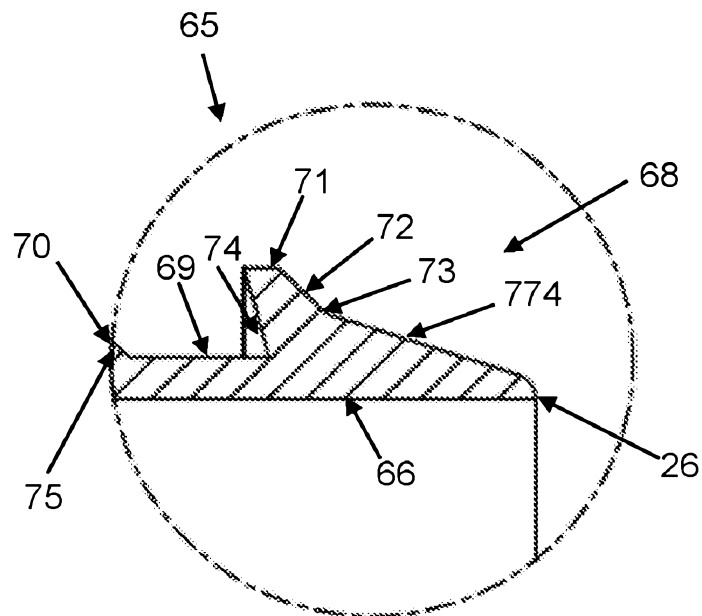
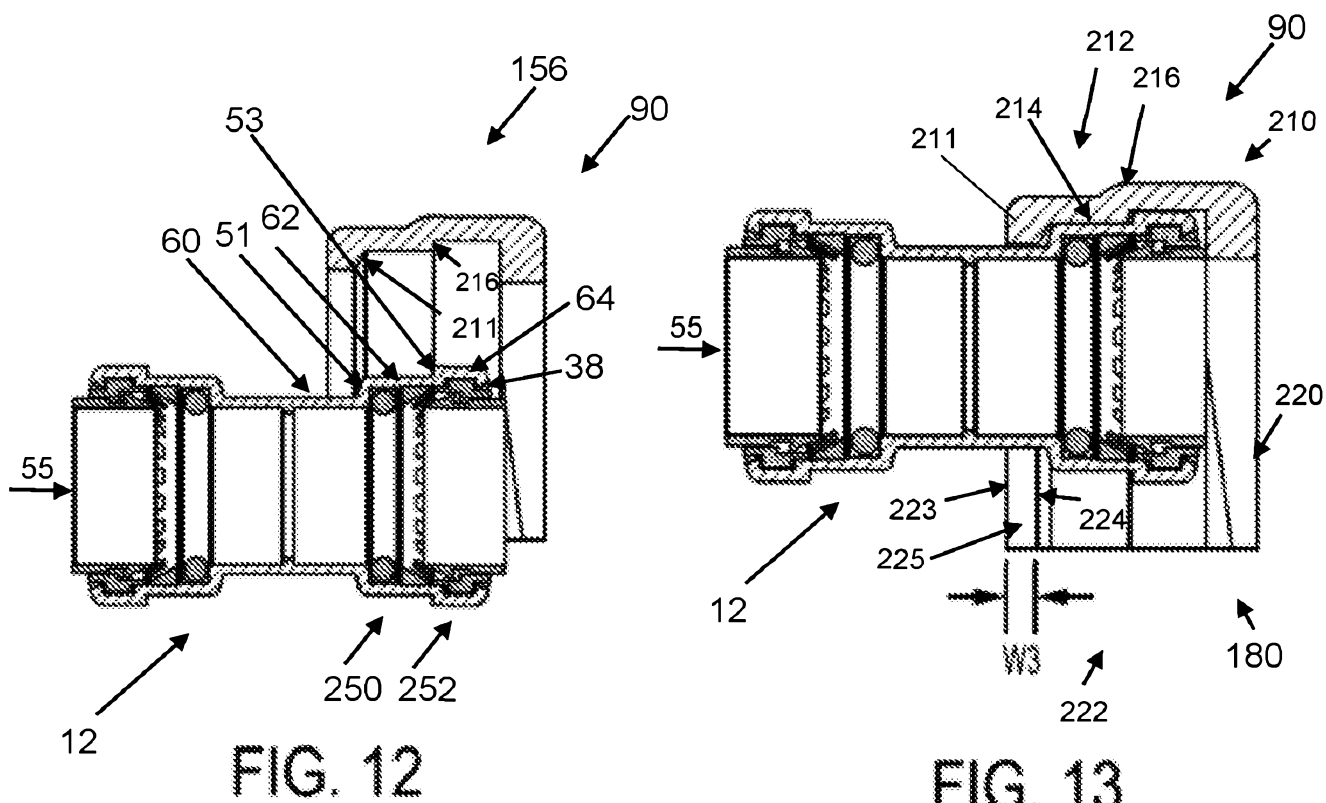
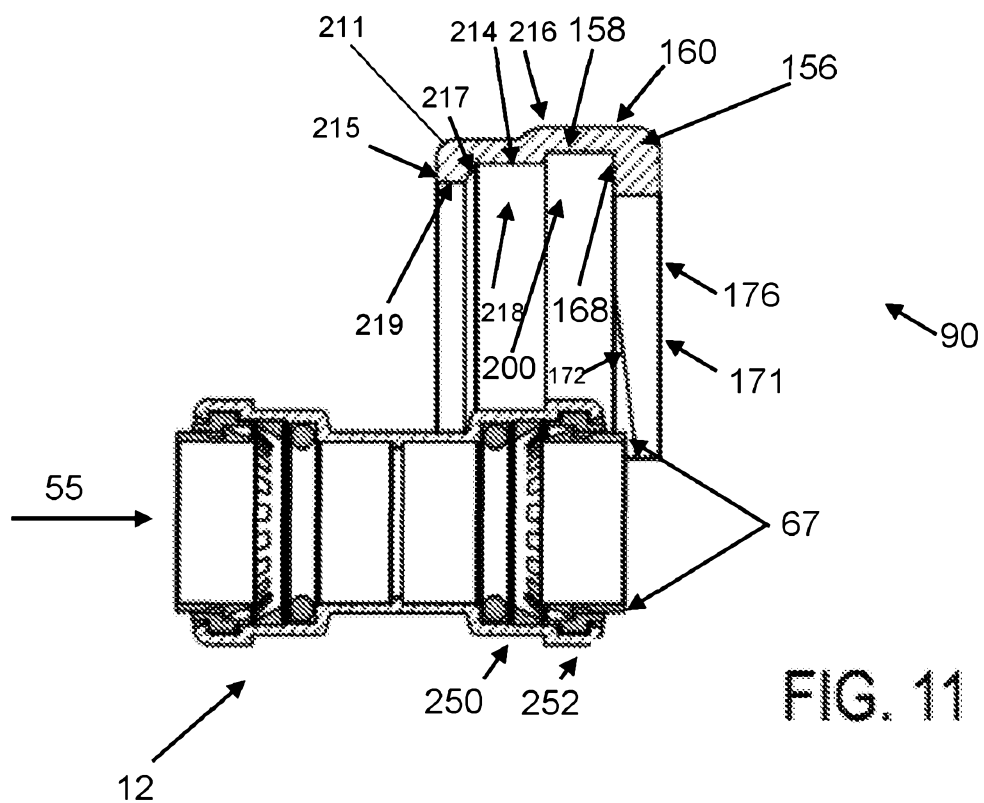


FIG. 10



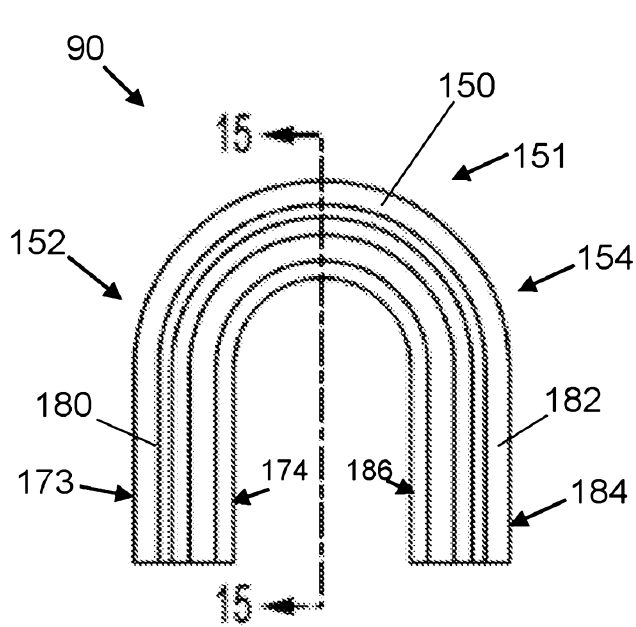


FIG. 14

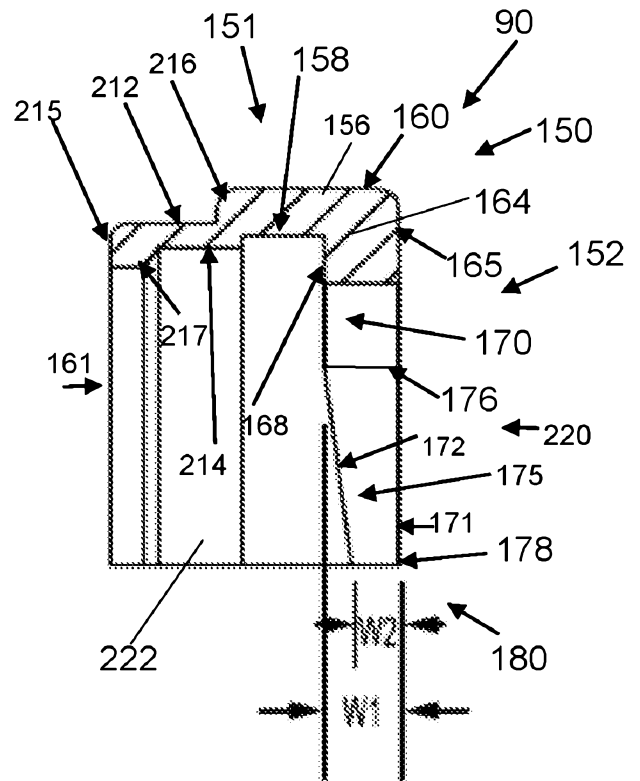


FIG. 15

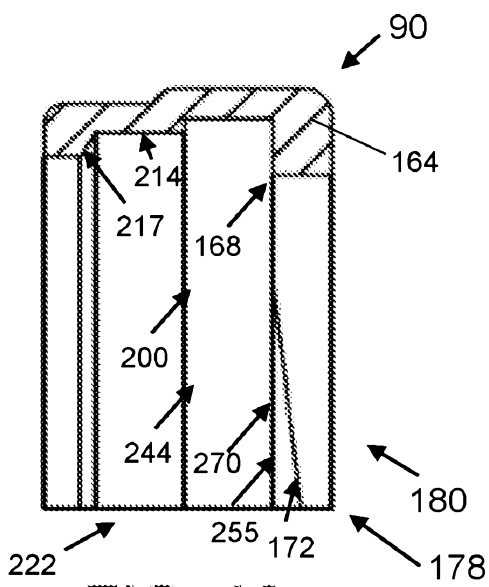


FIG. 16

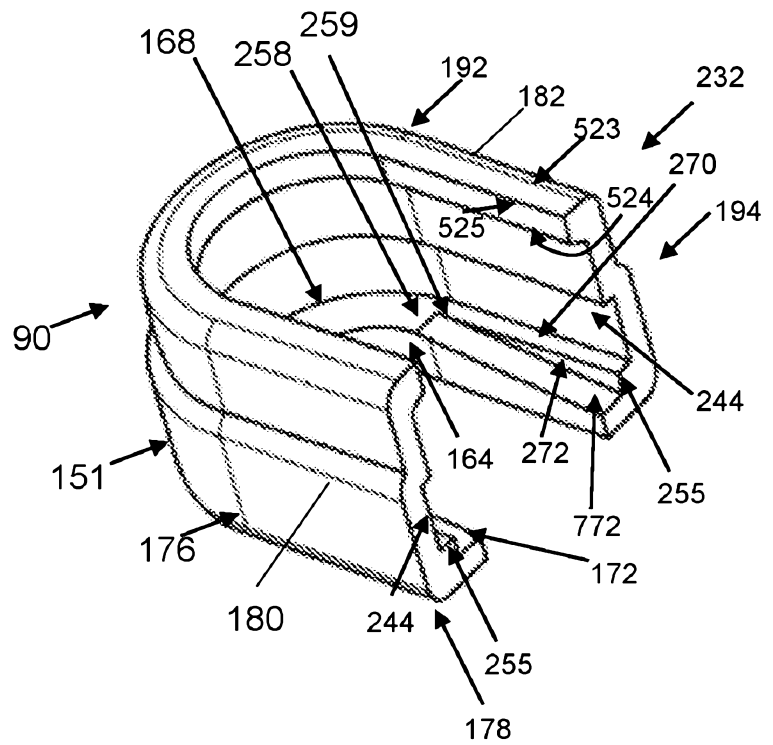


FIG. 17

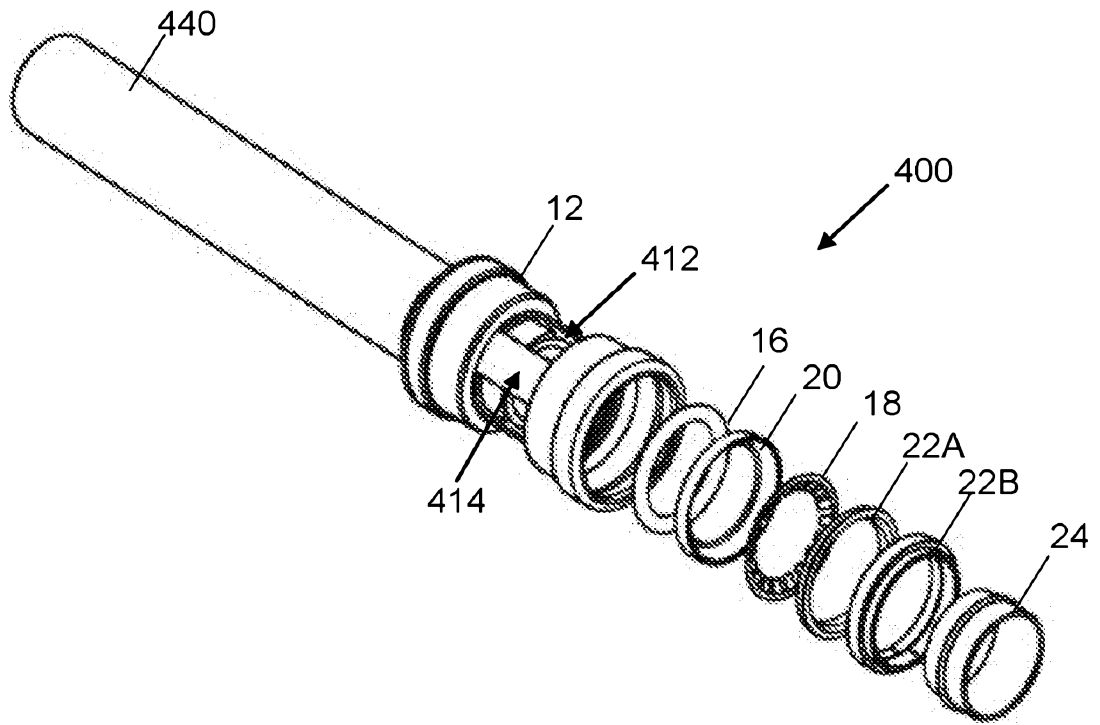


FIG. 18

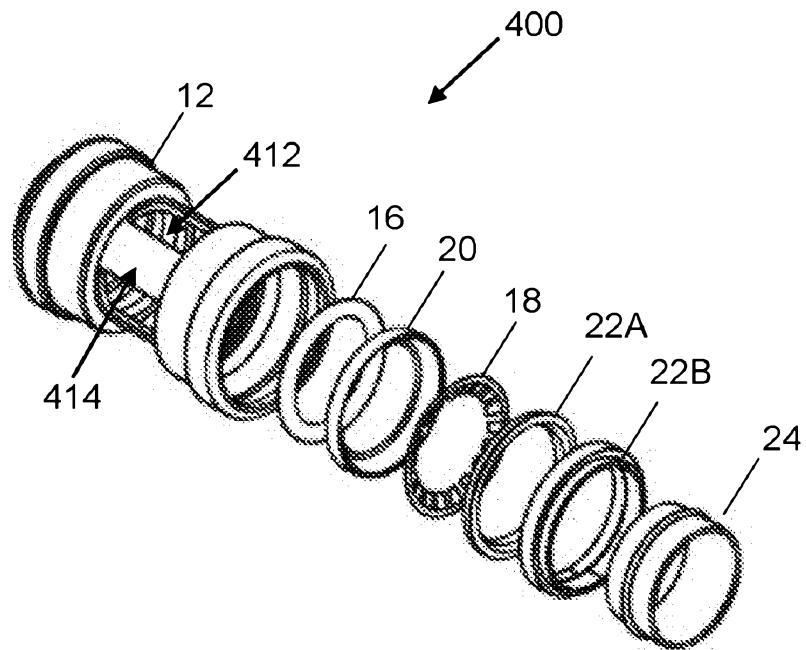


FIG. 19

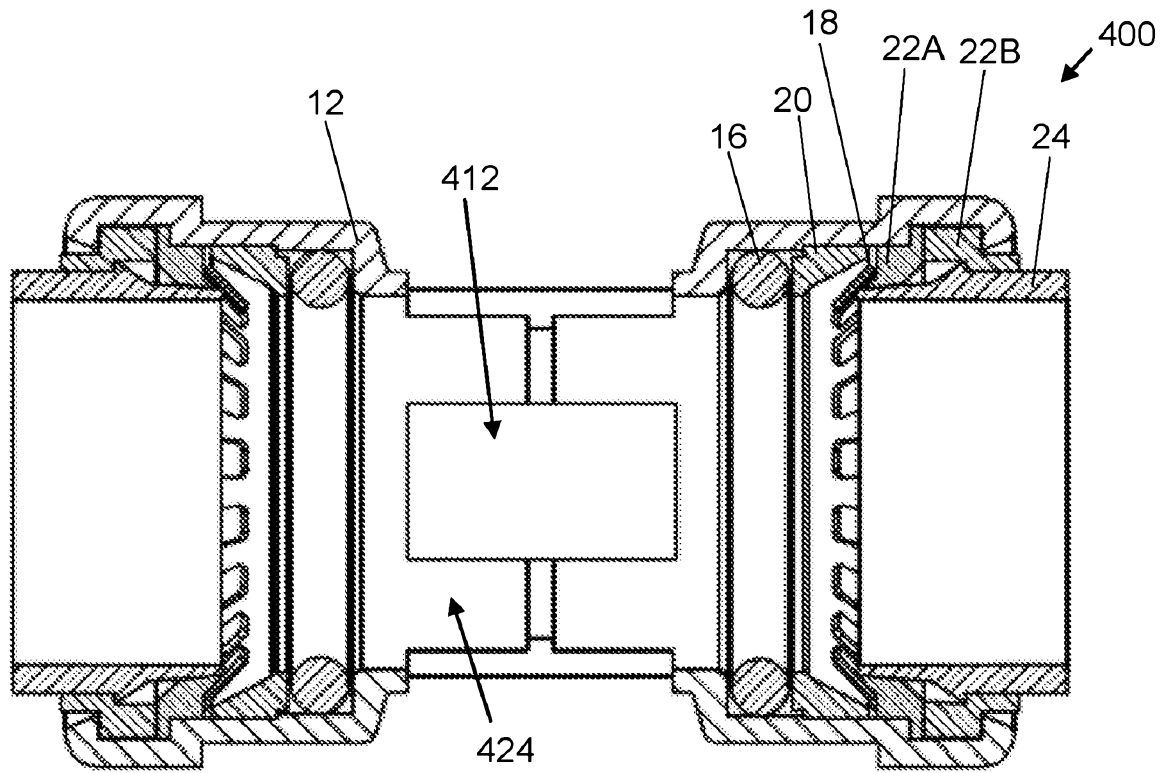


FIG. 20

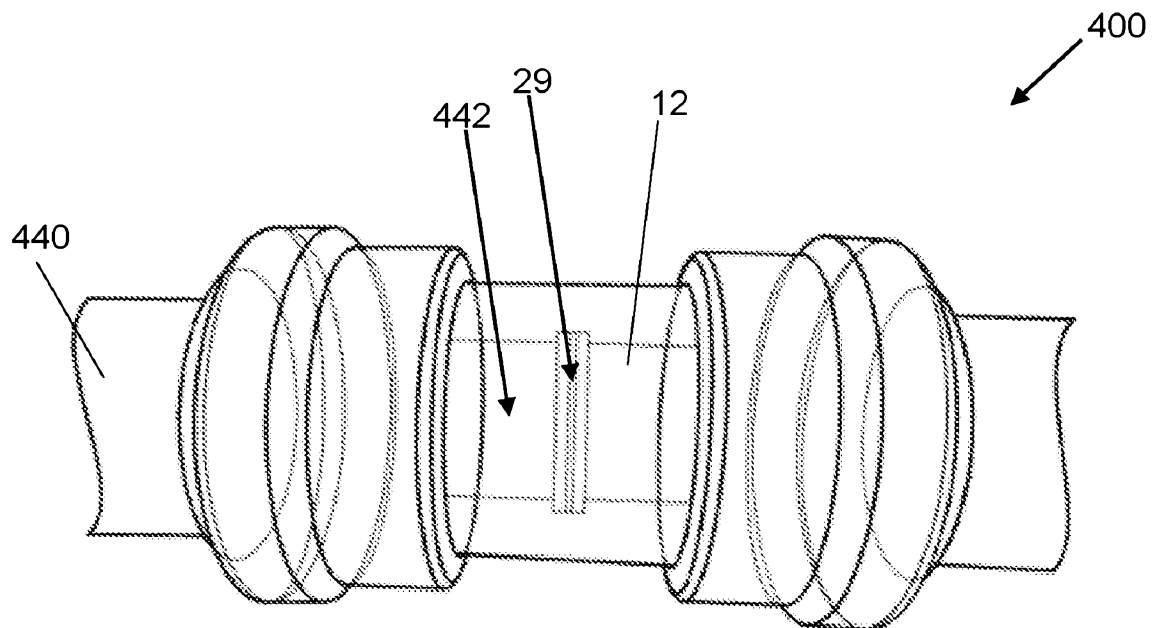


FIG. 21

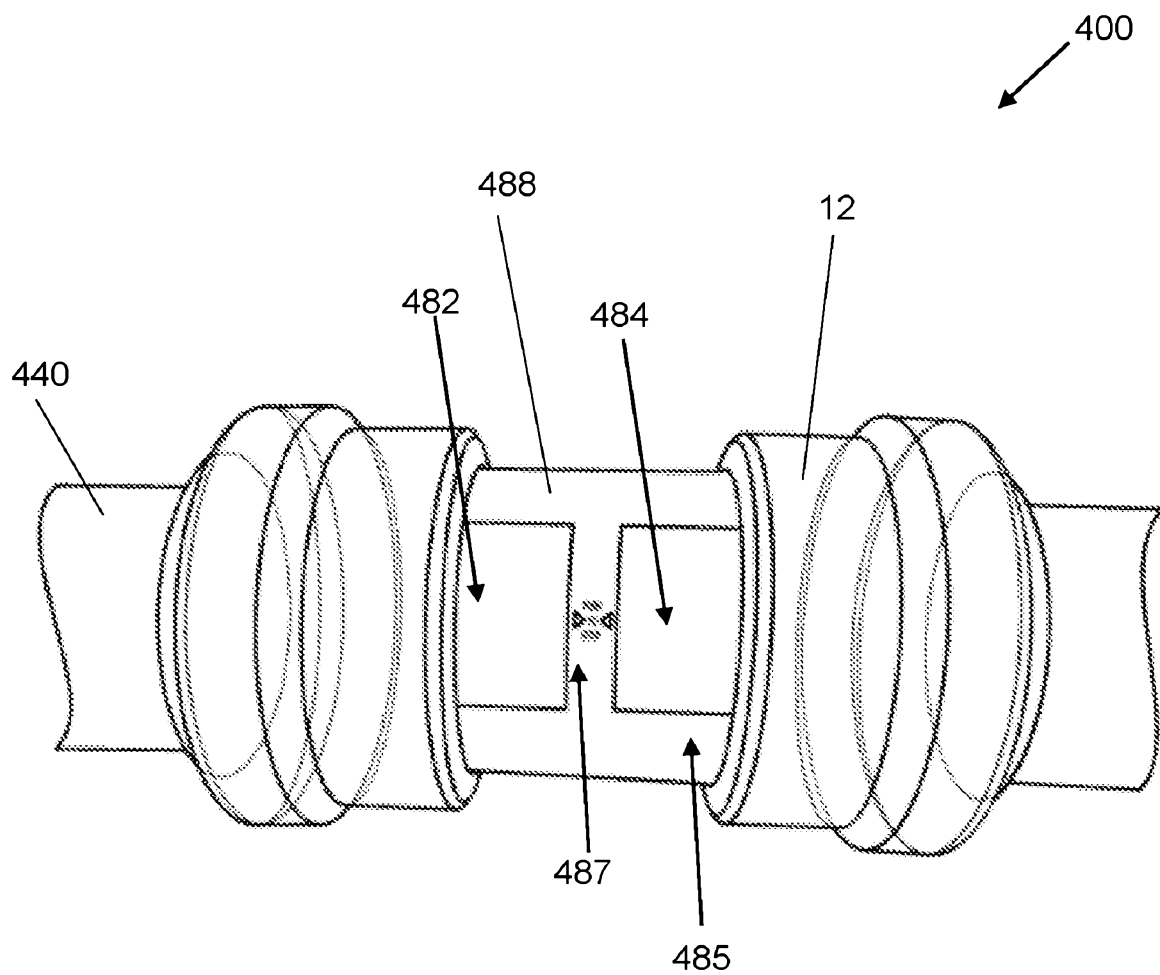


FIG. 22