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(54) **BEARING SLEEVE FOR A SHAFT**

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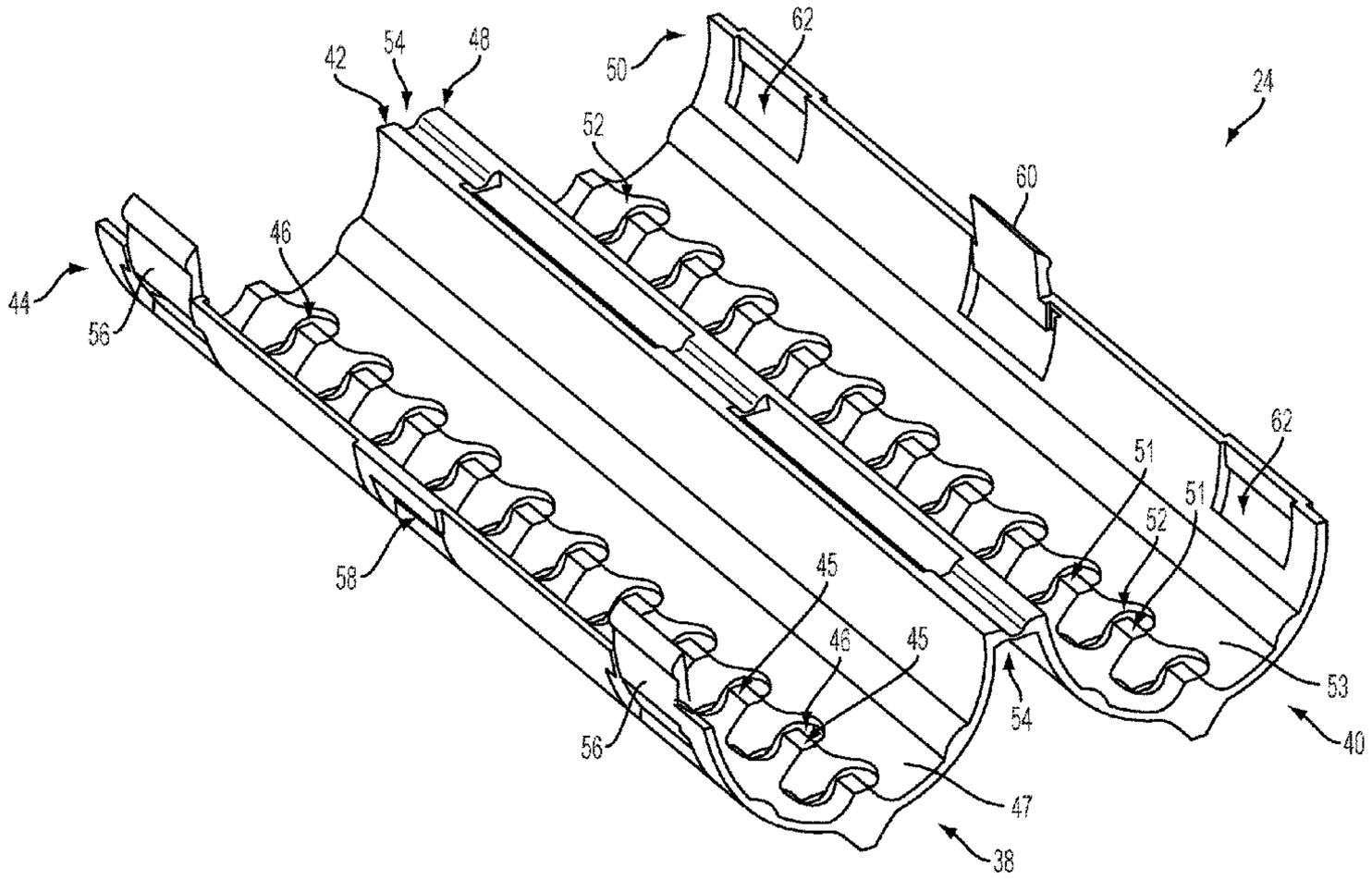
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(57) **ABSTRACT**

A rolling element shaft assembly includes a solid shaft having a first end and a second end, a tubular shaft configured to receive the shaft first end, and a bearing sleeve coupled to the solid shaft. The bearing sleeve includes a first portion defining a first edge, a second edge, and at least one first bearing aperture, and a second portion defining a third edge, a fourth edge, and at least one second bearing aperture. The first portion is configured to couple to the second portion about the solid shaft. The bearing sleeve further includes at least one first bearing disposed within the at least one first bearing aperture and at least one second bearing disposed within the at least one second bearing aperture.

6 Claims, 5 Drawing Sheets



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B23P 15/00	(2006.01)
F16D 3/06	(2006.01)
F16C 33/38	(2006.01)
F16C 33/40	(2006.01)

(52) **U.S. Cl.**
CPC ***F16C 33/3812*** (2013.01); ***F16C 33/40*** (2013.01); ***F16C 33/60*** (2013.01); ***F16D 3/065*** (2013.01); *F16C 2326/24* (2013.01)

(58) **Field of Classification Search**
CPC F16C 2326/24; F16D 3/065; B23P 15/003; B62D 1/20
USPC 464/167, 168
See application file for complete search history.

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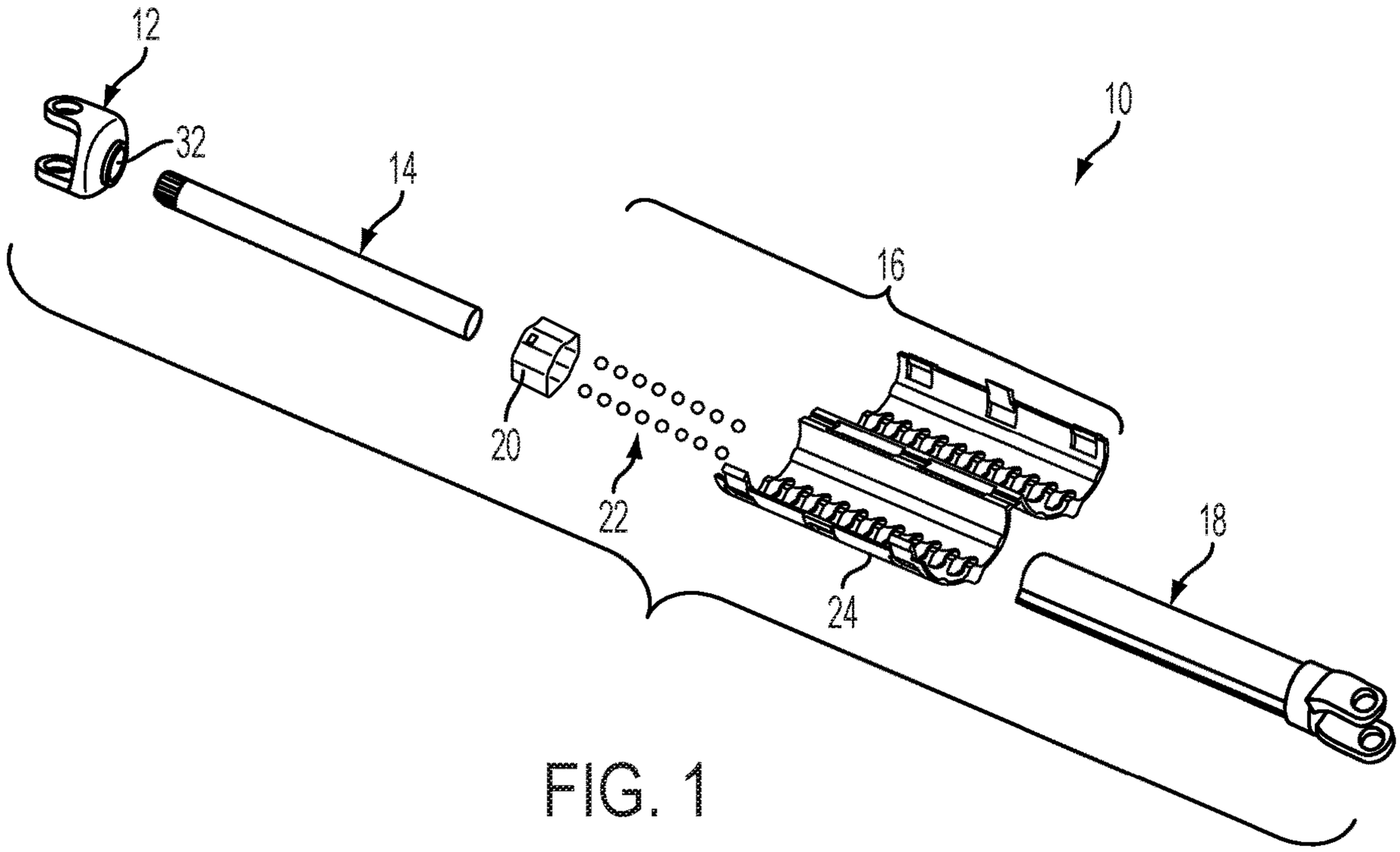


FIG. 1

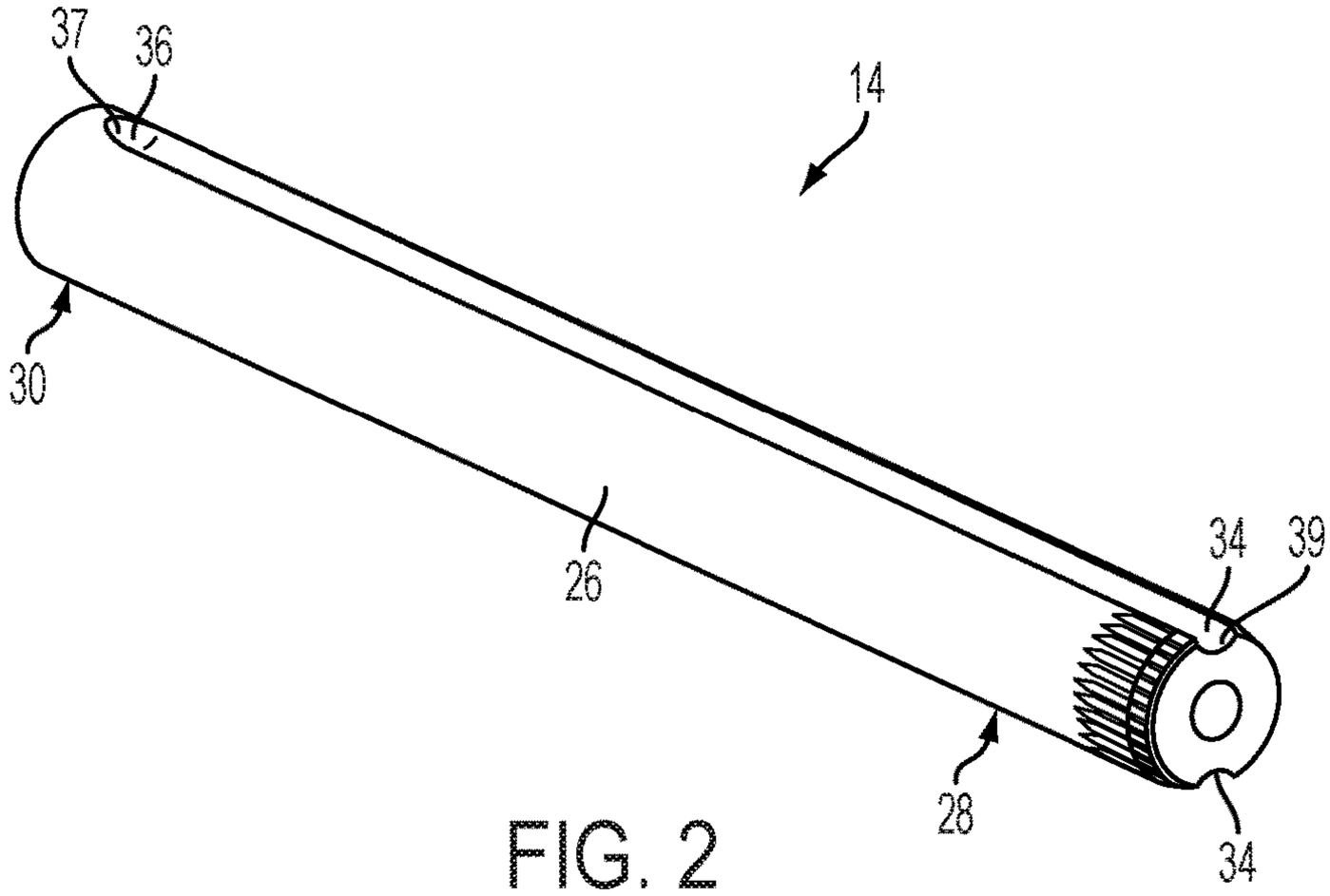


FIG. 2

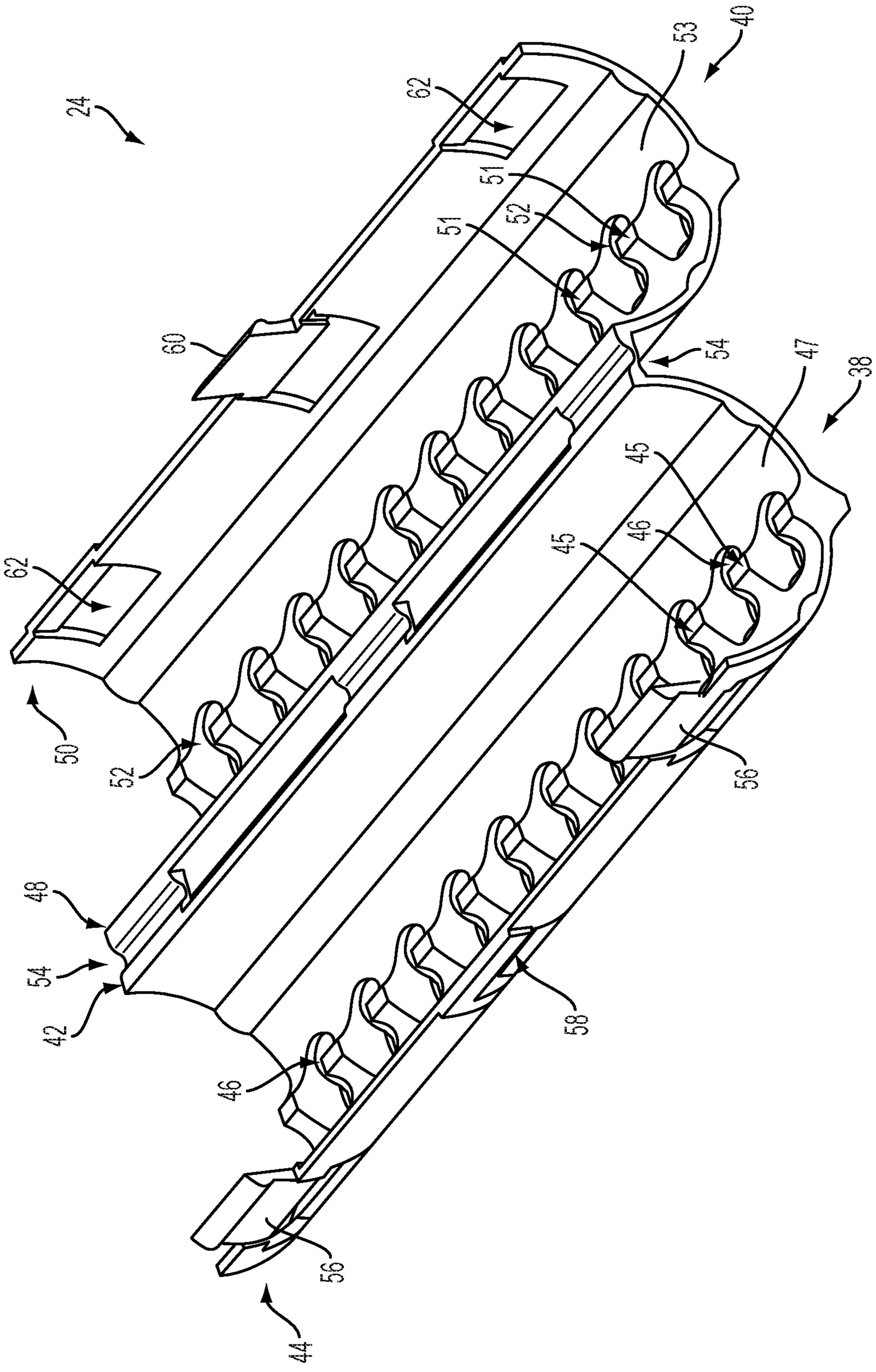

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FIG. 3

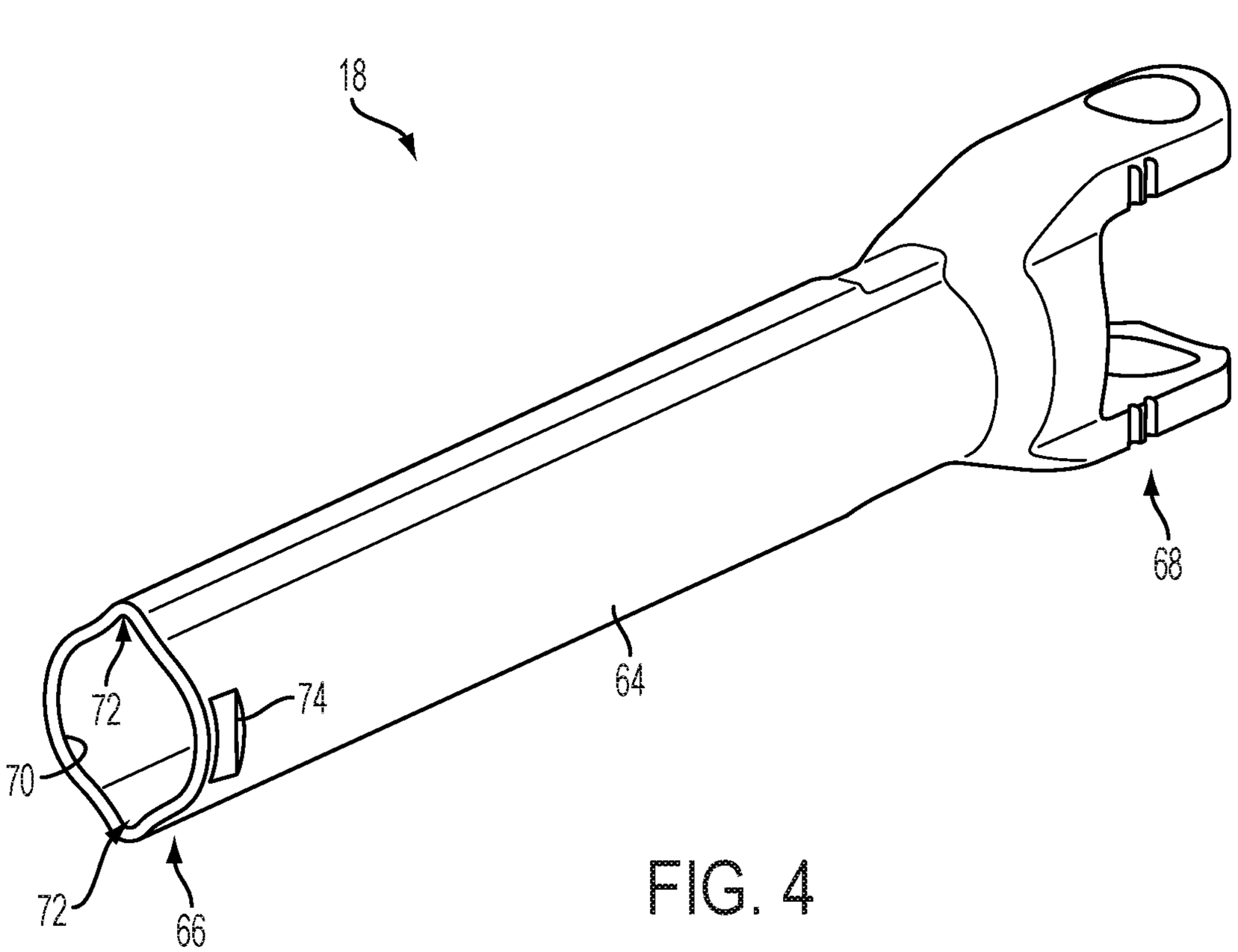


FIG. 4

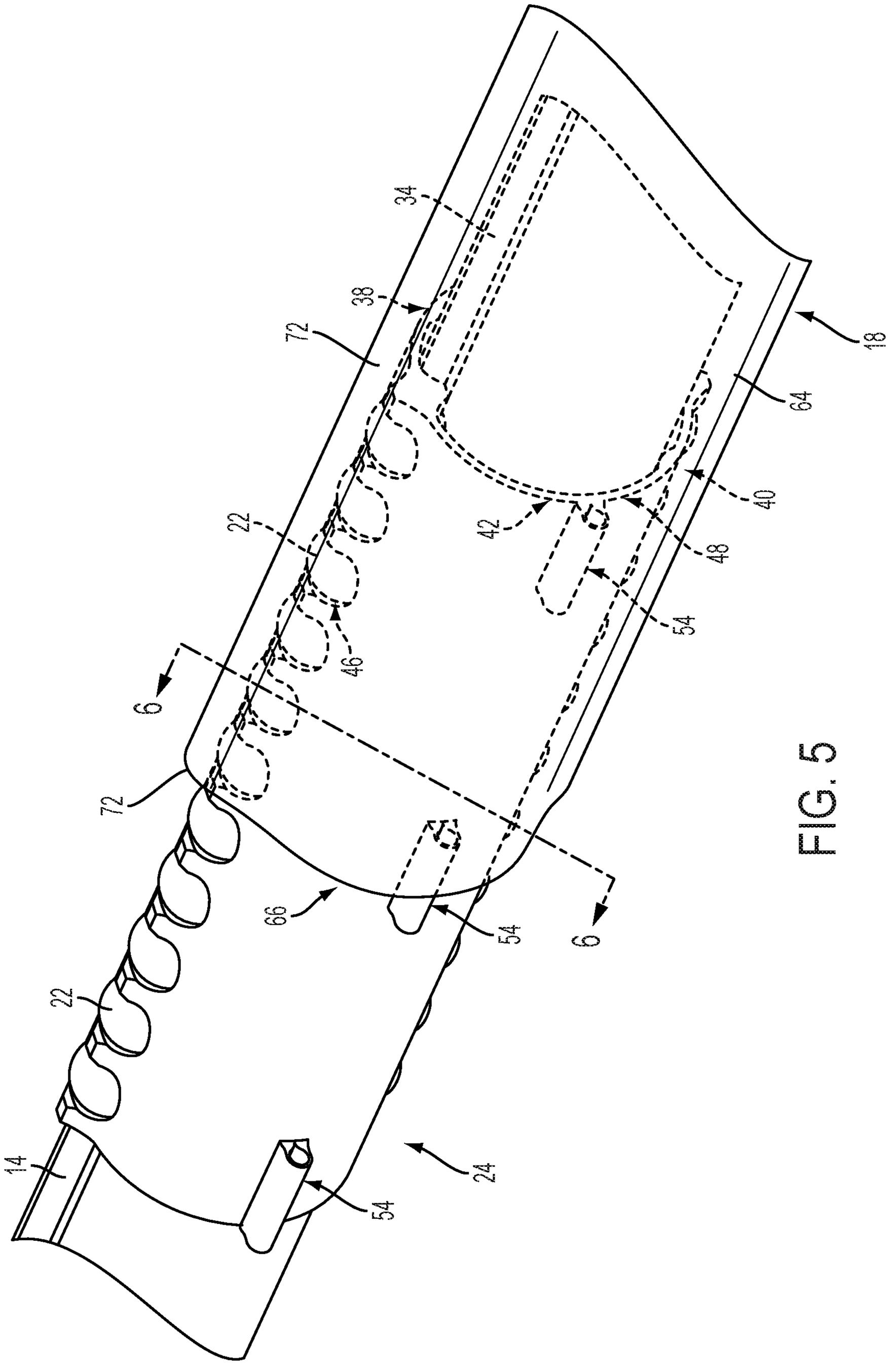


FIG. 5

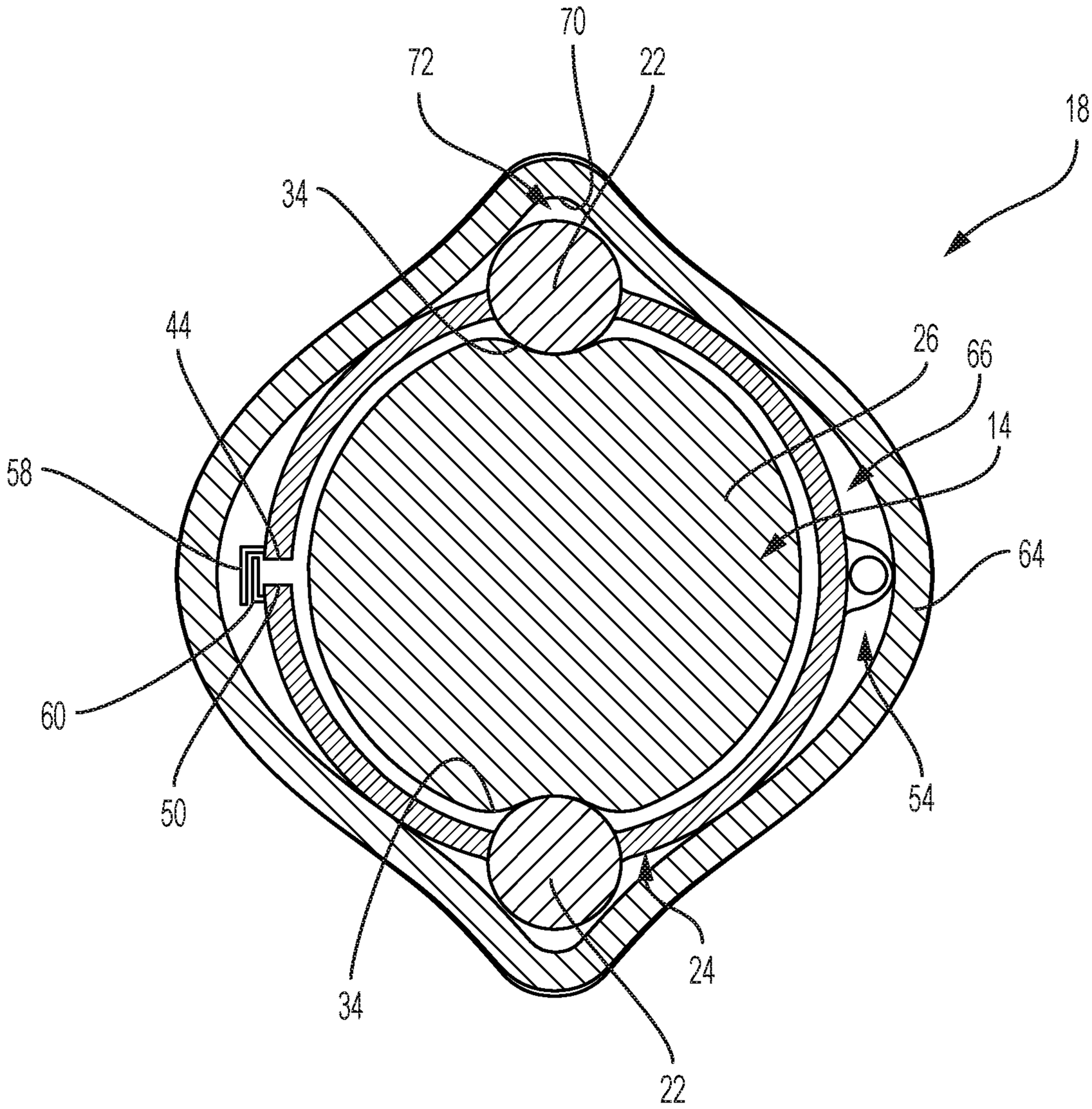


FIG. 6

BEARING SLEEVE FOR A SHAFT

CROSS-REFERENCES TO RELATED APPLICATIONS

This patent application is a divisional of U.S. patent application Ser. No. 14/547,558, filed Nov. 19, 2014, now U.S. Pat. No. 9,803,684, which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

The present disclosure generally relates to shaft assemblies and, more specifically, to intermediate shaft assemblies for vehicles.

BACKGROUND OF THE INVENTION

Intermediate shafts (I-shafts) are designed to be a component of torque transfer from a steering column to a steering gear. They may also allow axial movement while maintaining this ability to transfer torque. I-shafts that utilize ball bearings that roll between a metal solid shaft and a metal tubular shaft are commonly referred to as rolling element I-shafts.

Some known rolling element I-shafts include one piece ball bearing retention sleeve which slides onto the shaft axially into ball grooves. To allow for this process, secondary machining on the male shaft and separate components are required to create a mechanical retention feature for the retention sleeve. In addition, ball grooves must extend to the end of the shaft to facilitate assembly of the retention sleeve to the shaft. These design additions add cost and complexity. Accordingly, it is desirable to provide an I-shaft without the need for extra processing and retention features on the male shaft.

SUMMARY OF THE INVENTION

In one aspect, a bearing sleeve for a rolling element shaft assembly having a solid shaft is provided. The bearing sleeve includes a first portion defining a first edge, a second edge, and a first plurality of ball bearing apertures, and a second portion defining a third edge, a fourth edge, and a second plurality of ball bearing apertures. The first portion is configured to couple to the second portion about the solid shaft.

In another aspect, a rolling element shaft assembly is provided. The rolling element shaft assembly includes a solid shaft having a first end and a second end, a tubular shaft configured to receive the shaft first end, and a bearing sleeve coupled to the solid shaft. The bearing sleeve includes a first portion defining a first edge, a second edge, and at least one first bearing aperture, and a second portion defining a third edge, a fourth edge, and at least one second bearing aperture. The first portion is configured to couple to the second portion about the solid shaft. The bearing sleeve further includes at least one first bearing disposed within the at least one first bearing aperture and at least one second bearing disposed within the at least one second bearing aperture.

In yet another aspect, a method of assembling a rolling element shaft assembly is provided. The method includes providing a solid shaft having a first end and a second end, providing a tubular shaft, and providing a bearing sleeve having a first portion and a second portion, the first portion defining a first edge, a second edge, and at least one first bearing aperture, the second portion defining a third edge, a fourth edge, and at least one second bearing aperture. The method further includes providing at least one first ball bearing disposed within the at least one first bearing aperture, providing at least one second ball bearing disposed within the at least one second bearing aperture, coupling the bearing sleeve first and second portions radially about the solid shaft, and inserting the solid shaft into the tubular shaft.

These and other advantages and features will become more apparent from the following description taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The subject matter which is regarded as the invention is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. **1** is an exploded view of an exemplary shaft assembly of the invention;

FIG. **2** is a perspective view of an exemplary solid shaft of the assembly shown in FIG. **1**;

FIG. **3** is a perspective view of an exemplary bearing sleeve of the assembly shown in FIG. **1**;

FIG. **4** is a perspective view of an exemplary tubular shaft of the assembly shown in FIG. **1**;

FIG. **5** is a perspective view of a portion of the assembly shown in FIG. **1** after assembly; and

FIG. **6** is a cross-sectional view of the portion of the assembly of FIG. **5**.

DETAILED DESCRIPTION

Described herein are systems and method for an intermediate shaft assembly. A two-piece bearing sleeve may be assembled onto a solid shaft without having to be inserted on an end of the solid shaft. As such, the bearing sleeve may be assembled radially onto the solid shaft as opposed to axially. This eliminates the need to process or machine retention features on the solid shaft to retain the bearing sleeve after it has been assembled onto the solid shaft.

Referring now to the Figures, where the invention will be described with reference to specific embodiments, without limiting same, FIG. **1** illustrates an exemplary rolling element intermediate shaft (I-shaft) assembly **10** that generally includes a yoke **12**, a solid shaft **14**, a roller assembly **16**, and a tubular shaft **18**. Roller assembly **16** includes a cap **20**, ball bearings **22**, and a sleeve **24**. In the exemplary embodiment, I-shaft assembly **10** is configured for use in a vehicle steering column assembly (not shown). However, shaft assembly **10** described herein may be used in any other suitable system.

FIG. **2** illustrates solid shaft **14**, which generally includes a solid body **26** having a first end **28** and a second end **30**. First end **28** is configured for insertion into an aperture **32** of yoke **12** (see FIG. **1**) to facilitate coupling therebetween, and second end **30** is configured for insertion into tubular shaft **18**. Solid body **26** includes grooves **34**, which extend axially along the length of solid shaft **14** and include an end stop **36** having an abutting surface **37** acting as a termination or truncation of grooves **34** preventing an extension of grooves **34** to second end **30**. Groove **34** has an open end **39** at first end **28**. Although two grooves **34** are illustrated, solid shaft **14** may have any number of grooves that enable assembly **10**

to function as described herein. For example, solid shaft **14** may have three or four grooves **34**.

FIG. **3** illustrates sleeve **24**, which generally includes a first portion **38** and a second portion **40**. First portion **38** includes a first edge **42**, a second edge **44**, a first plurality of protrusions **45**, and a plurality of bearing apertures **46**. The first plurality of protrusions **45** extend away from an inner surface **47** of the first portion **38** such that a bearing aperture of the plurality of bearing apertures **46** is disposed between protrusions of the first plurality of protrusions **45**. The second portion **40** includes a first edge **48**, a second edge **50**, a second plurality of protrusions **51**, and a plurality of bearing apertures **52**. The second plurality of protrusions **51** extends away from an inner surface **53** of the second portion **40** such that a bearing aperture of the plurality of bearing apertures **52** is disposed between protrusions of the second plurality of protrusions **51**. In the exemplary embodiment, first and second portions **38**, **40** are semi-cylindrical or substantially semi-cylindrical, and further are semi-circular in cross-section or substantially semi-circular in cross-section. However, first and second portions **38**, **40** may have any suitable shape that enables sleeve **24** to function as described herein.

In the exemplary embodiment, first and second portions **38**, **40** are coupled along first edges **42**, **48** with one or more connectors or hinges **54** such that sleeve **24** has a clamshell configuration. In the embodiment shown, hinge **54** is a living hinge having the same physical properties of sleeve **24**. However, first and second portions **38**, **40** may be coupled by any means that enables sleeve **24** to function as described herein. For example, first edges **42**, **48** may be coupled by a pin operably associated with a pin aperture (not shown). Second edge **44** of first portion **38** includes one or more clip members **56** and one or more clip apertures **58**, and second edge **50** of second portion **40** includes one or more clip members **60** and one or more clip apertures **62**. Clip apertures **58** are configured to receive clip members **60**, and clip apertures **62** are configured to receive clip members **56** such that second edges **44**, **50** may be coupled. Accordingly, sleeve **24** is cylindrical or substantially cylindrical when first edges **42**, **48** and second edges **44**, **50** are coupled.

FIG. **4** illustrates tubular shaft **18**, which generally includes a tubular body **64** having an open end **66** and a yoke end **68**. Open end **66** is configured to receive roller assembly **16** and solid shaft second end **30**, as shown in FIG. **5** and FIG. **6**, and yoke end **68** is configured to couple to the steering column assembly (not shown). Tubular body **64** includes an inner wall **70** having axially extending grooves **72** formed therein. Grooves **72** are configured to receive ball bearings **22** at least partially therein. Tubular body **64** also includes one or more slots **74** configured to retain cap **20** on tubular shaft open end **66**. However, cap **20** may be coupled to tubular shaft **18** in any suitable manner.

With reference to FIGS. **1-5**, assembly of I-shaft assembly **10** includes providing yoke **12**, solid shaft **14**, roller assembly **16**, and tubular shaft **18**. With sleeve **24** in the open position (FIG. **3**), ball bearings **22** are inserted into and retained within bearing apertures **46**, **52** and retained between the first and second plurality of protrusions **45**, **51**. Sleeve first portion **38** is positioned against solid shaft **14** such that ball bearings **22** are aligned along groove **34**. Sleeve second portion **40** is then rotated about hinges **54** toward first portion **38** until second edges **44**, **50** are in contact or in close proximity. At this point, ball bearings of second portion **40** are aligned along groove **34** clip members **56** and **60** are inserted into respective clip apertures **62** and **58** to secure sleeve **24** to solid shaft **14** (see FIG. **5**). Ball bearings **22** are able to roll along grooves **34** toward shaft second end **30** until they are stopped by end stop **36**. Machining of shaft **14** with end stop **36** is significantly easier than machining shaft **14** with grooves that would run to the end **39** of shaft **14**. In addition, end stop **36** facilitates maintaining roller assembly **16** on shaft **14** during final assembly of shaft **14** within tubular shaft **18**. Accordingly, sleeve **24** may be assembled onto solid shaft **14** from a radial direction and is not required to be assembled from the axial direction like some known assemblies.

Solid shaft second end **30** is inserted into tubular shaft open end **66** and oriented such that ball bearings **22** are aligned within grooves **72**. As illustrated in FIGS. **2** and **4**, both grooves **34** as well as both grooves **72** are oriented approximately 180° from each other. However, grooves **34** and grooves **72** may be oriented with respect to each other at any suitable angle that enables assembly **10** to function as described herein. Further, as noted herein, assembly **10** may include any number of sets of grooves **34** and grooves **72**. Grooves may be equally disposed about the circumference of shaft **14** as shown.

Cap **20** is inserted over solid shaft **14** and is coupled to tubular shaft open end **66** (see FIGS. **1** and **4**), which facilitates securing sleeve **24** between shafts **14**, **18** and preventing foreign objects or contaminants from getting into tubular shaft **18** and hindering the operation of roller assembly **16**. Yoke **12** may then be coupled to solid shaft first end **28** in any suitable manner (e.g., press-fitting, welding, etc.).

While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description.

Having thus described the invention, it is claimed:

1. A rolling element shaft assembly comprising:

a solid shaft having a first end and a second end;

a tubular shaft configured to receive the second end of the solid shaft;

a bearing sleeve coupled to the solid shaft, the bearing sleeve comprising:

a first portion defining a first edge, a second edge, a first plurality of protrusions extending from an inner surface of the first portion, and at least one first bearing aperture; and

a second portion defining a third edge, a fourth edge, and at least one second bearing aperture, the first portion configured to couple to the second portion about the solid shaft;

at least one first ball bearing disposed within the at least one first bearing aperture and retained between the first plurality of protrusions;

at least one second ball bearing disposed within the at least one second bearing aperture; and

the solid shaft further comprising a first axially extending groove and a second axially extending groove, the at least one first bearing and the first plurality of protrusions being disposed in the first axially extending groove, and the at least one second bearing disposed in the second axially extending groove.

2. The assembly of claim 1, wherein the first and second axially extending grooves each includes an end stop distanced from the second end of the solid shaft, the end stop having an abutting surface configured to prevent the at least one first and second bearings respectively disposed in the first and second axially extending grooves from extending to the second end of the solid shaft.

3. The assembly of claim 1, wherein the at least one first bearing aperture comprises a first plurality of bearing apertures, the at least one second bearing aperture comprises a second plurality of bearing apertures, the at least one first bearing comprises a first plurality of bearings, and the at least one second bearing comprises a second plurality of bearings.

4. A rolling element shaft assembly comprising:

a solid shaft having a first end and a second end;

a tubular shaft configured to receive the second end of the solid shaft;

a bearing sleeve coupled to the solid shaft, the bearing sleeve comprising:

a first portion defining a first edge, a second edge, a first plurality of protrusions extending from an inner surface of the first portion, and at least one first bearing aperture; and

a second portion defining a third edge, a fourth edge, and at least one second bearing aperture, the first portion configured to couple to the second portion about the solid shaft;

at least one first ball bearing disposed within the at least one first bearing aperture and retained between the first plurality of protrusions;

at least one second ball bearing disposed within the at least one second bearing aperture; and

at least one connector coupled between the first edge and the third edge, wherein the at least one connector is at least one hinge.

5. The assembly of claim 4, further comprising:

at least one clip member extending from the first portion second edge; and

at least one clip aperture formed in the second portion fourth edge, the at least one clip aperture configured to receive the at least one clip member to couple the first portion and the second portion.

6. The assembly of claim 5, further comprising:

at least one additional clip member extending from the fourth edge; and

at least one additional clip aperture formed in the second edge, the at least one additional clip aperture configured to receive the at least one additional clip member to couple the first portion and the second portion.

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