Innovation, Sciences et Développement économique Canada
Office de la Propriété Intellectuelle du Canada

Innovation, Science and Economic Development Canada
Canadian Intellectual Property Office

CA 3014082 A1 2017/08/17

(21) 3 014 082

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) Date de dépôt PCT/PCT Filing Date: 2017/02/08
(87) Date publication PCT/PCT Publication Date: 2017/08/17
(85) Entrée phase nationale/National Entry: 2018/08/09
(86) N° demande PCT/PCT Application No.: AU 2017/050097
(87) N° publication PCT/PCT Publication No.: 2017/136880
(30) Priorité/Priority: 2016/02/09 (AU2016900420)

(51) Cl.Int./Int.Cl. *E21D 20/02* (2006.01),
E21D 21/00 (2006.01)

(71) Demandeur/Applicant:
FERO STRATA SYSTEMS PTY LTD, AU

(72) Inventeur/Inventor:
MCLAREN, MATTHEW DAVID, AU

(74) Agent: BROUILLETTE LEGAL INC.

(54) Titre : ADAPTATEUR DE BOULON D'ANCRAGE
(54) Title: ROCK BOLT ADAPTER

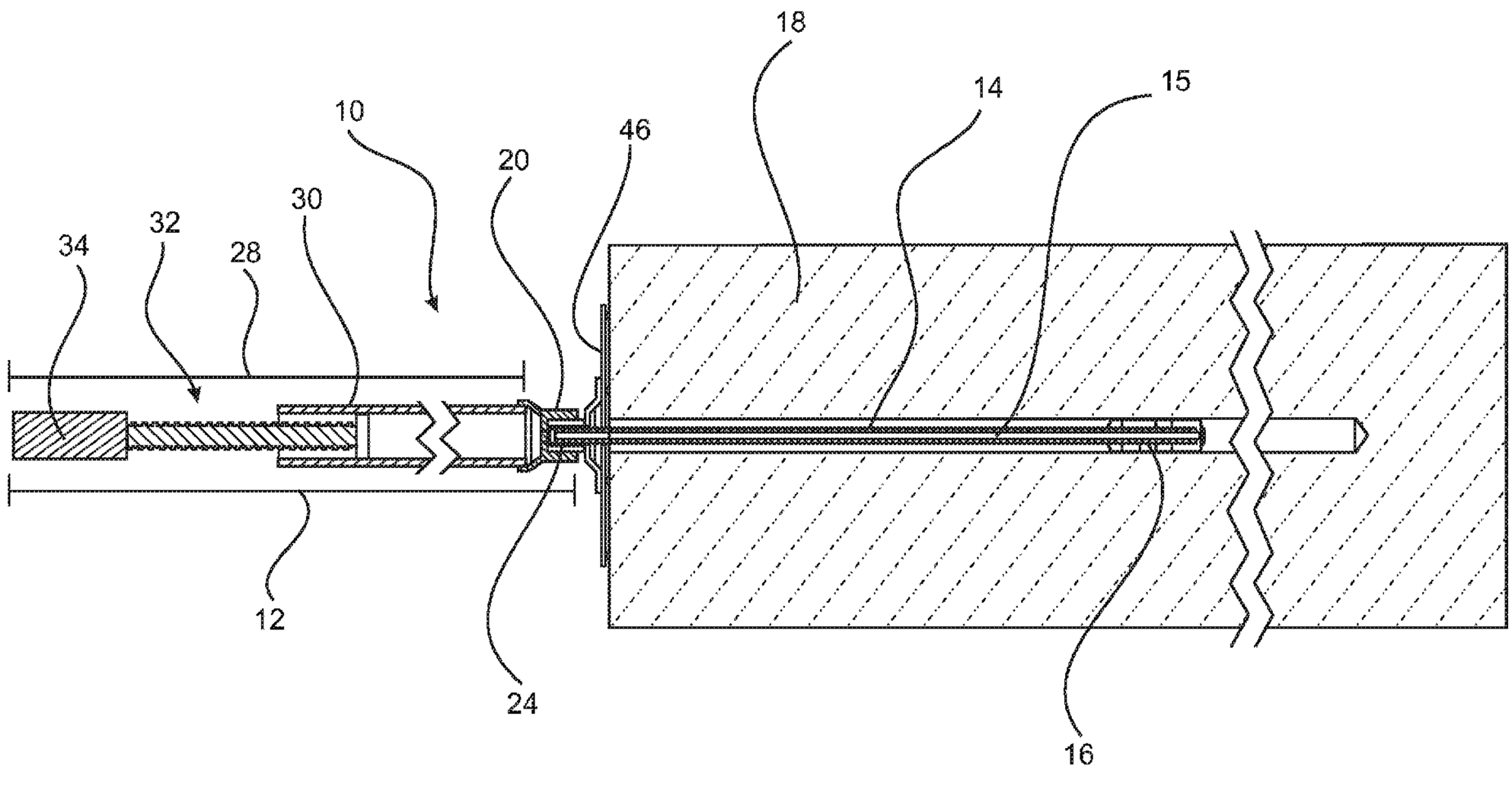

Figure 1

(57) Abrégé/Abstract:
A rock bolt adapter for a drill assembly comprising a drill and a rock bolt with an internal axial passage between a leading end of the rock bolt and a trailing end of the rock bolt, the rock bolt adapter comprising: (a) a leading end adapted to engage the trailing end of the rock bolt and define a fluid connection with the internal axial passage; and (b) a syringe member for delivering grout to the internal axial passage, said syringe member including: (i) a grout holding means; and (ii) a piston member comprising a drill engageable portion; wherein the rock bolt adapter is operable by the drill to deliver grout from the grout holding means to the internal axial passage.

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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
17 August 2017 (17.08.2017)

WIPO | PCT

(10) International Publication Number
WO 2017/136880 A1

(51) International Patent Classification:
E21D 20/02 (2006.01) *E21D 21/00* (2006.01)

(21) International Application Number:
PCT/AU2017/050097

(22) International Filing Date:
8 February 2017 (08.02.2017)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2016900420 9 February 2016 (09.02.2016) AU

(71) Applicant: **FERO STRATA SYSTEMS PTY LTD** [AU/AU]; PO Box 495, Kewdale, Western Australia 6105 (AU).

(72) Inventor: **MCLAREN, Matthew David**; 6 Javez Drive, Quinns Rocks, Western Australia 6030 (AU).

(74) Agent: **O'SULLIVANS PATENT & TRADE MARK ATTORNEYS PTY LTD**; PO Box 3294, Broadway Nedlands, Crawley, Western Australia 6009 (AU).

(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, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, 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))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(54) Title: ROCK BOLT ADAPTER

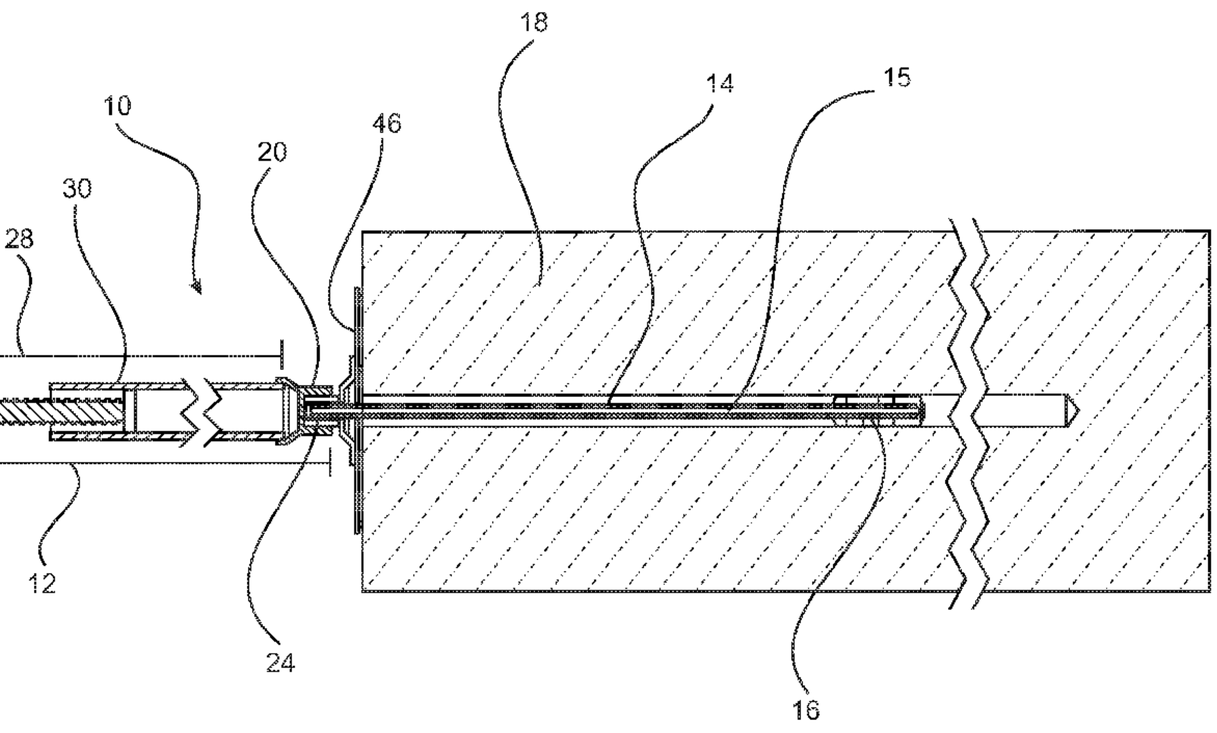

Figure 1

(57) Abstract: A rock bolt adapter for a drill assembly comprising a drill and a rock bolt with an internal axial passage between a leading end of the rock bolt and a trailing end of the rock bolt, the rock bolt adapter comprising: (a) a leading end adapted to engage the trailing end of the rock bolt and define a fluid connection with the internal axial passage; and (b) a syringe member for delivering grout to the internal axial passage, said syringe member including: (i) a grout holding means; and (ii) a piston member comprising a drill engageable portion; wherein the rock bolt adapter is operable by the drill to deliver grout from the grout holding means to the internal axial passage.

WO 2017/136880 A1

Rock Bolt Adapter

Field of the Invention

The present invention relates to a rock bolt adapter, a method of inserting and grouting a rock bolt and to a grout cartridge.

Background of the Invention

Rock strata and other materials can be stabilised using rock bolts which are inserted into drilled holes and retained therein either mechanically such as by friction and/or chemically by grouting.

The installation of chemically retained rock bolts is a multistage process and generally includes drilling a hole and introducing the chemical, generally a two part resin, inserting the rock bolt, spinning the bolt in order to rupture and mix the resin, and allowing the resin to cure to thereby retain the rock bolt in the hole.

Another approach involves inserting and tensioning a point anchored rock bolt and then, sometime later, introducing the chemical, generally a cement based composition, to surround the rock bolt and protect it from corrosion.

The grouting process can be complex, labour intensive, time consuming and often results in leakage of resin out of the hole causing damage to personnel and equipment. Sometimes suboptimal amounts of grout are used leading to less than ideal outcomes and in situations where two part chemicals are used, they are often mixed suboptimally – again leasing to less than ideal outcomes.

There exists a need for improved and simplified rock bolt installation assemblies that address or at least partially alleviate problems with existing solutions.

Summary of the Invention

According a first aspect of the present invention there is provided a rock bolt adapter for a drill assembly comprising a drill and a rock bolt with an internal axial passage between a leading end of the rock bolt and a trailing end of the rock bolt, the rock bolt adapter comprising:

(a) a leading end adapted to engage the trailing end of the rock bolt and define a fluid connection with the internal axial passage; and

(b) a syringe member for delivering grout to the internal axial passage, said syringe member including:

(i) a grout holding means; and

(ii) a piston member comprising a drill engageable portion;

wherein the rock bolt adapter is operable by the drill to deliver grout from the grout holding means to the internal axial passage.

According to a second aspect of the present invention there is provided a method of inserting and grouting a rock bolt comprising the steps of:

(a) inserting a rock bolt into a substrate using a drill assembly including a rock bolt adapter comprising a leading end adapted to engage the trailing end of the rock bolt and define a fluid connection with the internal axial passage; and a syringe member for delivering grout to the internal axial passage, said syringe member including a grout holding means and a piston member comprising a drill engageable portion; and

(b) using the drill assembly to actuate the rock bolt adapter to deliver grout from the grout holding means to the internal axial passage.

According to a third aspect of the present invention there is provided a grout cartridge adapted for insertion in a rock bolt adapter for use with a rock bolt with an internal axial passage between a leading end of the rock bolt and a trailing end of the rock bolt, the grout cartridge comprising:

(a) a grout compartment including grout;

(b) a moveable base portion; and

(c) a nozzle member, that in use, is adapted to be in fluid connection with the internal axial passage;

wherein, in use, pressure applied to the moveable base portion causes grout to be delivered to the internal axial passage.

Brief Description of the Drawings

Figure 1 is a side view in cross section of a drill assembly including a rock bolt adapter, according to one embodiment of the first aspect of the present invention, showing the drill assembly with the rock bolt inserted in a rock formation;

Figure 2A is a perspective view from above (leading end) of the socket member that forms part of the rock bolt adapter in Figure 1;

Figure 2B is a bottom view (trailing end) of the socket member in Figure 2A;

Figure 2C is a side view of the cross section through G-G in Figure 2B;

Figure 3A is a perspective view from above (leading end) of the grout holding means in Figure 1;

Figure 3B is a side view of the grout holding means in Figure 3A;

Figure 3C is a side view of the cross section H-H in Figure 3B;

Figure 4 is a schematic side view of the drill assembly of Figure 1 including a grout cartridge;

Figure 5 is a side view in cross section of a drill assembly including a rock bolt adapter, according to another embodiment of the first aspect of the present invention, showing the drill assembly with the rock bolt inserted in a rock formation;

Figure 6A is a perspective view from above (leading end) of the socket member that forms part of the rock bolt adapter in Figure 5;

Figure 6B is a bottom view (trailing end) of the socket member in Figure 6A;

Figure 6C is a side view of the cross section through G-G in Figure 6B;

Figure 7A is a perspective view from above (leading end) of the grout holding means in Figure 5;

Figure 7B is a side view of the grout holding means in Figure 7A;

Figure 7C is a side view of the cross section H-H in Figure 7B;

Figure 8 is a perspective view from above (trailing end) of the piston member depicted in the drill assembly in Figure 5;

Figure 9A is a perspective view from above (leading end) of another example of a grout holding means that could be used as part of the rock bolt adapter in Figure 5, instead of the grout holding means in Figure 7A;

Figure 9B is a side view of the grout holding means in Figure 9A;

Figure 9C is a side view of the cross section H-H in Figure 9B;

Figure 9D is an end view of the cross section I-I in Figure 9B;

Figure 10A is a perspective view from above (trailing end) of a piston member suitable for use with the grout holding means in Figure 9A; and

Figure 10B is an end view of the cross section J-J in Figure 10A.

Detailed Description of the Invention

According a first aspect of the present invention there is provided a rock bolt adapter for a drill assembly comprising a drill and a rock bolt with an internal axial passage between a leading end of the rock bolt and a trailing end of the rock bolt, the rock bolt adapter comprising:

(a) a leading end adapted to engage the trailing end of the rock bolt and define a fluid connection with the internal axial passage; and

(b) a syringe member for delivering grout to the internal axial passage, said syringe member including:

(i) a grout holding means; and

(ii) a piston member comprising a drill engageable portion;

wherein the rock bolt adapter is operable by the drill to deliver grout from the grout holding means to the internal axial passage.

Preferably, the rock bolt comprises a hollow bar rock bolt such as a threaded hollow bar rock bolt. The rock bolt may also be a friction bolt. Preferably, the rock bolt comprises a point anchoring means to enable it to be point anchored after being inserted.

Preferably, the leading end of the rock bolt adapter is adapted to engage the trailing end of the rock bolt in a manner that enables the adapter to impart rotational and/or percussive force on the rock bolt. Preferably, the leading end of the rock bolt adapter is adapted to engage a drive nut on the trailing end of the rock bolt. Even more preferably, the leading end of the rock bolt adapter leading end defines a socket adapted to receive and frictionally engage a drive nut on the trailing end of the rock bolt. Preferably, the socket comprises a polygonal shaped cross section such as a hexagonal shaped cross section.

Preferably, the leading end comprises at least two parts with different sized cross sectional areas. Preferably, a narrower part of the leading end is adapted to engage the drive nut on the trailing end of the rock bolt. Preferably, a wider part of the leading end is proportioned to have a cross sectional area similar or equivalent to that of the syringe member.

Even more preferably, the leading end comprises at least one tapered outer surface defining the transition between the at least two parts.

Preferably, the leading end further comprises a nozzle member that, in use, extends at least partially into the internal axial passage. Preferably, the nozzle member comprises a tube with a uniform cross sectional area. Alternatively, the nozzle member may comprise a taper. Preferably, the nozzle member is co-axial with the mixing means. The nozzle member may also be provided as part of the grout cartridge – this form of the invention is described in more detail below.

Preferably, the leading end further comprises a mixing means. Preferably, the mixing means is a static mixing means. Preferably, the static mixing means comprises a chamber through which the grout passes, prior to entering the internal

axial passage, when in use. Preferably, the chamber has a smaller cross sectional area than the syringe and/or the grout holding means so as to encourage the mixing of the grout prior to entering the nozzle member. The mixing means may be provided as part of the grout cartridge – this form of the invention is described in more detail below.

Preferably, for use with grout in packaged or capsule form, the leading end may comprise a grout release means for cutting the outer packaging of a grout capsule. This is particularly useful for grout in resin form that is often supplied in a two pack/part packaged form.

Preferably, the syringe member includes an aperture at its trailing end for receiving the piston member. Preferably, the aperture includes a sealing means adapted to form a fluid tight seal with the piston member. Even more preferably, the sealing means comprises an O-ring. Preferably, the aperture is threaded.

The aperture may also be adapted to frictionally engage a portion of the piston member, such as the shaft portion of the piston member. Preferably, the frictional engagement is such that it prevents or at least retard the relative rotational movement between the syringe member and the piston member so that rotation of the piston member causes rotation of the syringe member. For example, the aperture may be shaped to be compatible with and frictionally engage the shaft portion of the piston member.

In one particular example, the aperture is shaped to slidingly and frictionally receive the shaft portion of the piston member.

Preferably, the grout holding means comprises a tube member. Preferably, the grout holding means is adapted to receive loose grout. Alternatively, the grout holding means may be adapted to receive the grout contained in a separate cartridge.

Preferably, the tube member comprises a guide means for the piston member. Preferably, the guide means comprises at least one pair of opposed longitudinal channels that extend at least partially along the inner surface of the tube member.

When the aperture in the syringe member is threaded, the piston member may comprise a compatible threaded portion such that rotation of the piston member can advance or retract the piston member relative to the grout holding means to reduce or increase the interior volume thereof.

Alternatively, the piston member may be friction fitted in the aperture in the syringe member such that force, such as a pushing force, applied to the piston member can advance the piston member relative to the grout holding means to reduce the interior volume thereof, or a force, such as a pulling force, applied to the piston member can retract the piston member relative to the grout holding means to increase the interior volume thereof.

Preferably, the piston member is adapted to frictionally engage the syringe member such that rotation of the piston member results in rotation of the syringe member. This may be achieved in a variety of ways but in one form the piston member comprises a shaft including a spline that engages with a compatibly shaped aperture in the trailing end of the syringe member.

The piston member may also be adapted to be retracted by force applied by fluid injected into the grout holding means. In this regard, the syringe member may further comprise a fluid line that communicates with the grout holding means and enables fluid to be injected therein. Preferably, this fluid line is connected to the fluid line on the drill.

Preferably, the piston member comprises a leading end and a trailing end and a shaft member therebetween. Preferably, the piston member leading end is shaped to slidingly fit within the grout holding means and form a fluid tight seal with the inner surface of the grout holding means. When the grout holding means comprises a tube member including a guide means for the piston member, the head portion of the piston member is adapted to form a fluid tight seal with said guide means. When the grout holding means is adapted to receive a grout cartridge, the leading end of the piston member is adapted to engage with a trailing end or base of the grout cartridge that is moveable to push grout from the leading end of the cartridge.

The drill engageable portion of the piston member may be varied depending on the drill. Preferably, the drill engageable portion of the piston member is externally

threaded. Alternatively, the drill engageable portion of the piston member comprises an outer surface having a polygonal cross-section.

Preferably, the rock bolt adapter comprises a two part assembly. Thus, the present invention also provides a two part rock bolt adapter for a drill assembly comprising a drill and a rock bolt with an internal axial passage between a leading end of the rock bolt and a trailing end of the rock bolt, the rock bolt adapter comprising:

(a) a first part including a leading end adapted to engage the trailing end of the rock bolt and define a fluid connection with the internal axial passage; and

(b) a second part including a syringe member for delivering grout to the internal axial passage, said syringe member including:

(i) a grout holding means; and

(ii) a piston member comprising a drill engageable portion;

wherein the rock bolt adapter is operable by the drill to deliver grout from the grout holding means to the internal axial passage and wherein the first and second parts are releasibly engageable.

When the two parts are separated convenient access to the interior of the parts is provided.

Preferably, the first and second parts are adapted to threadedly engage. In this regard, it is preferred for the first part to include an internal threaded portion on its trailing end that is compatible with an external threaded portion on a leading end of the second part.

The grout may be a one part or a multi-part grout. Preferably, the grout is two part resin based grout that must be mixed to cure and provide its structural properties. Alternatively the grout may be a pre-mixed cement based grout that cures after application.

The rock bolt adapter may be adapted to receive grout in cartridge form. Thus the rock bolt adapter of the present invention may further comprise a grout cartridge.

Thus, the present invention also provides a rock bolt adapter for a drill assembly comprising a drill and a rock bolt with an internal axial passage between a leading end of the rock bolt and a trailing end of the rock bolt, the rock bolt adapter comprising:

(a) a leading end adapted to engage the trailing end of the rock bolt and define a fluid connection with the internal axial passage; and

(b) a syringe member for delivering grout to the internal axial passage, said syringe member including:

(i) a grout holding means including a grout cartridge; and

(ii) a piston member comprising a drill engageable portion;

wherein the rock bolt adapter is operable by the drill to deliver grout from the grout cartridge to the internal axial passage.

Preferably, the grout cartridge is shaped and sized to fit in the grout holding means. Preferably, the grout cartridge comprises a base adapted to be pushed by the piston member of the syringe member such that when fitted and the rock bolt adapter is operated the grout can be delivered from the grout cartridge to the internal axial passage.

Preferably, the grout cartridge comprises a nozzle member.

Preferably, the grout cartridge comprises a mixing means. In one particular form, the mixing means is included in the nozzle member.

It will be appreciated that when the grout holding means is adapted to directly hold grout therein suitable fluid sealing arrangements are required between parts of the rock bolt adapter. Use of a grout cartridge, incorporating its own seals reduces the need for fluid tight seals elsewhere in the rock bolt adapter.

According to a second aspect of the present invention there is provided a method of inserting and grouting a rock bolt comprising the steps of:

(a) inserting a rock bolt into a substrate using a drill assembly including a rock bolt adapter comprising a leading end adapted to engage the trailing end of the rock bolt and define a fluid connection with the internal axial passage; and a syringe member for delivering grout to the internal axial passage, said syringe member including a grout holding means and a piston member comprising a drill engageable portion; and

(b) using the drill assembly to actuate the rock bolt adapter to deliver grout from the grout holding means to the internal axial passage.

Preferably, the steps of the method are performed in a single pass i.e. without detaching the drill assembly from the rock bolt.

Preferably, the drill assembly actuates the rock bolt adapter via rotation of the piston member.

Preferably, the drill assembly actuates the rock bolt adapter via impact energy applied to the piston member.

Preferably, the method further comprises the step of using the drill assembly to actuate a point anchoring means included on the rock bolt.

Preferably, the method further comprises the step of tensioning the rock bolt via a nut on the trailing end of the rock bolt.

Preferably, the method delivers a predetermined amount of grout. Preferably, the predetermined amount is the amount required to fully encapsulate the rock bolt. Alternatively, the predetermined amount is the amount required to fully encapsulate the rock bolt plus 10%. Thus, it is preferred that the rock bolt adapter is actuated to deliver grout to the internal axial passage and extend out of the leading end of the rock bolt and around the rock bolt to also fill the annulus defined by the rock bolt and the drilled hole. This ensures that the method results in a fully encapsulated rock bolt.

Preferably, the method further comprises the step of using the drill assembly to retract the piston member. Preferably, the drill assembly delivers fluid to the syringe to retract the piston member. Alternatively, the drill assembly rotates the piston

member in the opposite to direction to the direction used to rotate the piston when the grout is being delivered to the internal axial passage.

Preferably, the method further comprises the step of inserting a grout cartridge into the grout holding means.

According to a third aspect of the present invention there is provided a grout cartridge adapted for insertion in a rock bolt adapter for use with a rock bolt with an internal axial passage between a leading end of the rock bolt and a trailing end of the rock bolt, the grout cartridge comprising:

(a) a grout compartment including grout;

(b) a moveable base portion; and

(c) a nozzle member, that in use, is adapted to be in fluid connection with the internal axial passage;

wherein, in use, pressure applied to the moveable base portion causes grout to be delivered to the internal axial passage.

Preferably, the grout cartridge further comprises a mixing means.

General

Those skilled in the art will appreciate that the invention described herein is susceptible to variations and modifications other than those specifically described. The invention includes all such variation and modifications. The invention also includes all of the steps and features referred to or indicated in the specification, individually or collectively and any and all combinations or any two or more of the steps or features.

Each document, reference, patent application or patent cited in this text is expressly incorporated herein in their entirety by reference, which means that it should be read and considered by the reader as part of this text. That the document, reference, patent application or patent cited in this text is not repeated in this text is merely for reasons of conciseness. None of the cited material or the information contained in that material should, however be understood to be common general knowledge.

The present invention is not to be limited in scope by any of the specific embodiments described herein. These embodiments are intended for the purpose of exemplification only. Functionally equivalent products and methods are clearly within the scope of the invention as described herein.

The invention described herein may include one or more range of values (e.g. size etc). A range of values will be understood to include all values within the range, including the values defining the range, and values adjacent to the range which lead to the same or substantially the same outcome as the values immediately adjacent to that value which defines the boundary to the range.

For the purposes of the present invention the terms “leading” and “following” or “trailing” for example in the phrases “leading end” and “following end” or “trailing end” refer to positions relative to the drilling process. “Leading” as used herein refers to a feature or part thereof that is closest or proximal to the drilling interface whereas “following” or “trailing” refers to a feature or part thereof that is furthest or distal to the drilling interface.

For the purposes of the present invention it is preferred that the term “friction bolt” is interpreted to cover any apparatus adapted to be inserted into a rock or other formation to provide reinforcement by exerting outward pressure on the hole into which it has been inserted.

Throughout this specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

Other definitions for selected terms used herein may be found within the detailed description of the invention and apply throughout. Unless otherwise defined, all technical terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which the invention belongs.

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and

should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

Description of the Preferred Embodiments

Figure 1 is a side view, in cross section, of a drill assembly, generally indicated by the numeral 10 including a rock bolt adapter 12 according to an embodiment of the first aspect of the present invention and a rock bolt in the form of a threaded bar 14 including an internal axial passage 15 and a point anchoring means 16, installed in a pre-drilled hole in a rock formation 18.

The rock bolt adapter 12 is in two parts, a first part or leading end in the form of a socket member 20 (best depicted in Figures 2A-2C) that includes, at its leading end, a hexagonal shaped recess 22 adapted to receive the hexagonal shaped drive nut 24 on the trailing end of the hollow threaded bar 14. The trailing end of the socket member 20 includes an internal thread 25 that is adapted to mate with an external thread 26 on the leading end of the second part of the rock bolt adapter in the form of syringe member 28.

Syringe member 28 includes a grout holding means in the form of a tube 30 (best depicted in Figures 3A-3C) and a piston member 32 that is threadedly engaged with the tube 30, via an aperture 31 at the trailing end of the tube 30. The piston member 32 also includes a drill engageable portion 34, at its trailing end, that is designed to be fitted to a compatible part 36 of a drill such as a jumbo or the like (see Figure 4) so that the rock bolt adapter can be operated by the drill to deliver grout 38 (see Figure 4) from the tube 30 to the internal axial passage 15 of the threaded bar 14.

Figure 4 depicts the drill assembly of Figures 1, 2A-2C and 3A-3C including a grout cartridge 40 according to an embodiment of the third aspect of the present invention. The grout cartridge 40 is filled with grout and is fitted inside tube 30 by removing the socket member 20 to gain access to the interior of tube 30. The grout cartridge 40 includes a moveable base portion 42 and a nozzle member 44 wherein in use, the nozzle member 44 extends into the internal axial passage 15 and pressure applied

to the moveable base portion 42 by the drill causes part 36 to deliver grout to the internal axial passage 15.

One embodiment of a method according to the second aspect of the present invention using the drill assembly depicted in Figures 1, 2A-2C, 3A-3C and 4 is as follows:

1. The syringe 28 is opened by turning socket 20 to detach it from and provide access to tube 30.

2. Grout cartridge 40 is inserted into tube 30 and socket 20 is re-attached to tube 30.

3. Threaded bar 14 including point anchoring means 16 is loaded on to the feed rail of the jumbo so that the hexagonal shaped recess 22 of socket 20 engages with the drive nut 24 on the end of the threaded bar 14.

4. A rock bolt plate 46 is then fitted over the leading end of the threaded bar 14 in front of the front feed rail centraliser.

5. The leading end of the threaded bar 14 is then located into the pre-drilled hole and fed to the end, until the rock bolt plate 46 is hard up against the surface of rock 18.

6. The drill is actuated to rotate the rock bolt adapter 12 in a counter clockwise direction resulting in expansion of the point anchoring means 16 to engage the wall of the pre-drilled hole.

7. Once the threaded bar 14 has been tensioned, rotation continues in the same direction and the drive nut 24 will break out and tighten the rock bolt plate 46 up against the surface of rock 18.

8. Once the drive nut 24 can no longer rotate, rotation of the drill causes the piston member 32 to rotate relative to the tube 30 causing the piston member 32 to apply pressure to the moveable base 42 of grout cartridge 40 forcing the pre-mixed grout out of the nozzle 42 and into the internal axial passage 15.

9. Injected grout travels up the internal axial passage 15, out of the leading end of the threaded bar 14 and back down to fill the annulus between the inside walls of the pre-drilled hole and the outside surface of the threaded bar 14.

10. The volume of grout will be sufficient to at least fill the internal axial passage 15 and fully encapsulate the threaded bar 14.

Figure 5 is a side view, in cross section, of a drill assembly, generally indicated by the numeral 100 including a rock bolt adapter 112 according to another embodiment of the first aspect of the present invention and a rock bolt in the form of a threaded bar 114 including an internal axial passage 115 installed in a pre-drilled hole in a rock formation 118.

The rock bolt adapter 112 is in two parts, a first part or leading end in the form of a socket member 120 (best depicted in Figures 6A-6C) that includes, at its leading end, a hexagonal shaped recess 122 adapted to receive the hexagonal shaped drive nut 124 on the trailing end of the hollow threaded bar 114. The trailing end of the socket member 120 includes an internal thread 125 that is adapted to mate with an external thread 126 on the leading end of the second part of the rock bolt adapter in the form of syringe member 128.

The rock bolt adapter also includes a nozzle member in the form of integrated nozzle 129 that is designed to extend into the internal axial passage 115, when in use. The nozzle 129 is in fluid communication with a mixing means in the form of a static mixing chamber 131.

Syringe member 128 includes a grout holding means in the form of a tube 130 (best depicted in Figures 7A-7C) and a piston member 132 (depicted separately in Figure 8) that is adapted to be slidably attached to tube 130, via an aperture 131 at the trailing end of the tube 130. The piston member 132 includes a head 160 on its leading end that is shaped to engage with compatible channels 162 in the inside surface of tube 130 to prevent, or at least retard, rotation of the piston member 132 relative to the tube 130. The piston member 132 also includes a drill engageable portion 134, at its trailing end, that is designed to be fitted to a compatible part 36 of a drill such as a jumbo or the like (see Figure 4) so that the rock bolt adapter 112 can

be operated by the drill to mix and deliver grout, in the form of resin, from the tube 130 to the internal axial passage 115 of the threaded bar 114.

In contrast to the piston member 32 in the first embodiment, that is adapted to be threadedly engaged and moved via rotation, the piston member 132 is adapted to be moved by the impact drive of the drill. In a similar fashion to the first embodiment, resin capsules (not shown) can be fitted inside tube 130 by removing the socket member 120 to gain access to the interior of tube 130. Pressure applied to the resin capsules by the drill causes the piston member 132 to pressure the resin capsules against a resin releasing means such as a cutting member to rupture the resin capsules, mix the resin using a static mixer and deliver the resin to the internal axial passage 115 via nozzle 129. Socket/Syringe apparatus is then pushed to the end of stroke by increasing the feed pressure on jumbo, the inside top of the Applicator will have a means of cutting resin package once pressure is on.

Another embodiment of a method according to the second aspect of the present invention using the drill assembly depicted in Figures 5, 6A-6C, 7A-7C and 8 is as follows:

1. The syringe 128 is opened by turning socket 120 to detach it from and provide access to tube 130.

2. Resin capsules are inserted into tube 130 and socket 120 is re-attached to tube 130.

3. Threaded bar 114 is loaded on to the feed rail of the jumbo so that the hexagonal shaped recess 122 of socket 120 engages with the drive nut 124 on the end of the threaded bar 114 and leading end of nozzle 129 is inserted into the internal axial passage 115.

4. A rock bolt plate 146 is then fitted over the leading end of the threaded bar 114 in front of the front feed rail centraliser.

5. The leading end of the threaded bar 114 is then located into the pre-drilled hole and fed to the end, until the rock bolt plate 146 is hard up against the surface of rock 118.

6. The drill is actuated to push the piston member 132 onto the resin capsules causing the resin to be released and pass through a static mixer before being injected into the internal axial passage 115 via nozzle 129.

7. Injected resin travels up the internal axial passage 115, out of the leading end of the threaded bar 114 and back down to fill the annulus between the inside walls of the pre-drilled hole and the outside surface of the threaded bar 114.

8. Feed pressure should remain on the threaded bar 114 to hold it in place until the resin stets (Usually around 30 – 60 seconds)

9. Once the resin has set the operator then applies rotational force via the drill to tighten the drive nut 124 and tension the rock bolt plate 146 against the surface of rock 118. The engagement between the head 160 on piston member 132 and channels 162 in the inside surface of tube 130 ensure rotation of the piston member will be transferred to the socket 120 to allow tensioning of the drive nut 124.

10. The volume of resin will be sufficient to at least fill the internal axial passage 115 and fully encapsulate the threaded bar 114.

Syringe member 128 could also include an alternative grout holding means in the form of a tube 230 (best depicted in Figures 9A-9D) and a piston member 232 (depicted separately in Figures 10A and 10B) that is adapted to be slidably attached to tube 230, via an aperture 231 at the trailing end of the tube 230. The aperture 231 is shaped to frictionally engage the shaft portion 262 of piston member 232 via a plurality of splines 264 on the shaft portion 262. Frictional engagement between the splines 264 and the aperture 231 prevent, or at least retard, rotation of the piston member 232 relative to the tube 230. This ensures that any rotational force applied to the piston member 232 by a drill is transferred to the tube 230.

The piston member 232 also includes a drill engageable portion 234, at its trailing end, that is designed to be fitted to a compatible part 36 of a drill such as a jumbo or the like (see Figure 4) so that the rock bolt adapter 112 can be operated by the drill to mix and deliver grout, in the form of resin, from the tube 230 to the internal axial passage 115 of the threaded bar 114. In this regard, similar to the piston member

132 in Figure 8, the piston member 232 in Figure 10A is adapted to be actuated by the impact drive of the drill to move up through the tube 230 resulting in the head 260 on the leading end of the piston member 232 forcing the contents of the tube 230 towards the leading end of the tube 230, into the internal axial passage 115 and then around the outside of the threaded bar 114 to fully encapsulate the threaded bar 114.

Claims

1. A rock bolt adapter for a drill assembly comprising a drill and a rock bolt with an internal axial passage between a leading end of the rock bolt and a trailing end of the rock bolt, the rock bolt adapter comprising:

(a) a leading end adapted to engage the trailing end of the rock bolt and define a fluid connection with the internal axial passage; and

(b) a syringe member for delivering grout to the internal axial passage, said syringe member including:

(i) a grout holding means; and

(ii) a piston member comprising a drill engageable portion;

wherein the rock bolt adapter is operable by the drill to deliver grout from the grout holding means to the internal axial passage.

2. A rock bolt adapter according to claim 1 wherein the rock bolt comprises a hollow bar rock bolt.

3. A rock bolt adapter according to claim 1 wherein the rock bolt comprises a threaded hollow bar rock bolt.

4. A rock bolt adapter according to claim 1 wherein the rock bolt comprises a point anchoring means.

5. A rock bolt adapter according to claim 1 wherein the leading end of the rock bolt adapter is adapted to engage the trailing end of the rock bolt in a manner that enables the adapter to impart rotational and/or percussive force on the rock bolt.

6. A rock bolt adapter according to claim 5 wherein the leading end of the rock bolt adapter is adapted to engage a drive nut on the trailing end of the rock bolt.

7. A rock bolt adapter according to claim 5 wherein the rock bolt adapter leading end defines a socket adapted to receive and frictionally engage a drive nut on the trailing end of the rock bolt.

8. A rock bolt adapter according to claim 1 wherein the rock bolt adapter leading end comprises at least two parts with different sized cross sectional areas.

9. A rock bolt adapter according to claim 8 wherein a narrower part of the leading end is adapted to engage the drive nut on the trailing end of the rock bolt.

10. A rock bolt adapter according to claim 8 wherein a wider part of the leading end is proportioned to have a cross sectional area similar or equivalent to that of the syringe member.

11. A rock bolt adapter according to claim 8 wherein the rock bolt adapter leading end comprises at least one tapered outer surface defining the transition between the at least two parts.

12. A rock bolt adapter according to claim 1 wherein the rock bolt adapter leading end comprises a nozzle member that, in use, extends at least partially into the internal axial passage.

13. A rock bolt adapter according to claim 12 wherein the nozzle member comprises a tube with a uniform cross sectional area.

14. A rock bolt adapter according to claim 12 wherein the nozzle member comprises a taper towards its leading end.

15. A rock bolt adapter according to claim 1 wherein the rock bolt adapter leading end further comprises a mixing means.

16. A rock bolt adapter according to claim 15 wherein the mixing means is a static mixing means.

17. A rock bolt adapter according to claim 16 wherein the static mixing means comprises a chamber through which the grout passes, prior to entering the internal axial passage, when in use.

18. A rock bolt adapter according to claim 12 further comprising a mixing means and wherein the nozzle member is co-axial with a mixing means.

19. A rock bolt adapter according to claim 1 wherein the rock bolt adapter leading end comprises a grout release means for cutting the outer packaging of a grout capsule.

20. A rock bolt adapter according to claim 1 wherein the syringe member comprises an aperture at its trailing end for receiving the piston member.

21. A rock bolt adapter according to claim 20 wherein the aperture includes a sealing means adapted to form a fluid tight seal with the piston member.

22. A rock bolt adapter according to claim 21 wherein the sealing means is an O-ring.

23. A rock bolt adapter according to claim 20 wherein the aperture is threaded.

24. A rock bolt adapter according to claim 1 wherein the grout holding means comprises a tube member.

25. A rock bolt adapter according to claim 1 wherein the grout holding means is adapted to receive loose grout.

26. A rock bolt adapter according to claim 1 wherein the grout holding means is adapted to receive grout contained in a grout cartridge.

27. A rock bolt adapter according to claim 24 wherein the tube member comprises a guide means for the piston member.

28. A rock bolt adapter according to claim 27 wherein the guide means comprises at least one pair of opposed longitudinal channels that extend at least partially along the inner surface of the tube member.

29. A rock bolt adapter according to claim 1 wherein the piston member comprises a threaded portion such that rotation of the piston member can advance or retract the piston member relative to the grout holding means to reduce or increase the interior volume thereof.

30. A rock bolt adapter according to claim 20 wherein the piston member is adapted to be friction fitted in the aperture in the syringe member such that a force, such

as a pushing force, applied to the piston member can advance the piston member relative to the grout holding means to reduce the interior volume thereof.

31. A rock bolt adapter according to claim 20 wherein the piston member is adapted to be retracted by force applied by fluid injected into the grout holding means.

32. A rock bolt adapter according to claim 1 wherein the syringe member further comprises a fluid line that communicates with the grout holding means and enables fluid to be injected therein.

33. A rock bolt adapter according to claim 32 wherein the fluid line is connected to a fluid line on the drill.

34. A rock bolt adapter according to claim 1 wherein the piston member comprises a leading end and a trailing end and a shaft member therebetween.

35. A rock bolt adapter according to claim 34 wherein the piston member leading end is shaped to slidingly fit within the grout holding means and form a fluid tight seal with the inner surface of the grout holding means.

36. A rock bolt adapter according to claim 34 wherein the leading end of the piston member comprises a head portion that is adapted to form a fluid tight seal with a guide means in the tube member.

37. A rock bolt adapter according to claim 34 wherein the leading end of the piston member is adapted to engage with a trailing end or base of a grout cartridge that is moveable to push grout from the leading end of the cartridge.

38. A rock bolt adapter according to claim 1 wherein the drill engageable portion of the piston member is externally threaded.

39. A rock bolt adapter according to claim 1 wherein the drill engageable portion of the piston member comprises an outer surface having a polygonal cross-section.

40. A two part rock bolt adapter for a drill assembly comprising a drill and a rock bolt with an internal axial passage between a leading end of the rock bolt and a trailing end of the rock bolt, the rock bolt adapter comprising:

(a) a first part including a leading end adapted to engage the trailing end of the rock bolt and define a fluid connection with the internal axial passage; and

(b) a second part including a syringe member for delivering grout to the internal axial passage, said syringe member including:

(i) a grout holding means; and

(ii) a piston member comprising a drill engageable portion;

wherein the rock bolt adapter is operable by the drill to deliver grout from the grout holding means to the internal axial passage and wherein the first and second parts are releasibly engageable.

41. A two part rock bolt adapter according to claim 40 wherein the first part includes an internal threaded portion on its trailing end that is compatible with an external threaded portion on a leading end of the second part.

42. A rock bolt adapter for a drill assembly comprising a drill and a rock bolt with an internal axial passage between a leading end of the rock bolt and a trailing end of the rock bolt, the rock bolt adapter comprising:

(a) a leading end adapted to engage the trailing end of the rock bolt and define a fluid connection with the internal axial passage; and

(b) a syringe member for delivering grout to the internal axial passage, said syringe member including:

(i) a grout holding means including a grout cartridge; and

(ii) a piston member comprising a drill engageable portion;

wherein the rock bolt adapter is operable by the drill to deliver grout from the grout cartridge to the internal axial passage.

43. A rock bolt adapter according to claim 42 wherein the grout cartridge is shaped and sized to fit in the grout holding means.

44. A rock bolt adapter according to claim 42 wherein the grout cartridge comprises a base adapted to be pushed by the piston member of the syringe member such that when fitted and the rock bolt adapter is operated the grout can be delivered from the grout cartridge to the internal axial passage.

45. A rock bolt adapter according to claim 42 wherein the grout cartridge comprises a nozzle member.

46. A rock bolt adapter according to claim 42 wherein the grout cartridge comprises a mixing means.

47. A rock bolt adapter according to claim 46 wherein the mixing means is included in the nozzle member.

48. A method of inserting and grouting a rock bolt comprising the steps of:

(a) inserting a rock bolt into a substrate using a drill assembly including a rock bolt adapter comprising a leading end adapted to engage the trailing end of the rock bolt and define a fluid connection with the internal axial passage; and a syringe member for delivering grout to the internal axial passage, said syringe member including a grout holding means and a piston member comprising a drill engageable portion; and

(b) using the drill assembly to actuate the rock bolt adapter to deliver grout from the grout holding means to the internal axial passage.

49. A method according to claim 48 wherein the steps of the method are performed in a single pass.

50. A method according to claim 48 wherein the drill assembly actuates the rock bolt adapter via rotation of the piston member.

51. A method according to claim 48 wherein the drill assembly actuates the rock bolt adapter via impact energy applied to the piston member.

52. A method according to claim 48 further comprising the step of using the drill assembly to actuate a point anchoring means included on the rock bolt.

53. A method according to claim 48 further comprising the step of tensioning the rock bolt via a nut on the trailing end of the rock bolt.

54. A method according to claim 48 wherein the grout is a predetermined amount of grout.

55. A method according to claim 48 further comprising the step of retracting the piston member.

56. A method according to claim 55 wherein the piston member is retracted by delivering fluid to the syringe.

57. A method according to claim 55 wherein the piston member is retracted by rotating the piston member in the opposite to direction to the direction used to rotate the piston when the grout is being delivered to the internal axial passage.

58. A method according to claim 48 further comprising the step of inserting a grout cartridge into the grout holding means.

59. A grout cartridge adapted for insertion in a rock bolt adapter for use with a rock bolt with an internal axial passage between a leading end of the rock bolt and a trailing end of the rock bolt, the grout cartridge comprising:

(a) a grout compartment including grout;

(b) a moveable base portion; and

(c) a nozzle member, that in use, is adapted to be in fluid connection with the internal axial passage;

wherein, in use, pressure applied to the moveable base portion causes grout to be delivered to the internal axial passage.

60. A grout cartridge according to claim 59 comprising a mixing means.

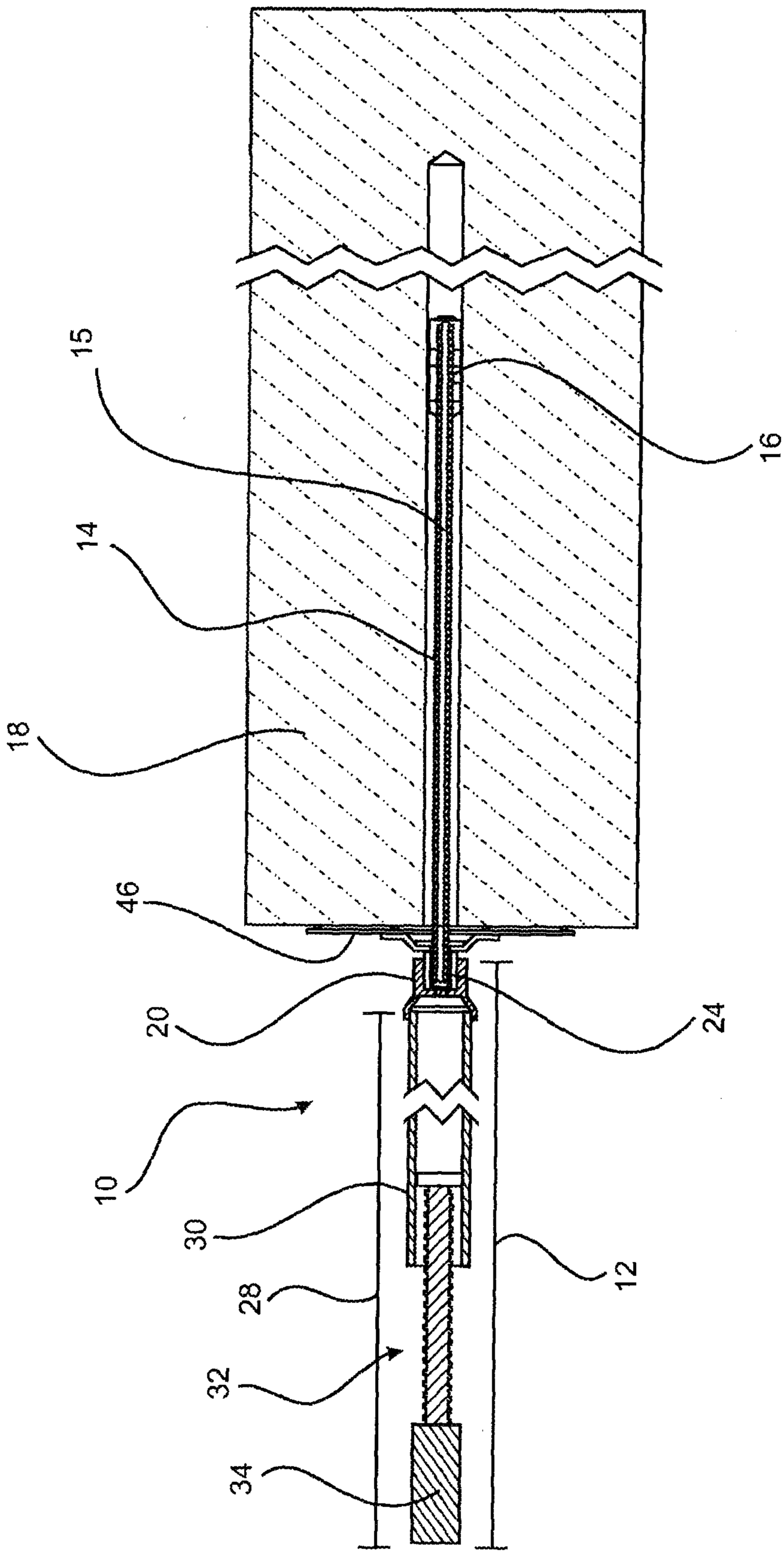

Figure 1

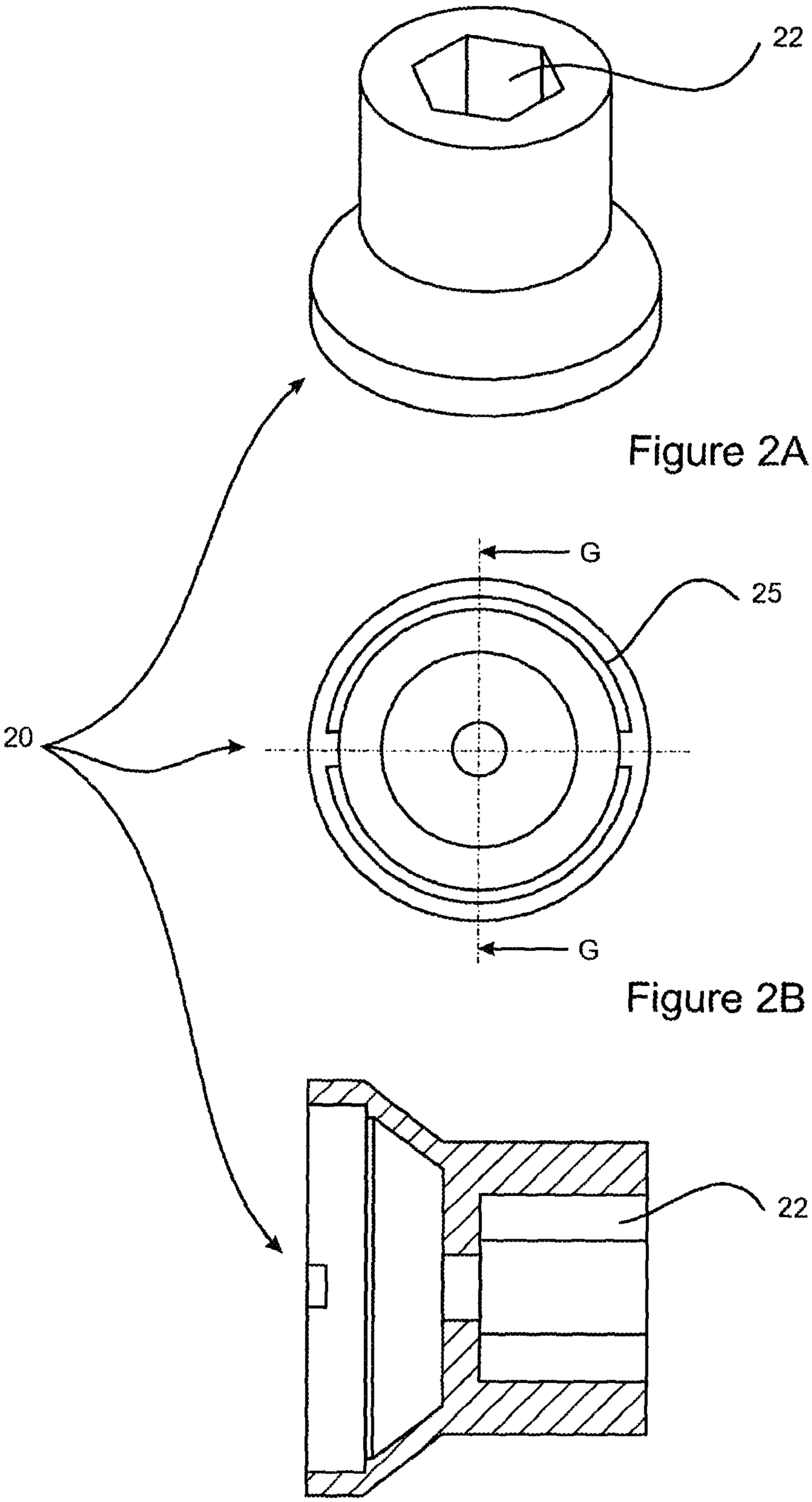

Figure 2A

Figure 2B

Figure 2C

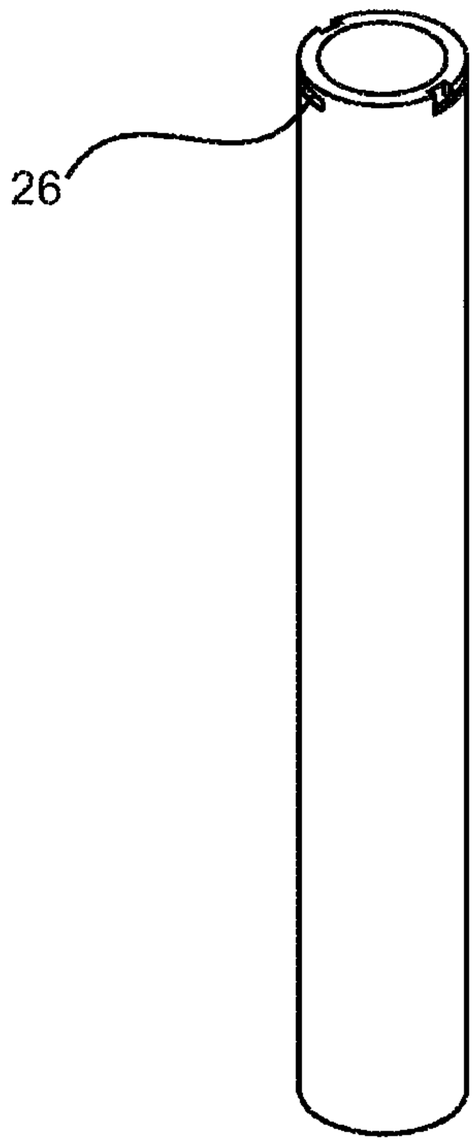

Figure 3A

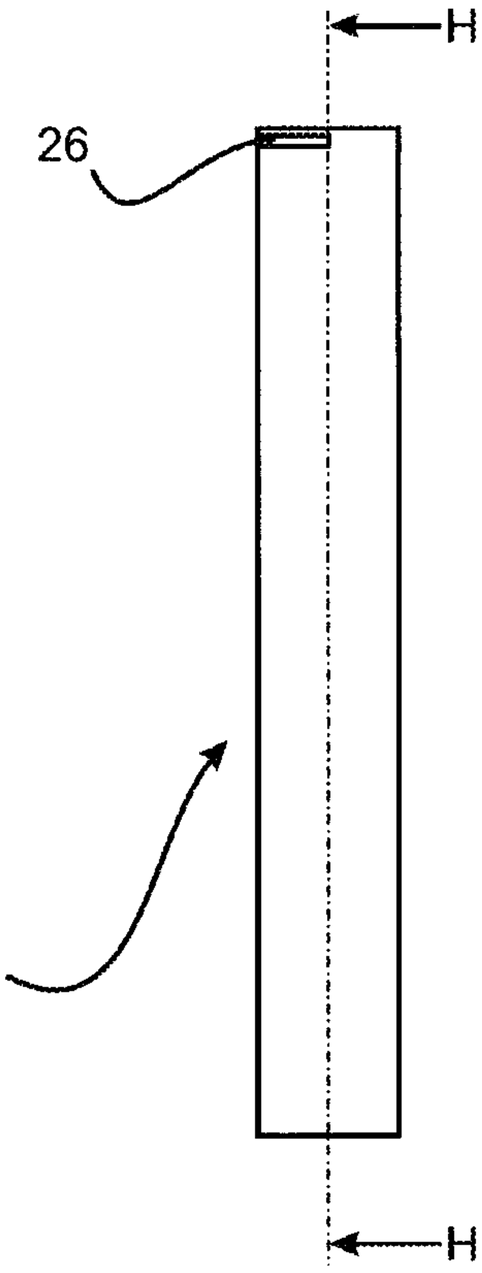

Figure 3B

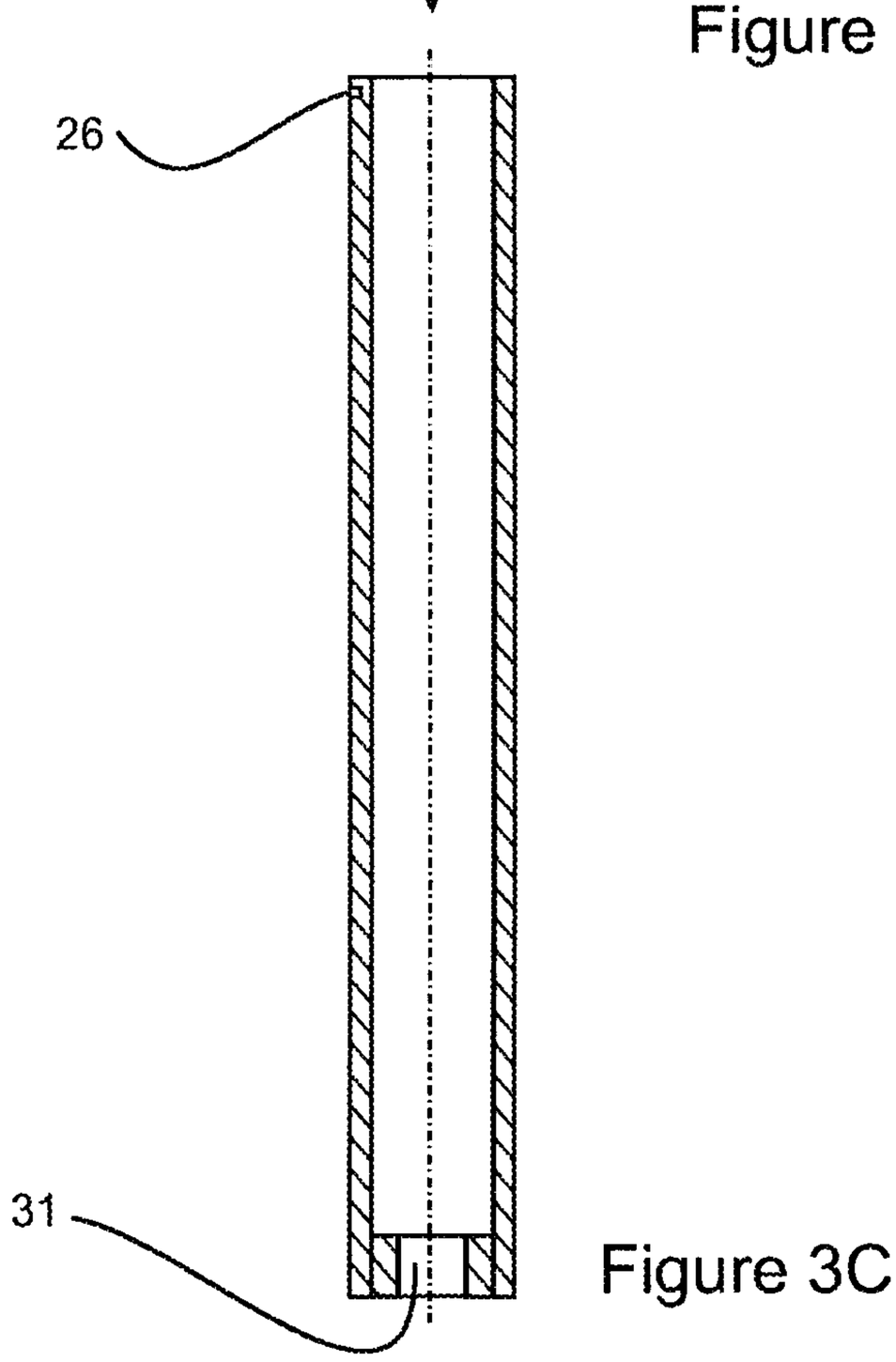

Figure 3C

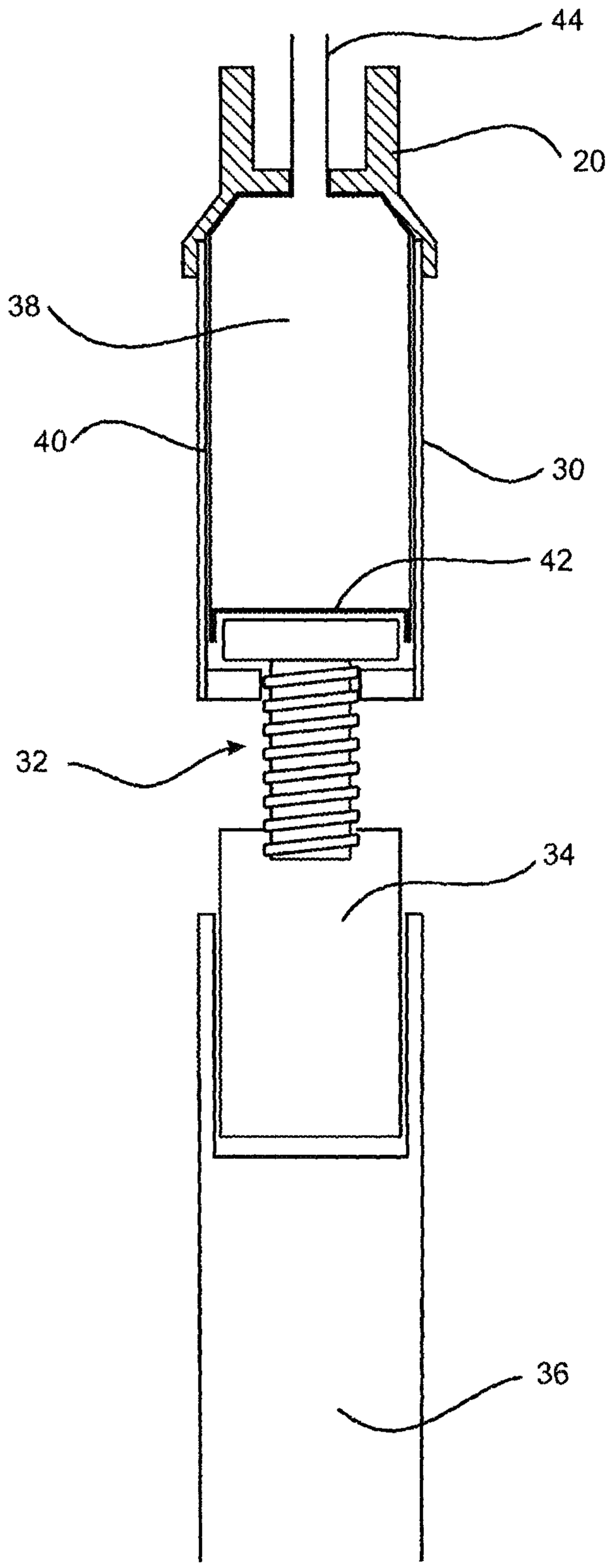

Figure 4

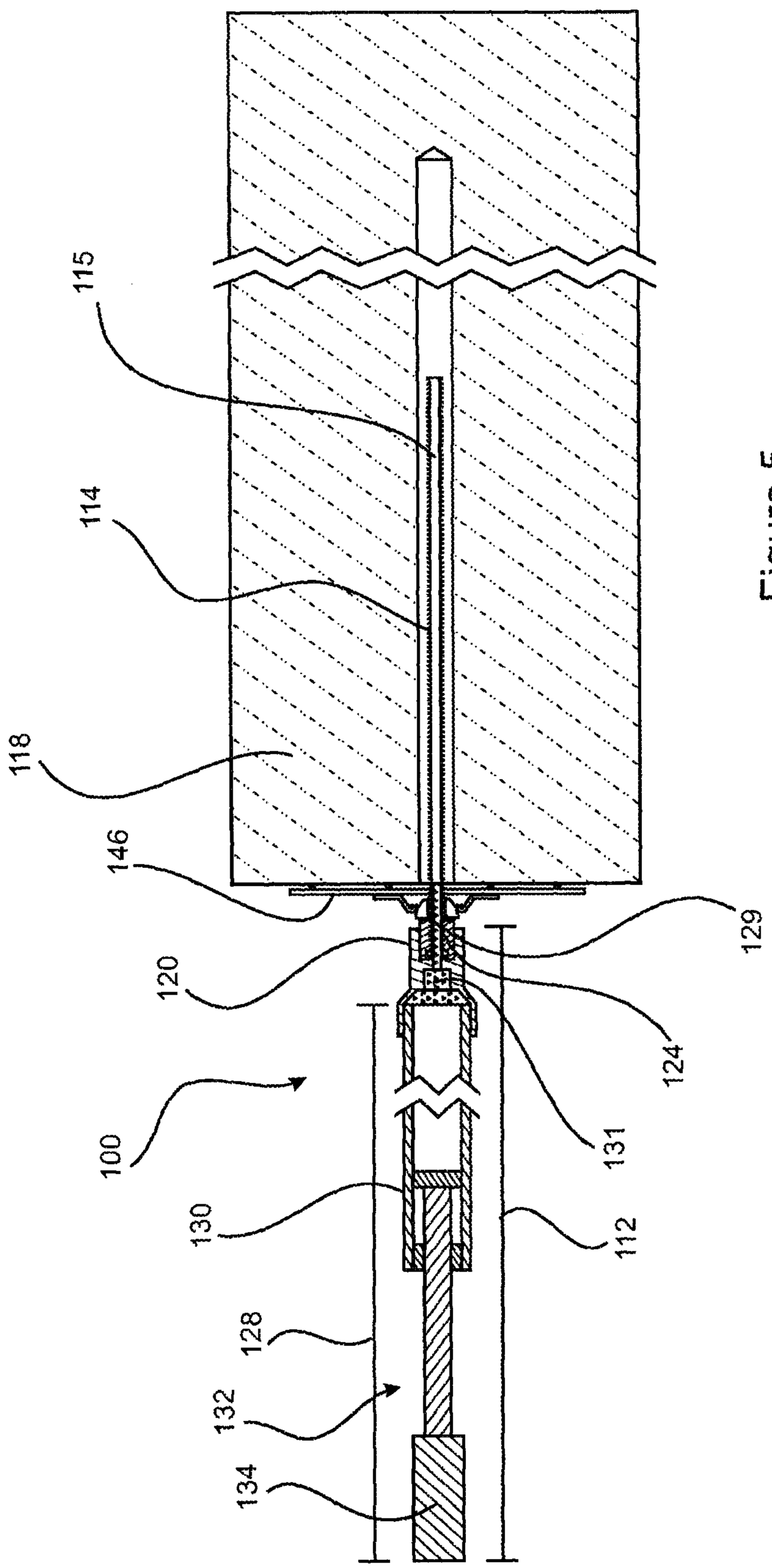

Figure 5

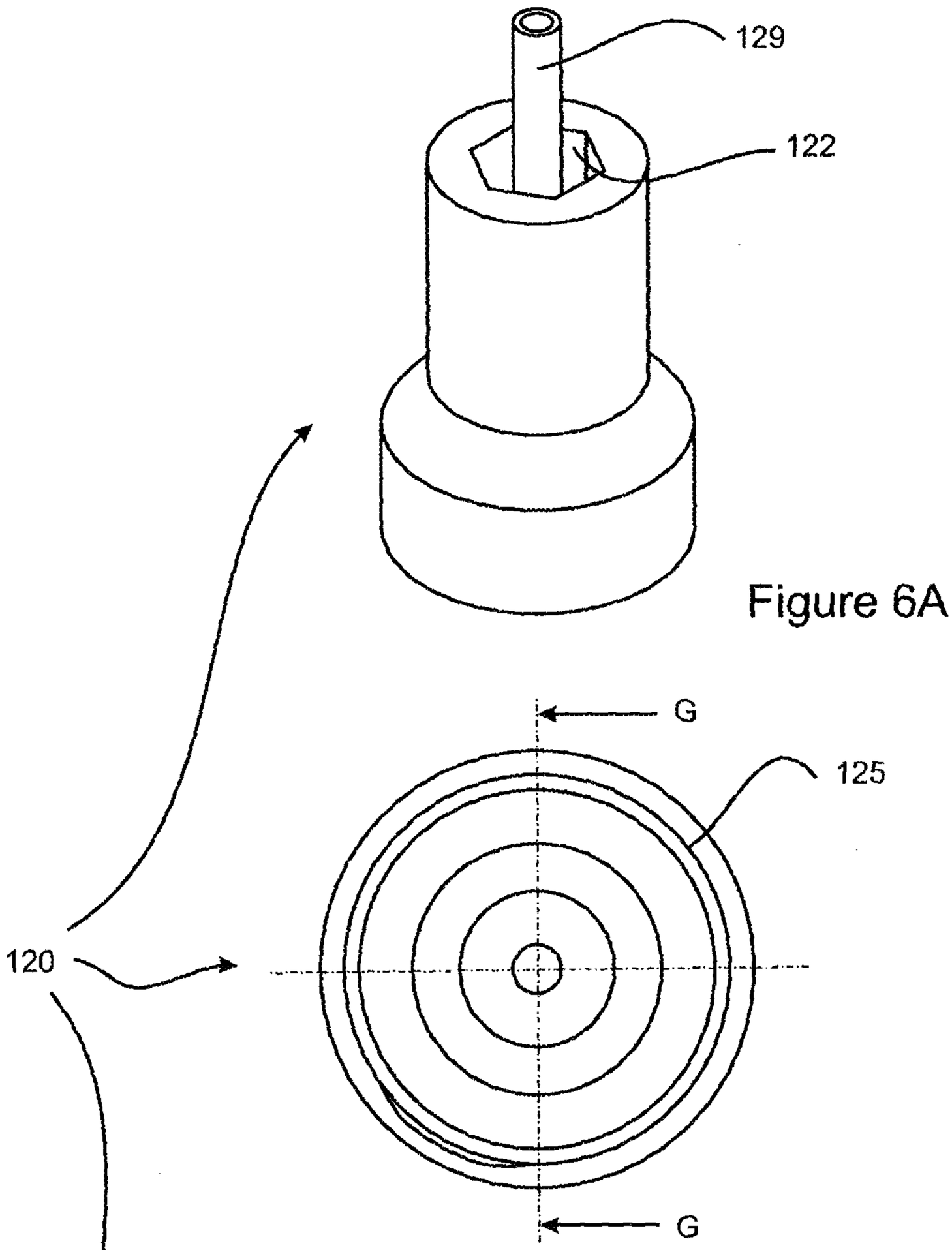

Figure 6A

Figure 6B

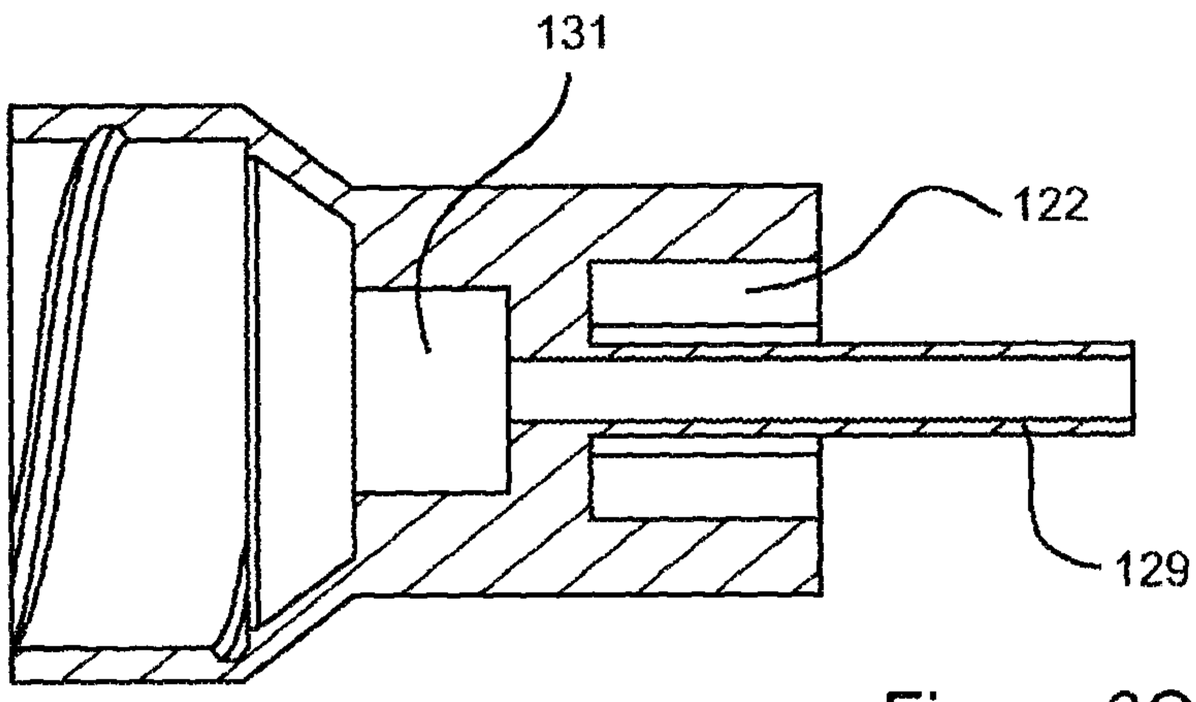

Figure 6C

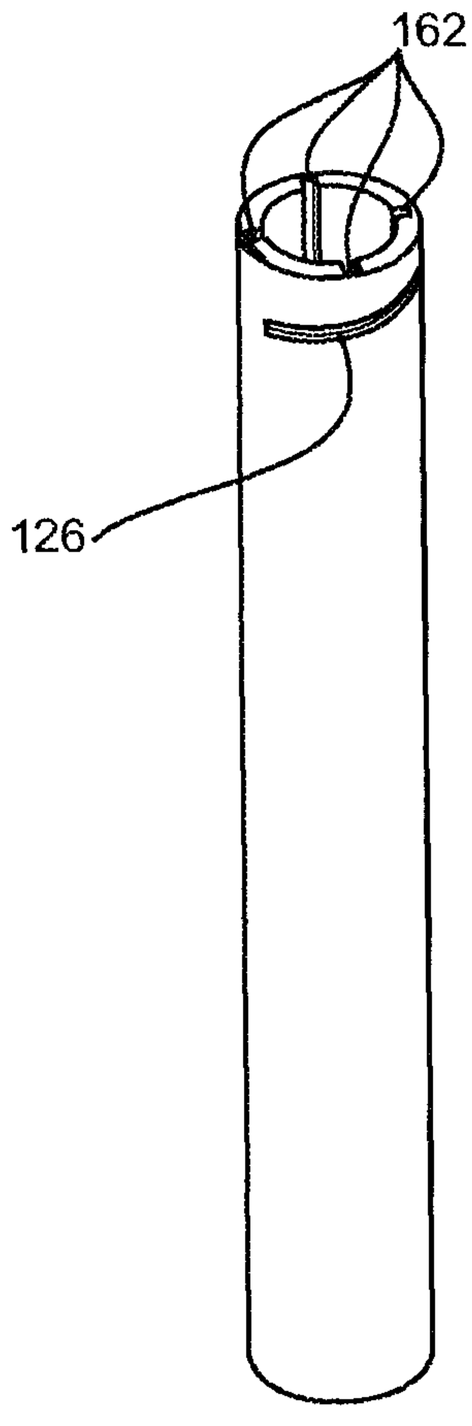

Figure 7A

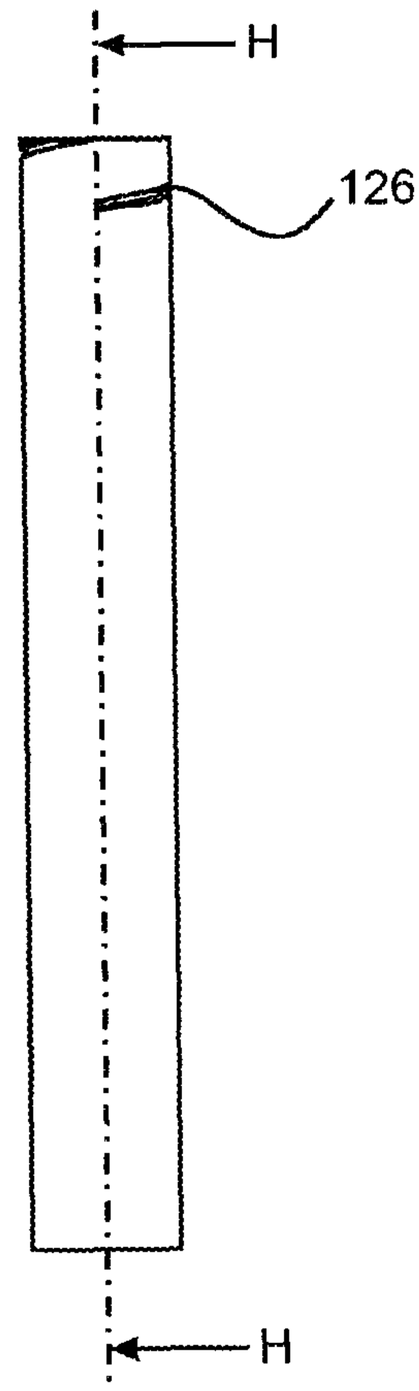

Figure 7B

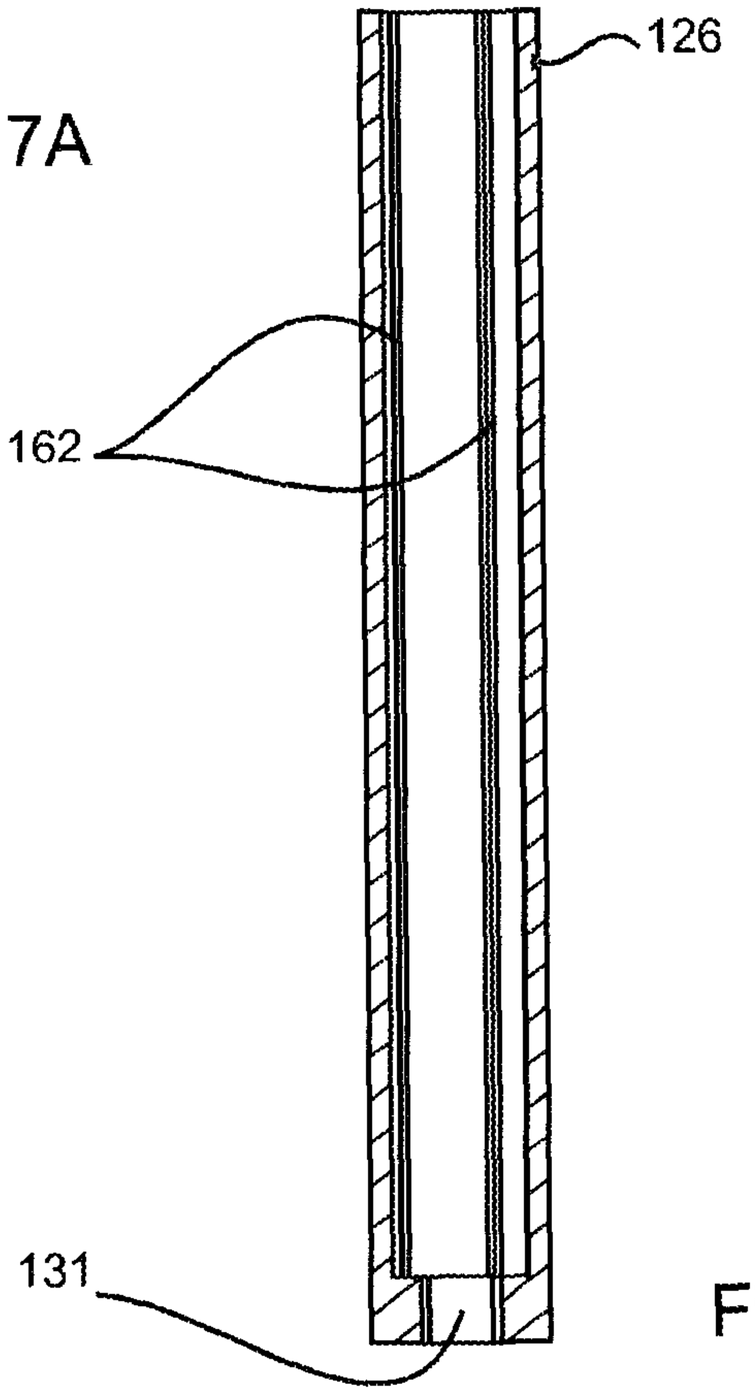

Figure 7C

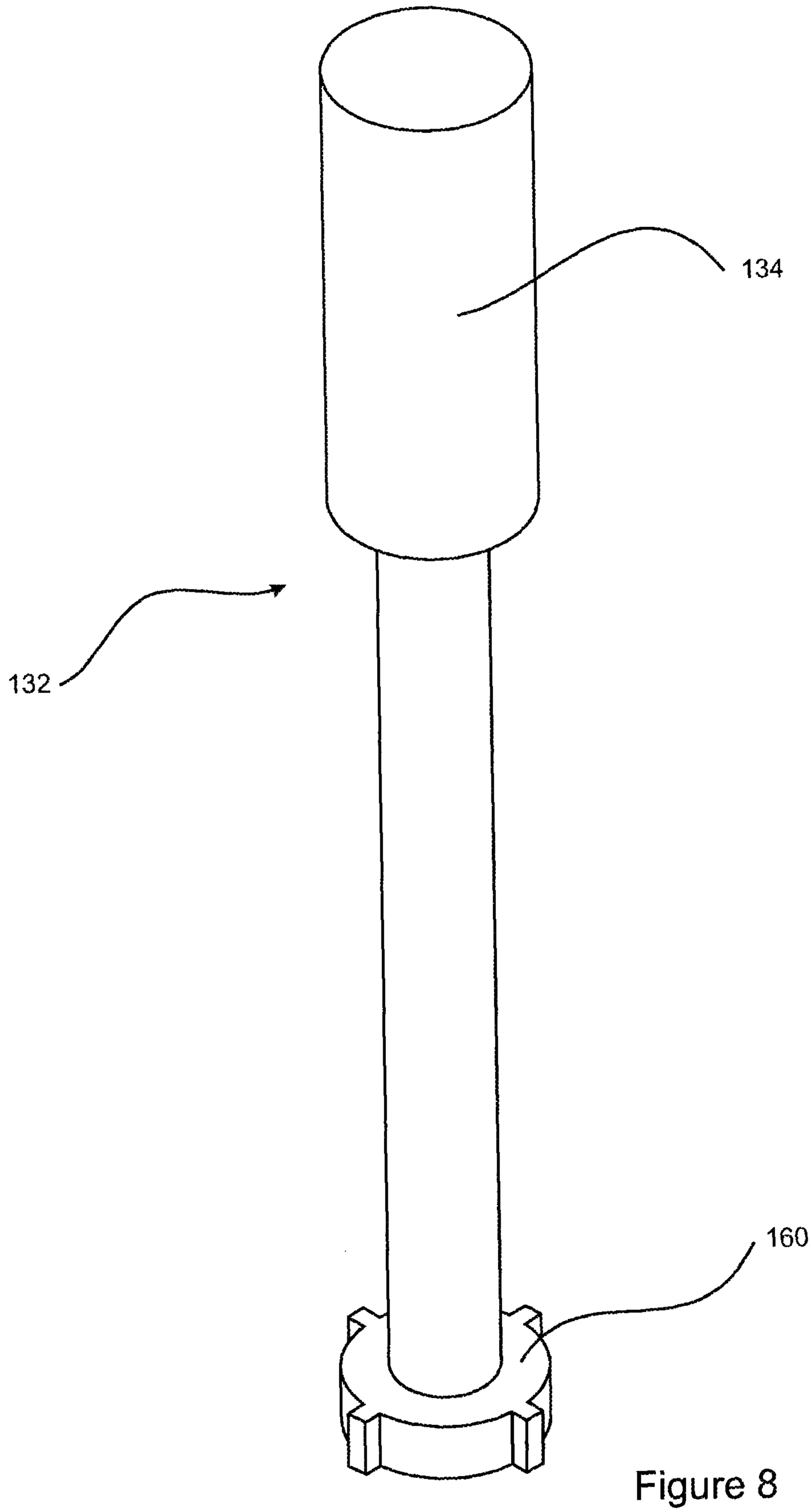

Figure 8

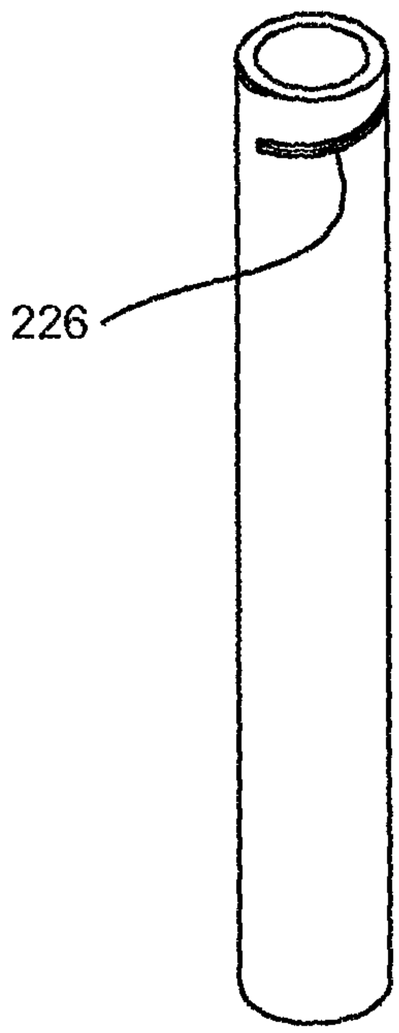

Figure 9A

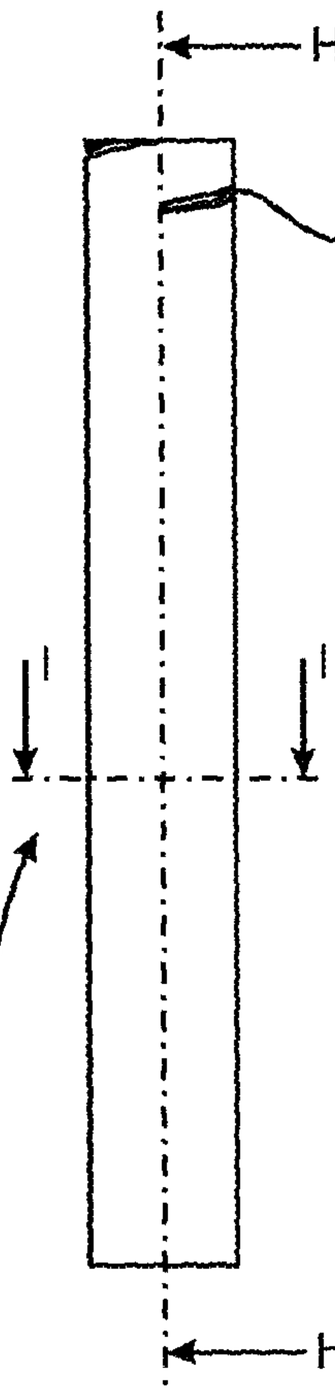

Figure 9B

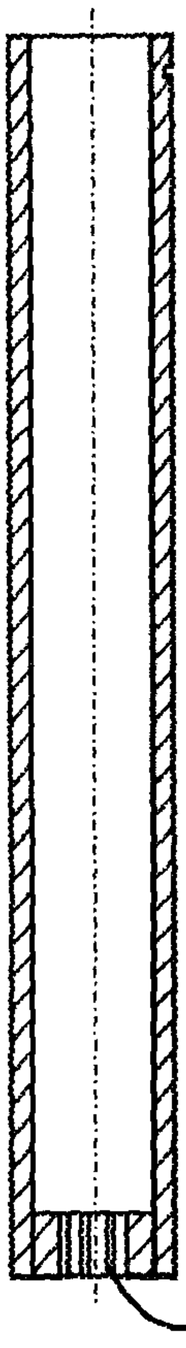

Figure 9C

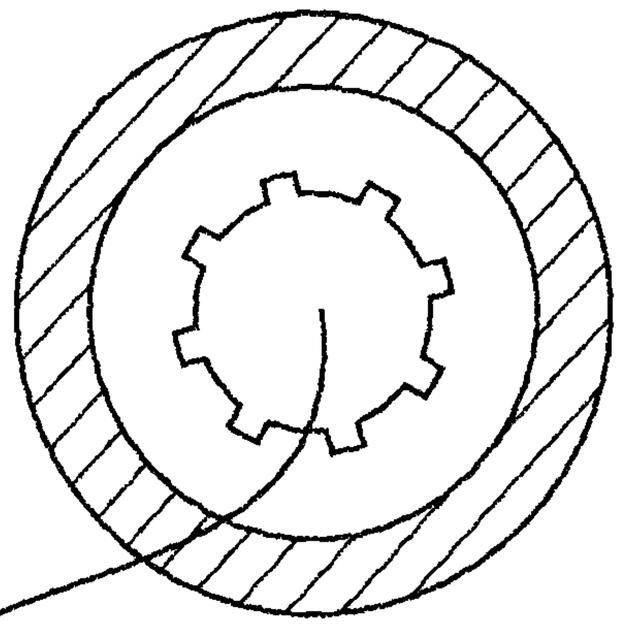

Figure 9D

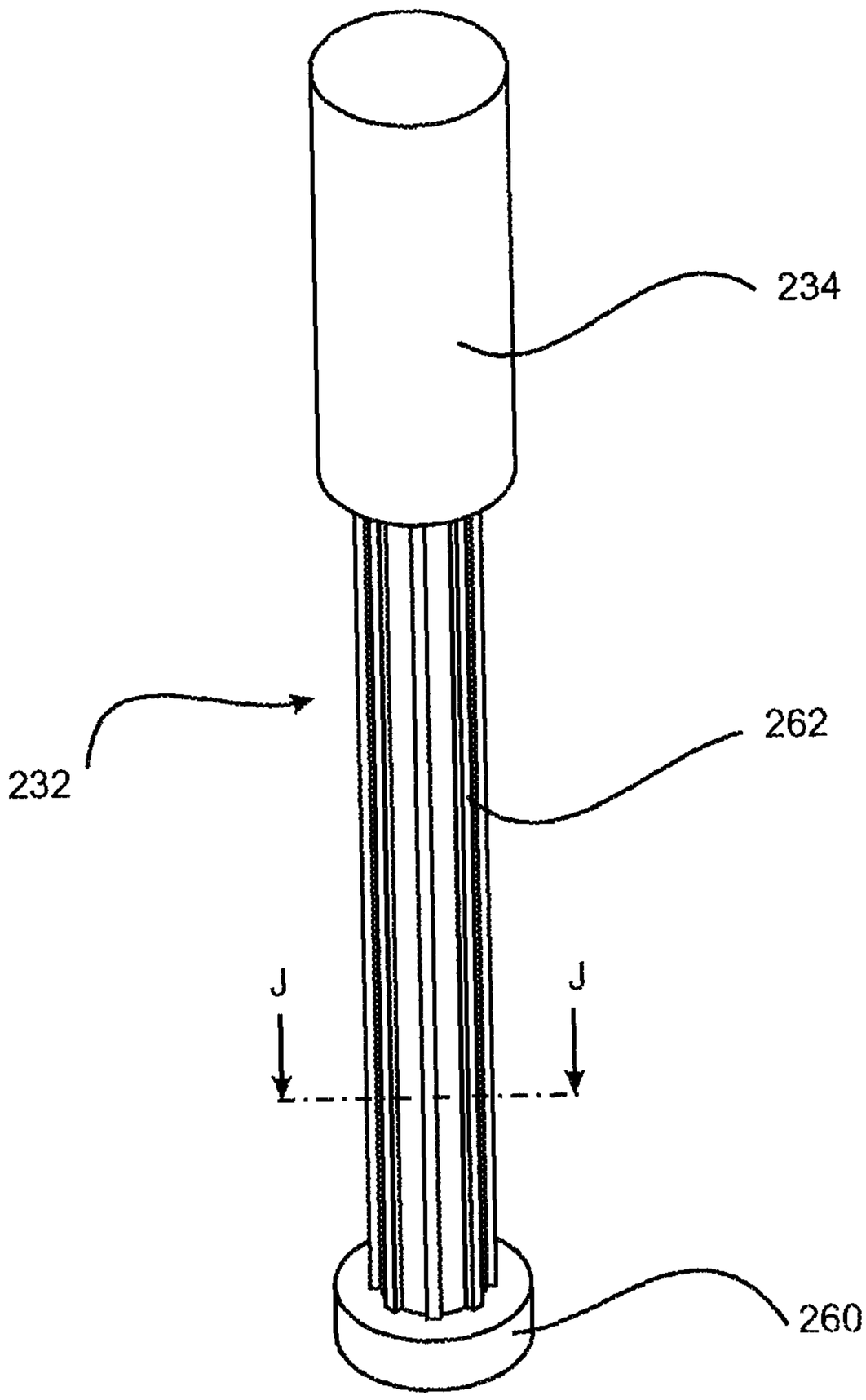

Figure 10A

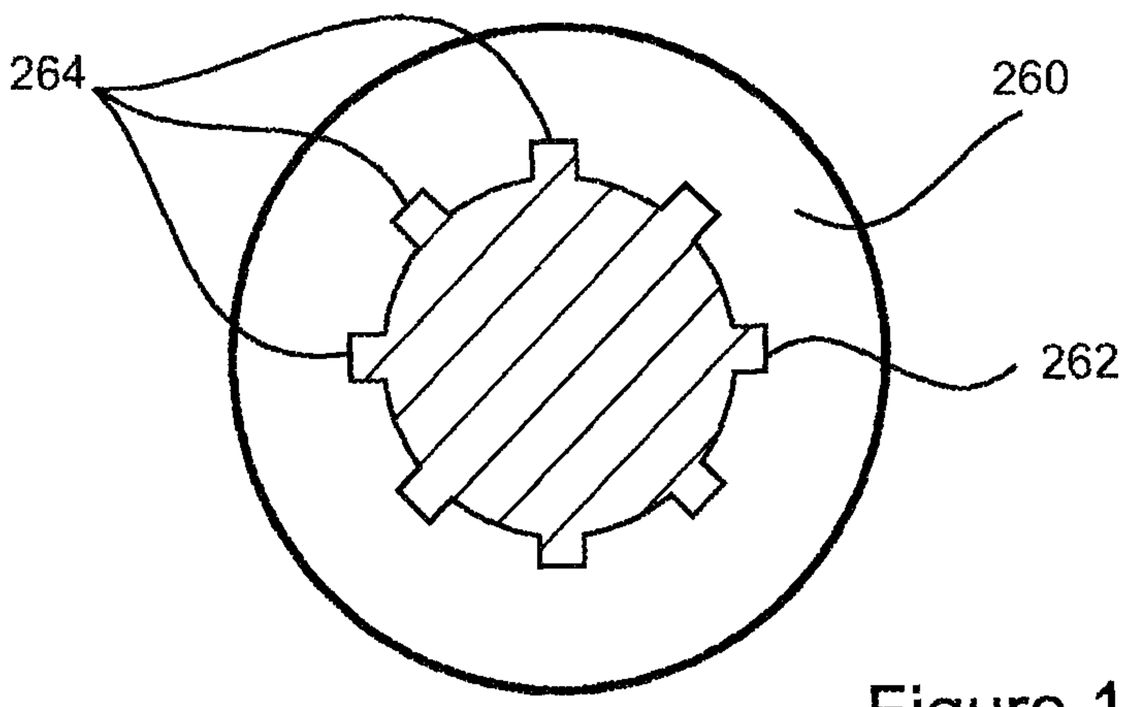

Figure 10B

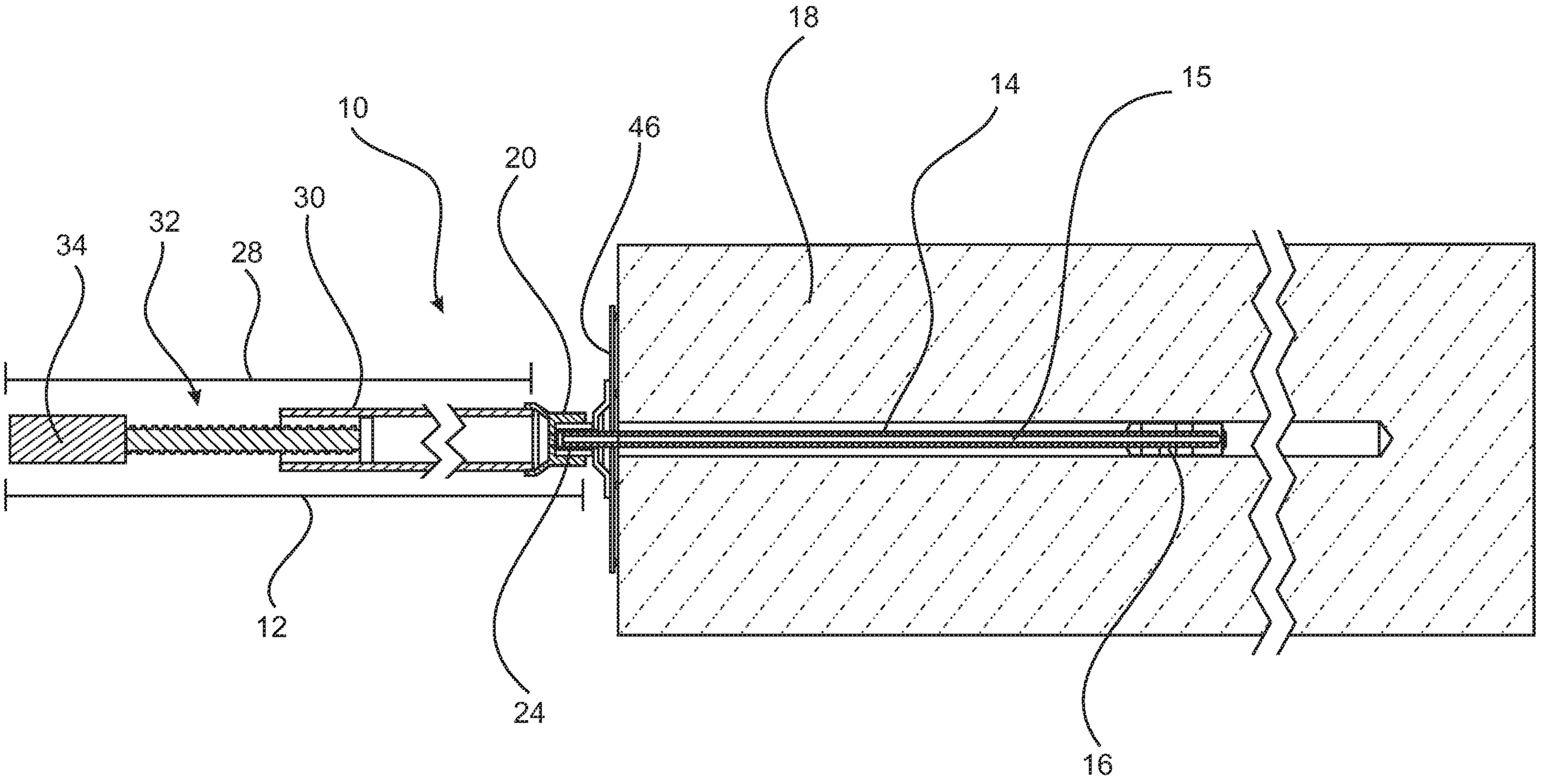

Figure 1