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**Kujawski, Jr.**

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(45) **Date of Patent: Mar. 30, 2021**

(54) **FLUID CONNECTOR WITH FULL INSERTION ASSURANCE CAP WITH SECONDARY LATCHES**

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( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(22) Filed: **Oct. 19, 2018**

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(60) Provisional application No. 62/005,136, filed on May 30, 2014.

(51) **Int. Cl.**

| | |
|---|---|
| ***F16L 21/08*** | (2006.01) |
| ***F16L 37/138*** | (2006.01) |
| ***F16L 37/12*** | (2006.01) |
| ***F02M 35/10*** | (2006.01) |
| ***F16L 37/088*** | (2006.01) |
| ***F16L 37/084*** | (2006.01) |

(52) **U.S. Cl.**

CPC ..... ***F16L 37/138*** (2013.01); ***F02M 35/10091*** (2013.01); ***F16L 21/08*** (2013.01); ***F16L 37/084*** (2013.01); ***F16L 37/0885*** (2019.08); ***F16L 37/1225*** (2013.01); *F16L 2201/10* (2013.01)

(58) **Field of Classification Search**

CPC ..... F16L 21/08; F16L 37/084; F16L 37/0842; F16L 37/088; F16L 37/096; F16L 37/098; F16L 37/0985; F16L 37/138; F16L 37/1225; F16L 2201/10

USPC ..... 285/87, 86, 85, 84, 81; 81/467, 469, 81/119, 124.2

See application file for complete search history.

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*Primary Examiner* — Matthew Troutman
*Assistant Examiner* — James A Linford
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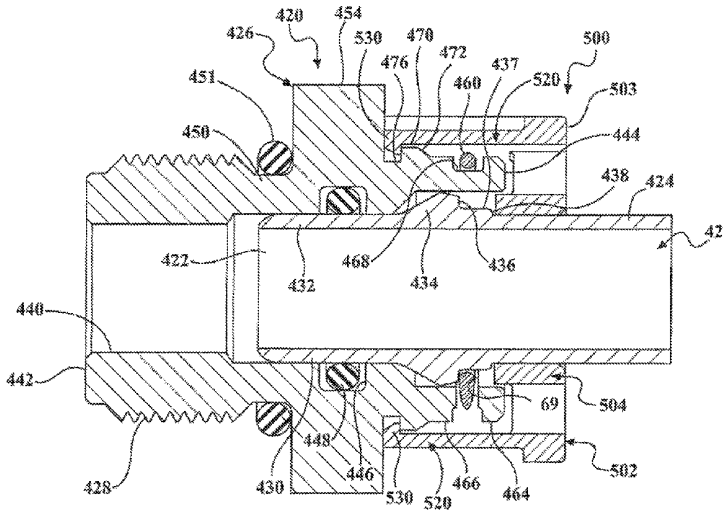
(57) **ABSTRACT**

A fluid connector for coupling a tubular member having an endform spaced from a first insertion end to an external component, including a connector body, including a bore having a first end for receiving the tubular member, and a first exterior groove spaced from the first end and arranged for receiving one or more projections of an assurance cap for latching the assurance cap to the connector body when the tubular member is fully inserted into the bore.

**11 Claims, 19 Drawing Sheets**



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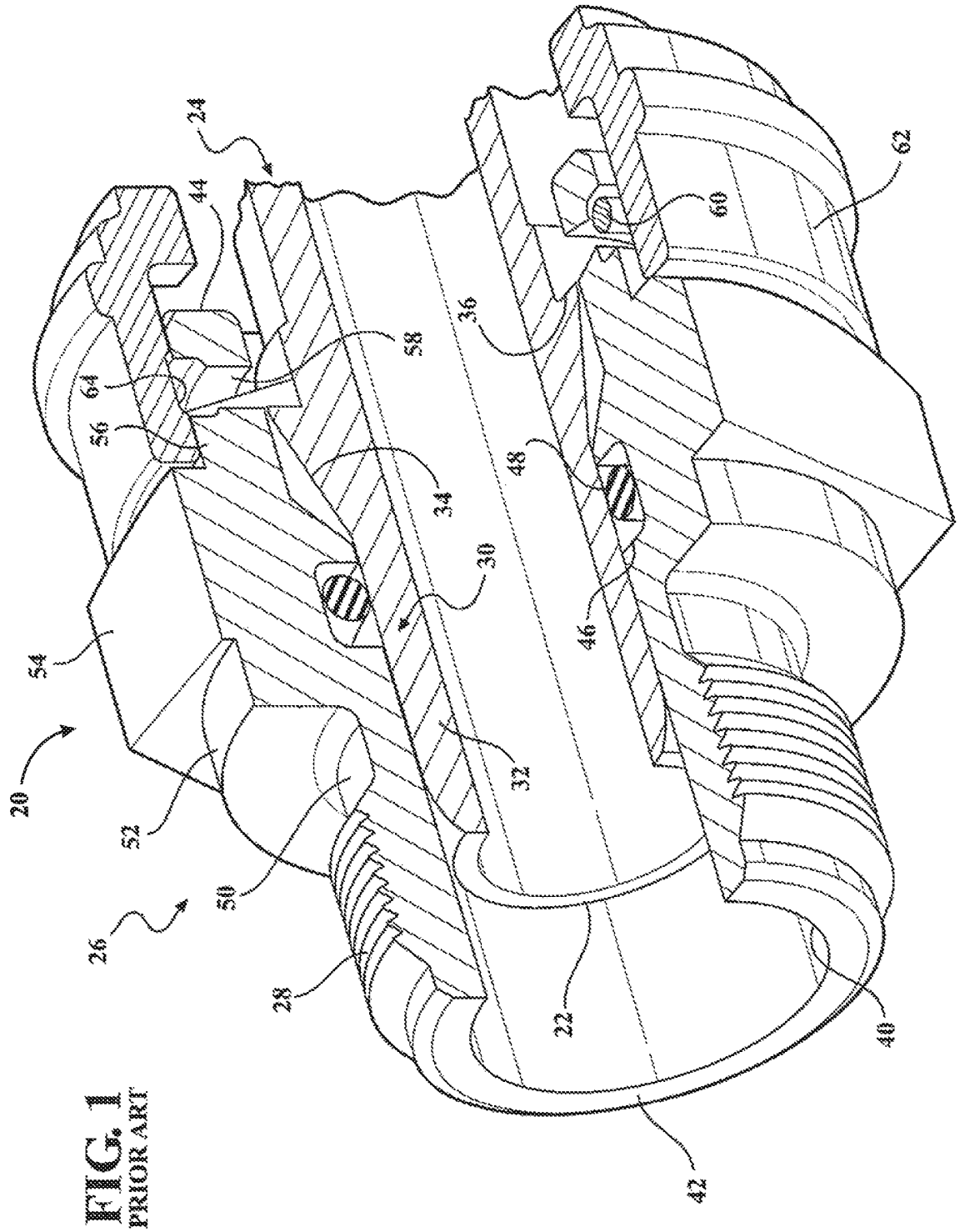


FIG. 1
PRIOR ART

FIG. 2

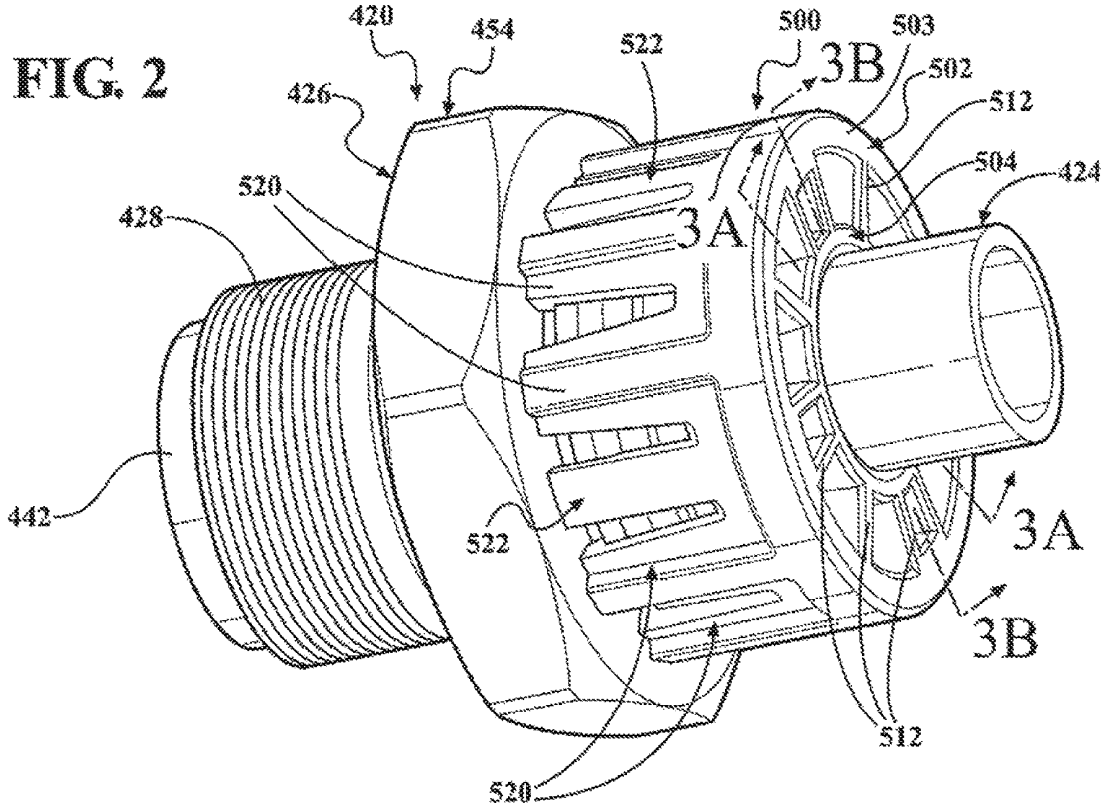
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FIG. 3A

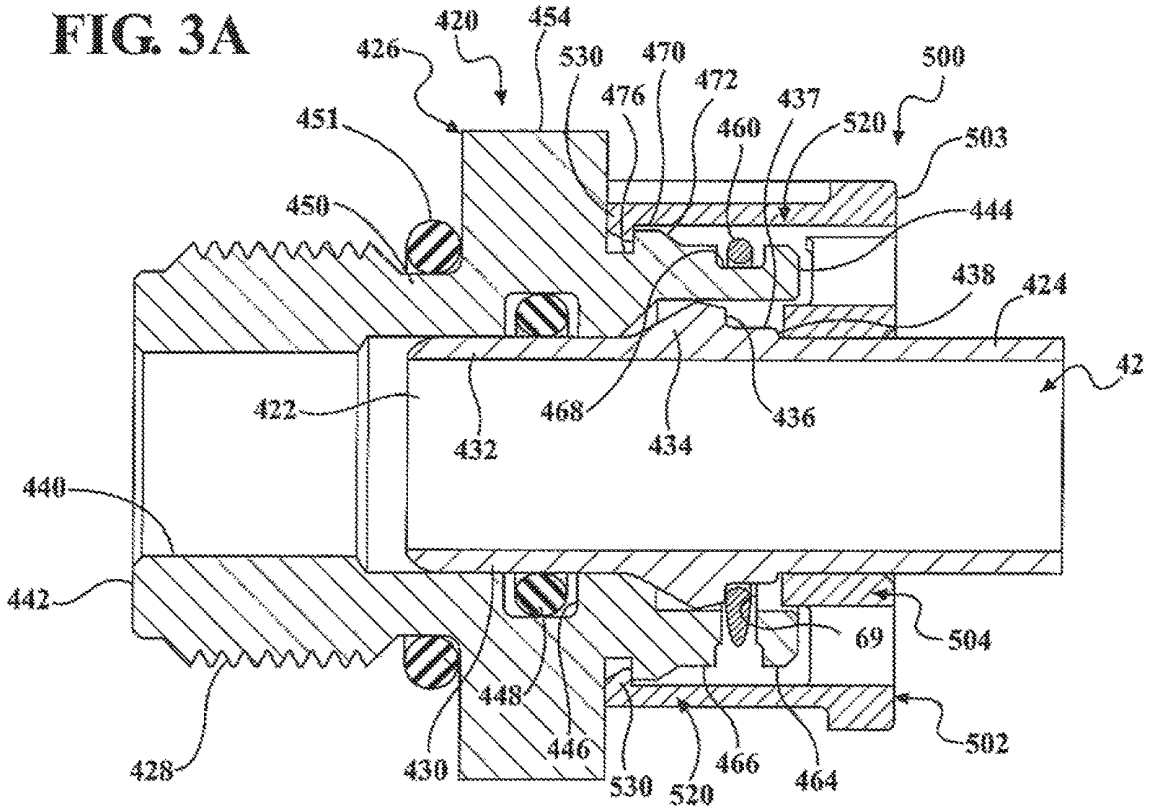
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FIG. 3B

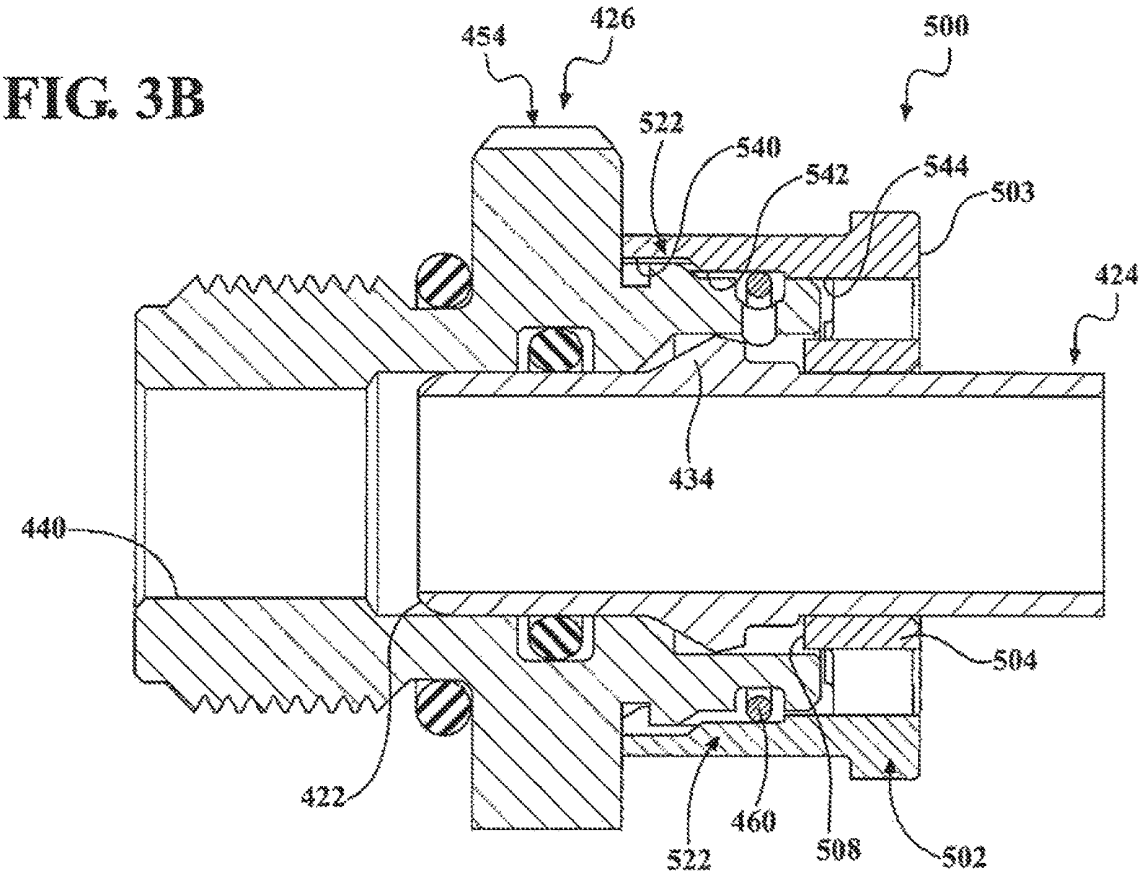
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FIG. 4

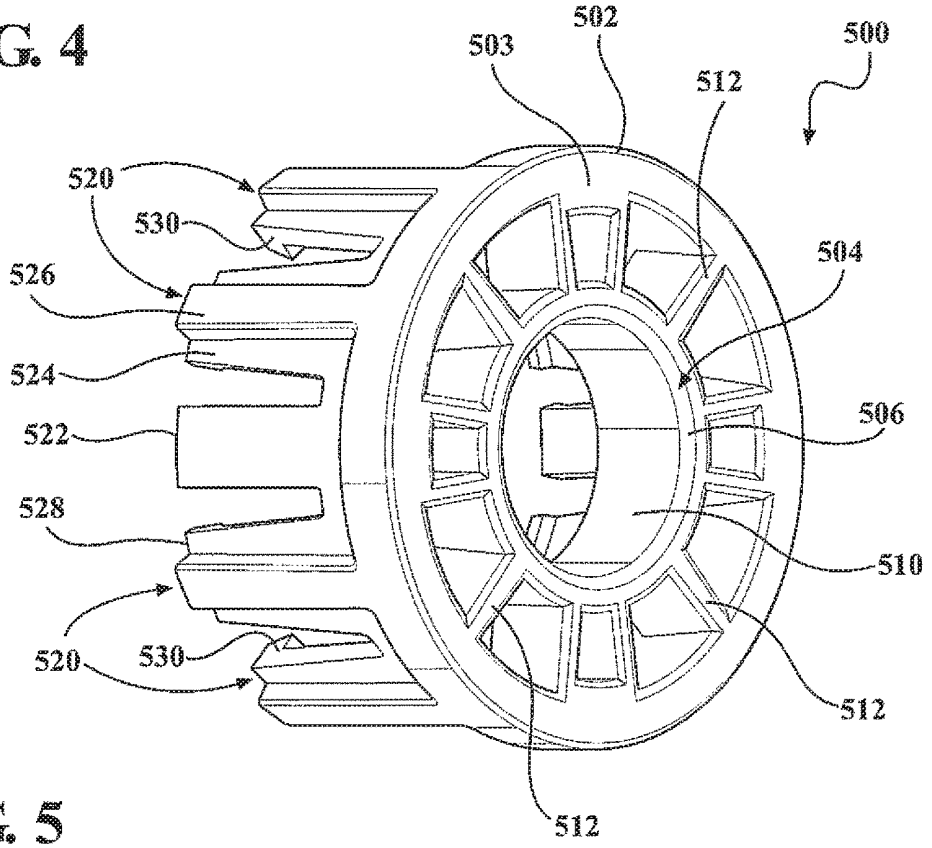
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FIG. 5

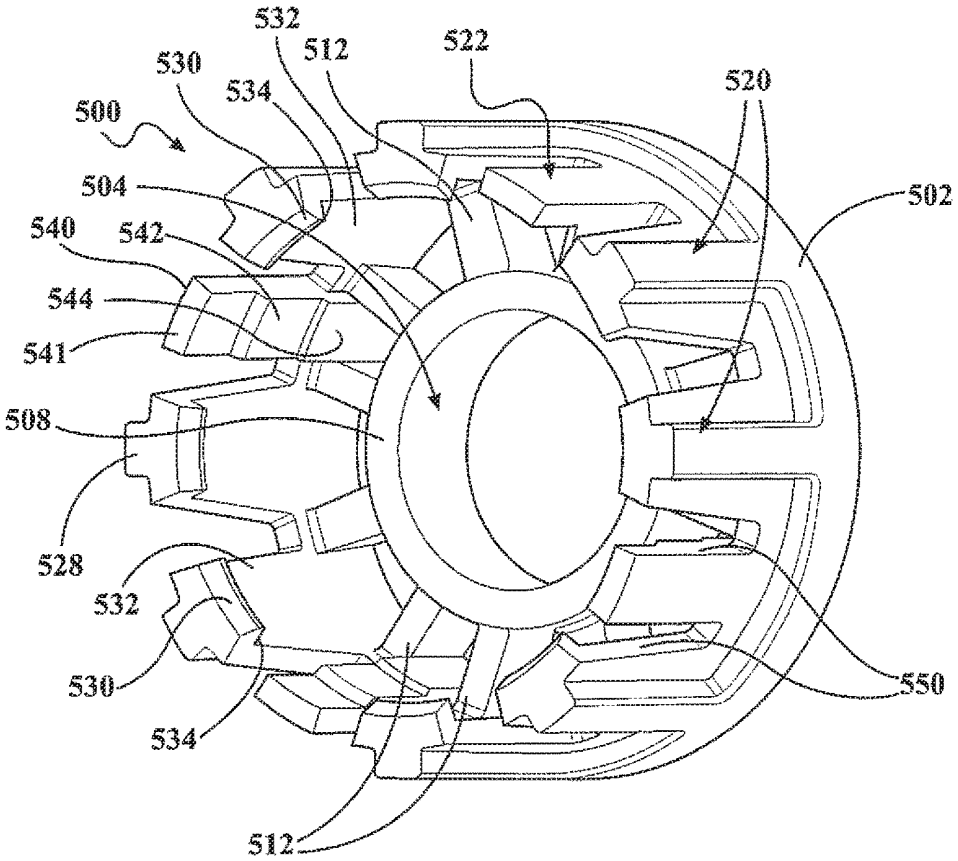
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FIG. 6

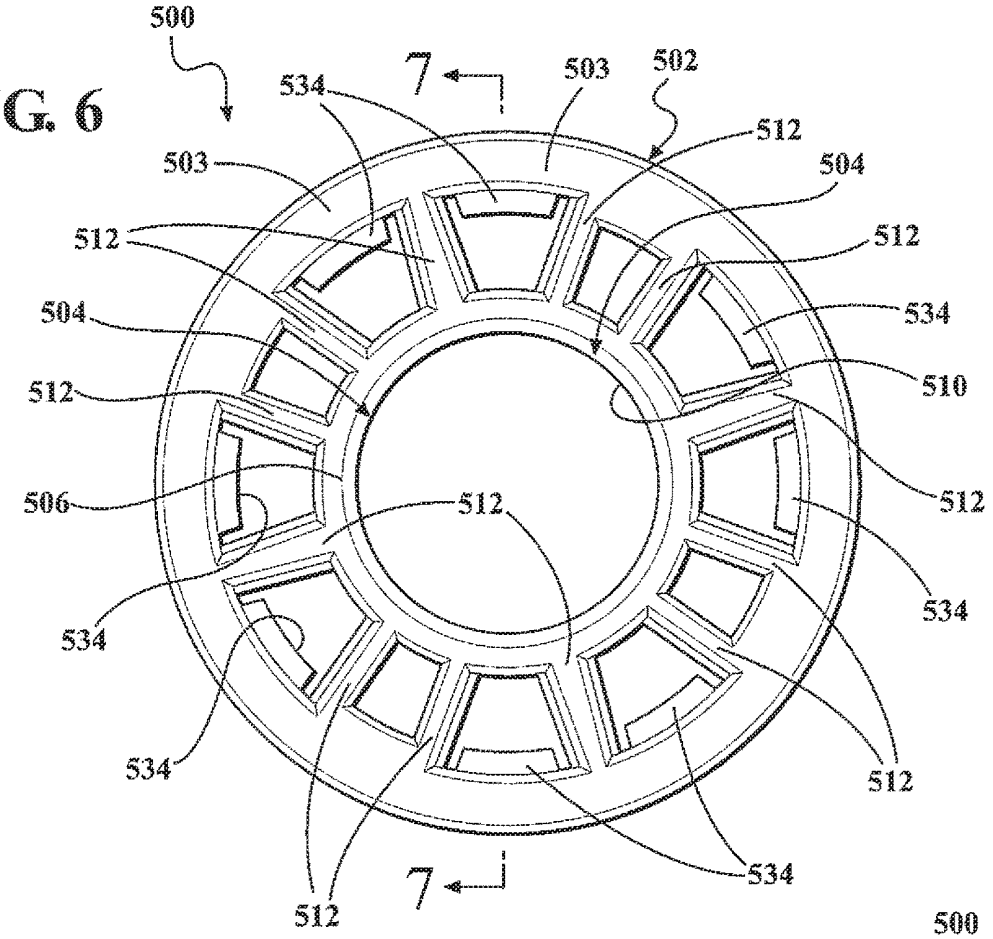
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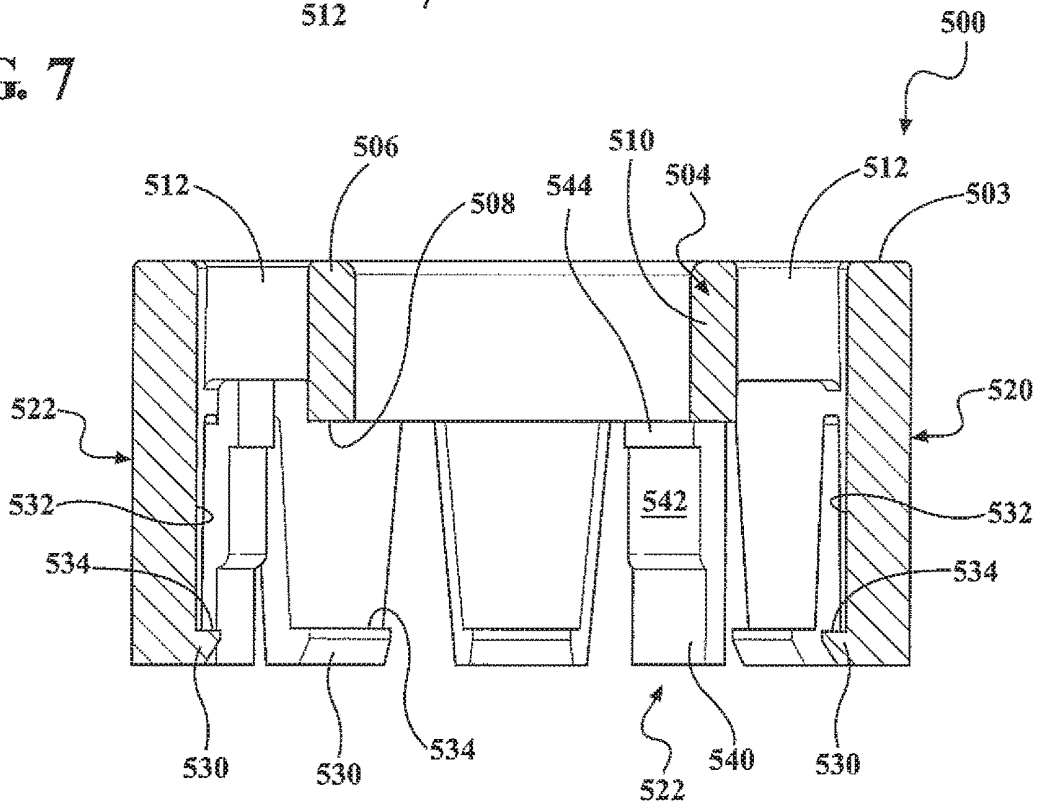
FIG. 7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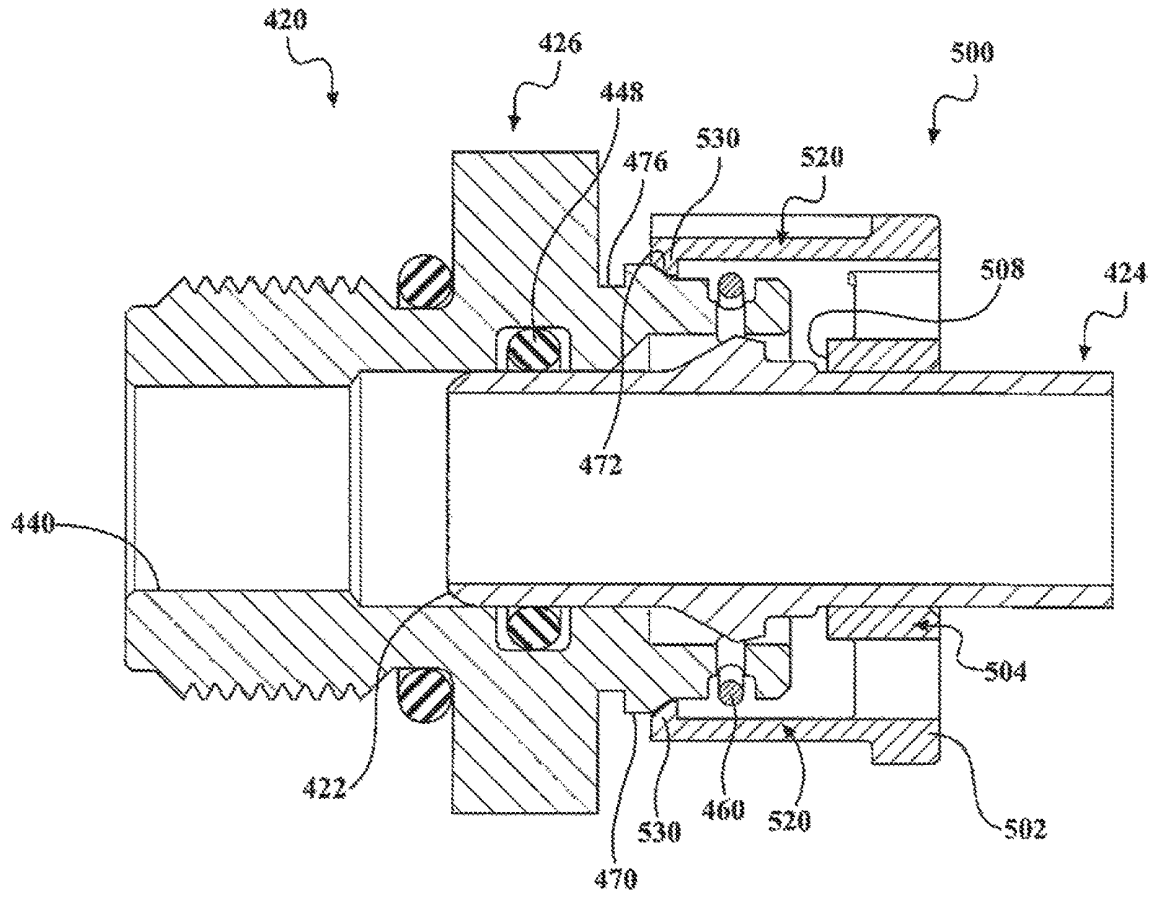
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FIG. 8

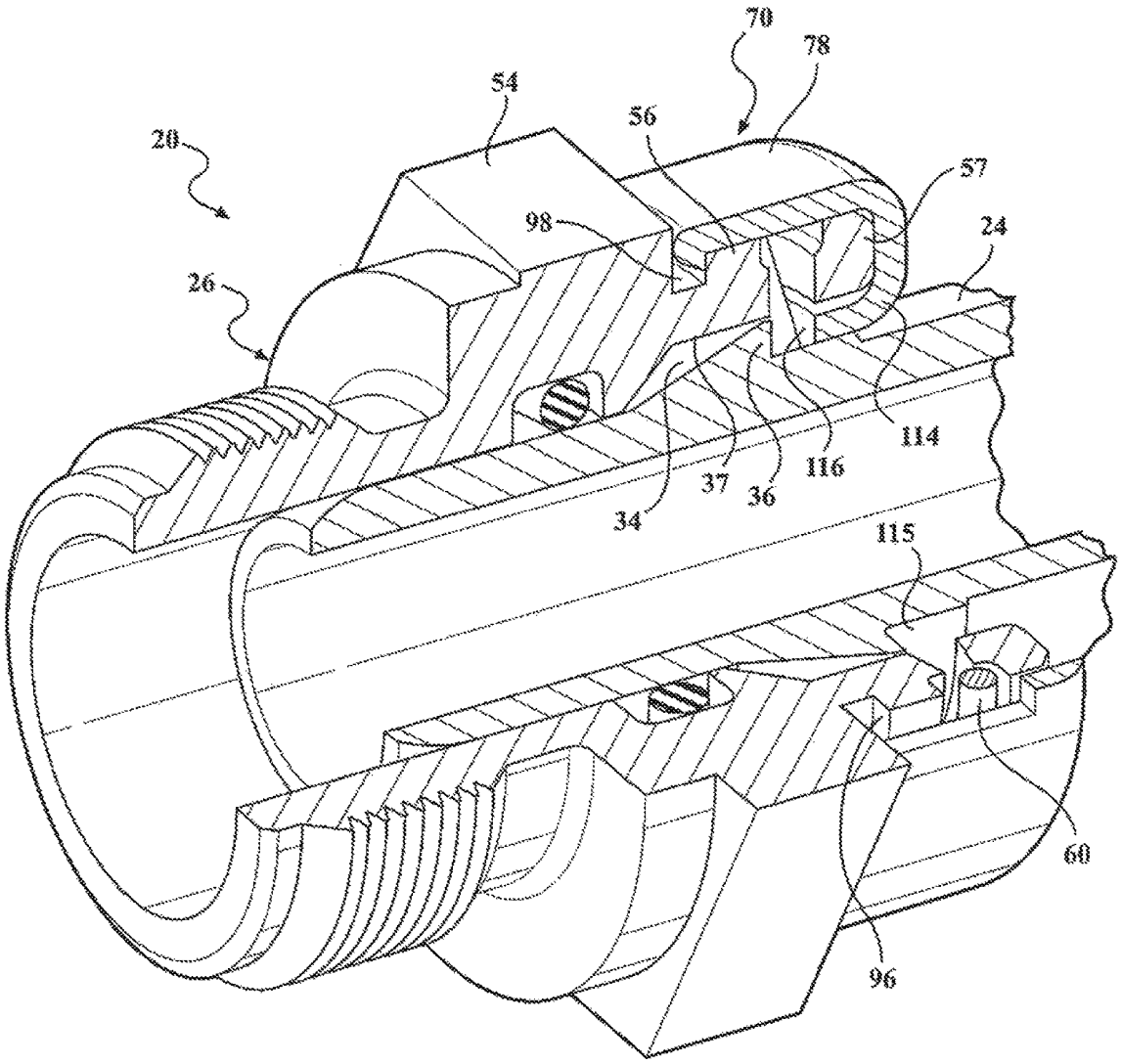


FIG. 9

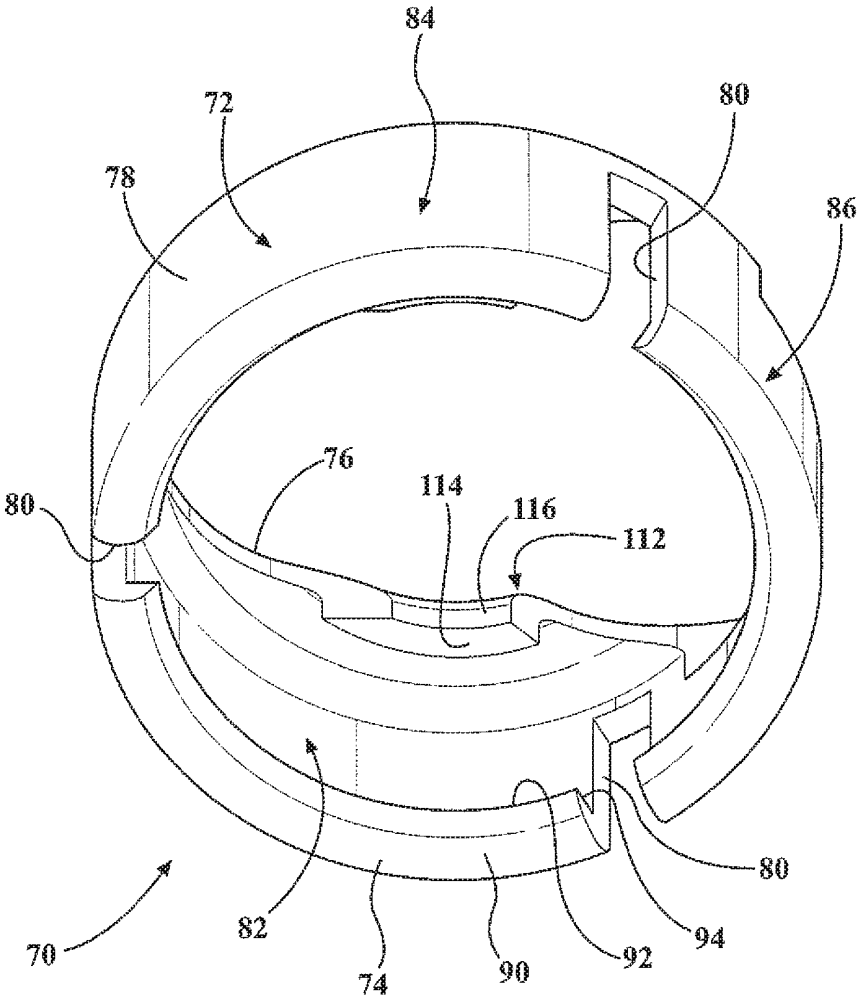


FIG. 10

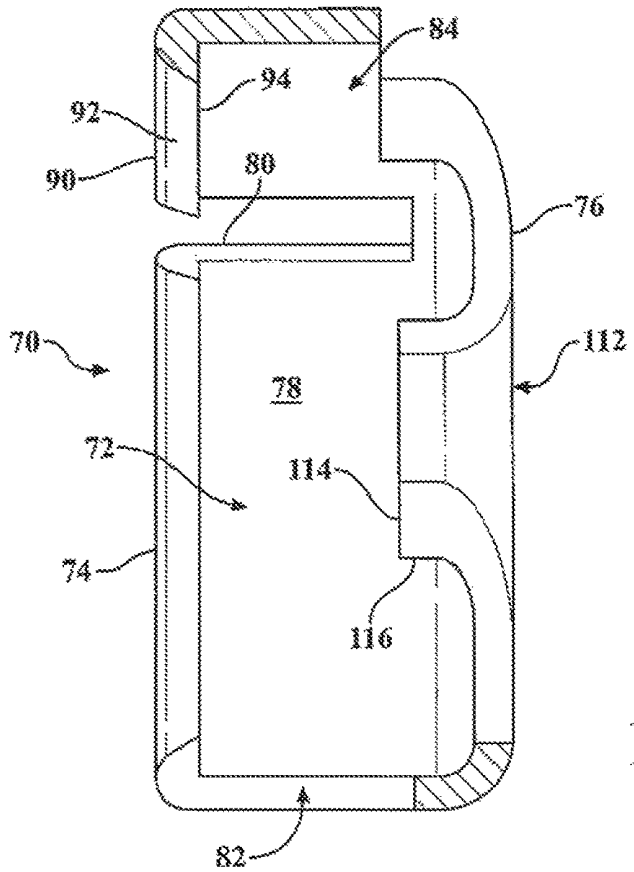
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FIG. 11

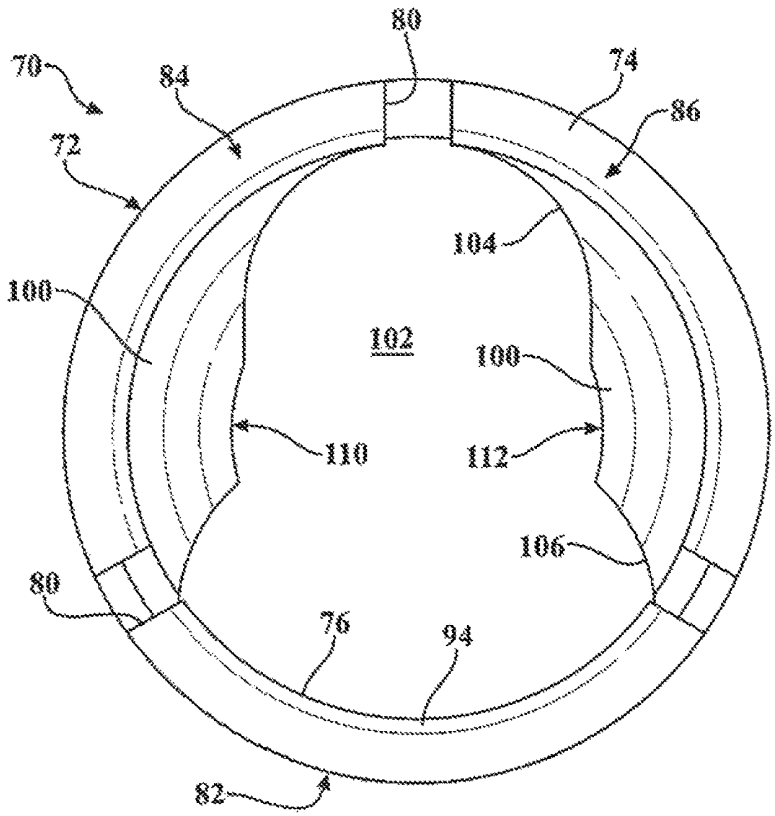
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FIG. 12

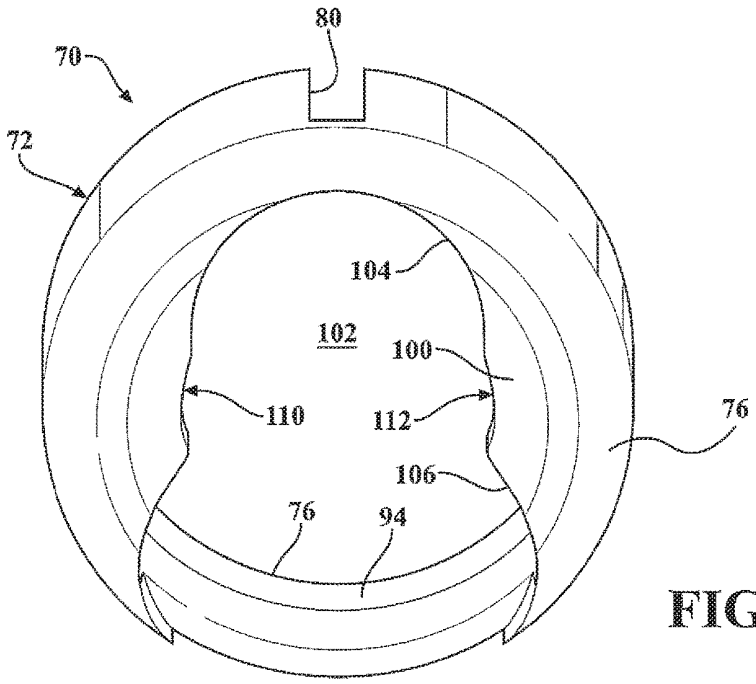
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FIG. 13

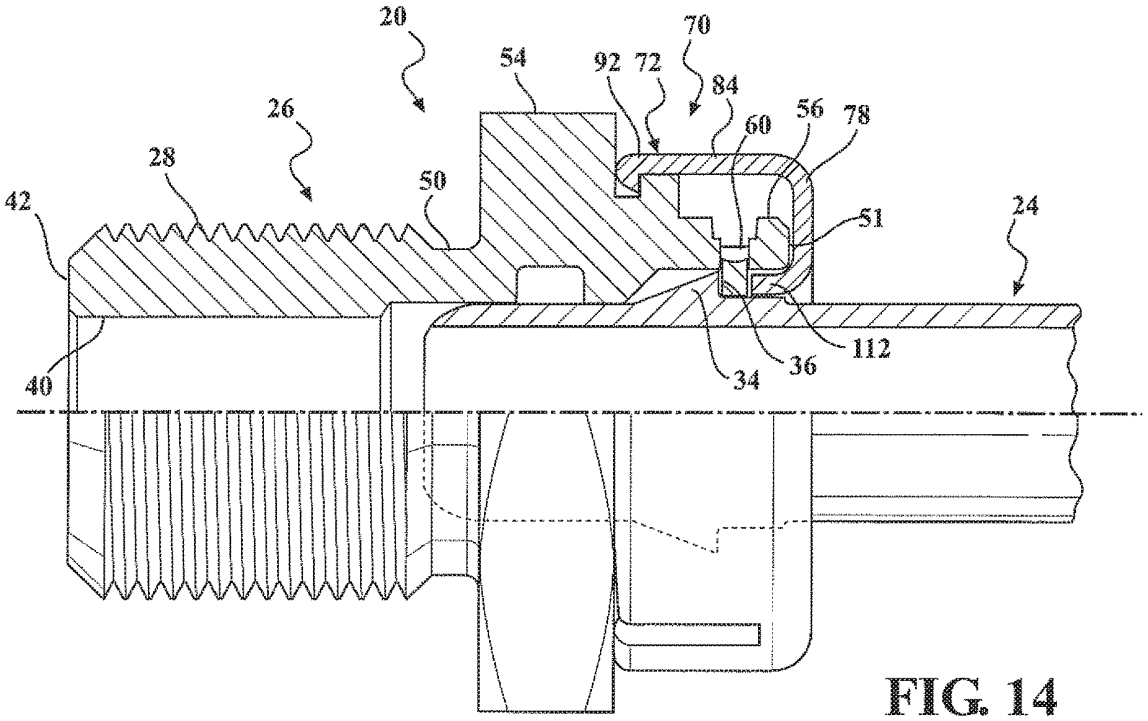
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FIG. 14

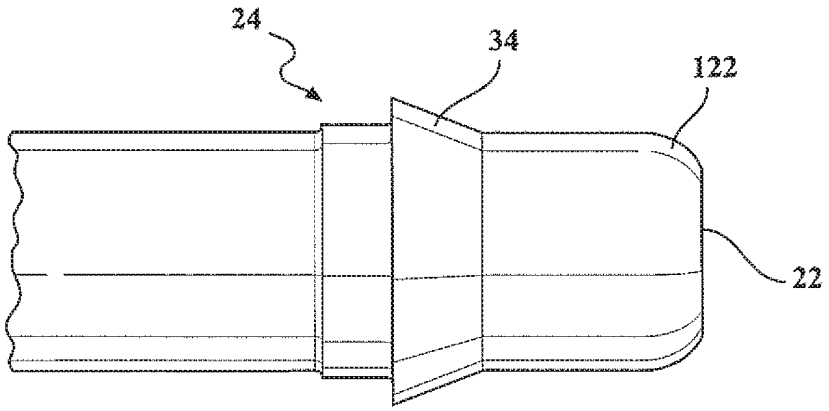


FIG. 15A

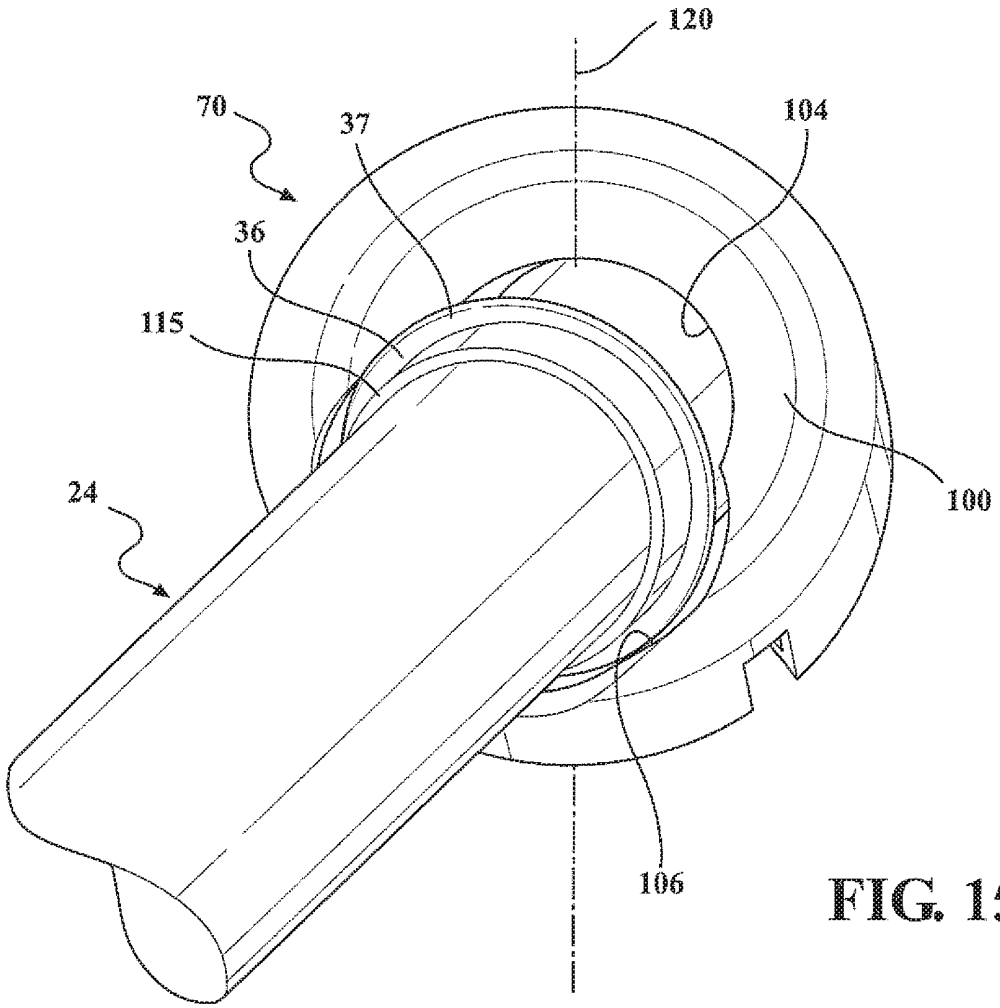


FIG. 15B

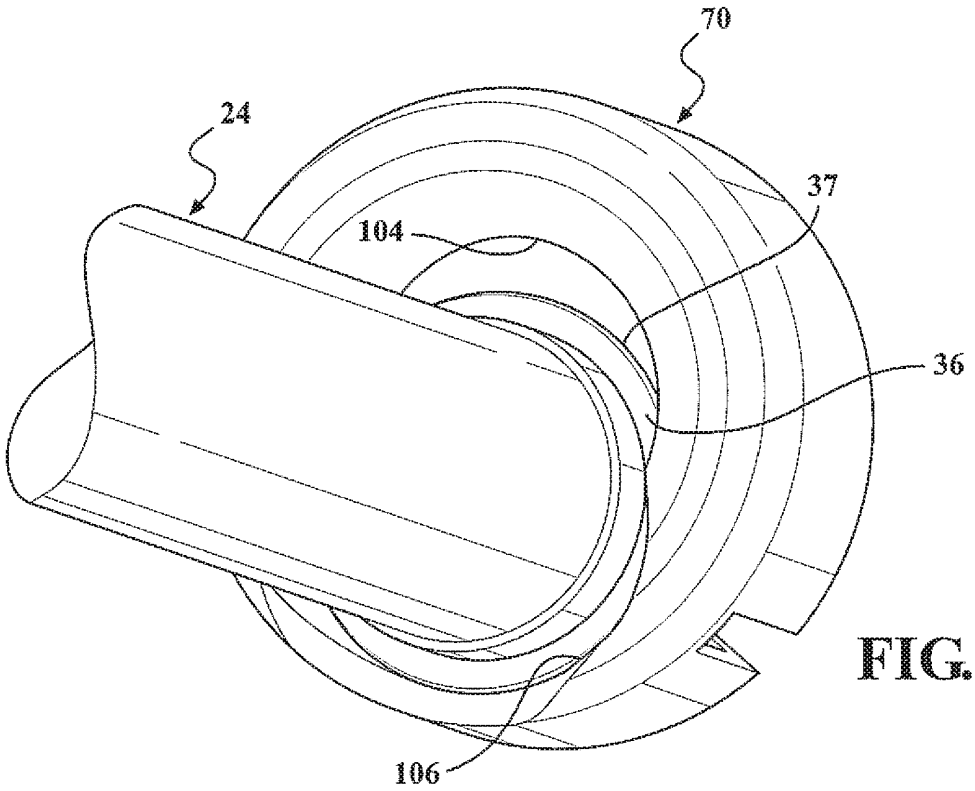


FIG. 15C

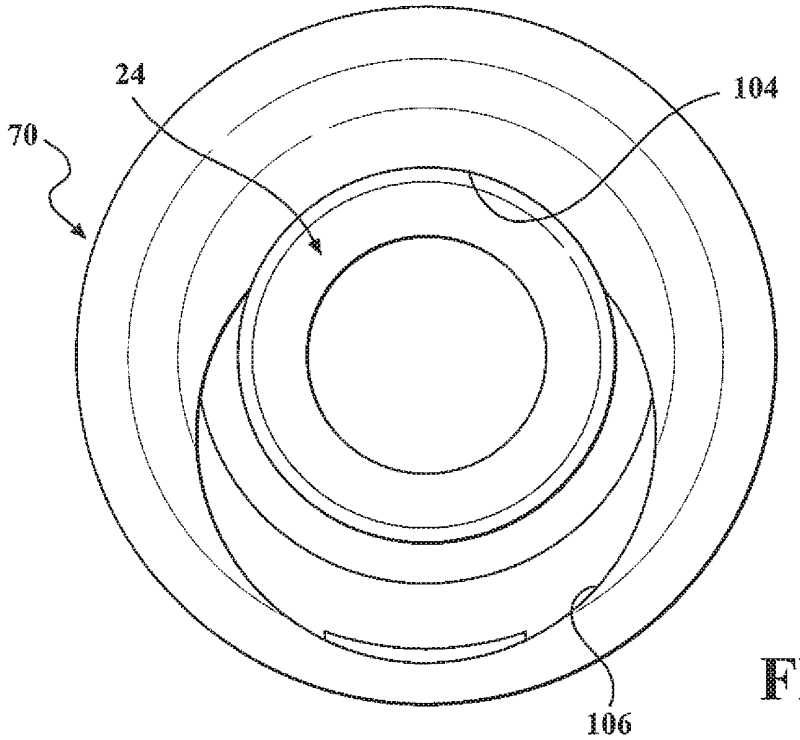


FIG. 15D

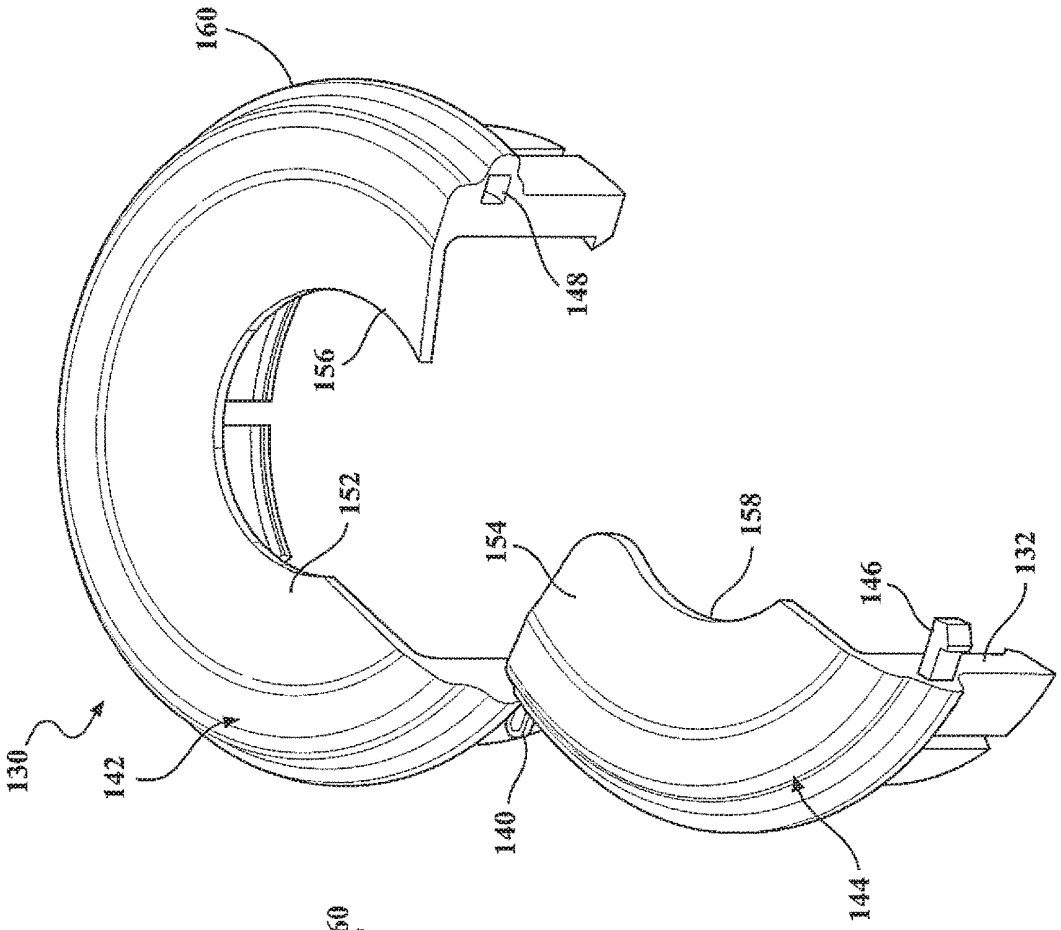


FIG. 16B

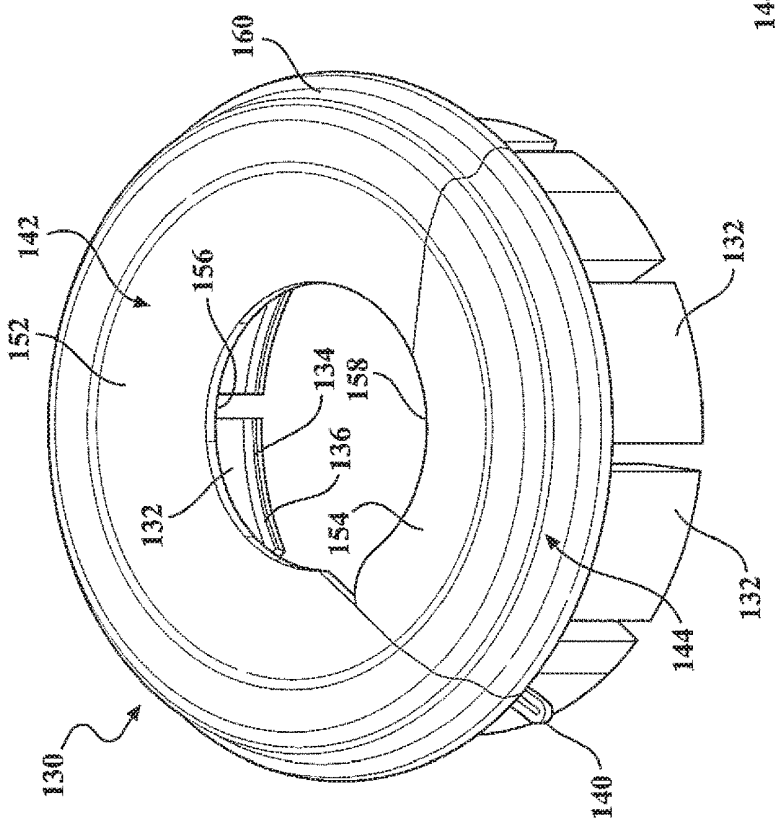


FIG. 16A

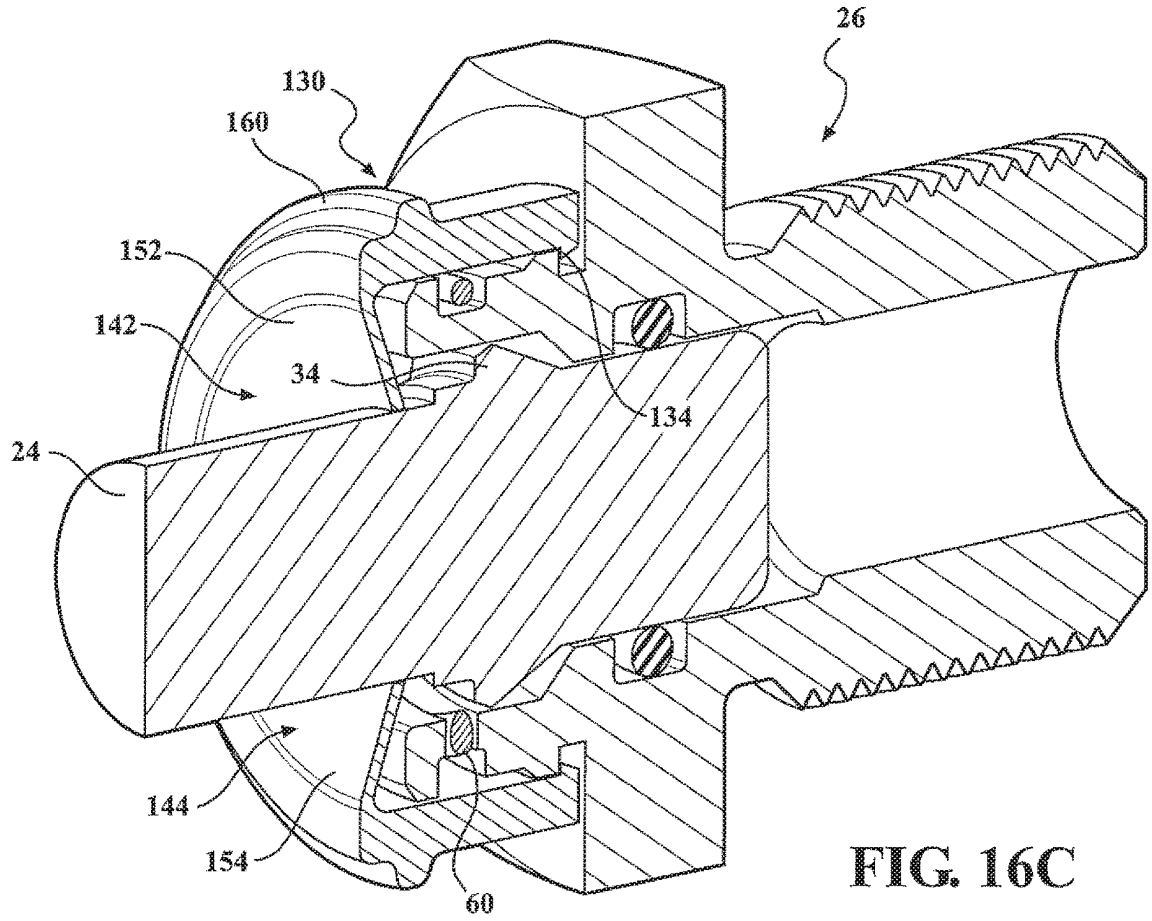


FIG. 16C

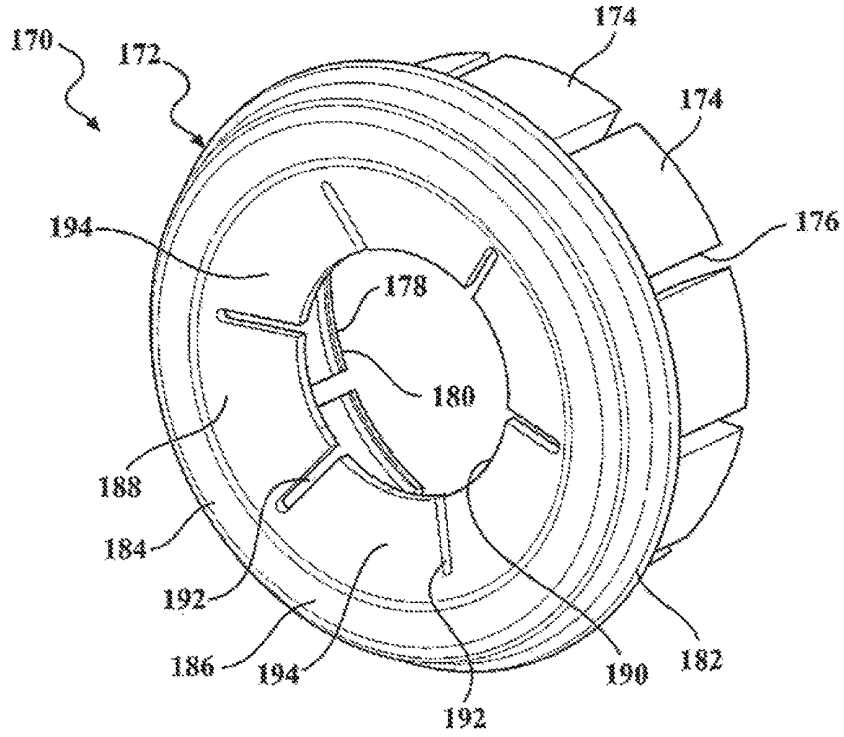


FIG. 17A

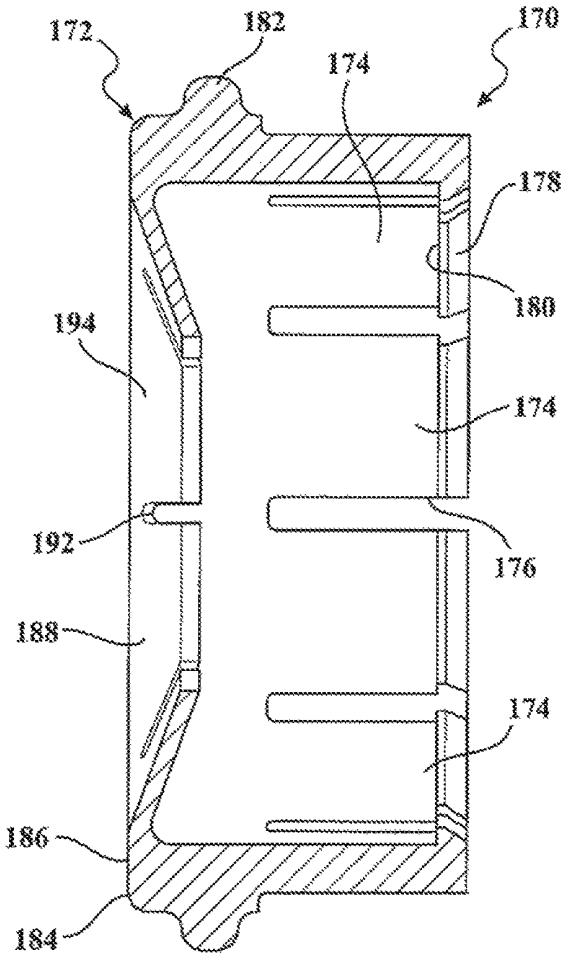


FIG. 17B

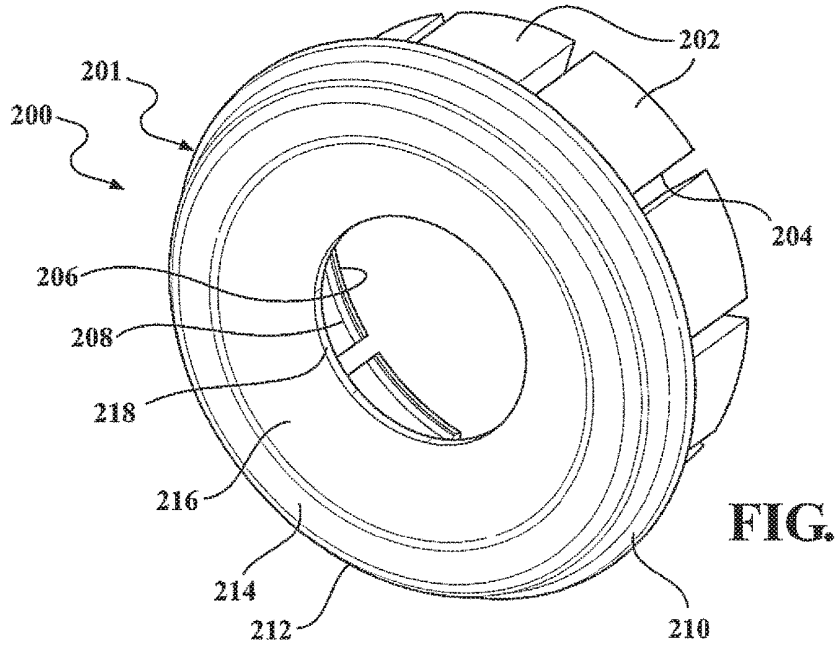


FIG. 18A

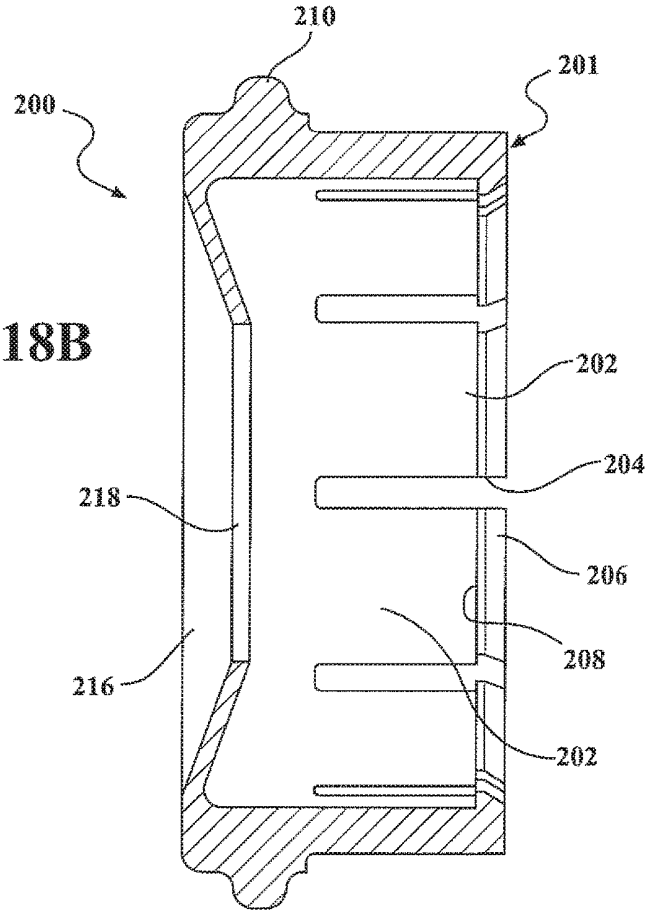


FIG. 18B

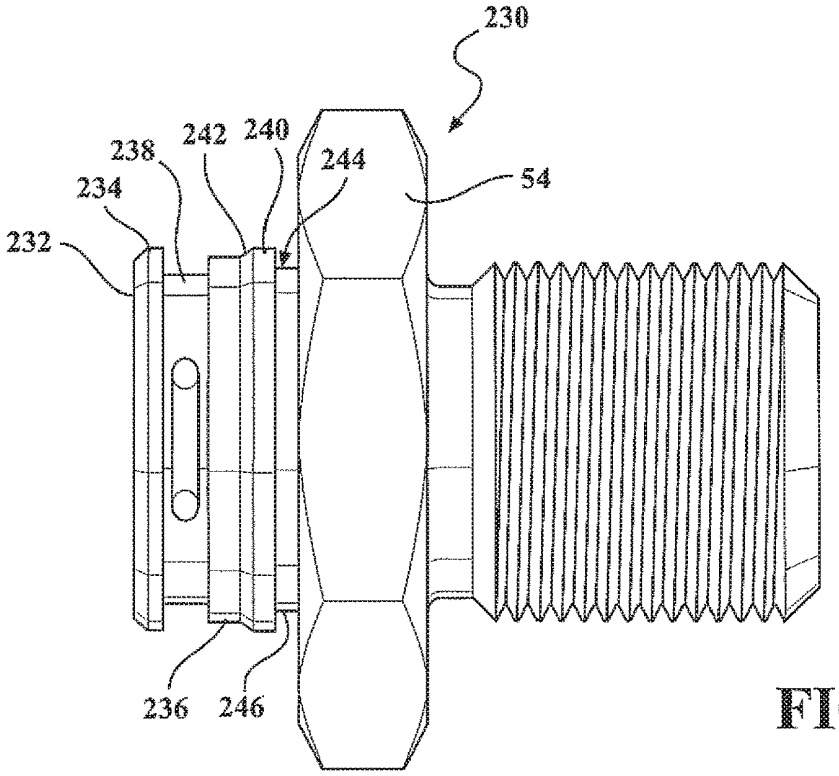


FIG. 19A

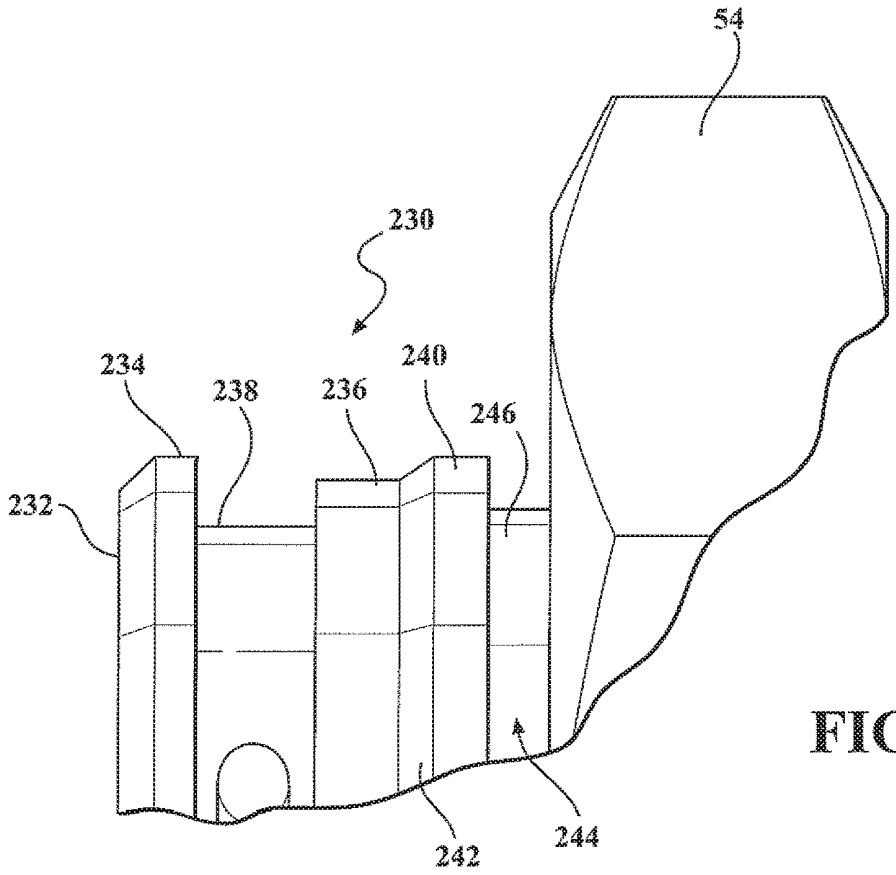


FIG. 19B

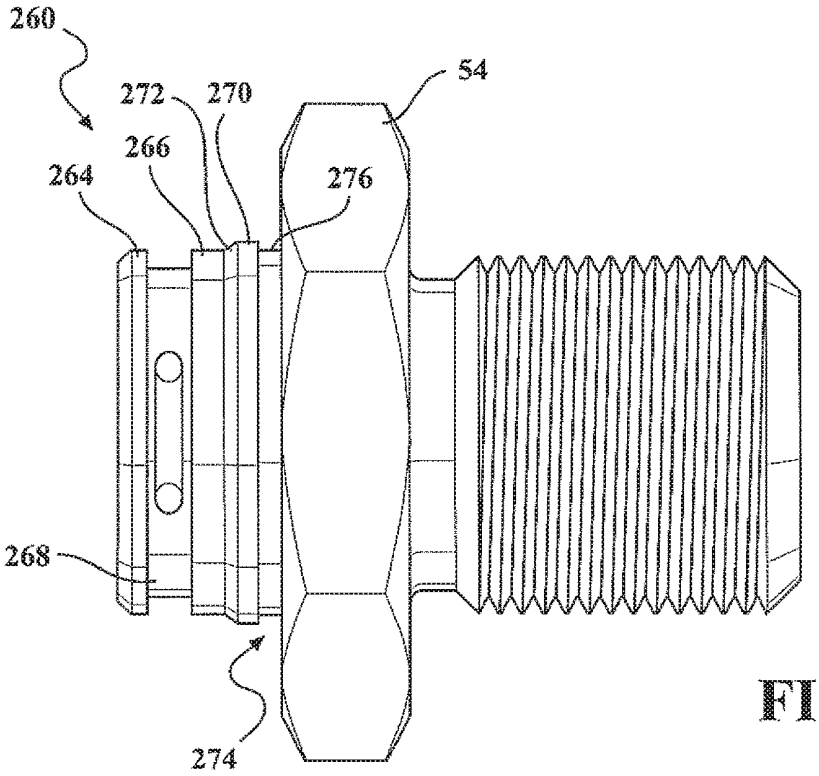


FIG. 20A

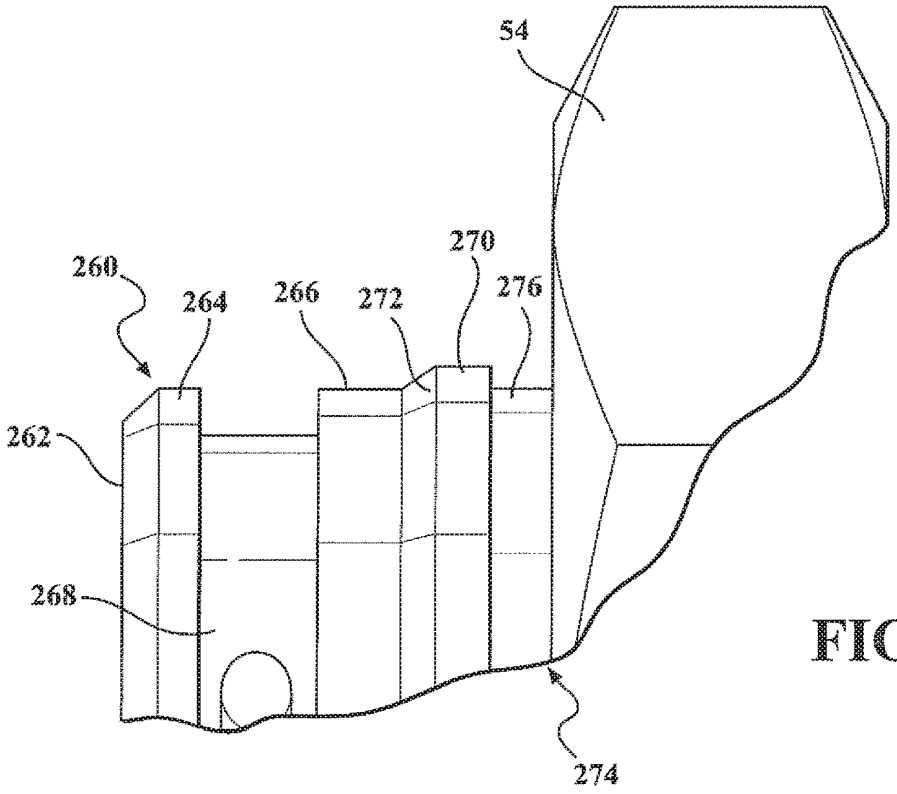


FIG. 20B

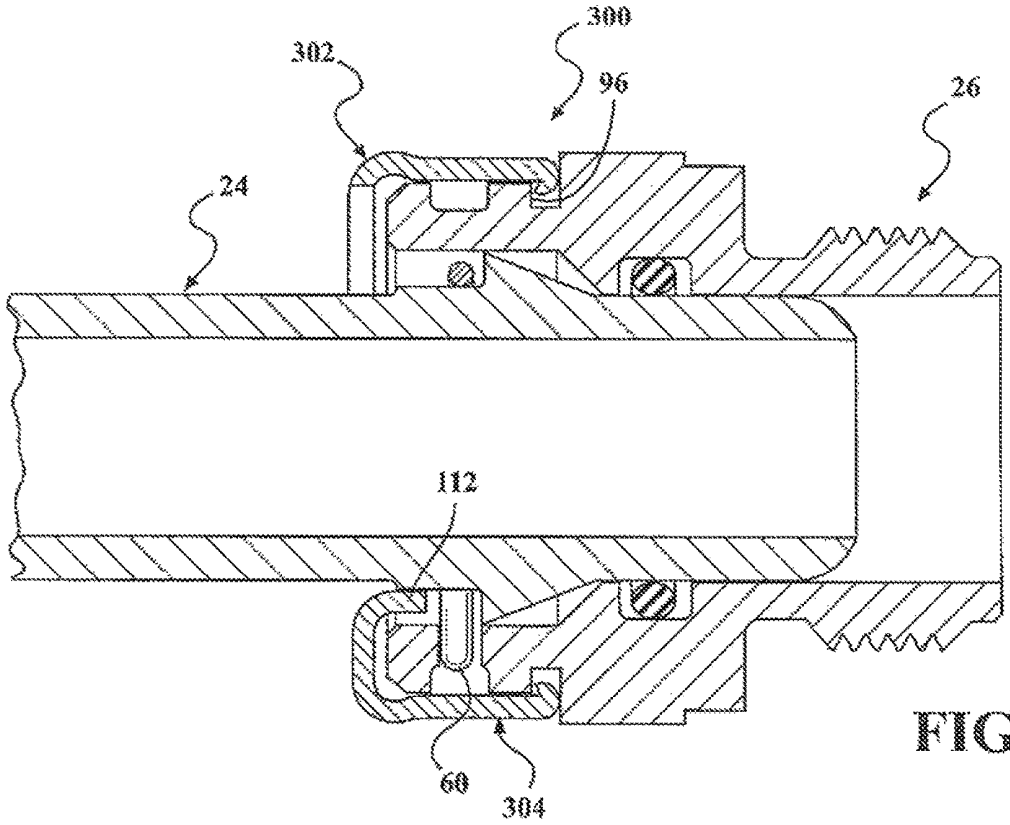


FIG. 21A

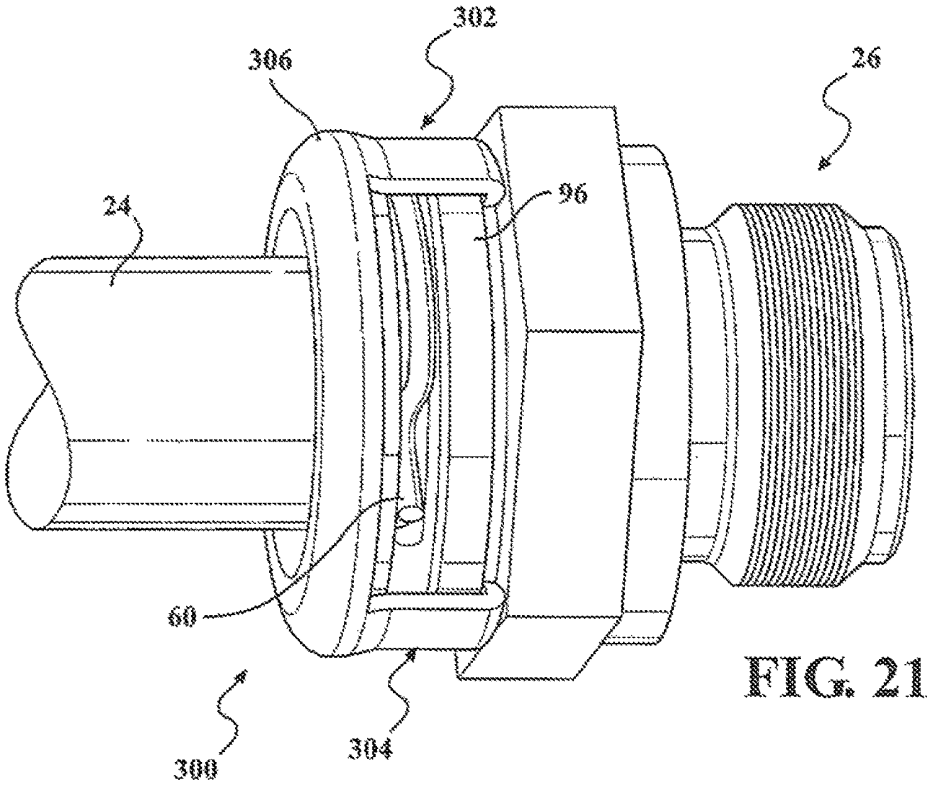


FIG. 21B

# FLUID CONNECTOR WITH FULL INSERTION ASSURANCE CAP WITH SECONDARY LATCHES

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application is filed under 35 U.S.C. § 120 as a divisional of U.S. Non-Provisional patent application Ser. No. 14/725,639, filed on May 29, 2015, which application claims priority benefit of U.S. Provisional Patent Application No. 62/005,136, filed on May 30, 2014, which applications are incorporated herein in their entireties.

## FIELD

The present disclosure relates to fluid connectors including a fluid carrying tubular member which is coupled to a connector body that is connected to a device which uses the fluid, and more particularly, to a connector body which is arranged for fitting with a tubular member and an assurance cap which ensures proper connection between the connector body and the tubular member.

## BACKGROUND

In an automotive application, the fluid carrying components are connected at one end to an automatic transmission and at another end to a cooler disposed within a vehicle radiator. Other automotive applications using fluid connectors include turbo connections. Such quick connectors, as they are often called, typically include a resilient clip carried on the fitting body which is adapted to snap behind a raised shoulder of an end form on the tubular member when the tubular member is fully inserted into the fitting body to lock the tubular member in place.

Assurance caps can be used to ensure full insertion of the tubular member in the body. As assurance cap is carried by the tubular member and slides over the tubular member insertion end of the body and snaps over the outer edges of the resilient clip. If the tubular member is not fully inserted in the body such that the resilient clip is not seated behind the raised shoulder on the tubular member, raised portions of the resilient clip extend further radially outward from the body and interfere with the complete movement of the assurance cap to its fully installed position thereby providing an indication to the installer that the tubular member is not fully latched in the body.

Thus, there is a long felt need for a connector body that is arranged to be engaged by a tubular member and an assurance cap such that the assurance cap may ensure that proper connection is made between the tubular member and the connector body.

## SUMMARY

According to aspects illustrated herein, there is provided a fluid connector for coupling a tubular member having an endform spaced from a first insertion end to an external component, comprising a connector body, including a bore having a first end for receiving the tubular member, and a first exterior groove spaced from the first end and arranged for receiving one or more projections of an assurance cap for latching the assurance cap to the connector body when the tubular member is fully inserted into the bore.

According to aspects illustrated herein, there is provided a fluid connector for coupling a tubular member having an endform spaced from a first insertion end to an external component, comprising a connector body, including a bore having a first end for receiving the tubular member, an outer surface, a first exterior groove arranged at an axial distance from the first end for receiving one or more projections of an assurance cap for latching the assurance cap to the connector body when the tubular member is fully inserted into the bore, and a raised portion disposed between the first end and the first exterior groove, the raised portion extending radially outward from the outer surface, and a retainer clip carried on the connector body and extending partially into the bore to engage a shoulder of the endform to lock the tubular member in the connector body when the first insertion end is fully inserted into the bore.

A fluid connection with an assurance cap for assuring full insertion and latching of a tubular member in a connector body comprising an endform spaced from a first insertion end defining a radially disposed shoulder, a connector body comprising a bore with one open end receiving the tubular member. A retainer clip is carried on the connector body and extends partially into the bore to engage the shoulder of the tubular member to lock the tubular member in the connector body when an insertion end of the tubular member is fully inserted into the bore in the fitting body. An assurance cap is slidably mounted relative to the tubular member. The assurance cap defining an annular body with a plurality of primary latch fingers with end projections configured for latching in a recessed groove in the connector body spaced from one end of the connector body to latch the assurance cap on the connector body only when the tubular member is fully inserted into the connector body. A secondary latch is carried on the assurance cap body for engaging one of the retainer clip and the tubular member to secondarily latch the assurance cap to the tubular member only when the tubular is fully inserted into the bore in the connector body.

The primary latch fingers may comprise a plurality of circumferentially spaced primary latch fingers extending from a first end of the assurance cap body.

In one aspect, the primary latch fingers include a radially inward projection formed on a flexible end of the primary latch finger; and a radially outward opening groove formed in the connector body, spaced from the one open end of the connector body, the groove and the projections on the primary latch fingers engageable to primarily latch the assurance cap to the connector body only when the tubular member is fully inserted into the bore in the connector body.

The secondary latch may include an inner support ring fixed in the assurance cap body radially inward of the primary latch fingers, the inner support ring comprising a through bore through which the tubular member extend, the inner support ring comprising an inner end positioned to engage a surface on the tubular member to provide a secondary latch between the assurance cap body and the tubular member when the tubular member is fully inserted into the bore in the connector body.

The surface on the tubular member is axially spaced from the endform and defines a raised surface on the tubular member.

The secondary latch may include a plurality of stepped fingers circumferentially spaced between the primary latch finger, each of the stepped fingers comprising an inner stepped surface configured to overlay a radially outward portion of the retainer clip when the assurance cap is latched to the quick connector body and the tubular member to resist radially outward expansion of the retainer clip.

The primary latch fingers may include a plurality of circumferentially spaced primary latch fingers extending

from a first end of the assurance cap body, and one stepped finger disposed intermediate at least one primary latch finger.

The plurality of primary latch fingers may be arranged in circumferentially spaced pairs of adjacent side-by-side arranged primary latch fingers, and one stepped finger is interposed between each pair of primary latch fingers.

The raised portion of the connector body may include an outward extending tapered portion extending from the outer diameter of the connector body to the outer surface of the raised portion on the connector body.

The raised portion formed on a receiving end of the fitting body comprising an outer diameter substantially equal to an outer diameter of the receiving end of the fitting body extending from the receiving end of the fitting body, an annular recess positioned adjacent to the raised portion for receiving the latch fingers of the assurance cap in a latch position of the assurance cap on the fitting body.

The connector assembly including the assurance cap body comprising pivotally connected first and second sections lockable in a continuous annular body about the tubular member, and the first and second section of the assurance cap body being pivotally movable relative to a pivotally connected end to allow mounting of the assurance cap body around the tubular member.

The connector assembly including secondary latch includes an inner support ring fixed in the assurance cap body radially inward of the primary latch fingers, the inner support ring comprising a through bore through which the tubular member extends, the inner support ring comprising an inner end positioned to engage a surface on the tubular member to provide a secondary latch between the assurance cap body and the tubular member when the tubular member is fully inserted into the bore in the connector body, the surface on the tubular member is axially spaced from the endform and defines a raised surface on the tubular member; a plurality of stepped fingers circumferentially spaced between the primary latch fingers, and each of the stepped fingers comprising an inner stepped surface configured to overlay a radially outward portion of the retainer clip when the assurance cap is latched to the quick connector body and the tubular member to resist radially outward expansion of the retainer clip.

The connector assembly includes the primary latch fingers further including a plurality of circumferentially spaced primary latch fingers extending from a first end of the assurance cap body, and one step finger disposed intermediate at least one primary latched finger.

The connector assembly including the plurality of primary latch fingers arranged in circumferentially spaced pairs of adjacent side-by-side arranged primary latch fingers, and one stepped finger interposed between each pair of primary latch fingers.

These and other objects, features, and advantages of the present disclosure will become readily apparent upon a review of the following detailed description of the disclosure, in view of the drawings and appended claims.

## BRIEF DESCRIPTION OF THE DRAWING

Various embodiments are disclosed, by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts, in which:

FIG. **1** is a partial cross-sectional perspective view of a prior art fluid quick connector with assurance cap;

FIG. **2** is a perspective view of an assembled quick connector and assurance cap;

FIG. **3**A is a cross-sectional view generally taken along line **3**A-**3**A in FIG. **2**;

FIG. **3**B is a cross-sectional view generally taken along line **3**B-**3**B in FIG. **2**;

FIG. **4** is a perspective view of a right end of the assurance cap shown in FIG. **2**;

FIG. **5** is a perspective view from the opposite end of the assurance cap shown in FIG. **4**;

FIG. **6** is an elevational view of the assurance cap shown in FIG. **4**;

FIG. **7** is a cross-sectional view generally taken along line **7**-**7** in FIG. **6**;

FIG. **8** is a cross-sectional view showing the position of the assurance cap and quick connector body when the tubular member is not fully inserted into the quick connector body;

FIG. **9** is a partial cross-sectional perspective view of a quick connector body with another aspect of an assurance cap;

FIG. **10** is a perspective view of one end of the assurance cap shown in FIG. **9**;

FIG. **11** is a partially cross-sectional side elevation view of the assurance cap shown in FIG. **10**;

FIG. **12** is an elevational view of an opposite end of the assurance cap shown in FIG. **10**;

FIG. **13** is a perspective view of an opposite end of the assurance cap shown in FIGS. **10**-**12**;

FIG. **14** is a cross-sectional view showing the fully latched position of the assurance cap of FIGS. **9**-**13** on the quick connector body;

FIG. **15**A is a side elevational view of a tubular member insertable into the quick connector body;

FIGS. **15**B, **15**C, and **15**D are perspective views showing the installation of the tubular member shown in the assurance cap of FIGS. **9**-**13** to pre-mount the assurance cap on the tubular member;

FIG. **16**A is a perspective view of an assurance cap;

FIG. **16**B is a partially opened perspective view of the assurance cap shown in FIG. **16**A;

FIG. **16**C is a cross-sectional perspective view of the assurance cap shown in FIGS. **16**A and **16**B mounted on a tubular member, which is in a fully inserted position within a quick connector body;

FIG. **17**A is a perspective view of an assurance cap;

FIG. **17**B is a cross-sectional view of the assurance cap shown in FIG. **17**A;

FIG. **18**A is a perspective view of an assurance cap;

FIG. **18**B is a cross-sectional view of the assurance cap shown in FIG. **18**A;

FIG. **19**A is a side elevational view of a quick connector body;

FIG. **19**B is a partial enlarged side elevational view of a portion of the quick connector body shown in FIG. **19**A;

FIG. **20**A is a side elevational view of a quick connector body;

FIG. **20**B is a partial enlarged side elevational view of a portion of the quick connector body shown in FIG. **20**A;

FIG. **21**A is a cross-sectional view of an assurance cap shown in an assembled position on a quick connector body; and,

FIG. **21**B is a perspective view of the assurance cap and quick connector body shown in FIG. **21**A.

## DETAILED DESCRIPTION

At the outset, it should be appreciated that like drawing numbers on different drawing views identify identical, or

functionally similar, structural elements. It is to be understood that the claims are not limited to the disclosed aspects.

Furthermore, it is understood that this disclosure is not limited to the particular methodology, materials and modifications described and as such may, of course, vary. It is also understood that the terminology used herein is for the purpose of describing particular aspects only, and is not intended to limit the scope of the claims.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this disclosure pertains. It should be understood that any methods, devices or materials similar or equivalent to those described herein can be used in the practice or testing of the example embodiments. The assembly of the present disclosure could be driven by hydraulics, electronics, pneumatics, and/or springs.

It should be appreciated that the term "substantially" is synonymous with terms such as "nearly," "very nearly," "about," "approximately," "around," "bordering on," "close to," "essentially," "in the neighborhood of," "in the vicinity of," etc., and such terms may be used interchangeably as appearing in the specification and claims. It should be appreciated that the term "proximate" is synonymous with terms such as "nearby," "close," "adjacent," "neighboring," "immediate," "adjoining," etc., and such terms may be used interchangeably as appearing in the specification and claims. The term "approximately" is intended to mean values within ten percent of the specified value.

It should be appreciated that facet joints are a set of synovial, plane joints between the articular processes of two adjacent vertebrae. There are two facet joints in each spinal motion segment and each facet joint is innervated by the recurrent meningeal nerves.

By "non-rotatably connected" elements, we mean that: the elements are connected so that whenever one of the elements rotate, all the elements rotate; and relative rotation between the elements is not possible. Radial and/or axial movement of non-rotatably connected elements with respect to each other is possible, but not required. By "rotatably connected" elements, we mean that the elements are rotatable with respect to each other.

Referring now to FIG. **1**, there is depicted prior art fluid connector **20** which locks first end **22** of tubular member **24** in connector or fitting body **26** which is itself removably mountable in a port, such as by engagement of external threads **28** on one end of body **26** with internal threads in the port.

Tubular member **24** is generally made of metallic materials, but rigid plastic material may also be employed. Tubular member **24** comprises a generally constant diameter extending from first end **22**.

Head section **30** extends from first end **22** at first diameter portion **32** to an outward extending endform comprising tapered raised surface **34** which terminates at a large diameter end and radially extending shoulder **36**.

Connector body **26** can be, but need not necessarily be, integrally made from a single piece of metallic or plastic material. Body **26** comprises through bore **40** extending from first end **42** to opposite second end **44**. Bore **40** need not have a constant diameter between first and second ends **42** and **44**. Annular internal groove **46** is formed in body **26** intermediate first and second ends **42** and **44** and receives seal member **48**, such as an O-ring, for sealing tubular member **24** to body **26** and to prevent fluid leakage there between.

As described above, body **26** comprises externally threaded end portion **28** spaced from first end **42**. Recessed radially inward extending groove **50** can be formed in certain applications adjacent one end of threaded end portion **28** and annular collar **52** to receive a washer, not shown. Hexagonal portion or flange section **54** is formed adjacent annular collar **52**. Reduced diameter receiving portion **56** comprising a generally constant diameter extends from one end of hexagonal portion **54** to second end **44** of body **26**. Recessed, outward opening, annular groove **58** is formed in receiving portion **56**. Groove **58** comprises a constant closed inner end facing bore **40** in body **26** which is interrupted by one or more circumferentially spaced slots.

Retainer clip **60** is mounted in groove **58**. Retainer clip **60** can be, but need not necessarily be formed of a spring wire. Retainer clip **60** can be formed with inwardly extending protrusions which project through the slots in groove **58**, when retainer clip **60** is in a relaxed state behind tapered shoulder **36** on tubular member **24**, to lock tubular member **24** to connector body **26**.

When first end **22** of tubular member **24** is inserted in receiving portion **56** of body **26**, first end **22** and head section **30** of tubular member **24** slide through receiving portion **56** toward first end **42** of body **26**. The inward extending protrusions on retainer clip **60** seated in groove **58** slide along tapered surface **34** on tubular member **24** causing retainer clip **60** to expand radially outward moving the protrusions on retainer clip **60** out of bore **40** until tapered shoulder **36** of tubular member **24** slides past one end of retainer clip **60**. At this point, the protrusions on retainer clip **60** snap radially inward into bore **40** behind tapered shoulder **36** locking tubular member **24** in body **26**. Also, at this point during the insertion process, the outermost portions of retainer clip **60** extend only slightly above the outer surface of receiving portion **56** of the body **26**.

Prior art assurance cap **62** shown in FIG. **1**, carried on tubular member **24**, can then be slid over receiving portion **56** of body **26**. Assurance cap **62** includes inward opening recess **64**, which is positioned between the ends of assurance cap **62** to encompass the outer portions of retainer clip **60** extending outward from body **26** when retainer clip **60** is in the fully seated position in groove **58** behind tapered shoulder **36** of tubular member **24**. This provides the installer with a visual indication that tubular member **24** is fully inserted and seated in body **26** in a fluid sealed position.

In the event that tubular member **24** is not fully inserted into body **26** such that it is not in the position shown in FIG. **1**, the outer portions of clip **60** will have been pushed radially outward into a radially expanded state as clip **60** rides up along the tapered surface **34** of tubular member **24**. The outer tips of the outer portions of retainer clip **60** then extend further outward beyond the outer surface of receiving portion **56** of the body **26** in an interference position with the sliding movement of assurance cap **62**. This interference prevents assurance cap **62** from being slid fully forward such that recess **64** cannot snap over clip **60**. Since assurance cap **62** is therefore not in a fully forward position, the installer has a visual indication that tubular member **24** is not fully inserted into body **26**.

FIGS. **2-8** depict alternate assurance cap **500** mounted on fluid connector assembly **420**. Fluid connector assembly **420** locks first end **422** of fluid flow tubular member or conduit **424** (hereafter "tubular member **424**") in connector body **426** which is itself removably mountable in a port, such as by engagement of external thread **428** on one end of body **426** with internal threads in the port of an external device, connector, housing, etc.

Tubular member **424** comprises a generally constant diameter extending from first end **422**. Head section **430** extends from first end **422** at a first diameter **432** to an outward extending endform comprising tapered radially outward endform ramp portion **434** which terminates in a large diameter end and radially extending shoulder **436**. Raised bead or collar **437** is formed on the exterior surface of tubular member **424** and extends axially from radially extending shoulder **436** for a short distance to end or shoulder **438** which transitions to the constant first diameter of the overall tubular member **424**.

Connector body **426** comprises through-bore **440** extending from first end **442** to opposite second end **444**. Through-bore **440** may or may not have a constant diameter between first and second ends **442** and **444**. Annular internal groove **446** is formed in connector body **426** intermediate first and second ends **442** and **444** and receives a seal member, such as O-ring **448**, for sealing tubular member **424** to connector body **426** and to prevent fluid leakage there between.

Connector body **426** comprises external threaded end portion **428** spaced from first end **442**. Radially inward extending groove **450** can be formed adjacent one end of threaded end portion **428** for receiving external seal member **451**, such as an O-ring, for sealing connector body **426** to the external component. Hexagonal portion or flange section **454** is formed adjacent to recess **450**.

Annular recess or groove **476** of a first diameter extends axially from one edge of hexagonal portion **454**. Recess **476** terminates in a radially outward extending shoulder at one end of annular ring **470**. Annular ring **470** transitions into radially inward extending ramp or conical surface **472** which transitions into an axially extending surface **466** comprising an outer diameter larger than the inner diameter of recess **476**. Axial surface **466** transitions into recess or groove **468**. Groove **468** includes a plurality of circumferentially spaced apertures **469**, with three apertures being employed, for example, for three-protrusion retainer clip **460**. Recess **468** transitions into larger diameter end annular ring **464** which extends to second end **444** of body **426**.

Resilient retainer clip **460** (hereinafter "clip **460**") mounted in groove **468** can be, but need not necessarily be, formed of a single piece of spring wire. Clip **460** can be formed with a plurality of radially inward extending protrusions which project through slots or apertures **469** in groove **468** when clip **460** is in a relaxed state behind the radially extending shoulder **436** on tubular member **424** to lock tubular member **424** to connector body **426**. At the same time, clip **460** can be in a relaxed state prior to insertion of tubular member **424** into open insertion second end **444** of connector body **426**.

When first end **422** of tubular member **424** is inserted into open second end **444** of connector body **426**, first end **422** and head section **430** of tubular member **424** slide through the aperture in bore **440** at second end **444** of connector body **426** toward first end **442** of connector body **426**. The inwardly extending protrusions on clip **460** slide along tapered endform ramp portion **434** on tubular member **424** causing clip **460** to expand radially outward moving the protrusions on resilient clip **460** out of groove **468** until radially extending shoulder **436** on the end of outward tapered endform ramp portion **434** of tubular member **424** slide past one end of clip **460**. At this point, the protrusions on clip **460** snap radially inward into bore **440** in connector body **426** behind radially extending shoulder **436** locking tubular member **424** in connector body **426**.

As shown in FIGS. **2-8**, assurance cap **500** is in the form of a one-piece body, which may be molded, machined, or otherwise formed out of plastic, metal, such as aluminum, etc.

Assurance cap **500** is formed with first outer annular ring **502** at first end **503**. Inner support ring **504**, generally in the form of a cylindrical annular member, comprises first end **506** generally disposed coplanar with first end **503** of first annular outer ring **502**, and second opposed end **508** spaced a distance by a tubular wall of inner support ring **504** from first end **506** of inner support ring **504**. Inner support ring **504** includes a hollow interior defining through bore **510** extending between first and second ends **506** and **508**.

A plurality of radially extending ribs **512** form spokes extending radially outward between inner support ring **504** and first outer annular ring **502**. Ribs **512** are circumferentially spaced about the first end of first outer annular ring **502** and have an overall length extending from first end **503** of first outer annular ring **502** and first end **506** of inner support ring **504** for a predetermined distance less than the length of inner support ring **504** as shown in FIGS. **5** and **7**.

A plurality of primary latch fingers **520** and a plurality of stepped fingers **522** are formed on the body of assurance cap **500** and are arranged in an annular, circumferential spaced, arrangement extending parallel to the longitudinal axis of assurance cap **500** from first annular ring **502** at first end **503** of assurance cap **500**.

Primary latch fingers **520** and stepped fingers **522** are arranged in a generally alternating arrangement around the periphery of first end **503** of assurance cap **500**. Although primary latch fingers **520** and stepped fingers **522** may alternate in a circumferentially spaced side-by-side arrangement of one primary latch finger **520** located between two stepped fingers, by example only, as shown in FIGS. **4-7**, two primary latch fingers **520** are arranged in a spaced side-by-side pair between single stepped fingers **522**. This arrangement of two primary latch fingers **520** between two spaced stepped fingers **522** continues in a circumferential consecutive manner about the periphery of the body of assurance cap **500**.

Primary latch fingers **520** are formed of an axially extending member with a generally planar, slightly arcuate leg **524** which is recessed a short distance below the outer periphery of first outer annular ring **502**. Elongated rib or structural support **526** is integrally formed on leg **524** and projects axially from the outer peripheral edge of annular ring **502**. Rib **526** provides structural support for leg **524** of primary latch fingers **520** while still allowing flexure of primary latch fingers **520** as described hereafter.

Leg **524** of each primary latch finger **520** terminates in outer end **528**. Projection **530** is formed on outer end **528** of primary latch fingers **520** and projects radially inward from inner surface **532** of primary latch finger **520** to form shoulder **534** extending radially inward from outer end **528** of primary latch finger **520**.

Stepped fingers **522** have outmost first step **540** which terminates in outer end **541** contiguous with outer end **528** of each primary latch finger **520**. Second step **542** is disposed axially adjacent first step **540** and comprises an inner surface disposed radially inward of the inner surface of first step **540**. Third step **544** is disposed axially adjacent second step **542** and includes an inner surface disposed radially inward of the inner surface of second step **542**.

Primary latch fingers **520** and stepped fingers **522** are circumferentially spaced apart by slots **550** which open at first ends **528** and **541** of primary latch fingers **520** and stepped fingers **522**, respectively. Slots **550** are generally

axially aligned with ribs **512**. Slots **550** provide a degree of flexibility to primary latch fingers **520** and stepped fingers **522**.

Referring to FIGS. **3**B and **8**, assurance cap **500** is first installed over tubular member **424** from either end of tubular member **424** prior to formation of endform ramp portion **434** adjacent first end **422** of tubular member **424**. Endform ramp portion **434** slidably captures assurance cap **500** on tubular member **424**.

Alternately, assurance cap **500** may be inserted over tubular member **424** from the end of tubular member **424** opposite first end **422** prior to the connection of the opposite end of tubular member **424** to another component. Endform ramp portion **434**, in this alternate installation, can be pre-formed on tubular member **424** prior to the mounting of assurance cap **500** from the opposite end of tubular member **424**.

When tubular member **424** is to be coupled to quick connector body **426**, first end **422** of tubular member **424** is inserted through open first end **444** of connector body **426**. The ramp surface of endform ramp portion **434** of tubular member **424** will engage the radially inward extending projection on clip **460** and force the entire clip radially outward until, when first end **422** of tubular member **424** is fully inserted into bore **440** in connector body **426**, the projections on clip **460** snap radially inward to their relaxed normal state behind radially extending shoulder **436** on endform ramp portion **434** on tubular member **424**.

With tubular member **424** locked to connector body **426** by clip **460**, the operator can slide assurance cap **500** toward hex portion **454** of quick connector body **426**. Projections **530** on outer ends **528** of primary latch fingers **520** will engage ramp surface **472** on connector body **426** forcing the ends of primary latch fingers **520** radially outward. When assurance cap **500** is in the fully forward position, projections **530** snap into recess or groove **476** on connector body **426** latching assurance cap **500** to quick connector body **426**. At the same time, as shown in FIG. **3**B, second step **542** of each stepped finger **522** will be located circumferentially over the outer surface of clip **460**. This arrangement holds clip **460** in its normal non-expanded state and prevents expansion of clip **460** due to any axial separation forces exerted on connector body **426** and/or tubular member **424** tending to disengage or separate connector body **426** and tubular member **424**. Stepped fingers **552** thereby act as an axillary latch for assurance cap **500**.

The arrangement of a pair of primary latch fingers **520**, one stepped fingers **522**, pair of primary latch fingers **520**, etc., about the circumference of assurance cap **500** enables one or two stepped fingers **522** to be in contact with clip **560** at all annular positions of assurance cap **500** relative to quick connector body **426**.

When projections **530** on primary latch fingers **520** are in the fully latched position in groove **476** on quick connector body **426**, inner end **508** of inner support ring **504** will be in engagement with shoulder **438** on raised bead or flange **437** on tubular member **424**. This serves as a secondary latch function securing assurance cap **500** to connector body **426** and tubular member **424** in the fully inserted position of tubular member **424** in connector body **426** between engaged projections **530** of primary latch fingers **520** in groove **476** and engaged inner end **508** of inner support ring **504** with flange **437** on tubular member **424**.

Referring briefly to FIG. **8**, the primary function of assurance cap **500** is to insure that tubular member **424** is fully inserted into quick connector body **426** so that tubular member **424** can be latched in place by clip **460**. During the insertion of tubular member **424** into bore **440** in quick connector body **426**, the installer may feel resistant to forward insertion movement of tubular member **424** into bore **440** when, for example, first end **422** of tubular member **424** contacts O-ring **448** in the interior of quick connector body **426**. This may give a false full insertion indication to the installer. However, assurance cap **500** is configured so that at all non-fully inserted position of tubular member **424** relative to quick connector body **426**, projections **530** on ends **528** of primary latch fingers **520** will not be fully latched in recess or groove **476** in connector body **426**; but rather, will be in engagement with ramp surface **472** on radial outer surface **470** on connector body as shown in FIG. **8**. This prevents latching of primary latch fingers **520** to quick connector body **426**. A non-fixed position of body **426** or a slight pull-out movement by the installer exerted on assurance cap **500** moving assurance cap **500** away from body **426** will provide an indication of non-latching of assurance cap **500** to quick connector body **426**.

At the same time, assurance cap **500**, due to the rib support structure of primary latch fingers **520** and the number of such primary latch fingers **520** on assurance cap **500** and primary latching of projections **530** of primary latch fingers **520** in groove **476** of quick connector body **426** and engagement of inner end **508** of inner support ring **504** with shoulder **438** on radially extending shoulder **436** on tubular member **424**, provides a resistance force sufficient to prevent axial separation of tubular member **424** from quick connector body **426** despite any axial separation forces acting on quick connector body and tubular member **424**.

FIG. **9** depicts fluid connector **20** of FIG. **1** which is used to sealingly lock the tubular member **24** to the body **26**. However, fluid connector **20** in FIG. **9** includes novel assurance cap **70** which provides assurance of a full insertion of tubular member **24** into body **26** and, at the same time, provides secondary latches to hold assurance cap **70** on body **26** and to provide an additional latching force against disengagement of tubular member **24** from body **26**.

Assurance cap **70**, shown in an assembled position in FIG. **9** and in detailed views in FIGS. **10-14** and FIGS. **15**A-**15**D, can be formed of a material having a suitable strength, such as high strength plastic, or a metal, such as stainless steel, aluminum, etc.

In this aspect, assurance cap **70** is in the form of annular body **72** comprising first end **74**, opposed second end **76**, and intermediate sidewall **78** extending between first and second ends **74** and **76**. At least one or a plurality of slots **80**, with three slots **80** shown by example, are formed through first end **74** and a portion of sidewall **78** to separate sidewall **78** into a plurality of fingers with three fingers **82**, **84**, and **86** being shown by example in FIGS. **10-14**. Slots **80** and intervening fingers **82**, **84**, and **86** provide flexibility to assurance cap **70** allowing first end **74** of assurance cap **70** to flex radially outward over the outer surface of receiving portion **56** of body **26** until assurance cap **70** has reached its fully forward position of movement, as described hereafter.

First end **74** of each of fingers **82**, **84**, and **86** comprises rounded over end portion **90** which terminates in radially inward extending edge **92** forming shoulder **94**. Shoulder **94** is configured to snap over and engage mating shoulder **96** formed along one side of open ended annular groove **98** formed in body **26** between hexagonal portion **54** and receiving portion **56** of body **26**. Shoulders **94** on each of the three fingers **82**, **84**, and **86**, which extend over substantially the entire circumference of assurance cap **70**, provide a secure circumferential secondary latching force to secure

assurance cap **70** on body **26** as well as providing additional latching force to resist separation of tubular member **24** from body **26**.

Second end **76** of assurance cap **70** comprises a partially closed, irregularly shaped endwall **100** which includes keyhole shaped aperture **102** comprising reduced diameter or width first end portion **104** and larger diameter second end portion **106**. The walls forming first end portion **104** and second end portion **106** are generally arcuate to enable assurance cap **70** to be mounted over first end **22** of tubular member **24** as described hereafter and shown in FIGS. **15**A-**15**D.

Diametrically opposed, inward extending fingers **110** and **112** are provided generally centrally in endwall **100** on second end **76** of assurance cap **70**. Fingers **110** and **112**, with only finger **112** shown in FIG. **10**, have inward curled wall **114** terminating in inner edge wall **116**. As shown in FIG. **9**, wall **114** is generally parallel to intermediate sidewall **78** of assurance cap **70**, with inner edge wall **116** facing, but spaced from resilient clip **60**.

Edge walls **114** will rest on raised bead **115** on tubular member **24** extending from tapered shoulder **36** at the fully inserted position of tubular member **24** in body **26** latching assurance cap **70** on body **26** between shoulders **94** on fingers **82**, **84**, and **86** and fingers **110** and **112**.

Fingers **110** and **112** provide an additional engagement or latching function for assurance cap **70** on fluid connector **20** when assurance cap **70** is in the full forward, latched position shown in FIG. **9**.

FIGS. **15**A-**15**D depict the orientation of tubular member **24** and assurance cap **70** for mounting of assurance cap **70** over first end **22** of tubular member **24** and tapered surface **34**. At the time of assembly, assurance cap **70** is oriented as shown in FIG. **15**B with longitudinal axis **120** extending through keyhole shaped aperture **102** oriented at an angle along axis line **122** of tubular member **24** in FIG. **15**A to bring larger diameter or width second end portion **106** of keyhole shaped aperture **102** over large diameter end **37** of tapered surface **34** of tubular member **24**.

The other end of assurance cap **70** can then be pivoted in the direction of arrow **124** in FIG. **15**C to move entire keyhole shaped aperture **102** over large diameter end **37** of tapered surface **34** of tubular member **24** until first end **74** of assurance cap **70** clears large diameter end **37** of tapered surface **34** of tubular member **24**.

After large diameter end **37** of tapered shoulder **36** of tubular member **24** has been urged past the inner edges of large diameter end portion **106** of keyhole aperture **102** in assurance cap **70**, assurance cap **70** can be tilted upward toward a perpendicular orientation with respect to a longitudinal axis of tubular member **24** and moved longitudinally along tubular member **24** until the inner edges of keyhole shaped aperture **102** are completely past large diameter end **37** of tapered surface **34** of tubular member **24**, as shown in FIG. **15**C. Assurance cap **70** can then be urged or slid into smaller diameter first end portion **104** of keyhole shaped aperture **102** to center assurance cap **70** with respect to tubular member **24** as shown in FIG. **15**D.

Referring now to FIGS. **16**A, **16**B, and **16**C, there is depicted another aspect of assurance cap **130** which functions in the same manner as assurance cap **70** described above and shown in FIGS. **9**-**15**D. Assurance cap **130** includes a plurality of longitudinally extending, spaced fingers **132**, each with radially inward extending edge **134** terminating in shoulder **136** configured to latchably engage edge **96** of groove **98** in fluid connector **20** to secure assurance cap **130** in position at its forward most position of movement relative to tubular member **24** and body **26**. It should be noted that instead of three longer circumferential length fingers **82**, **84**, and **86**, fingers **132** in assurance cap **130** are smaller in length and greater in number to provide a greater degree of flexibility to enable assurance cap **130** to be easily slid over the raised end of receiving portion **56** of body **26**.

Assurance cap **130** comprises a body with hinge **140** interconnecting first body section **142** with second body section **144**. First and second body sections **142** and **144** are pivotally movable with respect to each other about hinge **140** from an open position shown in FIG. **16**B which enables assurance cap **130** to be mounted over tubular member **24** to a closed position forming a continuous body about tubular member **24** by pivotal movement of first and second body sections **142** and **144** toward each other about hinge **140** until latch finger **146** on second body section **144** engages latch recess **148** in opposite first body section **142** as shown in FIG. **16**B. The engagement of latch finger **146** in latch recess **148** locks first and second body sections **142** and **144** of assurance cap **130** into a continuous body encircling tubular member **24**.

It should also be noted that the second end of assurance cap **130** comprises a radially inward extending skirt formed of first skirt portion **152** on first body section **142** of assurance cap **130** and second skirt portion **154** on second body section **144** of assurance cap **130**. Arcuate inner edges **156** and **158** respectively on first and second skirt portions **152** and **154** form a continuous annular edge configured to engage or be slightly spaced from the outer surface of tubular member **24** when assurance cap **130** is slid to its forward most position over tubular member **24** and latched to body **26** as shown in FIG. **16**C. First and second skirt portions **152** and **154** also act to center assurance cap **130** about tubular member **24** during the forward sliding movement of assurance cap **130**.

Raised annular rib **160** is formed on the outer surface of assurance cap **130** between the first and second ends to act as a gripping surface to facilitate movement of assurance cap **130** from a rest position about tubular member **24** to its forward position shown in FIG. **16**C.

The two-part hinged cap described above and shown in FIGS. **16**A-**16**B may be applied to any of the other assurance caps described herein. Particularly, assurance cap **500** described above and shown in FIGS. **2**-**8** can be split into two hinged body section by a slit along one of the slots **550**, annular ring **502** at first end **503** of assurance cap **500** and inner support ring **504**. This hinged arrangement for assurance cap **500** enables assurance cap **500** to be snapped around tubular member **424** after endform ramp portion **434** has been formed on tubular member **424**.

FIGS. **17**A and **17**B show another modification in assurance cap **170**. In this aspect, assurance cap **170** comprises a unitary, close annular, one-piece cylindrical-shaped body **172**. The first end of body **172** comprises a plurality of fingers **174** spaced apart by longitudinally extending slots **176**. Inward extending edges **178** terminating in radially inward extending shoulder **180** extend from one end of each of the fingers **174** to engage edge **96** of groove **98** in body **26** to latch assurance cap **170** to body **26** in a forward most position of movement indicating full insertion of tubular member **24** in body **26**.

Annular radially outward extending ring **182** is formed intermediate the first end and opposed second end of body **172** to act as a gripping surface to facilitate movement of assurance cap **170**.

Second end **184** of body **172** includes continuous annular outer ring **186** and radially inward conical-shaped skirt **188** extending from outer ring **186** to inner edge **190**. A plurality of radially extending slots **192** are formed in skirt **188** and extend from the inner edge **190** partially through the radial extent of skirt **188**. Slots **192** divide **188** into a plurality of radially inward, conically tapered fingers **194**. Slots **192** provide flexibility to fingers **194** to enable assurance cap **170** to be forcibly urged over large diameter end portion **37** of tapered surface **34** on tubular member **24** to mount assurance cap **170** on tubular member **24** prior to insertion of tubular member **24** into body **26**.

FIGS. **18**A and **18**B depict another aspect of assurance cap **200** which is substantially similar to assurance cap **170** in that assurance cap **200** is formed of continuous one-piece body **201** comprising a plurality of fingers **202** at first end spaced apart by slots **204**. Fingers **202** terminate in inward extending edge **206** comprising inner shoulder **208** to engage edge **96** in groove **98** of body **26** when assurance cap **200** is moved to its forward position relative to body **26** indicating full insertion of tubular member **24** in body **26**.

Radially outward extending rib **210** is formed in body **201** intermediate the first and second ends. Second end **212** of body **201** is formed as annular ring **214** from which conically shaped radially inward extending skirt **216** extends to inner edge **218** defining an aperture the same size or slightly larger than the outer diameter of the constant diameter portion of tubular member **24**.

In this aspect of assurance cap **200**, skirt **216** does not include any slots. This aspect includes assurance cap **200** installed on tubular member **24** before the ramp or endform is formed.

Referring now to FIGS. **19**A and **19**B, there is depicted another aspect of body **230**, which includes variations from body **26** shown in FIG. **9**. As most of body **230** is identically constructed as body **26**, only variations between body **230** and body **26** will be described in detail.

As shown in body **26** depicted in FIG. **9**, receiving portion **56** extending from end **57** of fitting body **26** includes a constant outer diameter. This allows radially inward turned edges **92** of fingers **80**, **82**, and **84** on first end **74** of assurance cap **70** to snap into recessed groove **98** in body **26**.

In body **230** depicted in FIGS. **19**A and **19**B, the receiving portion extending from first end **232** of body **230** comprises first diameter end portion **234** and second smaller diameter end portion **236** disposed on opposite sides of groove **238** which receives resilient clip **60**. Raised intermediate annular ring **240** is formed adjacent to second end portion **236** and includes radially outward, extending conically shaped, tapered endwall **242** extending from second end portion **236**. The outer diameter of ring **240** is larger than the diameters of first and second end portions **234** and **236** of the receiving portion of body **230**.

Recessed groove **244** is formed between annular ring **240** and hexagonal shaped portion **54** of body **230**. Inner surface **246** of groove **244** comprises a diameter smaller than the diameter of second end portion **236** of the insertion portion of body **230** to define a recess for receiving the latch portions of the fingers of the assurance cap in the fully inserted position relative to body **26**.

During such forward sliding movement of any of the assurance caps described above, the radially inward turned fingers of the assurance cap flex outward over tapered endwall **242** and then along the outer surface of ring **240** before snapping in latched engagement with groove **244** to provide the secondary latch function for the assurance cap.

In another variation of body **260** shown in FIGS. **20**A and **20**B, again body **260** is substantially the same as body **26** and only variations there between will be described in detail.

Like body **230** shown in FIGS. **19**A and **19**B, body **260** comprises first end **262** from which extends first end portion **264** of the receiving portion at a first diameter. The receiving portion includes second end portion **266**, also at the same diameter to define recess **268** for resilient clip **60**.

Body **260** also includes raised annular ring **270** comprising an outer diameter greater than the first diameters of first and second end portions **264** and **266**. Radially outward, conical shaped tapered surface **272** extends from second end portion **266** to raised annular ring **270**. Recess or groove **274** is formed between raised annular ring **270** and hexed shaped portion **54** of body **260**. Inner surface **276** of groove **274** is spaced at the same first diameter of first and second end portions **264** and **266** of the receiving portion of body **260**.

In this aspect, annular ring **270** forms a raised outermost portion of the receiving portion of body **260**. The difference between the outer diameter of annular ring **270** and inner surface **276** of adjacent groove **274** requires that the fingers on the assurance cap can be flexed outward over the raised outer edge of annular ring **270** before snapping over the outer edge of annular ring **270** into groove **274**.

Referring now to FIGS. **21**A and **21**B, there is depicted another variation in the construction of assurance cap **300**. In this aspect, assurance cap **300** is similar to assurance cap **70** described above and shown in FIGS. **2-8**D except that the assurance cap **300** includes two small latch fingers **302** and **304** extending from intermediate annular portion **306**. Fingers **302** and **304**, which can be provided in any number, such as two, three, or more fingers, are configured more as standalone latch fingers rather than the closely separated fingers **82**, **84**, and **86** on assurance cap **70**, which have a much longer circumferential extent.

Latch fingers **302** and **304** are constructed similarly to latch fingers **82**, **84**, and **86** in assurance cap **70** and are designed to snap into and latch in groove **98** on body **26** when tubular member **24** is fully inserted into body **26**.

Fingers **302** and **304** are spaced apart about the circumference of assurance cap **300** in an angular orientation designed to intercept the raised portions of the resilient clip which would extend outward beyond the upper extent of receiving portion **56** of body **26** from groove **98** when tubular member **24** is not fully inserted in body **26**. Thus, for example, in a two finger construction shown in FIGS. **21**A and **21**B, the two fingers **302** and **304** are spaced less than 180° apart to one side of assurance cap **300** and greater than 180° apart on the other side of assurance cap **300**.

As shown in FIG. **21**B, fingers **302** and **304** are circumferentially spaced so that at least one of fingers **302** or **304** is in a interference position with retainer clip **60** so as to strike a raised portion of retainer clip **60** extending out of groove **68** in body **26** to prevent full movement of assurance cap **300** to the fully forward latched position. This assures that assurance cap **300** functions in its intended manner regardless of its angular orientation with respect to the protrusions and outer portions of retainer clip **60** in the groove **58**.

It will be appreciated that various aspects of the disclosure above and other features and functions, or alternatives thereof, may be desirably combined into many other different systems or applications. Various presently unforeseen or unanticipated alternatives, modifications, variations, or improvements therein may be subsequently made by those skilled in the art which are also intended to be encompassed by the following claims.

What is claimed is:

1. A fluid connector for coupling a tubular member having an endform spaced from a first insertion end to an external component, comprising: a connector body, including: a bore having a first end for receiving the tubular member; a constant diameter outer surface extending only between the first end and a flange section; a first exterior groove spaced from the first end and arranged for receiving one or more projections of an assurance cap for latching the assurance cap to the connector body when the tubular member is fully inserted into the bore; and, a second exterior groove disposed in the outer surface between the first end and the first exterior groove, the second exterior groove extending radially inward from the outer surface and comprising one or more apertures that extend to the bore; wherein the first exterior groove has a first radius and the outer surface has a second radius, the second radius being greater than the first radius.

2. The fluid connector as recited in claim 1, wherein the first exterior groove is an annular groove.

3. The fluid connector as recited in claim 1, wherein:

the flange section is spaced from the first end; and,

the first exterior groove is disposed between the first end and the flange section.

4. The fluid connector as recited in claim 3, wherein the first exterior groove is arranged adjacent to the flange section.

5. The fluid connector as recited in claim 1, wherein the connector body further comprises a raised portion extending from the outer surface.

6. The fluid connector as recited in claim 5, wherein the raised portion includes an outward extending tapered portion.

7. The fluid connector as recited in claim 5, wherein the raised portion is arranged adjacent to the first exterior groove.

8. The fluid connector as recited in claim 5, wherein the second exterior groove is disposed between the first end and the raised portion.

9. The fluid connector as recited in claim 8, wherein the second exterior groove is an annular groove.

10. The fluid connector as recited in claim 1, further comprising a retainer clip arranged in the second exterior groove and extending partially into the bore to engage a shoulder of the endform to lock the tubular member in the connector body when the first insertion end is fully inserted into the bore.

11. The fluid connector as recited in claim 10, wherein the retainer clip comprises one or more radially inward extending protrusions which project through the one or more apertures to engage the shoulder.

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