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(71) Applicant: HEYCO, INC. [US/US]; 1800 Industrial Way
North, Toms River, NJ 08754 (US).(72) Inventor: COYLE, William, J.; 35 South Gateway, Toms
River, NJ 08753 (US).(74) Agent: AGOSTINO, Joseph; c/o Greenberg Traurig, LLP,
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(54) Title: LIQUID-TIGHT STRAIN RELIEF

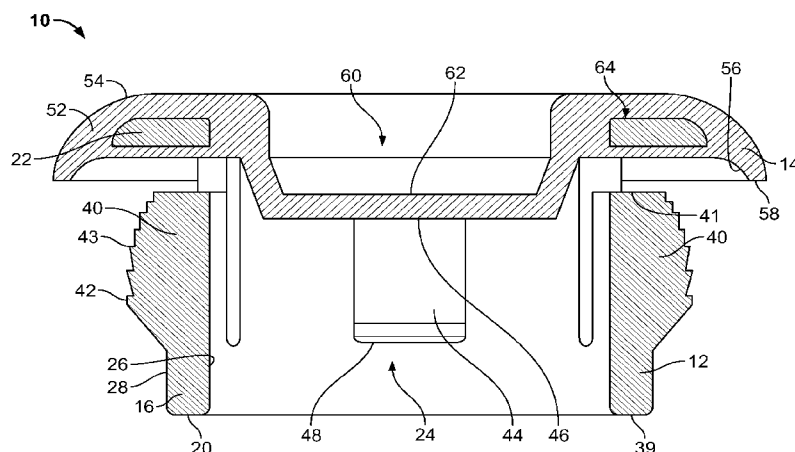


FIG. 5

(57) Abstract: A liquid-tight strain relief (10) includes a tubular-shaped bushing (12) and a dome-shaped gland (14). The bushing (12) includes a flange (22), a centrally-located aperture (24), a plurality of resilient outer fingers (40), and a plurality of resilient inner fingers (44) extending from an inner wall (26) into the aperture (24). The gland (14) includes a head (52) having a centrally-located membrane (62). The head (52) is co-molded with and encapsulates the flange (22), resulting in a strain relief (10) having a unitary construction. The strain relief (10) is adapted to be inserted within an orifice of a work piece, and the outer fingers (40) frictionally engage the work piece. A cable (C) is inserted within the strain relief (10) by piercing the membrane (62), which stretches and provides a seal against the cable (C). The cable (C) is inserted through the aperture (24) of the bushing (12) and the resilient inner fingers (44) flex outwardly to enable the cable (C) to pass through, while engaging and digging into the cable (C) to clasp it and provide strain relief (10).

LIQUID-TIGHT STRAIN RELIEF

Cross-Reference to Related Application

The present application relates to and claims the benefit of commonly-owned, co-
5 pending U.S. Provisional Patent Application No. 61/971,604 entitled "LIQUID-TIGHT
STRAIN RELIEF," filed on March 28, 2014, the entirety of which is incorporated herein
by reference.

Technical Field of the Invention

10 The present invention relates to a strain relief and, more particularly, to a liquid-
tight, co-molded strain relief for cables, wires, tubing, rods and other elongated objects.

Background of the Prior Art

Liquid-tight strain reliefs are affixed in a liquid-tight manner in orifices of work
15 pieces. The liquid-tight strain reliefs enable cables, wires, tubing or rods to be passed
through them in a locked and liquid tight engagement, while providing strain relief
protection. Liquid-tight strain reliefs are described in U.S. Patent Nos. 5,405,172 and
8,398,419, which are incorporated by reference herein in their entirety. Liquid-tight
strain reliefs are also described in pending U.S. Patent Application No. 14/459,495, filed
20 August 14, 2014, published as U.S. Patent Application Publication No. 2015/0048614
on February 19, 2015, which is incorporated herein by reference in its entirety.

Disclosure of the Invention

A liquid-tight strain relief includes a tubular-shaped bushing and a dome-shaped gland co-molded with the bushing. The bushing includes a flange, a centrally-located aperture, a plurality of resilient outer fingers, and a plurality of resilient inner fingers extending from an inner wall and positioned within the aperture. The gland includes a head having a centrally-located membrane. The head of the gland is co-molded with and encapsulates the flange of the bushing, thereby resulting in a strain relief having a unitary construction. The strain relief is inserted within an orifice of a work piece, such as a panel, and the outer fingers frictionally engage the work piece. A cable is inserted within the strain relief by piercing the membrane, which stretches and provides a seal against the cable. The cable is inserted through the aperture of the bushing and the resilient inner fingers of the bushing flex outwardly to enable the cable to pass through, while engaging and digging into the cable to clasp it and provide strain relief.

Brief Description of the Drawings

FIG. 1 is a top perspective view of a liquid-tight strain relief constructed in accordance with an embodiment of the invention;

FIG. 2 is a top plan view of the liquid-tight strain relief shown in **FIG. 1**;

FIG. 3 is a bottom plan view of the liquid-tight strain relief shown in **FIG. 1**;

FIG. 4 is a side elevational view of the liquid-tight strain relief shown in **FIG. 1**;

FIG. 5 is a side cross-sectional view, taken along lines A-A and looking in the direction of the arrows, of the liquid-tight strain relief shown in **FIG. 2**;

FIG. 6 is a side elevational view of the liquid-tight strain relief shown in **FIG. 1**;

FIG. 7 is a side cross-sectional view, taken along lines B-B and looking in the direction of the arrows, of the liquid-tight strain relief shown in **FIG. 2**;

FIG. 8 is a top perspective view of the liquid-tight strain relief shown in **FIG. 1** but with a cable positioned within it;

5 **FIG. 9** is a top plan view of the liquid-tight strain relief shown in **FIG. 8**;

FIG. 10 is a bottom plan view of the liquid-tight strain relief shown in **FIG. 8**;

FIG. 11 is a side elevational view of the liquid-tight strain relief shown in **FIG. 8**;

FIG. 12 is a side cross-sectional view, taken along lines D-D and looking in the direction of the arrows, of the liquid-tight strain relief shown in **FIG. 9**;

10 **FIG. 13** is a side elevational view of the liquid-tight strain relief shown in **FIG. 8**;
and

FIG. 14 is a side cross-sectional view, taken along lines E-E and looking in the direction of the arrows, of the liquid-tight strain relief shown in **FIG. 9**.

15 **Best Mode For Carrying Out The Invention**

Referring to **FIGS. 1** through **7**, in an embodiment, a liquid-tight strain relief **10** includes a tubular-shaped bushing **12** and a dome-shaped gland **14** attached to the bushing **12**. In an embodiment, the gland **14** is co-molded with the bushing **12** in a manner that will be described hereinafter. In an embodiment, the bushing **12** is made
20 from a thermoplastic material, while the gland **14** is made from a thermoplastic elastomer (TPE). In other embodiments, the bushing **12** and the gland **14** may be made from other suitable materials known in the art.

With continued reference to **FIGS. 1** through **7**, in an embodiment, the bushing **12** includes a cylindrical-shaped housing **16** having a first end **18** and second end **20** opposite the first end **18**, a peripheral flange **22** extending outwardly from the first end **18**, and a centrally-located aperture **24** that extends from the first end **18** to the second end **20**. The housing **16** of the bushing **12** further includes an inner wall **26**, an outer wall **28**, and a pair of diametrically opposed cutouts **30** extending from the inner wall **26** to the outer wall **28** (one of which is shown in **FIG. 6**). Each of the cutouts **30** includes a pair of spaced-apart and parallel, longitudinally extending slots **32a**, **32b**. Each of the slots **32a**, **32b** includes a first end **34** and second end **36** opposite the first end **34**. The first ends **34** of each of the slots **32a**, **32b** are connected by a corresponding transverse slot **38**. Each pair of the slots **32a**, **32b** and the corresponding transverse slot **38** define and surround a resilient outer finger **40**. The outer finger **40** includes a first end **39** attached integrally to the housing **16**, and an opposite free end **41**. In an embodiment, the bushing **12** includes two of the outer fingers **40** that are diametrically opposed to one another. In other embodiments, the bushing **12** includes more or less than two of the outer fingers **40**. Each of the outer fingers **40** includes an outer surface **42** having a plurality of elongated ribs **43** for frictional engagement with a work piece, which will be described hereinafter. In other embodiments, the outer surface **42** of the each of the outer fingers **40** may include other frictionally-engaging features known in the art.

Referring to **FIGS. 5** and **7**, in an embodiment, the bushing **12** includes a plurality of resilient inner fingers **44**. Each of the inner fingers **44** includes a first end **46**, which is attached to the inner wall **26** of the bushing **12** proximate to the first end **18** thereof, and a second, free end **48** opposite the first end **46**, which is positioned within the

aperture **24** of the bushing **12**. In an embodiment, the first end **46** of each of the inner fingers **44** is integral with the inner wall **26**. In an embodiment, each of the inner fingers **44** extends obliquely from the inner wall **26** of the bushing **12** within the aperture **24**. In an embodiment, the second end **48** of each of the inner fingers **44** includes a pointed tip **50**. It will be apparent to those of skill in the art that the plurality of resilient inner fingers **44** may include varying quantities of inner fingers **44**. In an embodiment illustrated in **FIG. 7**, the bushing **12** includes two of the inner fingers **44** that are diametrically opposed to one another. In another embodiment, the bushing **12** includes three of the inner fingers **44**. In another embodiment, the bushing **12** includes four of the inner fingers **44**. In an embodiment illustrated in **FIGS. 3, 13 and 14**, the bushing **12** includes two of the inner fingers **44** that are diametrically opposed to one another and two of the outer fingers **40** that are diametrically opposed to one another, and a diameter defining the diametric opposition of the two inner fingers **44** is offset by a right angle from a diameter defining the diametric opposition of the two outer fingers **40**.

Referring back to **FIGS. 1 through 7**, in an embodiment, the gland **14** includes a domed-shaped head **52** having a convex outer surface **54** and a concave inner surface **56**, which meet to form an annular lip **58**. A centrally-located, substantially circular-shaped depression **60** is formed within the outer surface **54** of the head **52**, which culminates at a centrally-located membrane **62**. In an embodiment, the membrane **62** includes a thickness that is sufficient for the membrane to be pierced, which will be described hereinafter. In an embodiment, the gland **14** is co-molded with the bushing **12** such that the flange **22** of the bushing **12** is encapsulated within an annular interior portion **64** of the head **52** of the gland **14**. When the gland **14** is co-molded to the

bushing **12**, the membrane **62** resides within the aperture **24** of the bushing **12** proximate to the first end **18** of the bushing **12**.

It will be known to those of skill in the art that when items are described as being “co-molded” to one another, reference is made to a fabrication process whereby items
5 made of different materials are fabricated simultaneously within a single mold. For example, when the bushing **12** and the gland **14** of the exemplary liquid-tight strain relief **10** are described herein as being co-molded to one another, those of skill in the art will understand this description to mean that the bushing **12** and the gland **14** are made of different materials that are formed within the same mold at the same time. As
10 discussed above, these materials may include a thermoplastic forming the bushing **12** and a thermoplastic elastomer (TPE) forming the gland **14**.

In use, the liquid-tight strain relief **10** is sized and shaped to be affixed in a liquid-tight manner within an orifice of a work piece, such as a panel or other structure (not shown in the Figures). When the strain relief **10** is installed within the orifice in the work
15 piece, the ribs **43** on the outer fingers **40** frictionally engage the work piece to facilitate the fixation of the strain relief **10** therein. In an embodiment, as the strain relief **10** is inserted into the orifice of the work piece, the ribs **43** are compressed to fit within the orifice. Once the strain relief **10** is secured within the orifice of the work piece, the annular lip **58** of the gland **14**, which acts on the engaged surface of the work piece,
20 forms a liquid-tight seal thereon.

Referring to **FIGS. 8** through **14**, when a cable **C** (or a wire, tubing, rod and other elongated object) is inserted in the strain relief **10**, it pierces the membrane **62** of the gland **14** (see **FIGS. 8, 12** and **14**). In this regard, the membrane **62** stretches and

forms a liquid-tight seal around the cable **C**. In another embodiment, the cable **C** may first be installed through the strain relief **10**, after which the strain relief **10** may be engaged in position along the cable **C** and then affixed within the orifice of the work piece. When the cable **C** is further inserted through the aperture **24** of the bushing **12**,
5 the cable **C** engages the inner fingers **44** which flex to allow the cable **C** to be inserted therethrough. As a result of the resiliency of the inner fingers **44**, they are movable outwardly towards the inner wall **26** of the bushing **12** from a first, disengaged position to a second, engaged position, in which the pointed tips **50** of the inner fingers **44** dig-in and clasp the outer surface of the cable **C** to provide strain relief (see **FIGS. 12** and **14**).

10 It should be understood that the embodiments described herein are merely exemplary and that a person skilled in the art may make many variations and modifications without departing from the spirit and scope of the invention. Accordingly, all such variations and modifications are intended to be included within the scope of the embodiments described herein as defined in the appended claims.

15

Claims

What is claimed is:

1. A liquid-tight strain relief, comprising a bushing including a first end, a
5 second end opposite said first end, an outer wall, an aperture extending from said first
end to said second end and defining an inner wall, an annular flange extending radially
outwardly from said first end, said at least one cutout extending from said outer wall to
said inner wall, said at least one cutout defining at least one outer finger, said at least
10 one outer finger including means for frictionally engaging an orifice of a work piece, and
a plurality of resilient, elongated inner fingers, each of which includes a first end
attached to said inner wall and a free, second end extending into said aperture; and

a gland including a head having an outer surface, an inner surface, an annular
interior portion located within said inner surface and encapsulating said annular flange
of the bushing.

15 2. The liquid-tight strain relief of Claim 1, wherein said at least one cutout
includes a plurality of cutouts.

3. The liquid-tight strain relief of Claim 2, wherein said plurality of cutouts
includes two cutouts that are diametrically opposed to one another, and wherein said at
least one outer finger includes two diametrically opposed outer fingers each of which is
20 defined by a corresponding one of said two diametrically opposed cutouts.

4. The liquid-tight strain relief of Claim 3, wherein said plurality of inner
fingers includes two inner fingers that are diametrically opposed to one another, and

wherein a diameter of said diametrically opposed inner fingers is offset by a right angle from a diameter of said diametrically opposed outer fingers.

5 5. The liquid-tight strain relief of Claim 1, wherein said bushing is made from a first material and said gland is made from a second material, said second material having a greater elasticity than said first material.

6. The liquid-tight strain relief of Claim 5, wherein said first material is a thermoplastic material.

7. The liquid-tight strain relief of Claim 6, wherein said second material is a thermoplastic elastomer.

10 8. The liquid-tight strain relief of Claim 1, wherein said second end of each of said inner fingers includes a pointed tip.

9. The liquid-tight strain relief of Claim 1, wherein said frictionally engaging means of said at least one cutout includes a plurality of ribs.

15 10. The liquid-tight strain relief of Claim 9, wherein said plurality of ribs is compressible so that the liquid-tight strain relief is adapted to be positioned within the orifice of the work piece.

11. The liquid-tight strain relief of Claim 1, wherein said bushing and said gland are co-molded with one another.

20 12. The liquid-tight strain relief of Claim 1, wherein said gland includes a depression formed within said outer surface thereof and coaxial with said aperture of

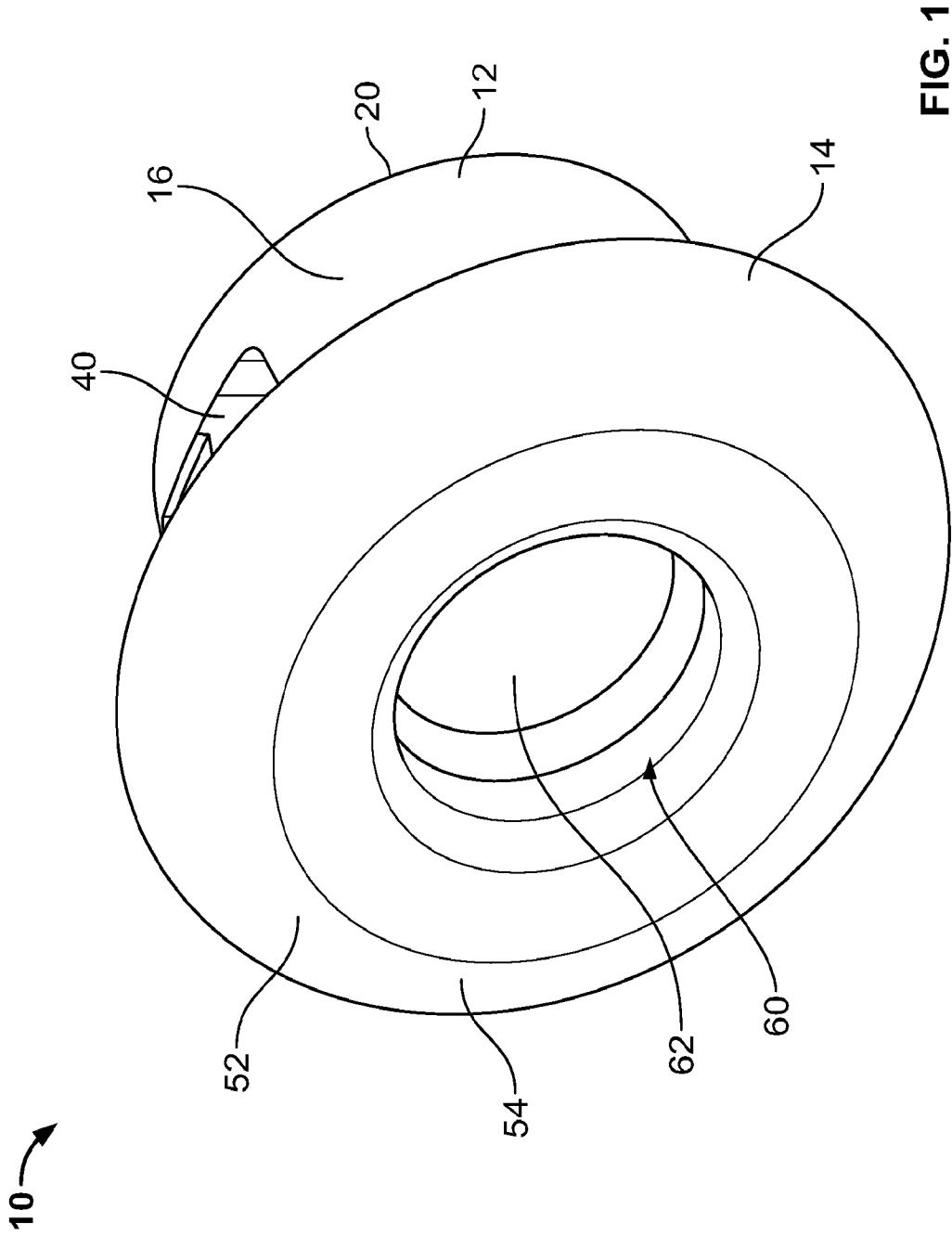
said bushing, said depression including a membrane that is adapted to be pierced by an external object.

13. The liquid-tight strain relief of Claim 12, wherein the external object includes one of a cable, a wire, a tube, and a rod.

5 14. The liquid-tight strain relief of Claim 13, wherein said membrane is adapted to form a liquid-tight seal around the external object when said membrane is pierced by the external object.

15. The liquid-tight strain relief of Claim 14, wherein said inner fingers are adapted to clasp the external object when said membrane is pierced by the external
10 object.

16. The liquid-tight strain relief of Claim 1, wherein said at least one cutout of said bushing includes a pair of parallel, longitudinal slots, each of which includes a first end located proximate to said first end of said bushing and a second end located proximate to said second end of said bushing, and a transverse slot extending from said
15 first end of one of said longitudinal slots to said first end of the other of said longitudinal slots.



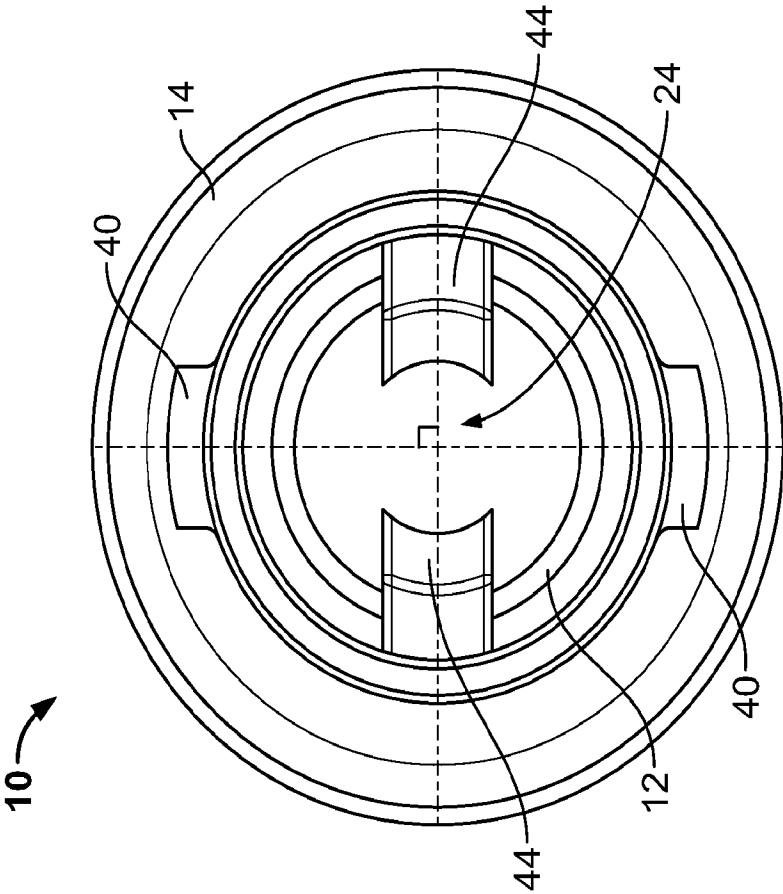


FIG. 3

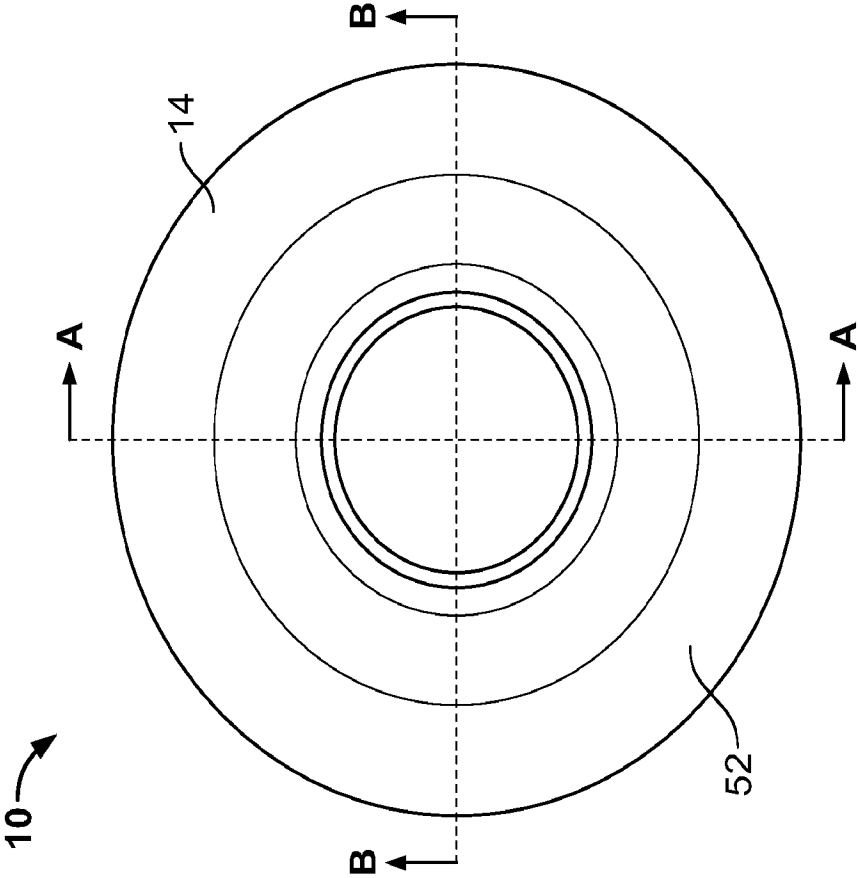


FIG. 2

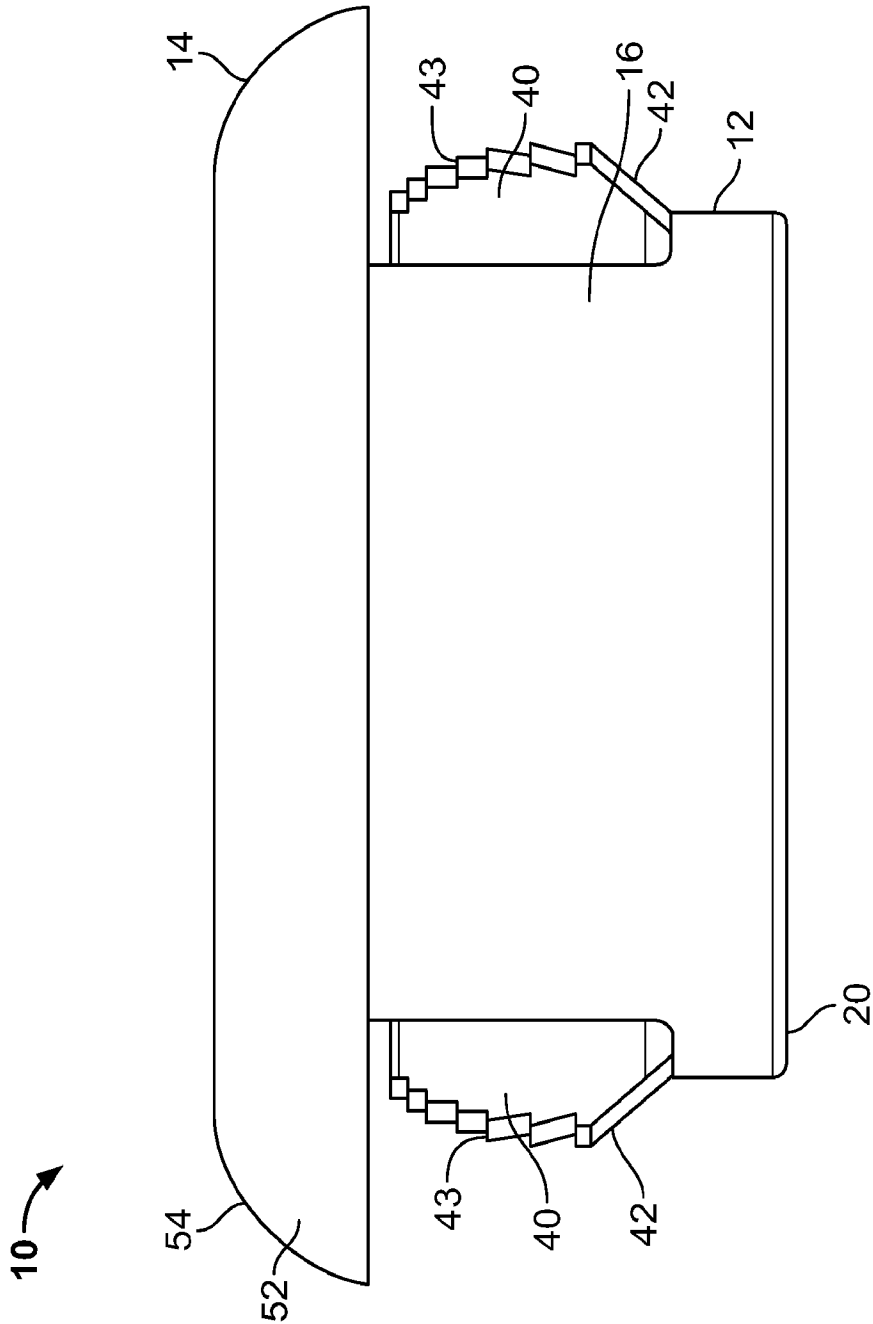


FIG. 4

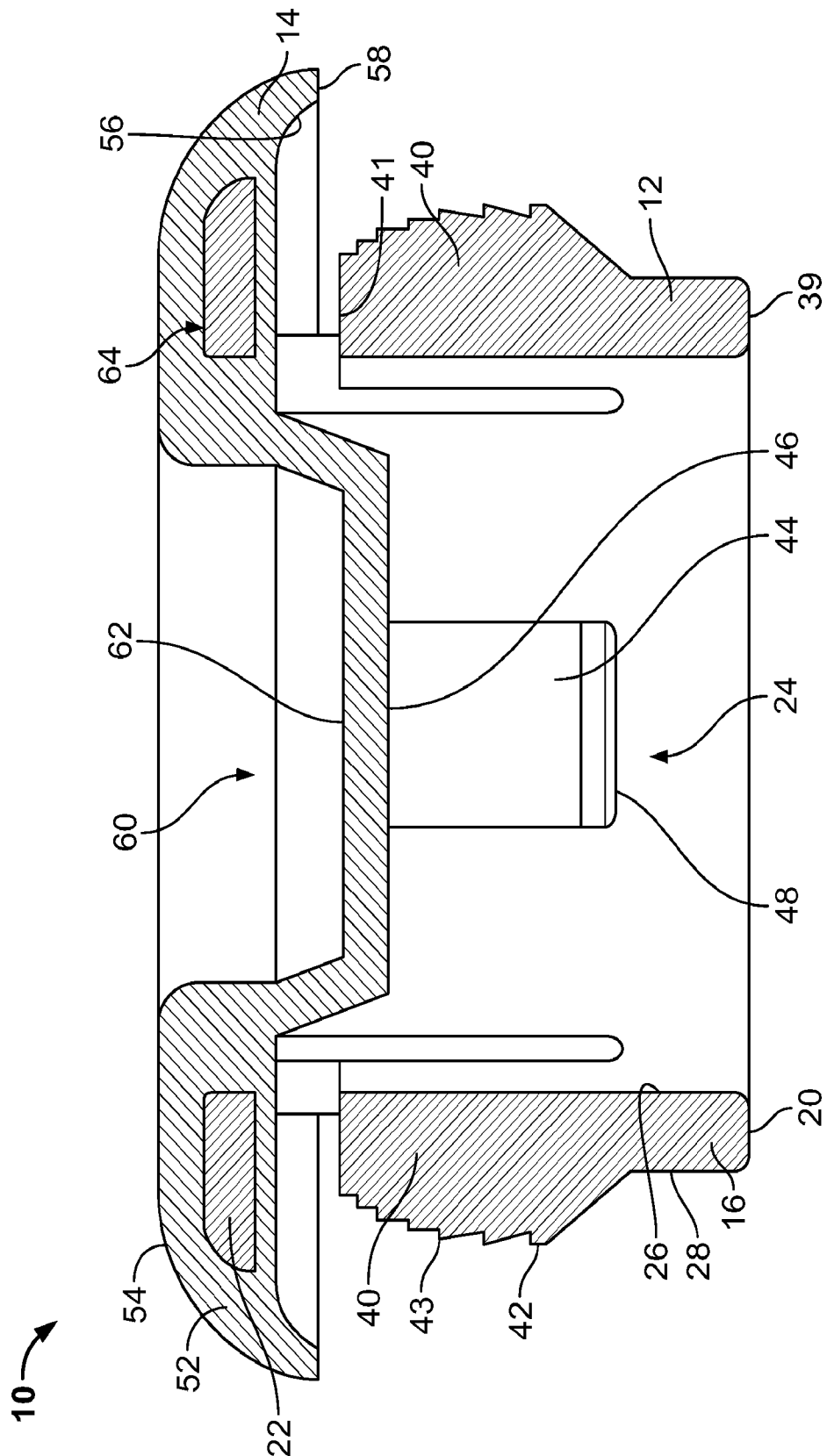


FIG. 5

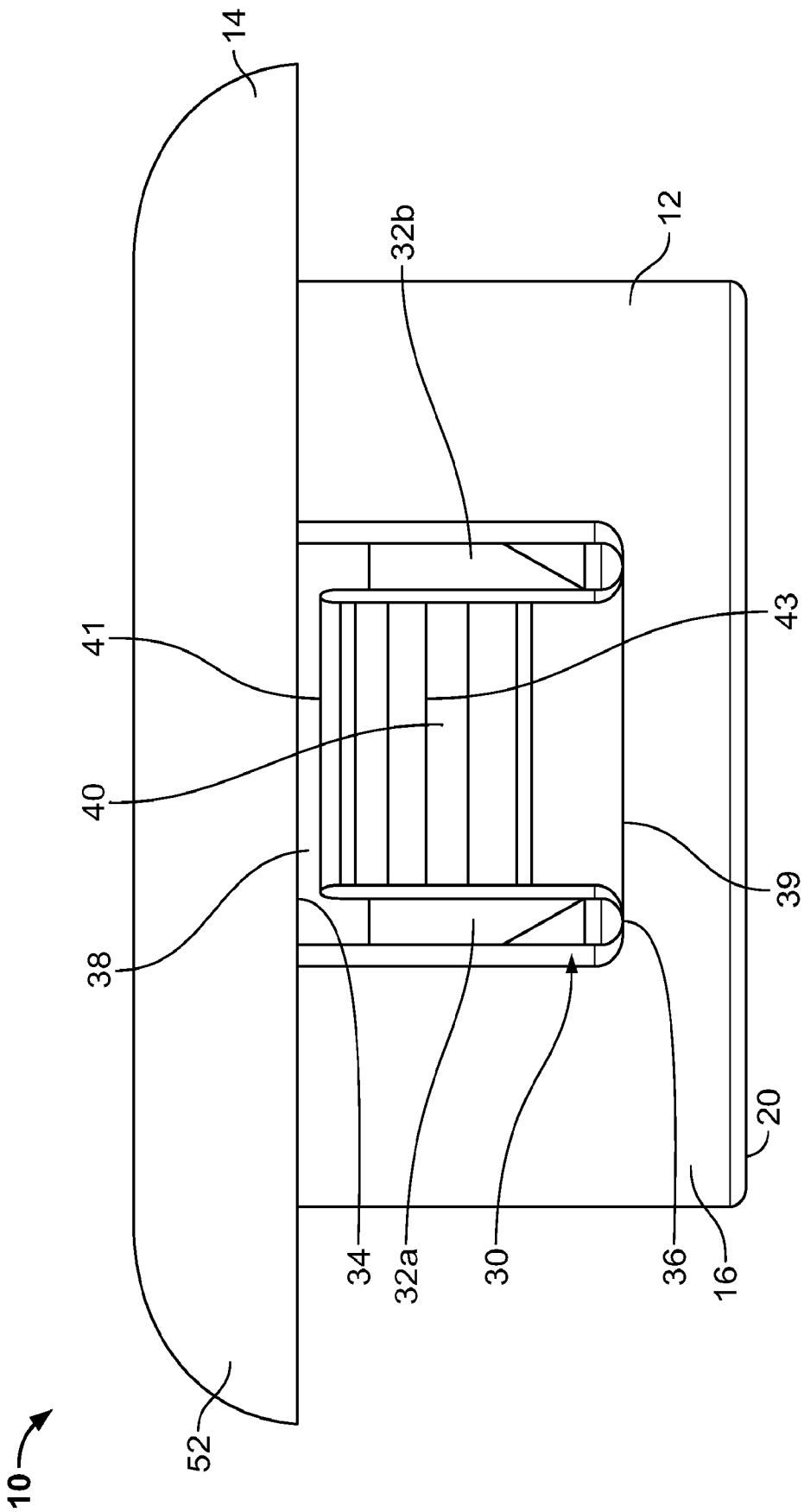


FIG. 6

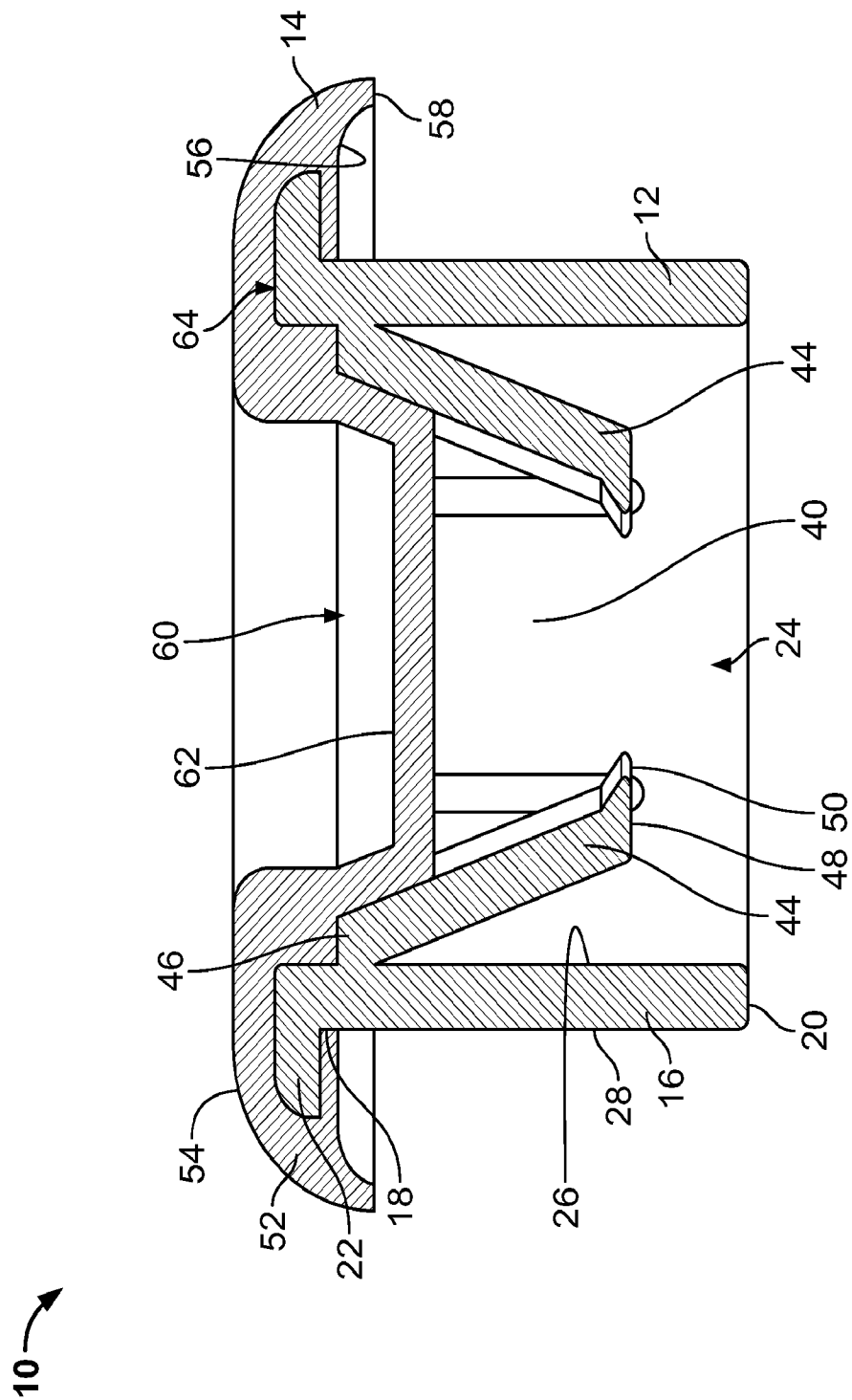


FIG. 7

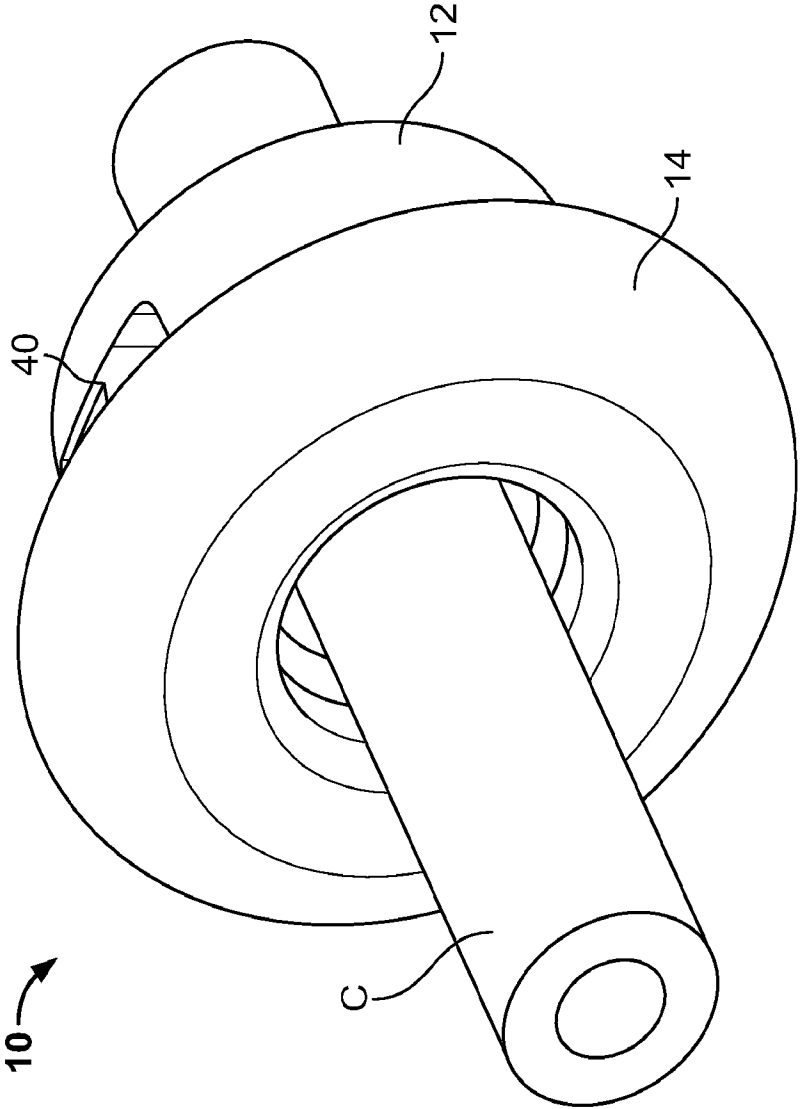


FIG. 8

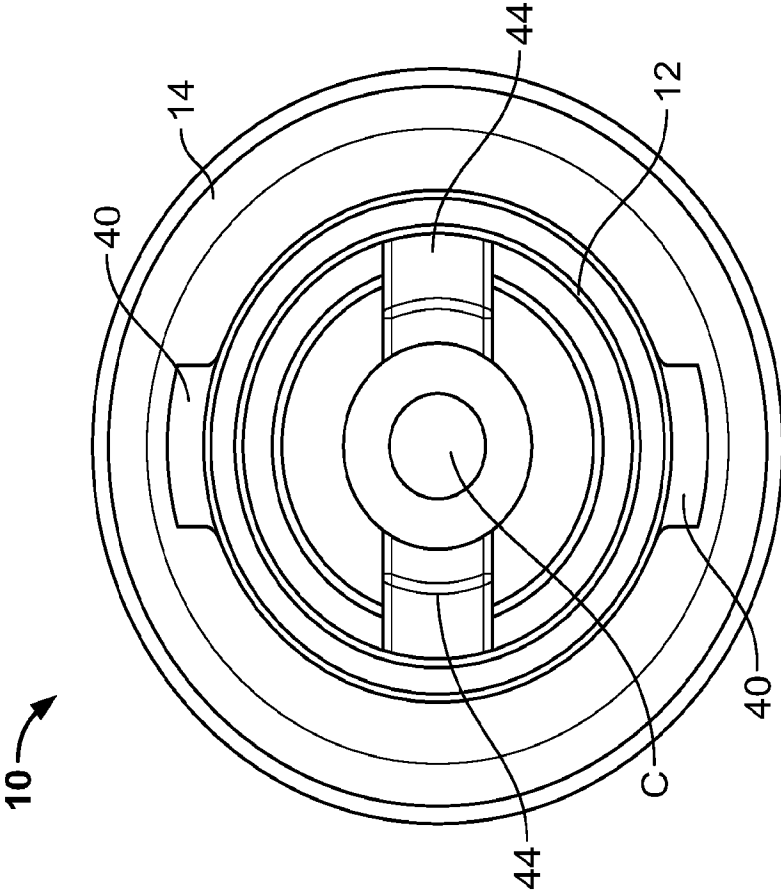


FIG. 10

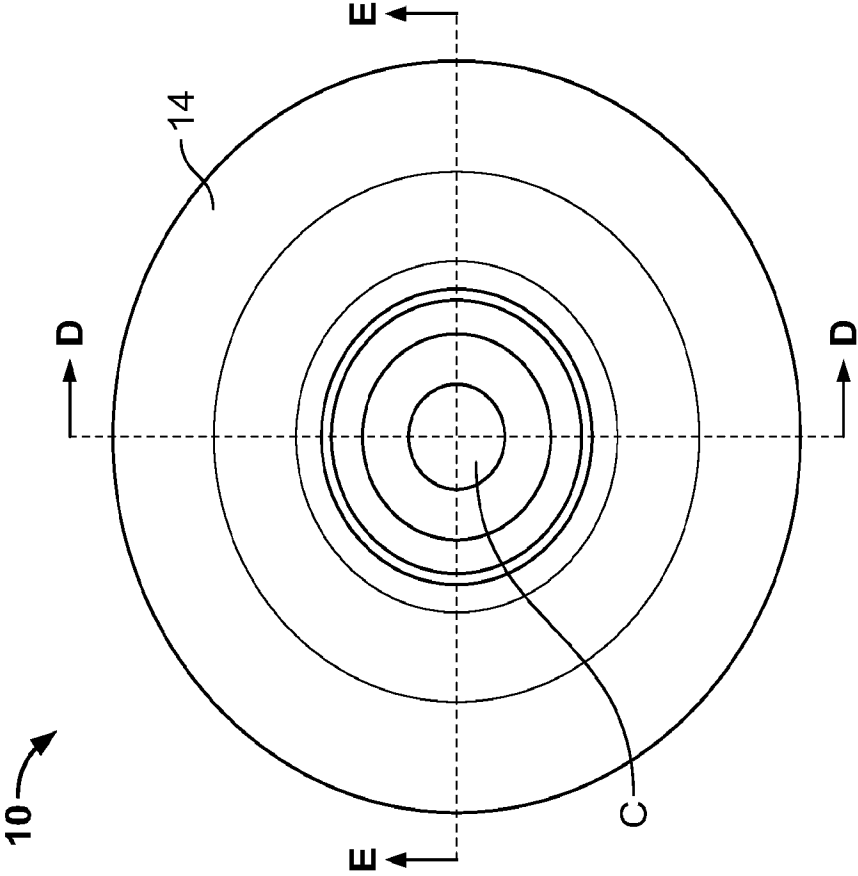


FIG. 9

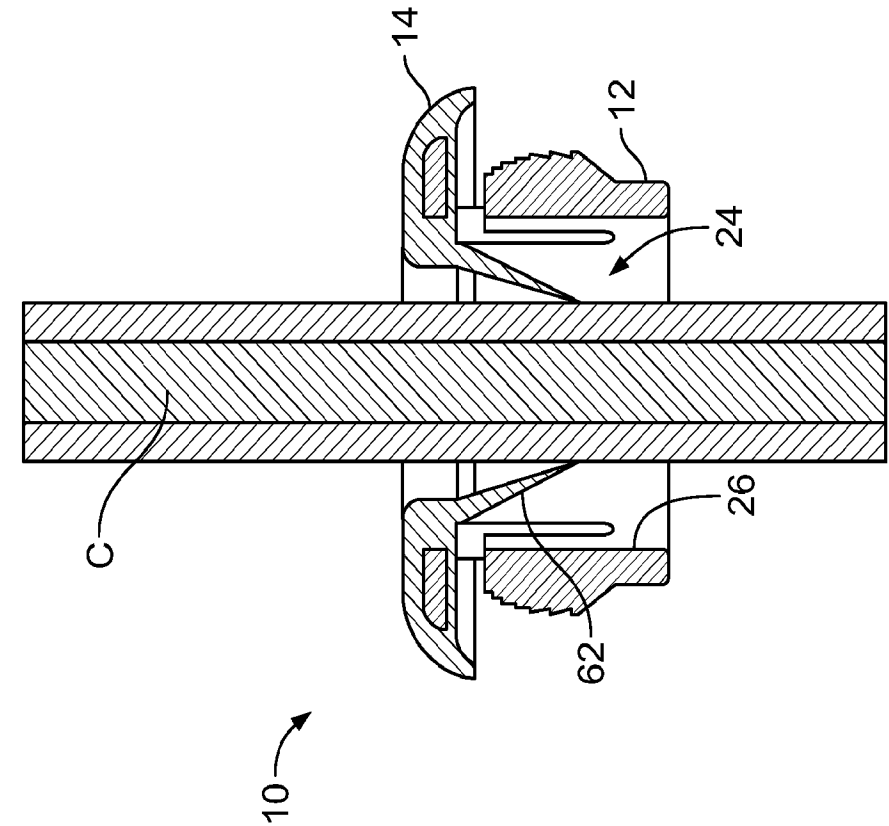


FIG. 11

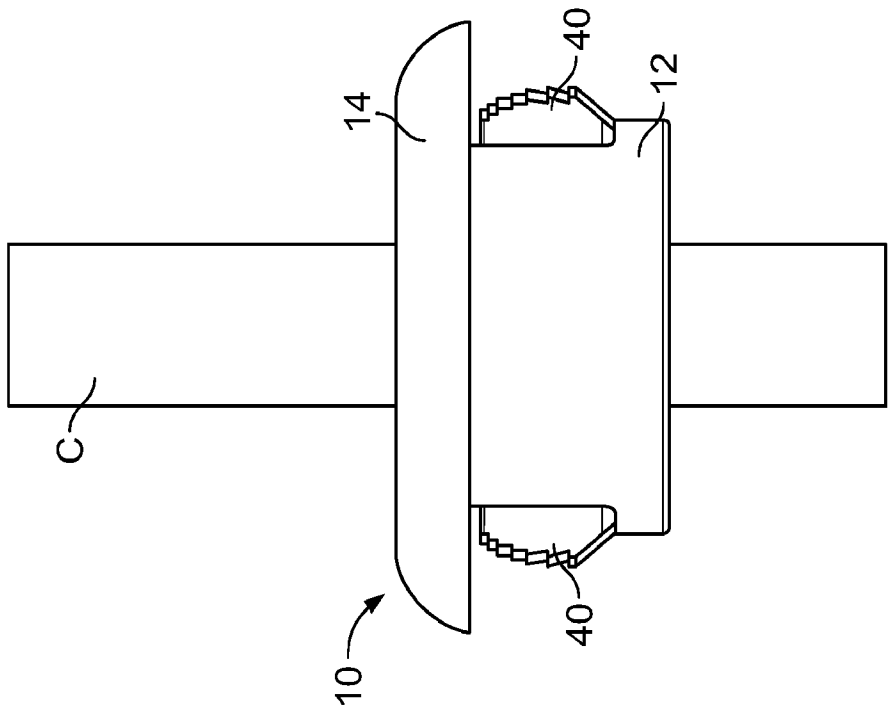


FIG. 12

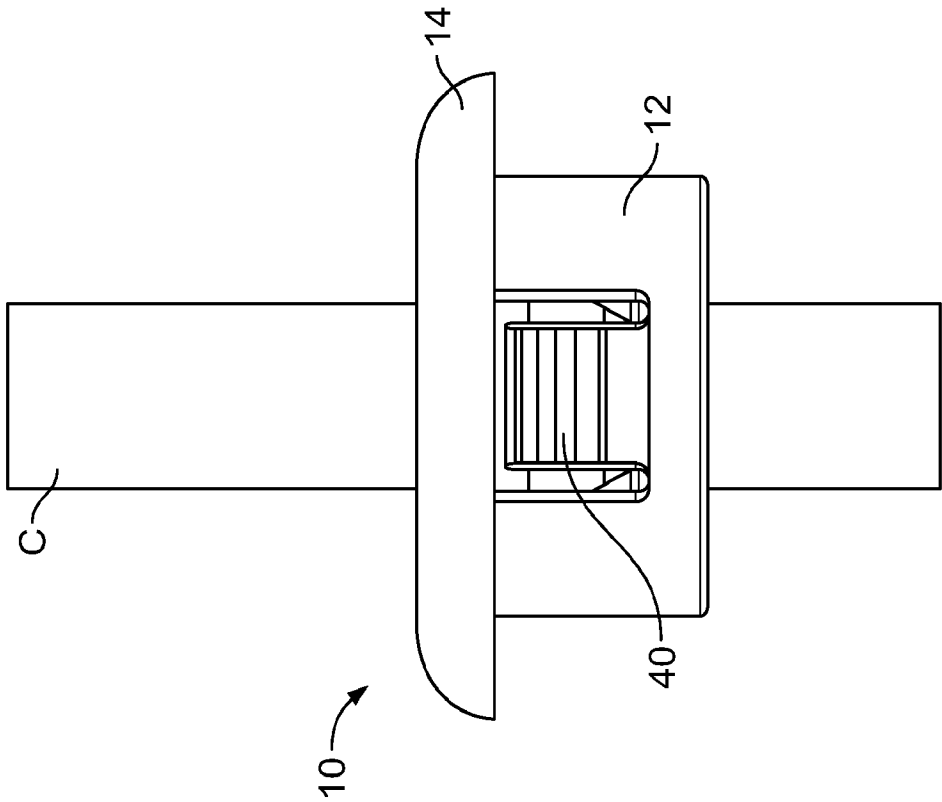


FIG. 13

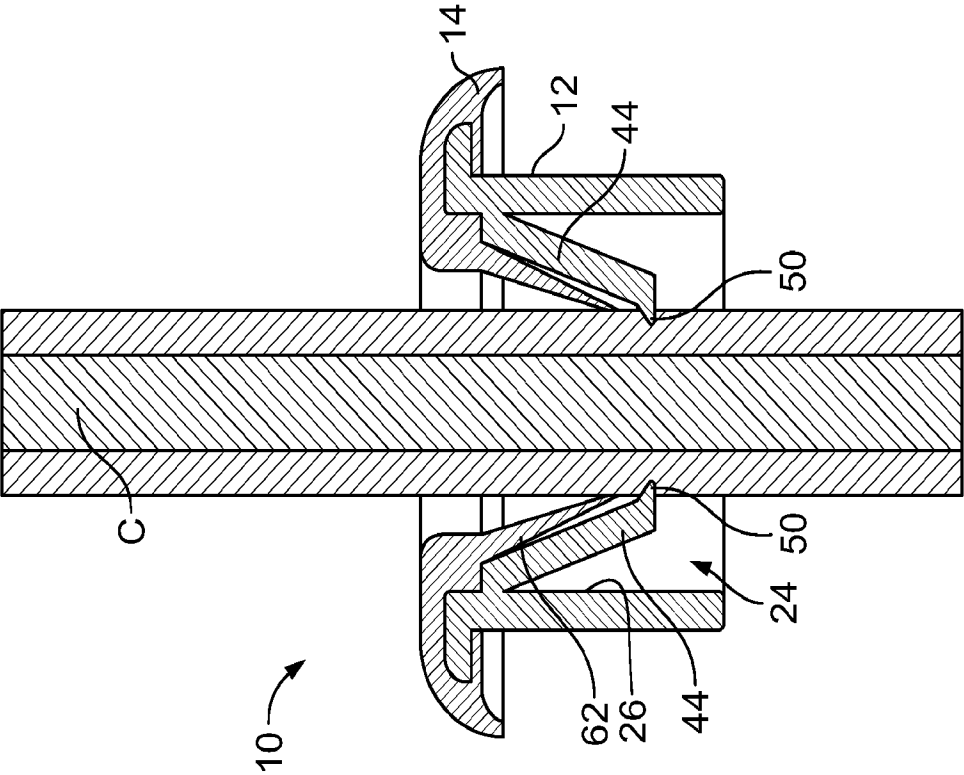


FIG. 14

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2015/022962

A. CLASSIFICATION OF SUBJECT MATTER

INV. H02G3/22 H02G15/007 H02G15/013
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H02G

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

12 June 2015

Date of mailing of the international search report

19/06/2015

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Standring, Michael

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2015/022962

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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