



(12) **DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION**

(13) **A1**

(86) Date de dépôt PCT/PCT Filing Date: 2018/03/14
(87) Date publication PCT/PCT Publication Date: 2018/09/20
(85) Entrée phase nationale/National Entry: 2019/09/13
(86) N° demande PCT/PCT Application No.: US 2018/022355
(87) N° publication PCT/PCT Publication No.: 2018/170076
(30) Priorité/Priority: 2017/03/15 (US15/459,247)

(51) Cl.Int./Int.Cl. *G01N 1/00* (2006.01),
G01N 1/02 (2006.01), *G01N 1/10* (2006.01),
G01N 1/20 (2006.01)
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(54) Titre : ECHANTILLONNEUR DE PIPELINE
(54) Title: PIPELINE SAMPLER

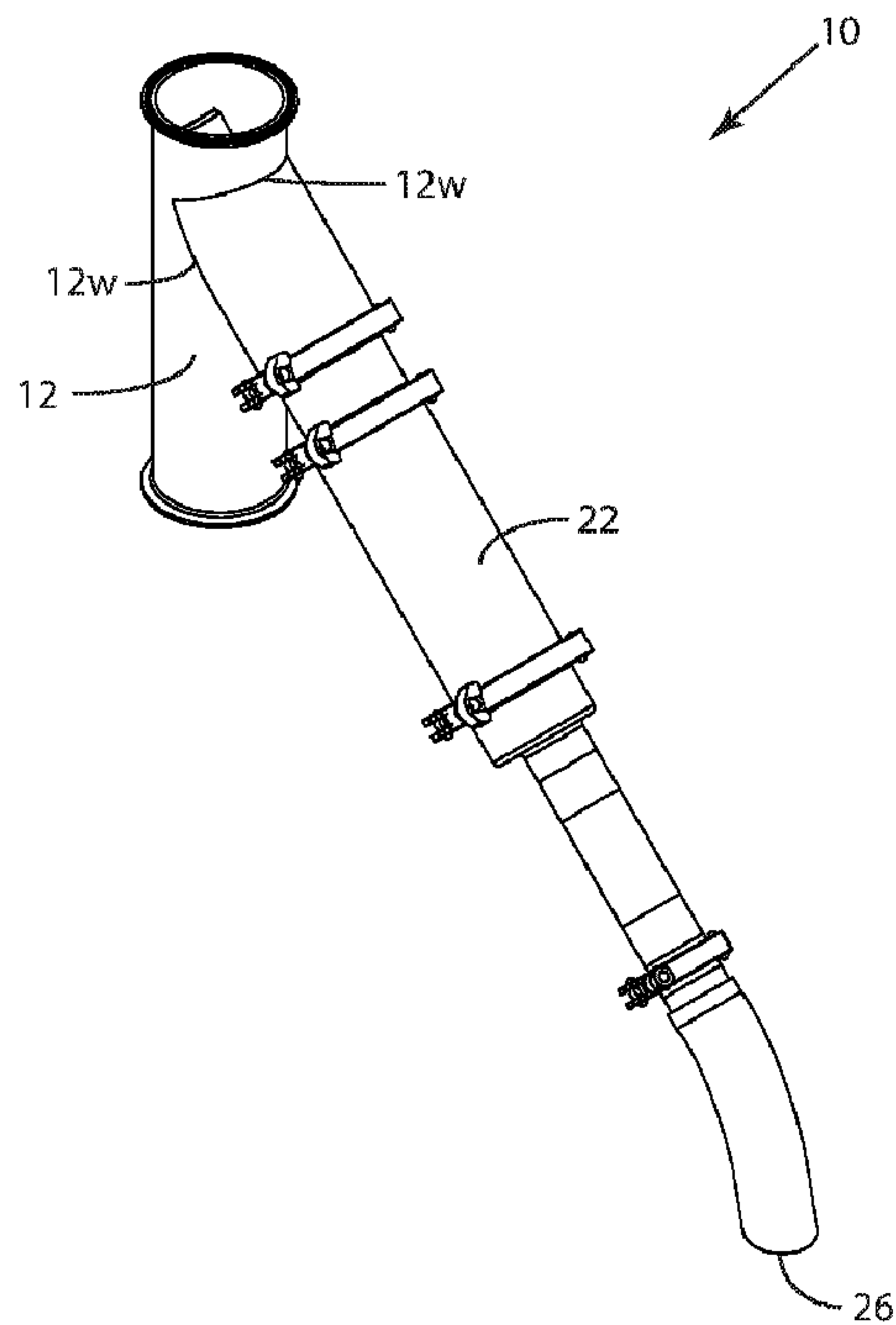


FIG. 1

(57) **Abrégé/Abstract:**

An apparatus 10 for collecting a dry material sample flowing in a duct 12 is disclosed. The apparatus 10 includes a sample tube 14 having a closed distal end 16 and a sample-inlet aperture 18 in the wall of the sample tube 14 adjacent the closed distal end 16 as

(57) **Abrégé(suite)/Abstract(continued):**

well as a fluid cylinder 22 with a duct end 24 and an outlet end 26 and a piston 28 mounted around and connected to the sample tube 14. The apparatus also includes first and second sealing sleeves 30, 32 around and slideably supporting the sample tube 14. A duct-connecting structure 34 extends between the duct end 24 of the housing 22 and the duct 12. The sample tube 14 is a piston 28 within the fluid-cylinder housing 22, the fluid-cylinder housing 22 is configured to extend and retract the sample tube 14 within the duct 12.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization

International Bureau

(43) International Publication Date
20 September 2018 (20.09.2018)(10) International Publication Number
WO 2018/170076 A1

(51) International Patent Classification:

G01N 1/00 (2006.01) *G01N 1/10* (2006.01)*G01N 1/02* (2006.01) *G01N 1/20* (2006.01)

(21) International Application Number:

PCT/US2018/022355

(22) International Filing Date:

14 March 2018 (14.03.2018)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

15/459,247 15 March 2017 (15.03.2017) US

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Wisconsin 53403 (US).(81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO,DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,
HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,
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MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.(84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: PIPELINE SAMPLER

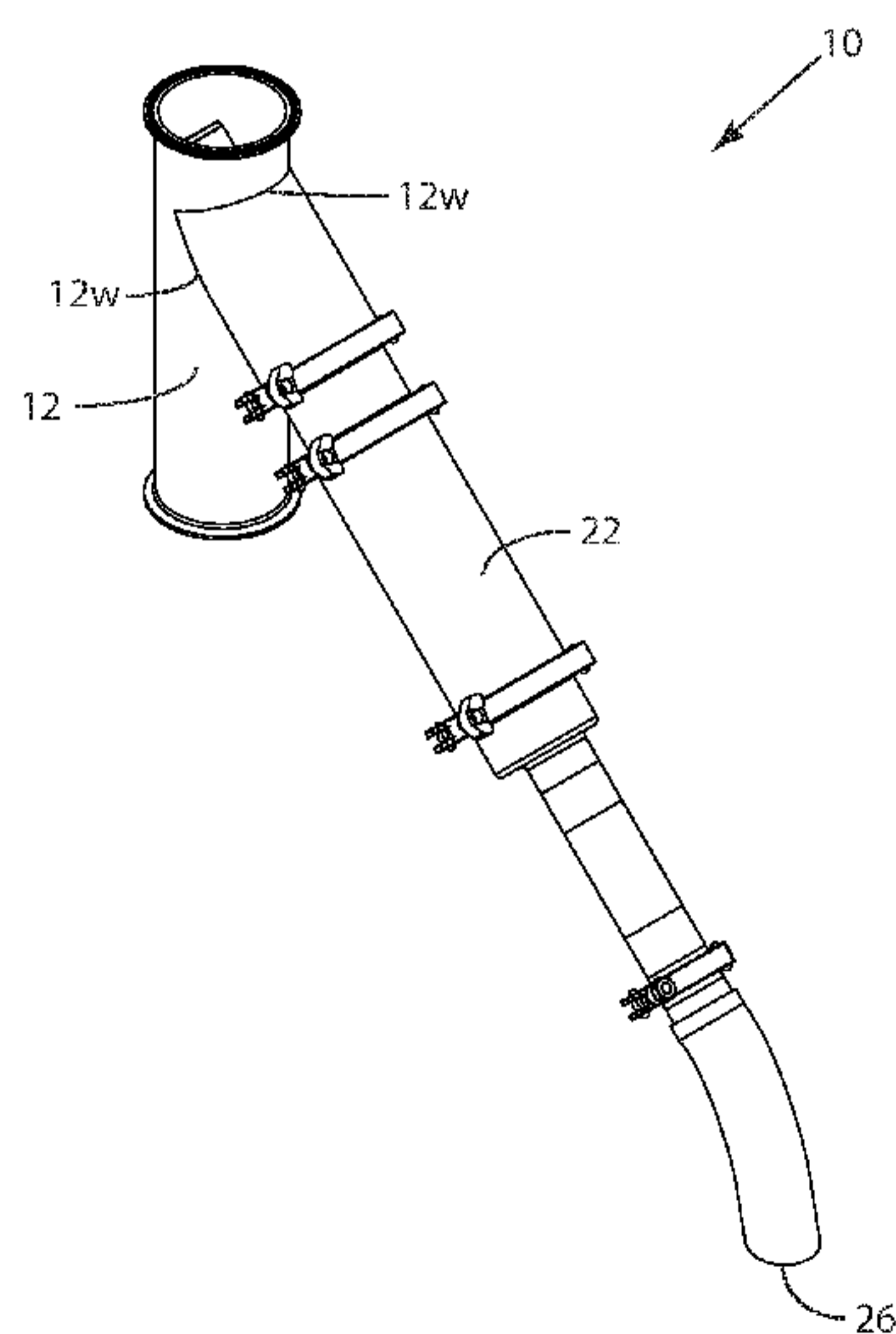


FIG. 1

(57) Abstract: An apparatus 10 for collecting a dry material sample flowing in a duct 12 is disclosed. The apparatus 10 includes a sample tube 14 having a closed distal end 16 and a sample-inlet aperture 18 in the wall of the sample tube 14 adjacent the closed distal end 16 as well as a fluid cylinder 22 with a duct end 24 and an outlet end 26 and a piston 28 mounted around and connected to the sample tube 14. The apparatus also includes first and second sealing sleeves 30, 32 around and slideably supporting the sample tube 14. A duct-connecting structure 34 extends between the duct end 24 of the housing 22 and the duct 12. The sample tube 14 is a piston 28 within the fluid-cylinder housing 22, the fluid-cylinder housing 22 is configured to extend and retract the sample tube 14 within the duct 12.

PIPELINE SAMPLER

FIELD OF THE INVENTION

The present invention generally relates to a sampler for sampling processes that convey bulk solid and friable powder, and more particularly, to a single-piece sampling apparatus with an anti-rotation configuration.

BACKGROUND OF THE INVENTION

A variety of systems for sampling various materials are known. However, numerous disadvantages and shortcomings exist with prior systems, and there is a need for improvement to overcome such disadvantages and shortcomings. Some examples of sampling devices of the prior art are disclosed in U.S. Patent Nos. 4,433,587 and 4,082,004.

The sampling systems of the prior art have several drawbacks. Some such drawbacks are that the sampling systems of the prior art have numerous functioning parts which can lead to the use of higher-cost components and to longer assembly times. It would be preferable to have a sampling device which has fewer components such as a body which functions as both the process tube and air cylinder. It would also be preferable to have a sampling device which includes an offset tube as well as an air cylinder piston which prevents rotation of the tube and maintains the aperture in proper alignment with process flow. It would also be preferable to have a sampling device that requires few or no tools to assemble or disassemble as well as clean and maintain.

In processes that convey bulk solid and friable powder media in a process pipeline (or process tube), there is a need to extract a sample of the process medium without affecting the material properties. Current samplers employ a tube that extends into the process pipeline (or process tube) and an aperture on the side of the tube which then allows process media to enter the sampler. The process media then are allowed to travel through the tube and be collected in a receptacle. The tube is then retracted from the process pipeline. Proper extraction of the sample requires the aperture of the sampling

tube to be facing in the direction of flow of the process medium. Currently, there are a number of methods to ensure rotational alignment which generally include the use of fixtures, effectors and apertures on pneumatic cylinders attached to sample extraction devices. These include using anti-rotation pins, dual piston rods, linkages and dual
5 support bars. All of these methods involve the added complexity of extra parts, seals and wear points. It is to these needs that this inventive sampling apparatus or device is drawn.

The present device uses a sample conveyance tube with an aperture that allows the process media to enter the tube. The device ensures the aperture maintains proper orientation to the medium flow. The invention allows for extraction of a sample while
10 maintaining aperture orientation to the flow. The inventive apparatus also reduces the number of parts, and therefore the complexity, and making it easier to clean and maintain.

The present device maintains simplicity by lowering the part count while providing the critical anti-rotation feature. This is a novel improvement because it maintains the basic shape and form of the air cylinder while still preventing rotation
15 through the offset piston and rod axes and allowing the piston rod in the cylinder to function as the sample conveyance tube. This is a substantial improvement over the samplers of the prior art.

It is to all the above-noted needs that the device of this application is drawn. This invention addresses and overcomes such problems.

20

OBJECTS OF THE INVENTION

An object of the present invention is to provide an improved pipeline-sampling apparatus in which the process tube and air cylinder are the same structure.

Another object of this invention is to provide an improved pipeline-sampling
25 apparatus which has fewer and lower-cost components.

Yet another object of this invention is to provide an improved pipeline-sampling apparatus which requires few or no tools to assemble/disassemble as well as clean and maintain.

Another object of the invention is to provide an improved pipeline-sampling apparatus which overcomes certain problems of existing devices and methods of the prior art.

5 SUMMARY OF THE INVENTION

The present invention relates to an improved apparatus for collecting a dry material sample flowing in a duct. The apparatus includes a sample tube having a closed distal end and a sample-inlet aperture in the wall of the sample tube adjacent the closed distal end, a housing configured as a fluid cylinder and having a duct end and an outlet end, a piston mounted around and connected to the sample tube and positioned within the housing, first and second sealing sleeves around and slideably supporting the sample tube, the duct end including the first sealing sleeve and the outlet end including the second sealing sleeve, and a duct-connecting structure extending between the duct end of the housing and the duct. The sampling tube is a piston rod within the fluid-cylinder housing, and the fluid-cylinder housing is configured to extend and retract the sample tube within the duct.

It is highly preferable that the fluid cylinder is an air cylinder. In preferred embodiments, the duct-connecting structure is welded to the duct and the duct end includes a retract fluid inlet to the fluid cylinder. Preferably, the outlet end includes an extend fluid inlet to the cylinder.

In some preferred embodiments, the sample tube and fluid cylinder housing have centerlines which are not coextensive. In other preferred embodiments, the piston and fluid-cylinder have non-circular cross-sections to prevent rotation of the piston in the cylinder.

It is preferable that the first and second sealing sleeves include non-circular seals and the sample tube is non-circular, configured to sealingly slide within the non-circular seals.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings illustrate a preferred embodiment including the above-noted characteristics and features of the invention. The invention will be readily understood from the descriptions and drawings. In the drawings:

5 FIGURE 1 is a front perspective view of an embodiment of the inventive pipeline apparatus for collecting a dry material sample flowing in a duct;

 FIGURE 2 is a side view of the pipeline apparatus of FIGURE 1 with the sampling tube in a extended position;

10 FIGURE 3 is a perspective view of the pipeline apparatus of FIGURE 1 illustrating the inlet sample aperture;

 FIGURE 4 is a cross-sectional view taken along line A-A of FIGURE 3;

 FIGURE 5 is a cross-sectional view taken along line E-E of FIGURE 4;

 FIGURE 6 is a perspective view of the pipeline apparatus of FIGURE 1 with the sampling tube in a retracted position;

15 FIGURE 7 is a cross-sectional view taken along line F-F of FIGURE 6;

 FIGURE 8 is a front view of a pipeline apparatus of FIGURE 1 with the sampling tube extended but without the pipeline shown;

 FIGURE 9 is a top view of the pipeline apparatus of FIGURE 8;

 FIGURE 10 is a side view of the pipeline apparatus of FIGURE 8;

20 FIGURE 11 is a cross-sectional view taken along line I-I of FIGURE 10;

 FIGURE 12 is a cross-sectional view taken along line J-J of FIGURE 8;

 FIGURE 13 is a front view of a pipeline apparatus of FIGURE 8 with the sampling tube retracted;

 FIGURE 14 is a top view of the pipeline apparatus of FIGURE 13;

25 FIGURE 15 is a side view of the pipeline apparatus of FIGURE 13;

 FIGURE 16 is a cross-sectional view taken along line G-G of FIGURE 15;

 FIGURE 17 is a cross-sectional view taken along line H-H of FIGURE 13;

FIGURE 18 is a perspective view of a second embodiment of the inventive pipeline apparatus for collecting a dry material sample flowing in a duct;

FIGURE 19 is a cutaway view of the pipeline apparatus of FIGURE 18;

FIGURE 20 is a cutaway view of the pipeline apparatus of FIGURE 18;

5 FIGURE 21 is a cross-sectional view taken along line K-K of FIGURE 20;

FIGURE 22 is a detailed view of Section B of the pipeline apparatus of FIGURE 21;

FIGURE 23 is an end view of the pipeline apparatus of FIGURE 18;

10 FIGURE 24 is a perspective view of a third embodiment of the inventive pipeline apparatus for collecting a dry material sample flowing in a duct; and

FIGURE 25 is an end view of the pipeline apparatus of FIGURE 24.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The inventive sampler apparatus maintains alignment of the sample tube aperture
15 to the product flow in a pressurized dry material product process line and uses the sample conveyance tube itself as the piston rod of a pneumatic (or alternatively, hydraulic) cylinder. The inventive apparatus combines the sampling tube with the air cylinder used to actuate it, thereby further reducing the overall parts count and complexity. Instead of
20 mechanically preventing rotation of the aperture via a restriction on the air cylinder and effector, the device incorporates the air cylinder, anti-rotation structure and sample conveyance tube into a single apparatus. FIGURES 1-25 illustrate embodiments of such inventive apparatus used for collecting a dry material sample flowing in a duct 12.

An embodiment 10 of the inventive apparatus, as illustrated in FIGURES 1-17, includes a sample tube 14 having a closed distal end 16 and a sample-inlet aperture 18 in
25 the wall of sample tube 14 adjacent closed distal end 16. FIGURES 1-3 illustrate that apparatus 10 also includes a housing configured as a fluid cylinder 22 which has a duct end 24 and an outlet end 26. A piston 28 is mounted around and connected to sample tube 14 and positioned within housing 22. First and second sealing sleeves 30, 32 are

around and slideably supporting sample tube 14. Duct end of fluid cylinder 24 includes first sealing sleeve 30 and outlet end of fluid cylinder 26 includes second sealing sleeve 32. As can be seen best in FIGURES 4 and 7, a duct-connecting structure 34 extends between duct end 24 of housing 22 and duct 12.

5 FIGURES 1-25 illustrate that fluid cylinder 22 is an air cylinder. In the inventive apparatus 10, sample tube 14 and fluid-cylinder housing 22 have centerlines which are not coextensive.

 FIGURES 1, 2, 4 and 7 all illustrate that duct-connecting structure 34 is welded to duct 12 by a weld 12w. Duct end 24 includes a retract fluid inlet 36 to fluid cylinder 22.
10 FIGURES 4 and 7 illustrate best that outlet end 26 includes an extend fluid inlet 38 to fluid cylinder 22.

 In apparatus 10, sample tube 14 is a piston 28 within fluid-cylinder housing 22, and fluid-cylinder housing 22 is configured to extend and retract sample tube 14 within duct 12. FIGURE 4 shows sample tube 14 in an extended state and in duct 12 collecting
15 a sample. FIGURE 5 illustrates sample tube 14 in a retracted state. FIGURE 5 specifically also illustrates closed distal end 16 and sample inlet aperture 18 of sample tube 14. Piston 28 is also easily visible in FIGURE 5.

 FIGURES 6-7 show the relationship between fluid cylinder 22 and piston 28. FIGURE 7 also illustrates the location of retract fluid inlet 36 and extend fluid inlet 38.

20 FIGURES 8-10 show apparatus 10 not connected to duct 12. Duct end 24 of fluid cylinder 22 is shown as well as duct-connecting structure 34. FIGURE 9 illustrates that sample tube 14 of apparatus 10 has a circular cross-section.

 FIGURES 11-12 illustrate sample tube 14 in an extended state and the interaction with piston 28 as well as retract fluid inlet 36 and extend fluid inlet 38.

25 FIGURES 13 and 15 are similar to FIGURES 8 and 10 except that FIGURES 13 and 15 illustrate sample tube 14 in the retracted position inside fluid cylinder 22. FIGURE 14 is identical to FIGURE 9 in illustrating that the cross-section of sample tube 14 is circular.

FIGURES 16-17 are similar to FIGURES 11-12 except that sample tube 14 is in the retracted state within fluid cylinder 22 in FIGURES 16-17. FIGURES 16-17 clearly show closed distal end 16 inside duct end of fluid cylinder 24.

FIGURES 18-25 illustrate two additional embodiments of apparatus 10, apparatus 5 10a in FIGURES 18-23 and apparatus 10b in FIGURES 24-25. In embodiment 10 of the inventive apparatus of FIGURES 18-23, piston 44 and fluid-cylinder 42 have non-circular cross-sections thereby preventing rotation of piston 44 in fluid-cylinder 42. FIGURES 22-23 also illustrate that first and second sealing sleeves may include non-circular seals 40. As illustrated in FIGURES 18-23, non-circular cylinder 42 and piston 44 have a 10 square shape but many other non-circular shapes provide the anti-rotation performance of the inventive apparatus. FIGURES 19-20 illustrate that piston 44 can also be non-circular, such as for example, a square shape or any other non-circular shape.

In FIGURES 24-25, a third embodiment 10b of the inventive apparatus includes a non-circular sample tube (not shown) which in such embodiment will rotate as desired. 15 Apparatus 10b includes a housing end 46 which has a non-circular aperture 46 through which a sample tube having a non-circular cross-section slides, driven by a piston (not shown) and cylinder housing 50. Such piston and cylinder 50 may have simple circular cross-sections since the anti-rotation performance of apparatus 10b is provided by aperture 46 and its mating sample tube. By comparison, apparatus 10 of FIGURES 1-17 20 includes a circular piston 28 and circular cylinder 22, and anti-rotation performance is provided by the centerline of cylinder 22 not being coextensive with the centerline of sample tube 14.

Wide varieties of materials are available for the various parts discussed and illustrated herein. While the principles of this invention and related method have been 25 described in connection with specific embodiments, it should be understood clearly that these descriptions are made only by way of example and are not intended to limit the scope of the application. It is believed that the invention has been described in such detail

as to enable those skilled in the art to understand the same and it will be appreciated that variations may be made without departing from the spirit and scope of the invention.

We claim:

1. An apparatus for collecting a dry material sample flowing in a duct, the apparatus comprising:

- 5
- a sample tube having a closed distal end and a sample-inlet aperture in the wall of the sample tube adjacent the closed distal end;
 - a housing configured as a fluid cylinder and having a duct end and an outlet end;
 - a piston mounted around and connected to the sample tube and positioned

10

 - within the housing;
 - first and second sealing sleeves around and slideably supporting the sample tube, the duct end including the first sealing sleeve and the outlet end including the second sealing sleeve; and
 - a duct-connecting structure extending between the duct end of the housing and

15

 - the duct,

whereby the sample tube is a piston rod within the fluid-cylinder housing, and the fluid-cylinder housing is configured to extend and retract the sample tube within the duct.

20

2. The apparatus of claim 1 wherein the fluid cylinder is an air cylinder.

3. The apparatus of claim 1 wherein the duct-connecting structure is welded to the duct.

25

4. The apparatus of claim 1 wherein the duct end includes a retract fluid inlet to the fluid cylinder.

5. The apparatus of claim 1 wherein the outlet end includes an extend fluid inlet to the fluid cylinder.

6. The apparatus of claim 1 wherein the sample tube and the fluid-cylinder housing have centerlines which are not coextensive.

7. The apparatus of claim 1 wherein the piston and fluid-cylinder have non-
5 circular cross-sections, thereby preventing rotation of the piston in the cylinder.

8. The apparatus of claim 1 wherein the first and second sealing sleeves include non-circular seals and the sample tube is non-circular, configured to sealingly slide within the non-circular seals.

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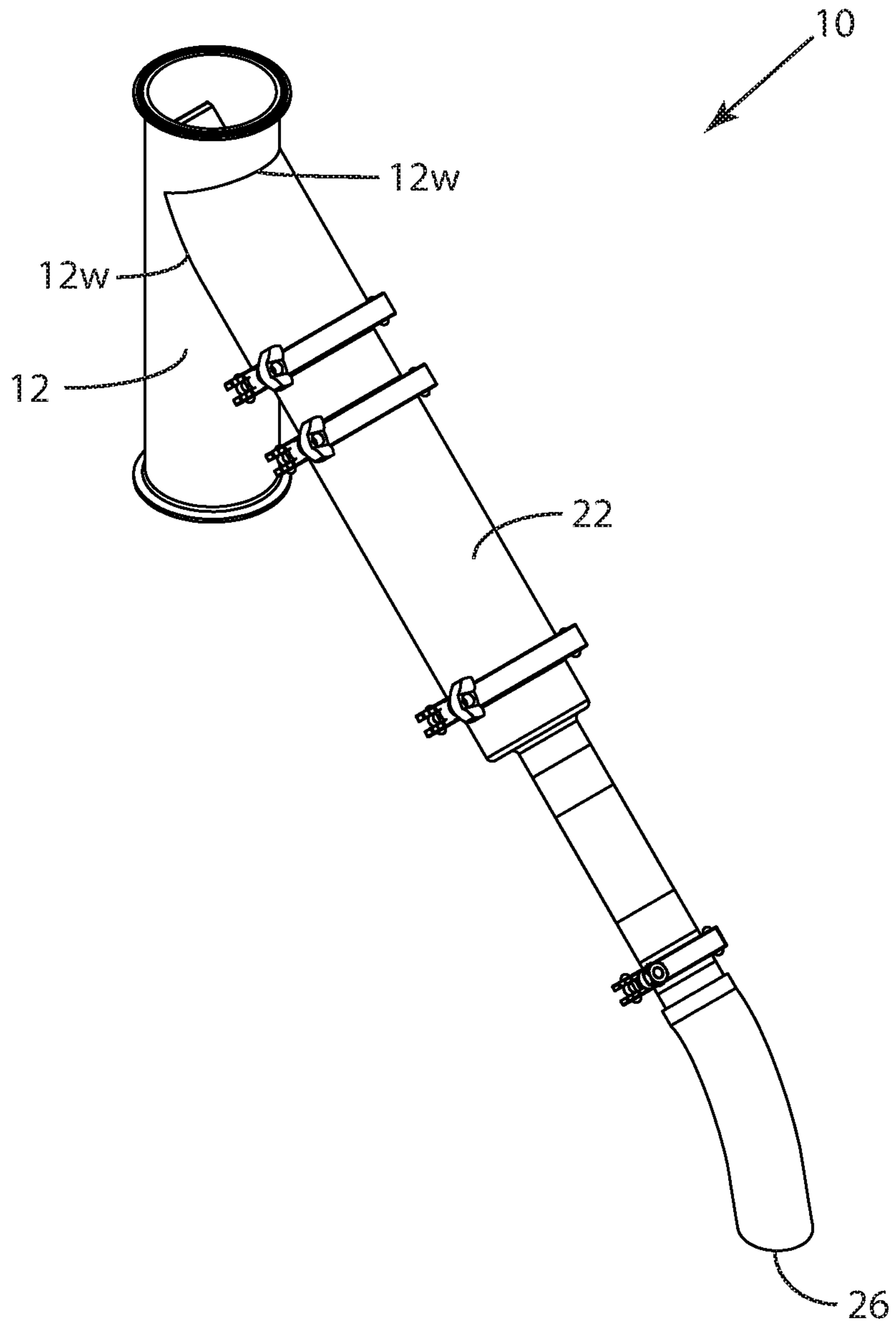
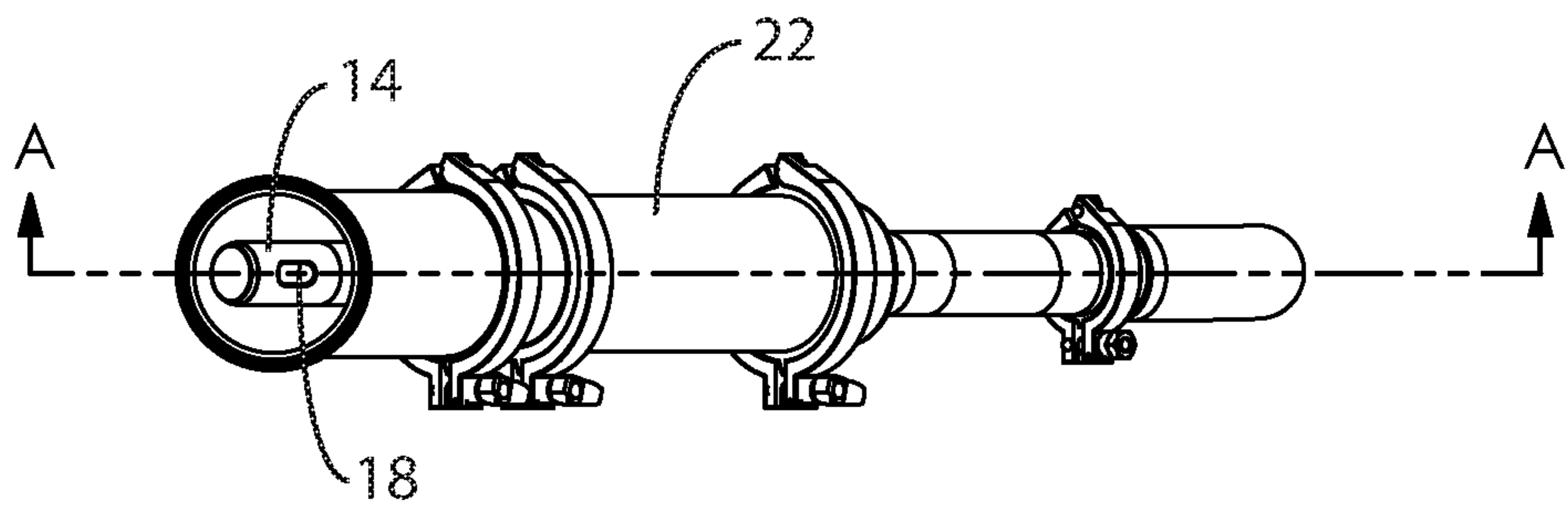
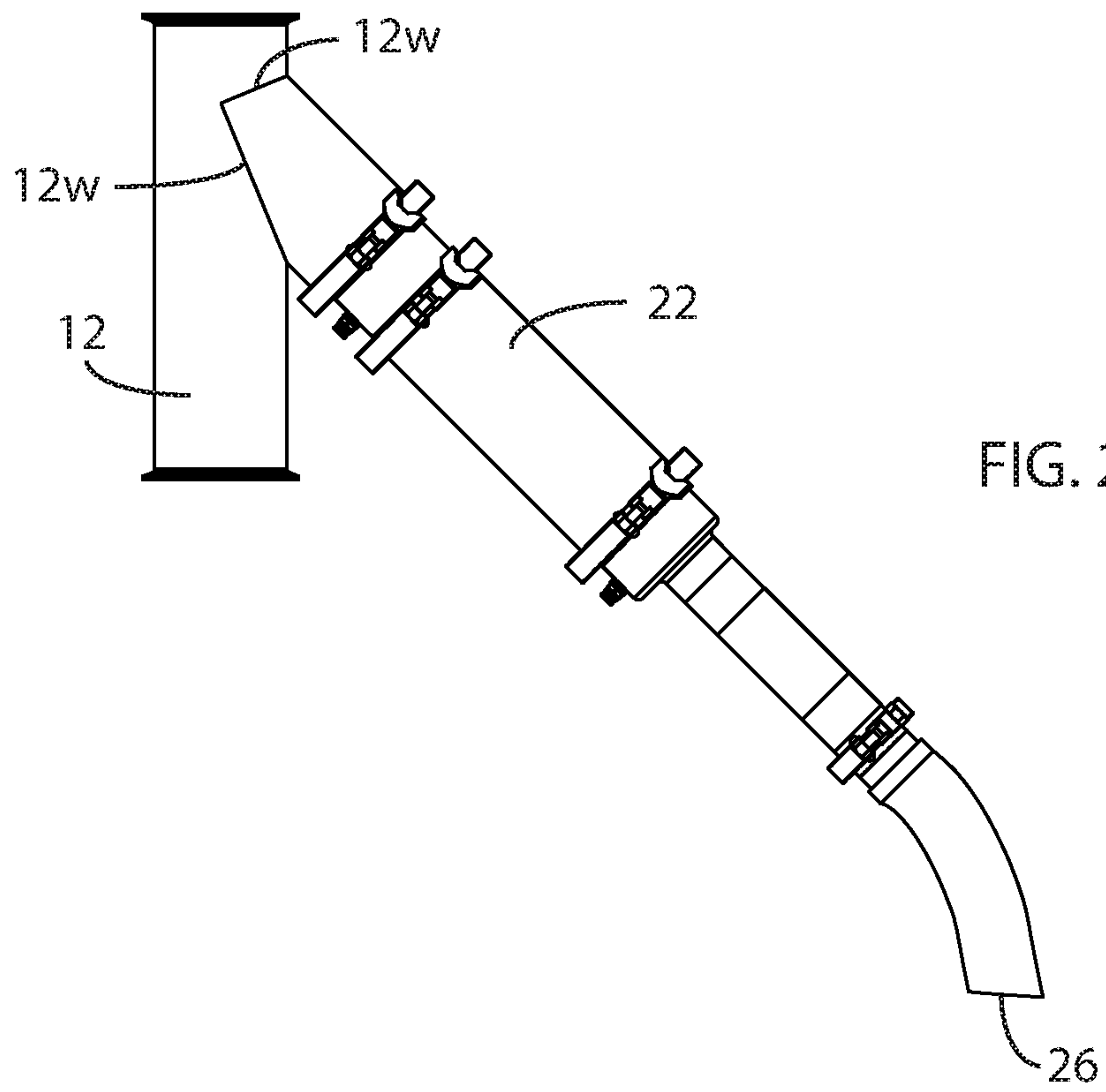


FIG. 1

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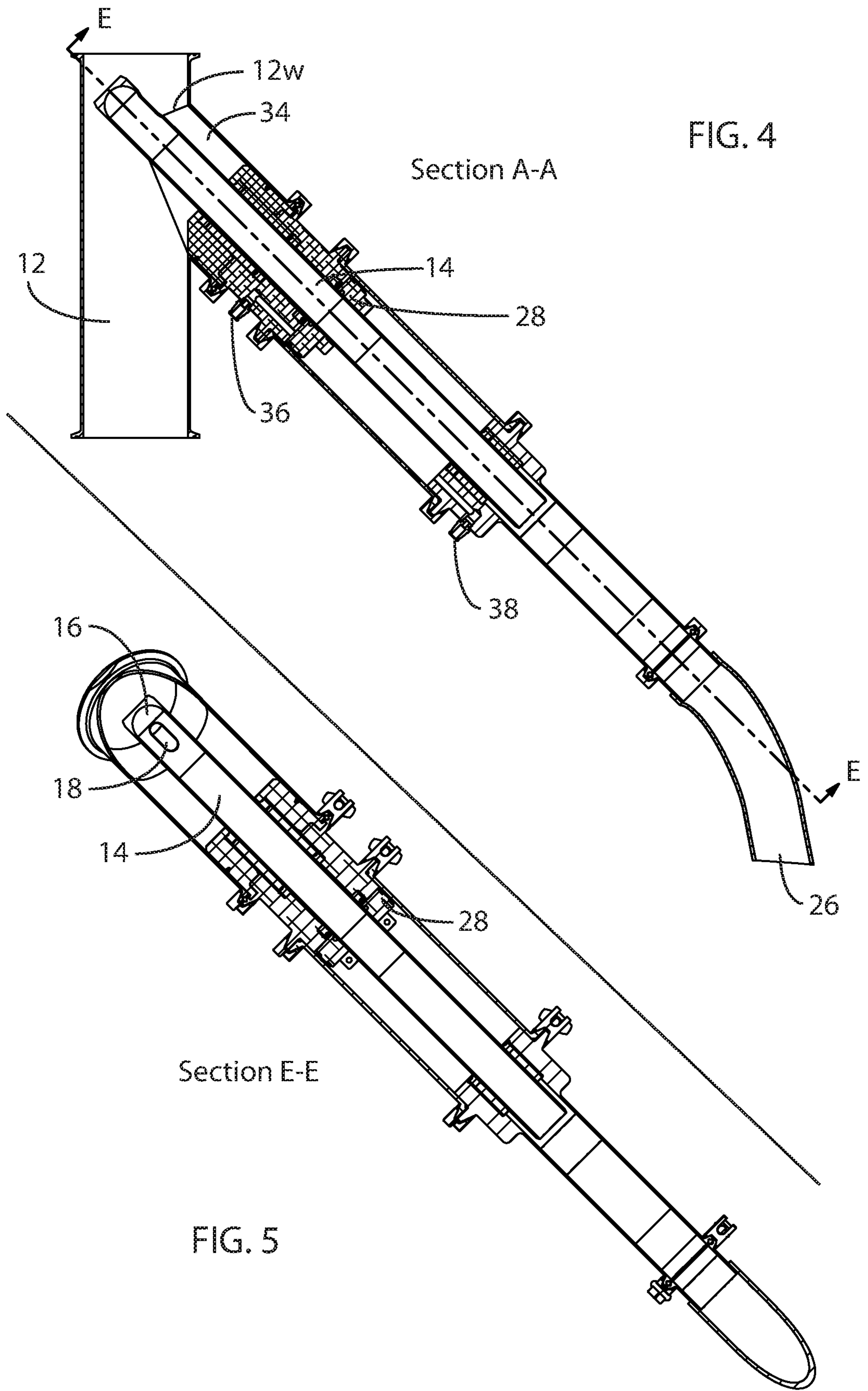


FIG. 4

FIG. 5

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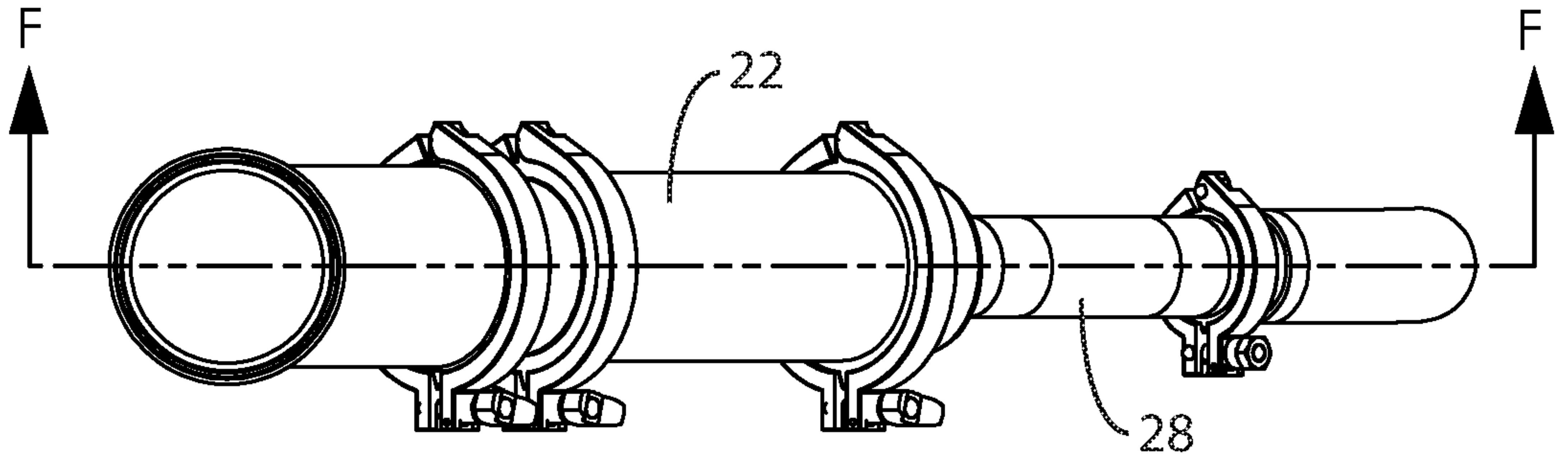


FIG. 6

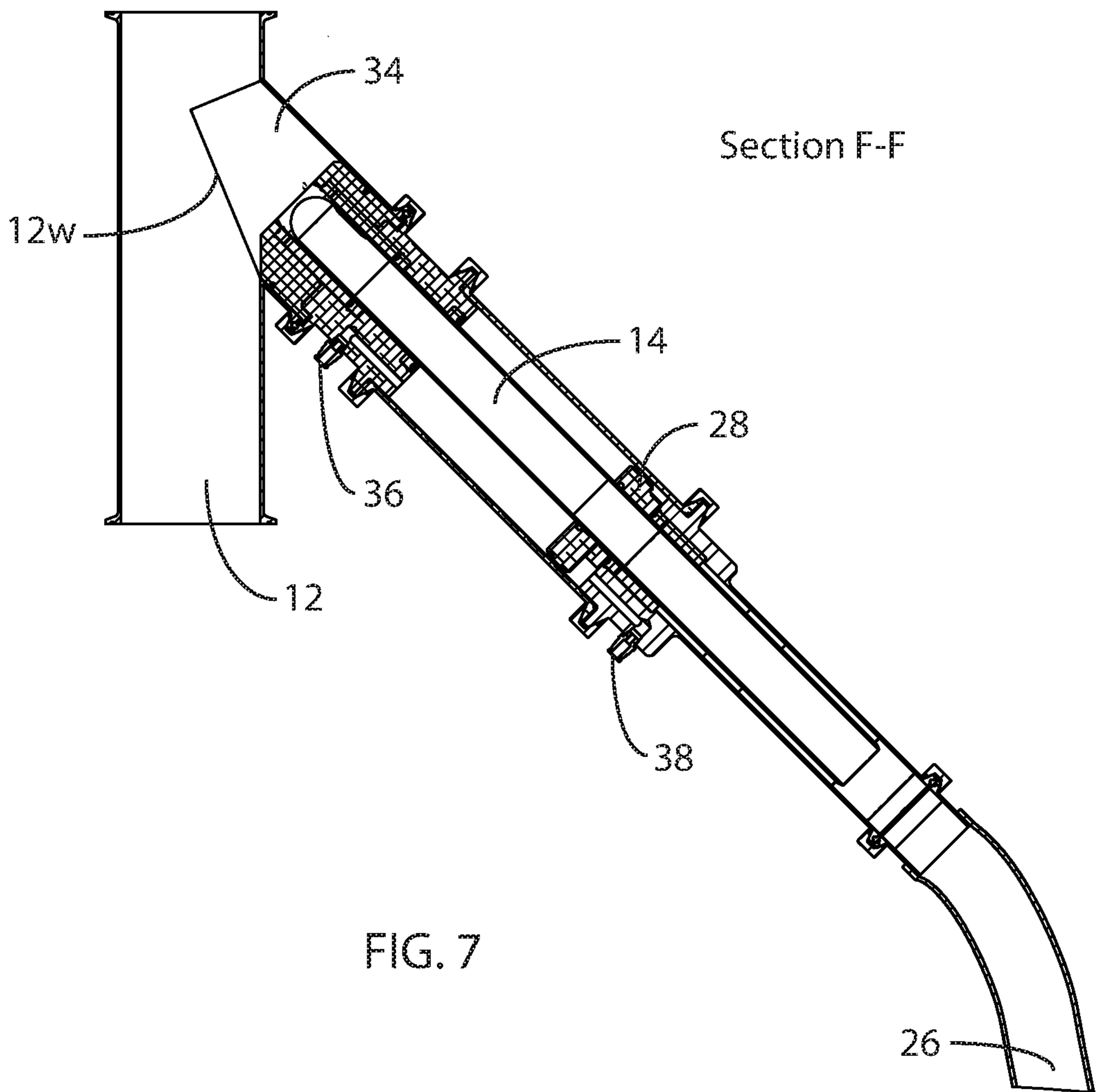


FIG. 7

FIG. 8

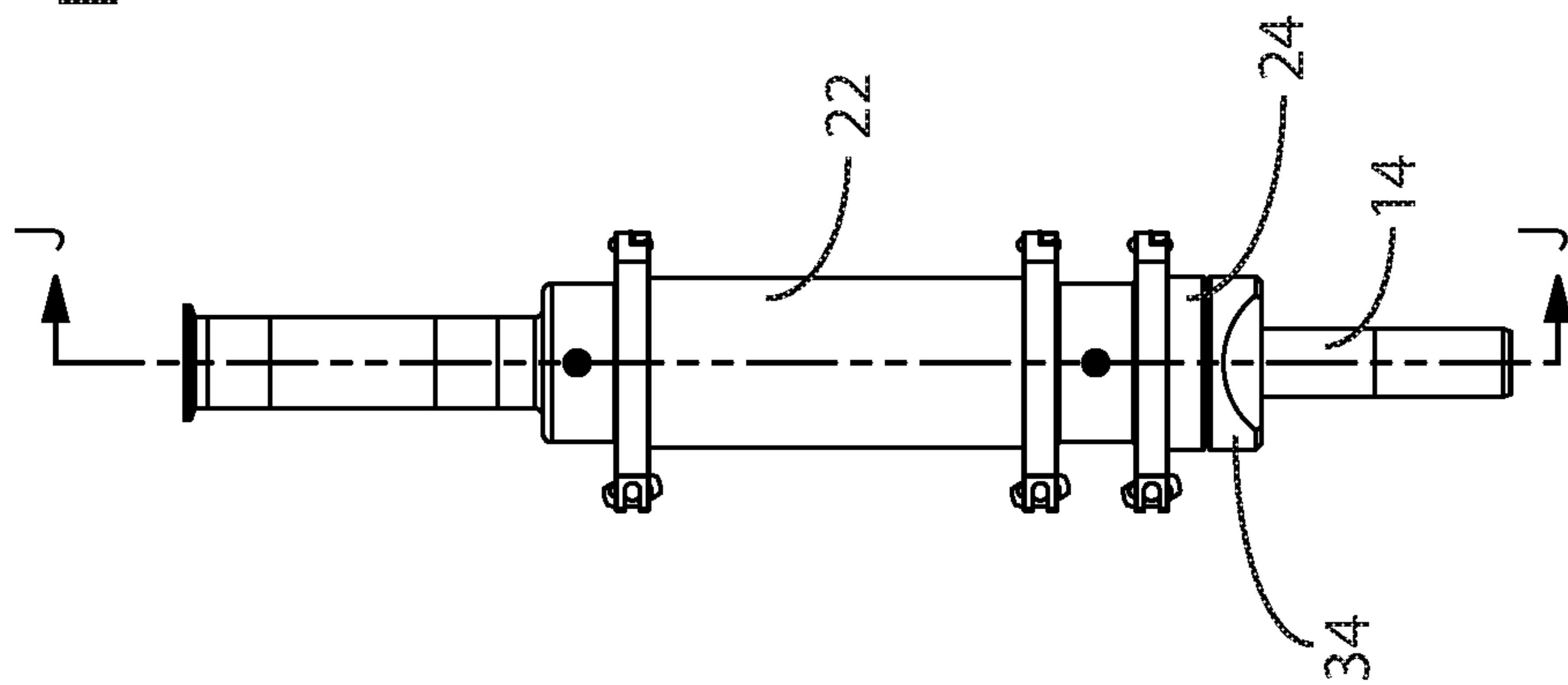


FIG. 10

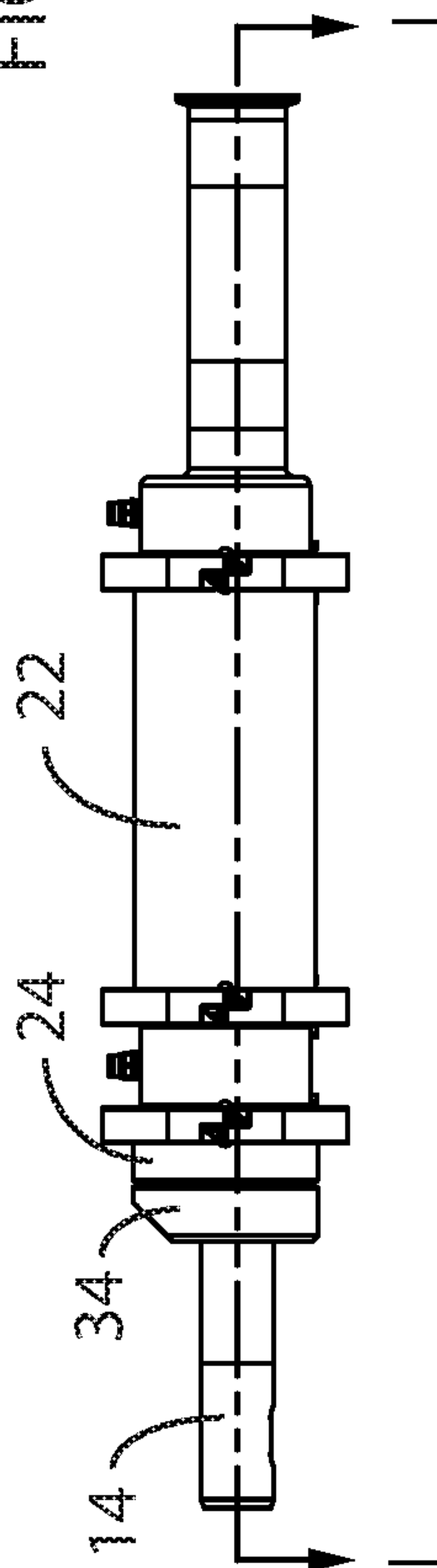
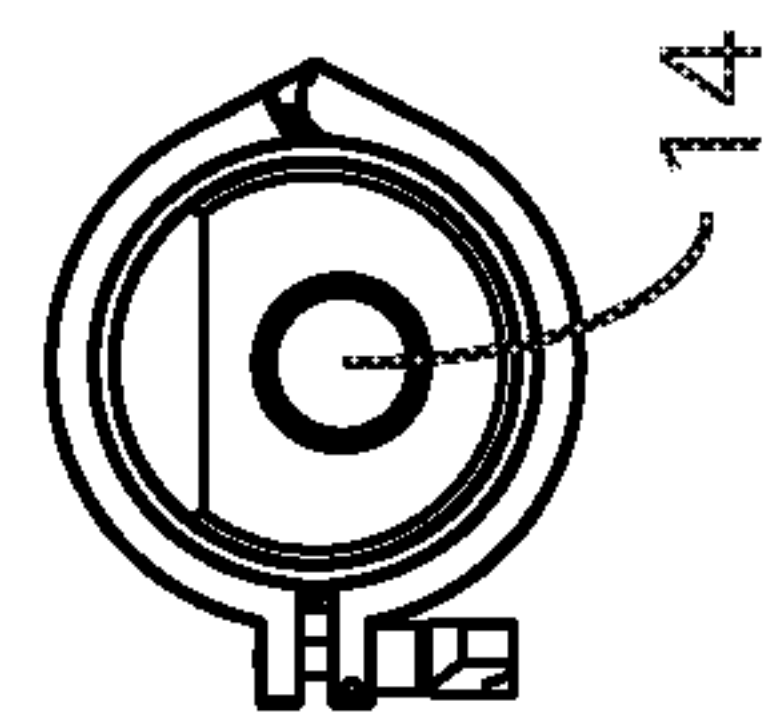


FIG. 9



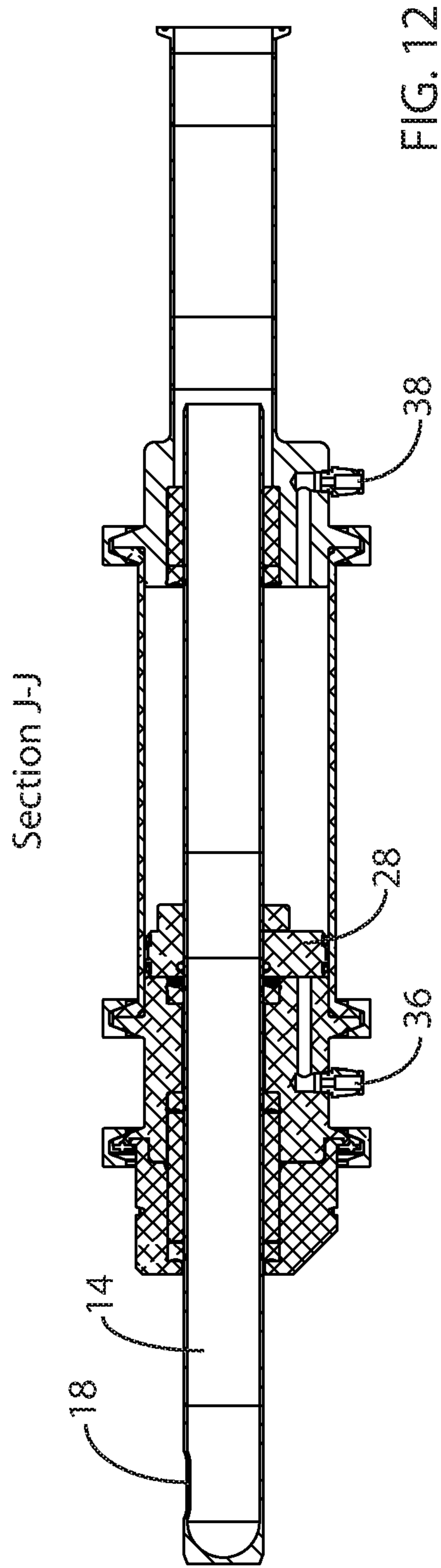
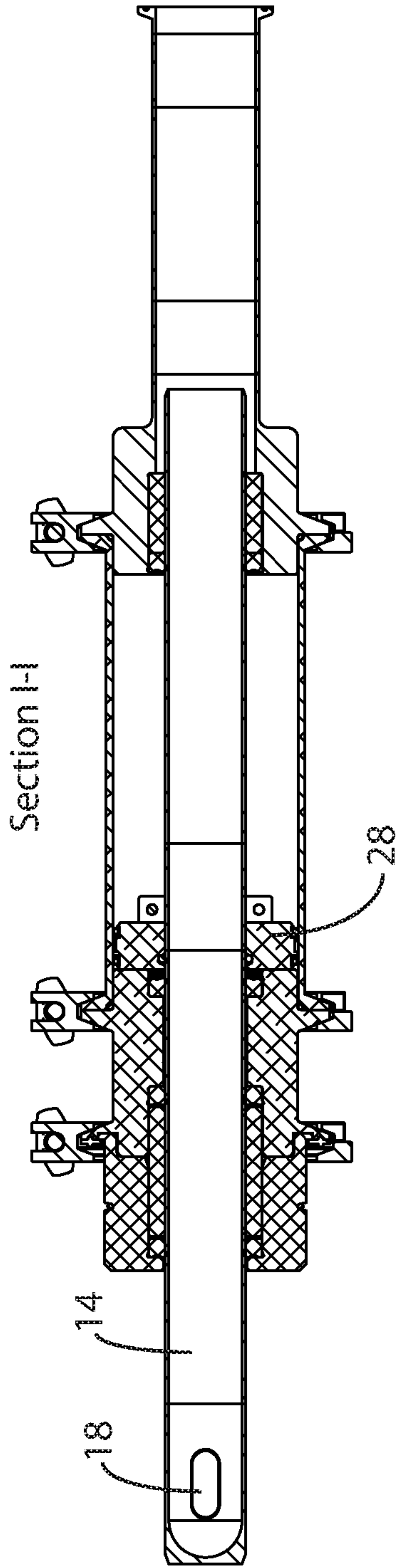


FIG. 13

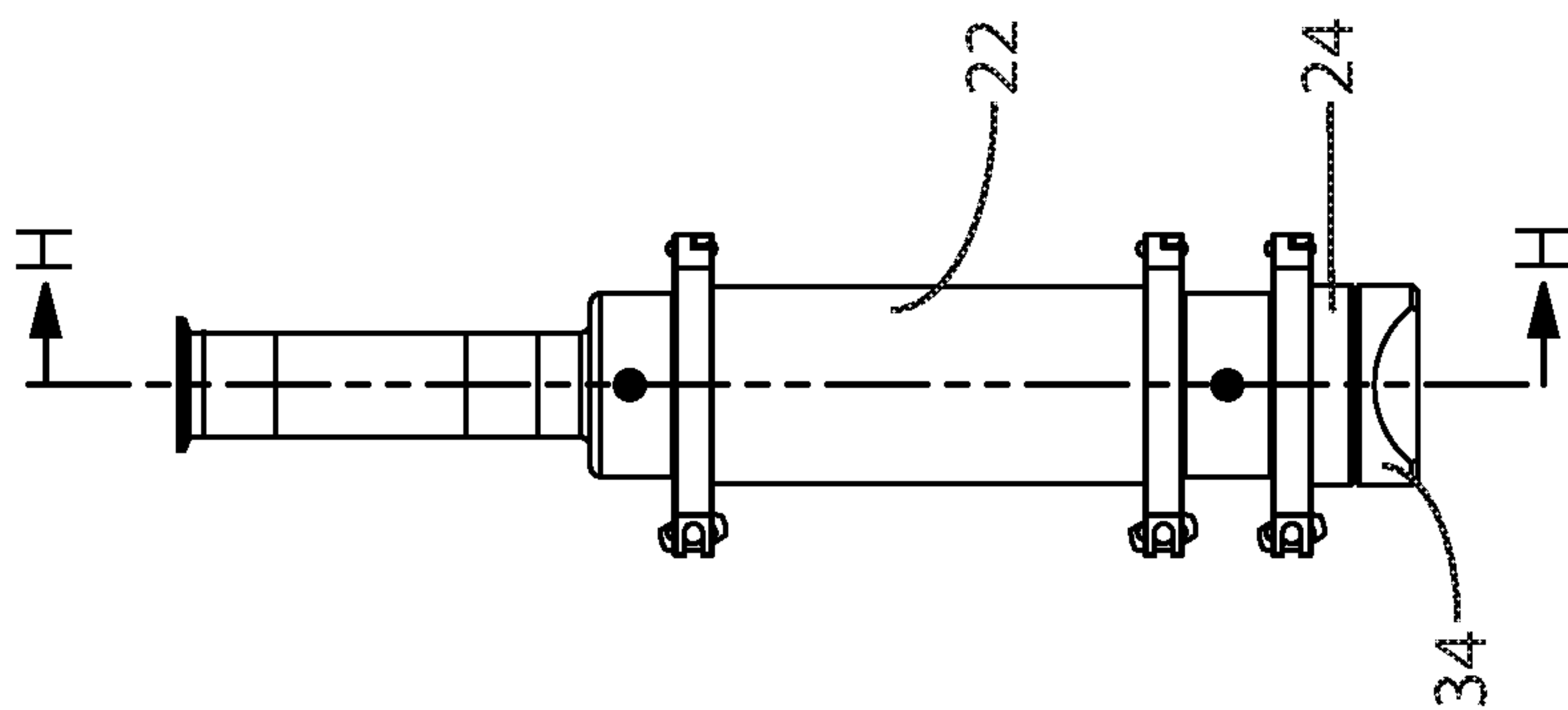


FIG. 15

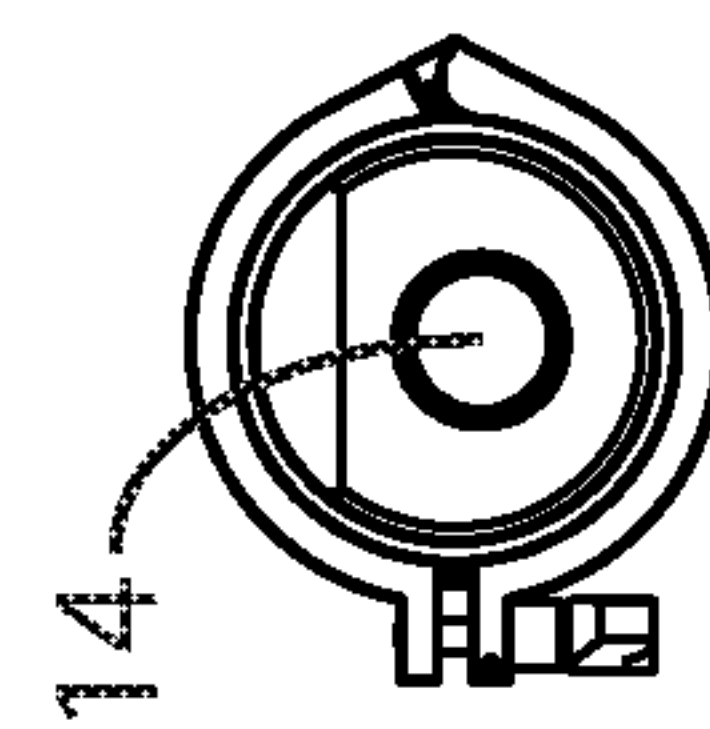
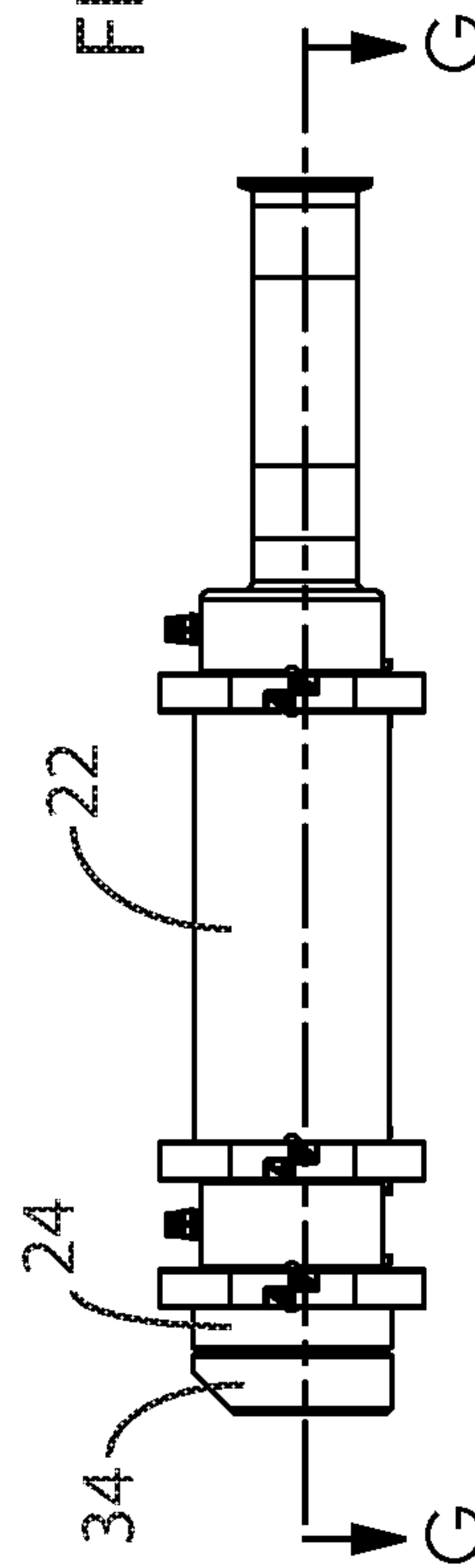


FIG. 14

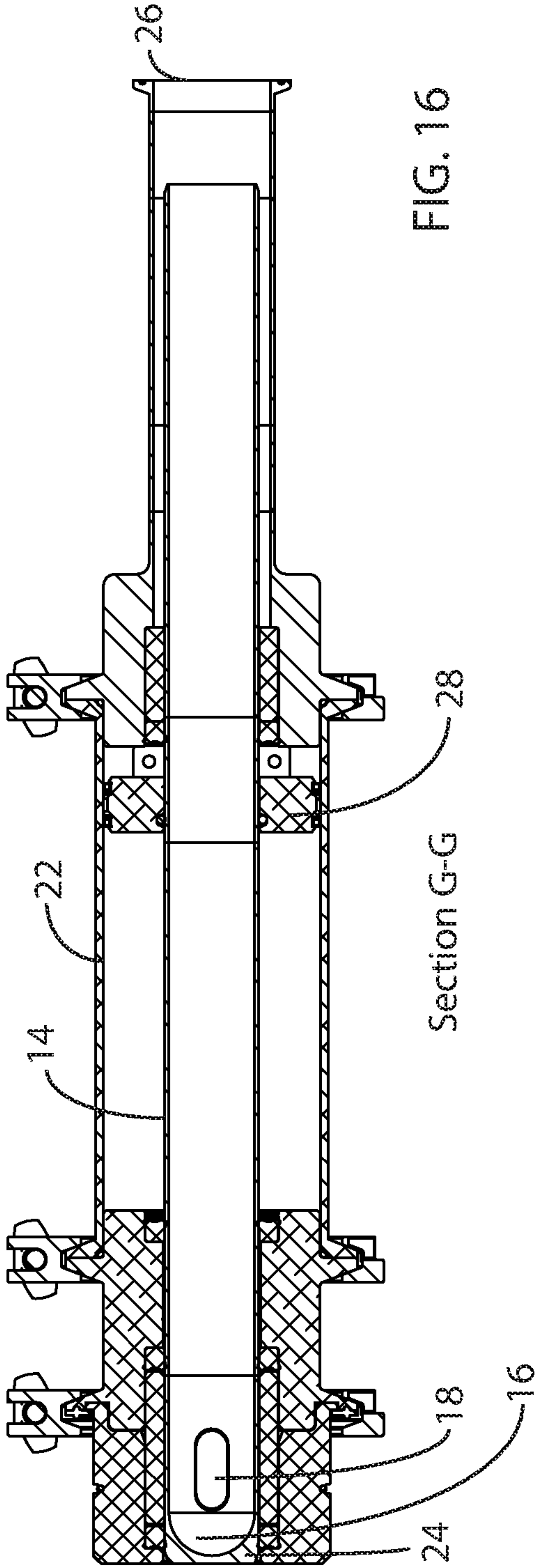


FIG. 16

Section G-G

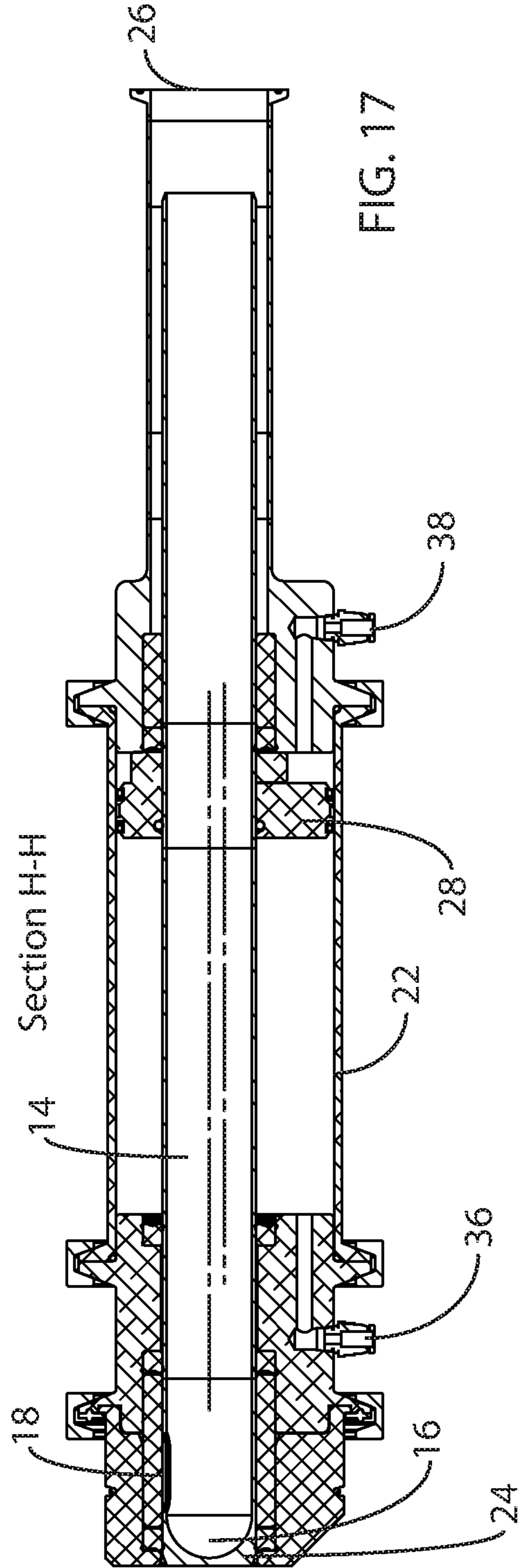


FIG. 17

Section H-H

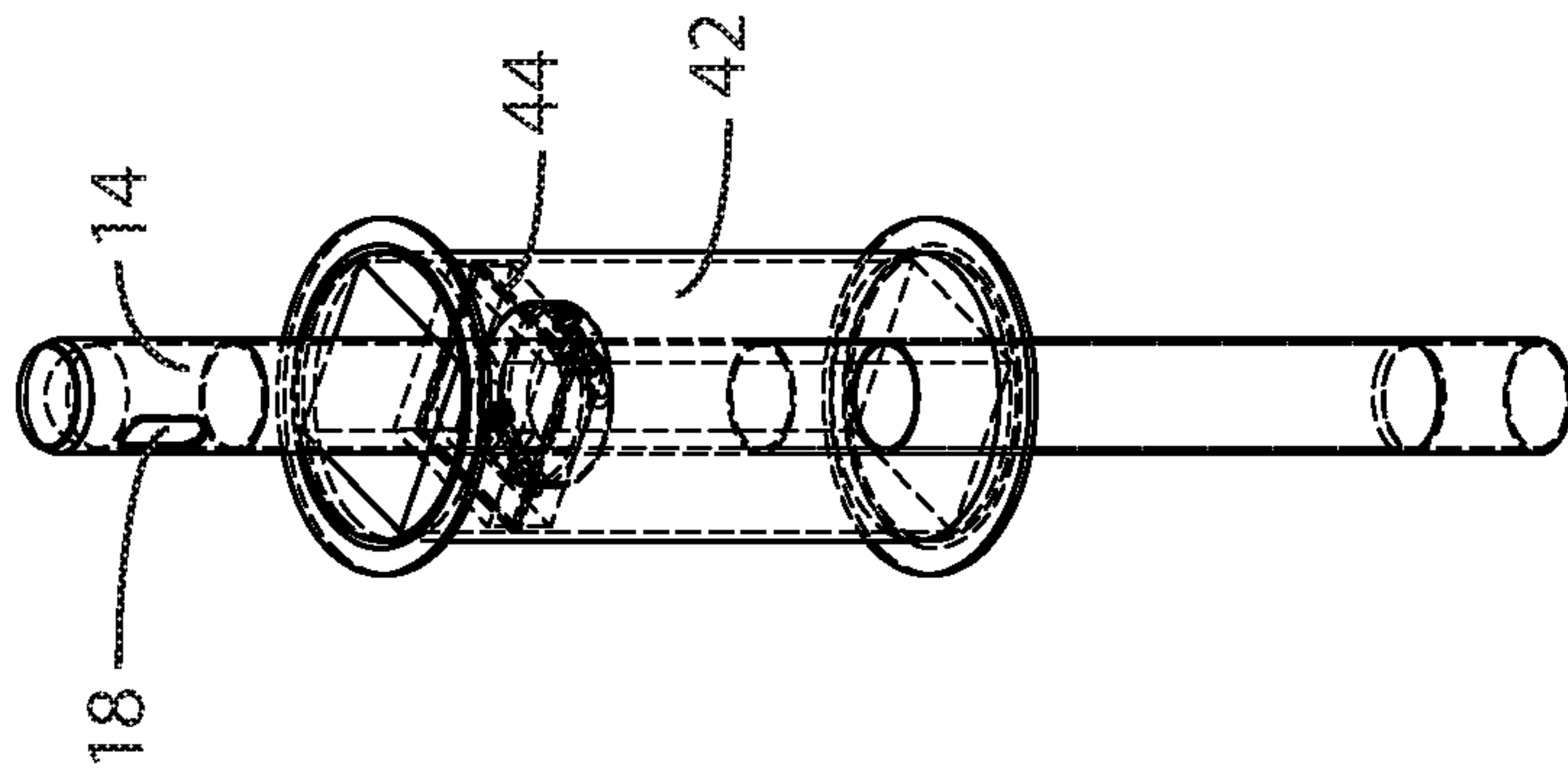


FIG. 19

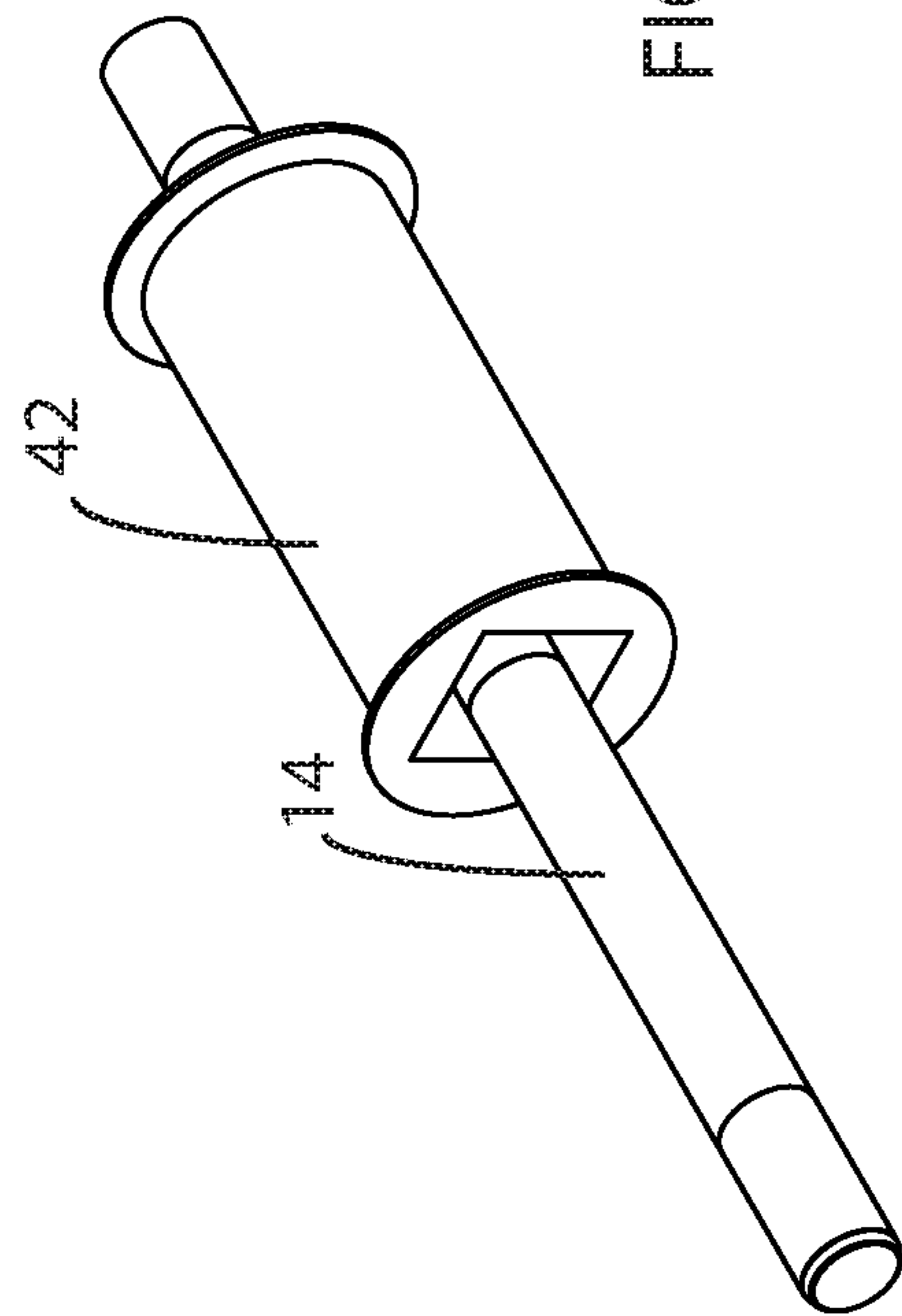
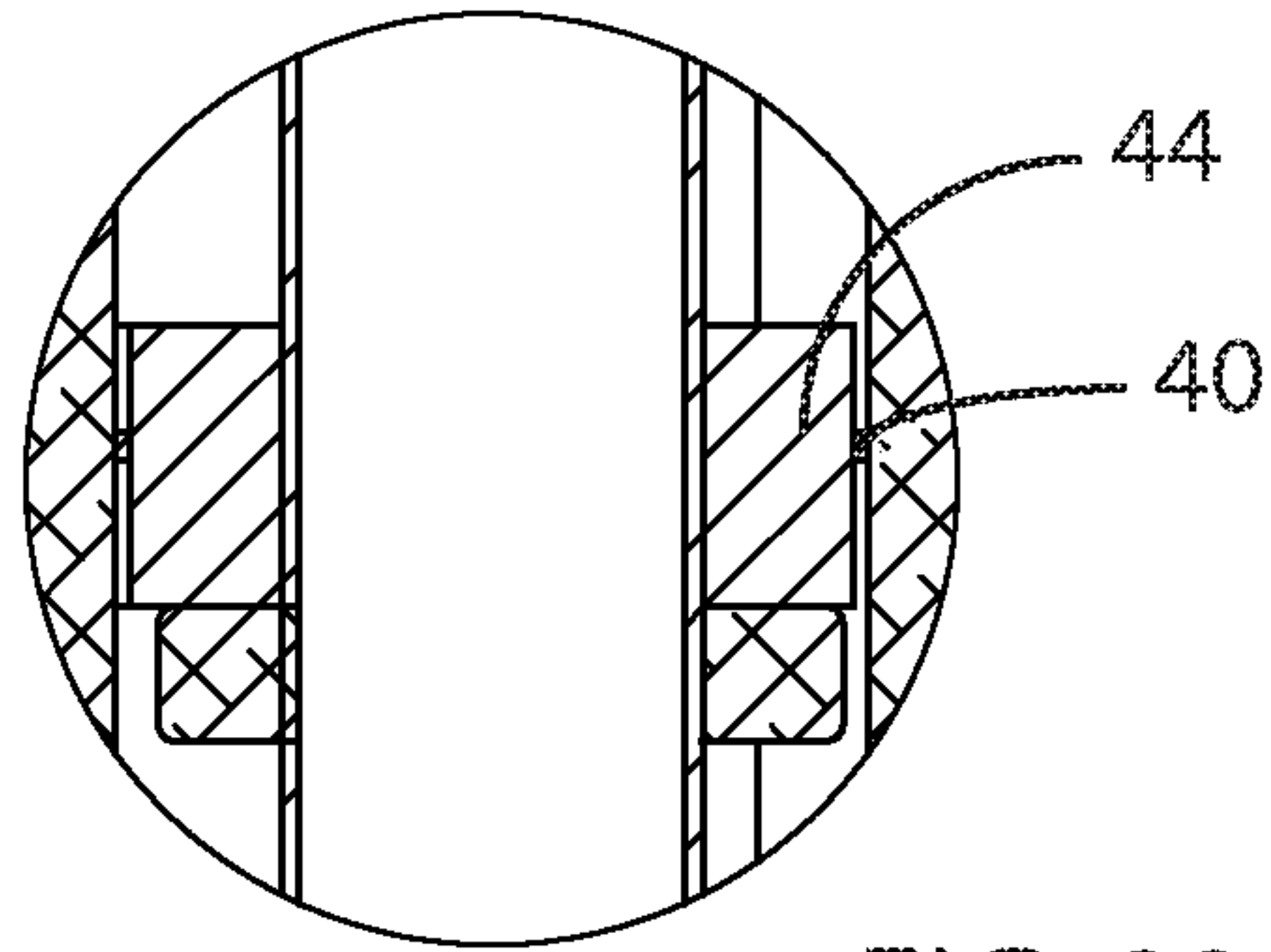


FIG. 18

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Detail L FIG. 22

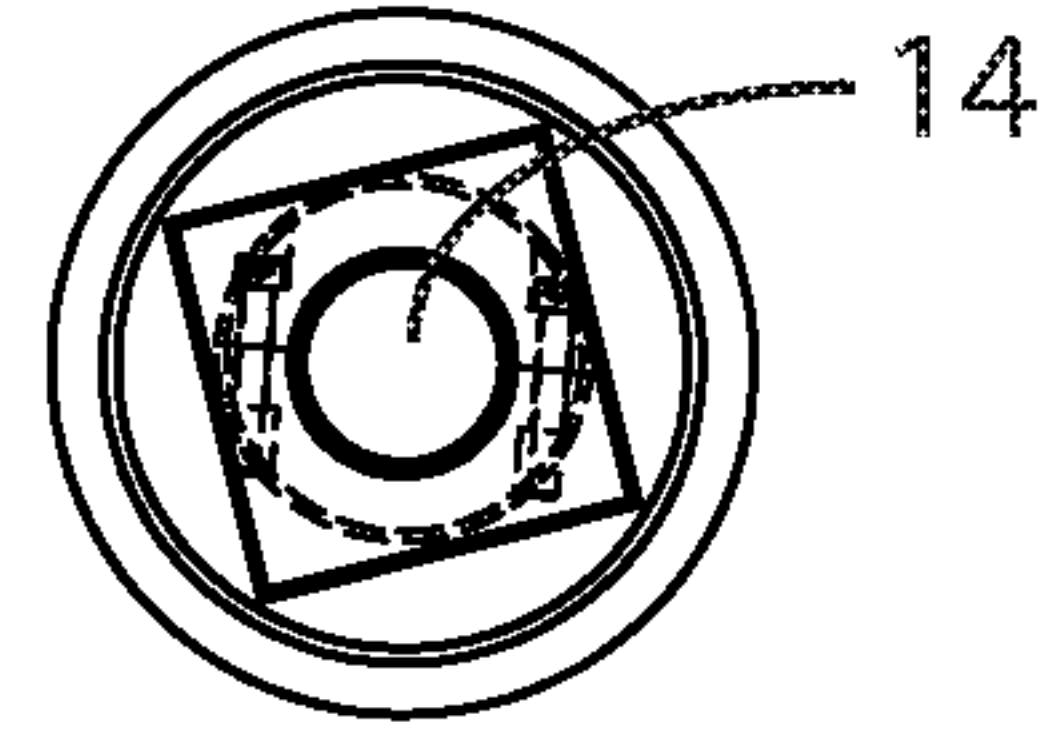
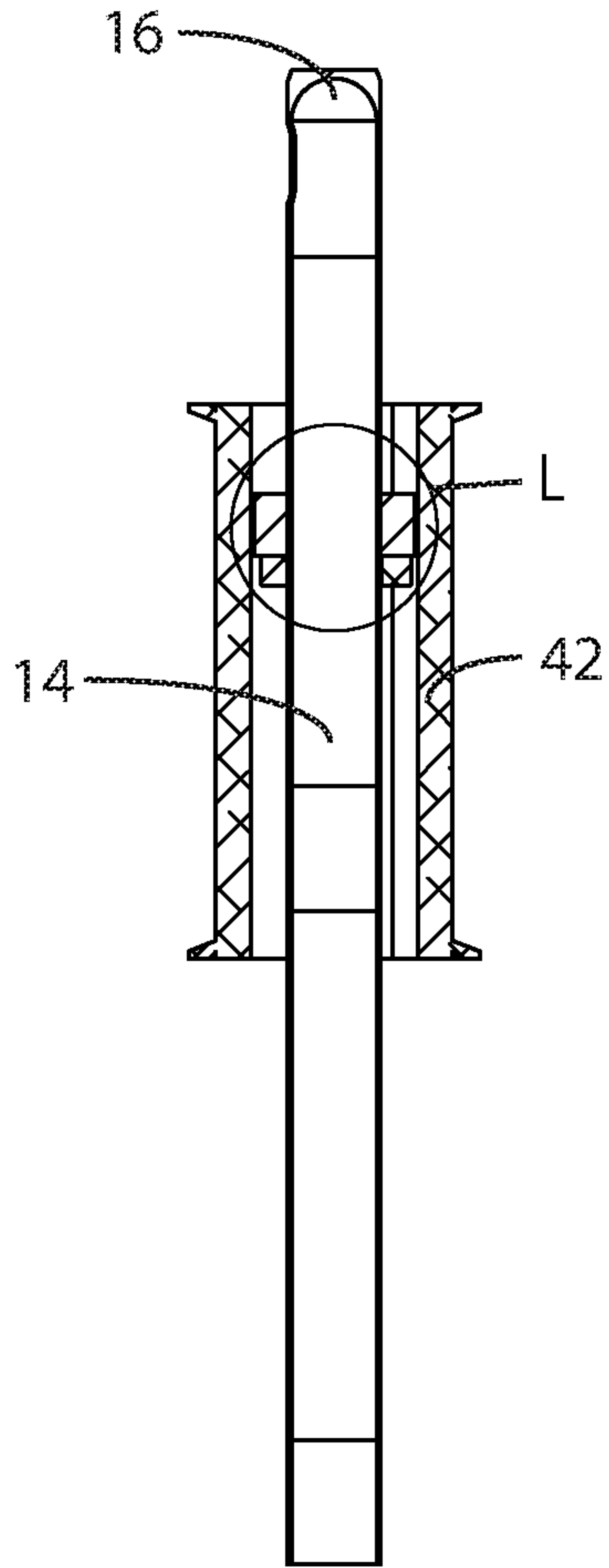


FIG. 23



Section K-K FIG. 21

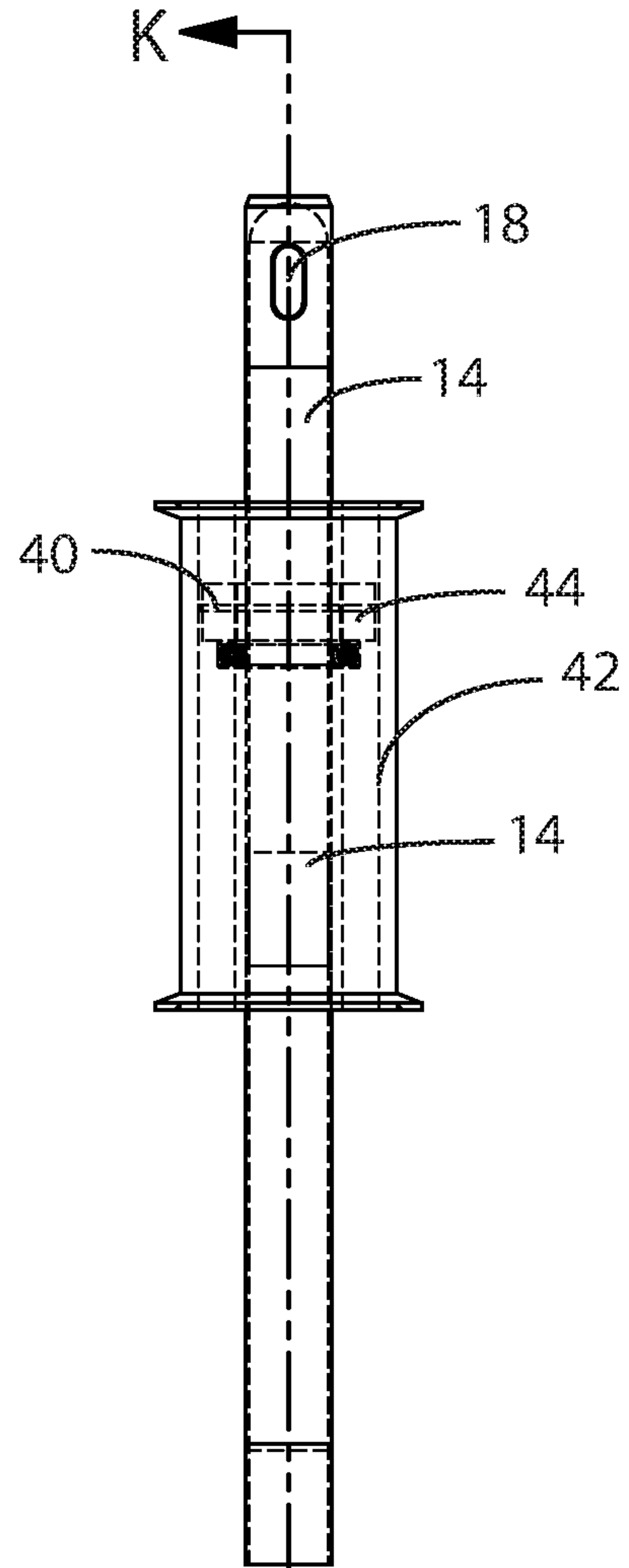


FIG. 20

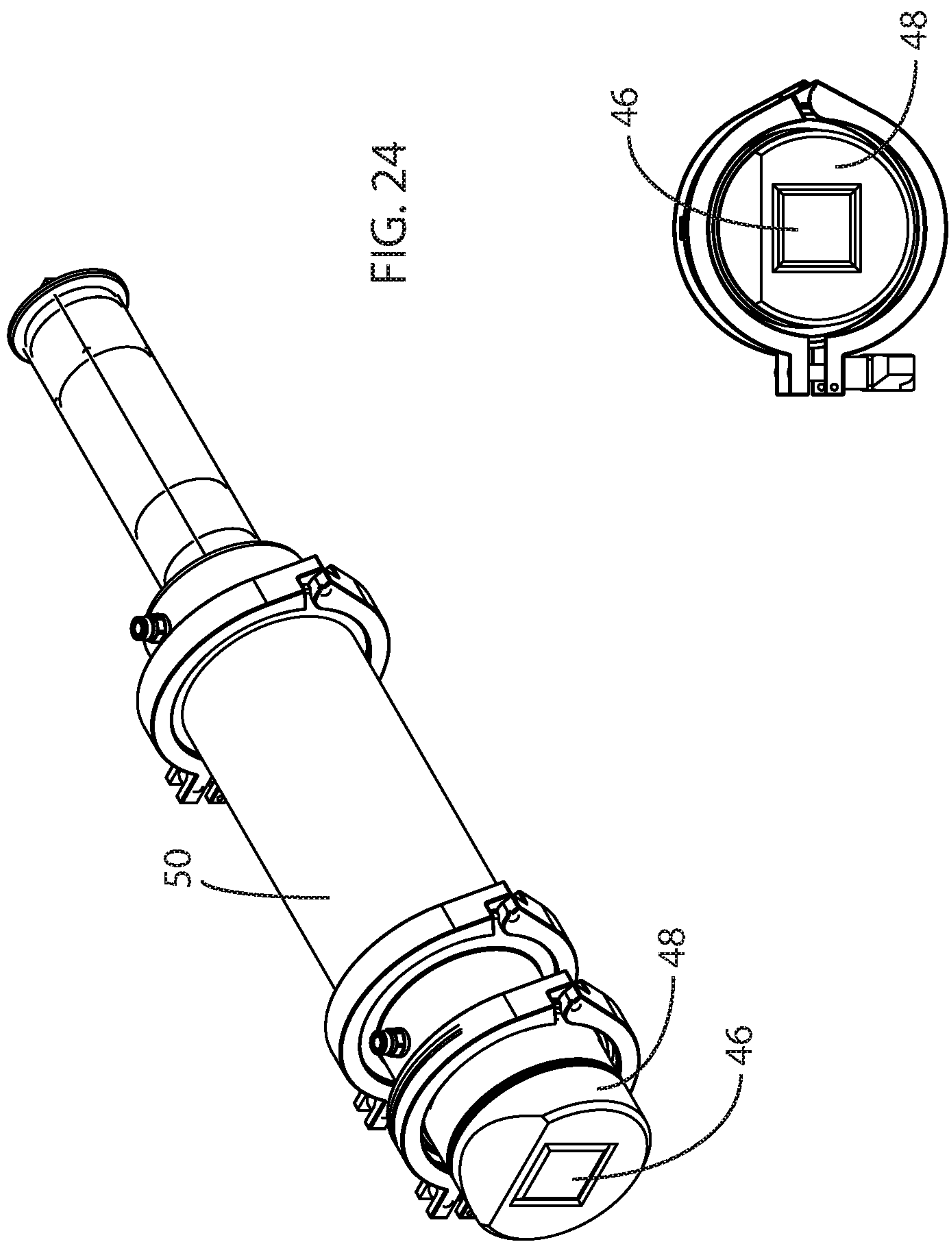


FIG. 24

FIG. 25

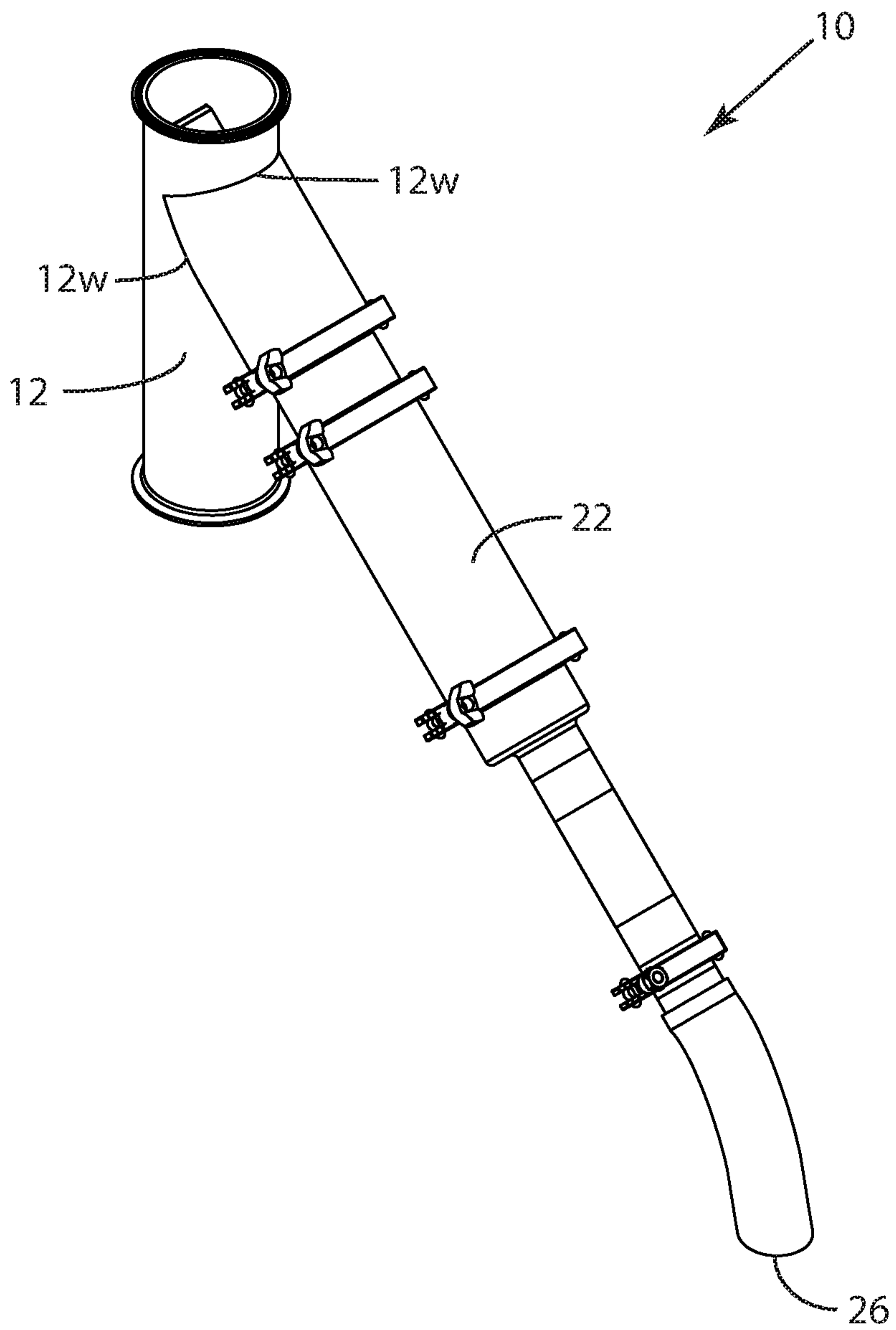


FIG. 1