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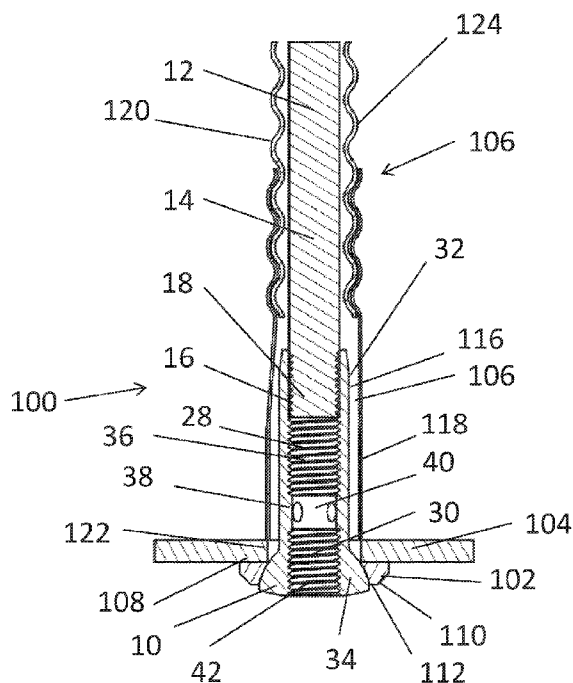
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(54) Title: FITTING FOR A ROCK BOLT AND ROCK BOLT ASSEMBLIES INCLUDING SAME



(57) Abstract: Abstract A fitting for a rock bolt is disclosed that includes a first passage portion extending from a leading end that is arranged to engage with an end of the rock bolt shaft, a second passage portion extending from the trailing end, the second passage portion being spaced from the first passage portion in the direction of the fitting axis. At least one outlet extends in the body to an external surface of the fitting, the at least one outlet being in fluid communication with the second passage portion. A rock bolt assembly including the fitting and a sleeve extending around the rock bolt shaft is also disclosed. The fitting allows grout (or other fluid) to be introduced through to the rock bolt via the second passage portion and the at least one outlet.

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FITTING FOR A ROCK BOLT AND ROCK BOLT ASSEMBLIES INCLUDING SAME

Technical Field

5 The present invention relates generally to rock bolt assemblies and fittings for use in such assemblies. The invention has particular application for strata support for both mining and civil applications and is herein described in that context.

Background of the Invention

10 Roof and wall support is vital in mining and tunnelling (and/or other civil) operations. Mine and tunnel walls and roofs consist of rock strata, which must be reinforced to prevent the possibility of collapse. Rock bolts are widely used for consolidating the rock strata.

15 In conventional strata support systems, a bore is drilled into the rock by a drill rod, which is then removed and a rock bolt is then installed in the drilled hole and secured in place typically using a resin or cement based grout. The rock bolt is tensioned which allows consolidation of the strata by placing that strata in compression. The rock bolt may be in the form of a rigid rock bolt having a shaft typically formed from a steel rod, or may be in the form of a flexible rock bolt having a shaft made from flexible cable strands.

20 To allow the rock bolt to be tensioned, the end of the bolt may be anchored mechanically to the rock formation by engagement of an expansion assembly on the end of bolt with the rock formation. Alternatively, the bolt may be adhesively bonded to the rock formation with a resin bonding material inserted into the bore hole. Alternatively, a combination of mechanical anchoring and resin bonding can be employed by using both an expansion assembly and resin bonding material.

25 In some environments it is preferable to introduce fluid (such as grout or water) as part of the installation of the rock bolt. The introduction of fluid introduces additional complexity to the rock bolt design as it necessitates the need for fluid passages, seals and the provision to receive a lance to inject the fluid into the bore. The design of the rock bolt becomes more problematic in these circumstances as it beneficial that there is
30 little or no tail protruding from the rock face.

Summary of the Invention

According to a first aspect, disclosed is a fitting for a rock bolt having an axis and the fitting comprising a body having a leading end and a trailing end spaced apart along the axis; a first passage portion extending from the leading end, the first passage portion being arranged to engage the shaft of the rock bolt; a second passage portion extending from the trailing end, the second passage portion being spaced from the first passage portion in the direction of the axis; and at least one outlet extending in the body to an external surface of the fitting, the at least one outlet being in fluid communication with the second passage portion. With this arrangement fluid (such as water or grout) may be introduced through a rock bolt assembly including the fitting via the second passage portion and the at least one outlet.

According to a second aspect, disclosed is a rock bolt assembly comprising a shaft; a fitting according to the first aspect, an end of the shaft disposed in the first passage portion and engaged with the fitting; and a sleeve disposed around the shaft with an interior cavity disposed between the sleeve and the shaft, and wherein the outlet in the fitting is in fluid communication with the interior cavity.

Brief Description of the Drawings

Embodiments will now be described by way of example only, with reference to the accompanying drawings in which:

Figure 1 is an isometric view of a first embodiment of a fitting;

Figure 2 is a trailing end view of the fitting of Fig. 2;

Figure 3 is a cross-sectional view of the fitting of Fig. 3;

Figure 4 is a cross-sectional view of an embodiment of a rock bolt assembly including the fitting of Fig. 1, and an embodiment of a sleeve;

Figure 5 is an isometric view of the rock bolt assembly of Fig. 4;

Figure 6a is a cross-sectional view of the rock bolt assembly of Fig. 4 including a resin capsule at the leading end of the rock bolt illustrating a first embodiment of the installation of the rock bolt assembly pre-grouting;

Figure 6b is a cross-sectional view of the rock bolt assembly of Fig. 6a post-grouting;

5 Figure 7a is a cross-sectional view of the rock bolt assembly of Fig. 4 including an expansion shell at the leading end of the rock bolt illustrating a second embodiment of the installation of the rock bolt assembly pre-grouting;

Figure 7b is a cross-sectional view of the rock bolt assembly of Fig. 7a post-grouting;

10 Figure 8a is a cross-sectional view of the rock bolt assembly of Fig. 4 including an expansion shell and resin capsule at the leading end of the rock bolt illustrating a second embodiment of the rock bolt assembly in installation pre-grouting;

Figure 8b is a cross-sectional view of the rock bolt assembly of Fig. 8a post-grouting;

Figure 9a is a cross-sectional view of an embodiment of a rock bolt assembly including the sleeve of Fig.4;

15 Figure 9b is a cross-sectional magnified view of the box marked 'A' of Fig. 9a;

Figure 9c is a cross-sectional magnified view of an embodiment of a tensioning assembly of Fig. 9a;

Figure 10a is a cross-sectional view of an embodiment of a rock bolt assembly and an embodiment of a sleeve;

20 Figure 10b is a cross-sectional magnified view of the box marked 'A' of Fig. 10a;

Figure 11a is a cross-sectional view of an embodiment of a rock bolt assembly and the sleeve of Fig. 10a;

Figure 11b is a cross-sectional magnified view of the box marked 'A' of Fig. 11a;

25 Figure 12a is a cross-sectional view of an embodiment of a rock bolt assembly and the sleeve of Fig. 10a; and

Figure 12b is a cross-sectional magnified view of the box marked 'A' of Fig. 12a.

Detailed Description

In the following detailed description, reference is made to accompanying drawings which form a part of the detailed description. The illustrative embodiments described in the detailed description, depicted in the drawings and defined in the claims, are not intended to be limiting. Other embodiments may be utilised and other changes may be made without departing from the spirit or scope of the subject matter presented. It will be readily understood that the aspects of the present disclosure, as generally described herein and illustrated in the drawings can be arranged, substituted, combined, separated and designed in a wide variety of different configurations, all of which are contemplated in this disclosure.

Disclosed is a fitting for a rock bolt having a shaft, the fitting having an axis and the fitting comprising a body having a leading end and a trailing end spaced apart along the axis; a first passage portion extending from the leading end, the first passage portion being arranged to engage the shaft of the rock bolt; a second passage portion extending from the trailing end, the second passage portion being spaced from the first passage portion in the direction of the axis; and at least one outlet extending in the body to an external surface of the fitting, the at least one outlet being in fluid communication with the second passage portion to introduce grout (or other fluid) through a rock bolt assembly including the fitting via the second passage portion and the at least one outlet.

The first passage portion of the fitting may engage shaft of the rock bolt by various means, for example, by threaded engagement, adhesive, welding, swaging or the like. In some forms a fixed connection may be provided between the shaft and the fitting, whereas in other embodiments (for example where the rock bolt is tensioned) the connection may allow axial displacement (e.g. by way of a threaded coupling) between the fitting and the shaft.

A feature of the fitting according to the above aspect is that the at least one outlet extends in the body to an external surface of the fitting to allow grout (or other fluid) to be directed to a rock bolt mounted on the fitting so as to typically flow along an outer surface of the shaft of the rock bolt. In an alternative arrangement if the rock bolt includes one or more interior passages, the fluid may be arranged to flow from the fitting and along these interior fluid passages of the rock bolt. With this arrangement grout can be pumped through the second passage portion and the at least one outlet

through to the rock bolt. It is understood that the at least one outlet may extend radially from the first passage portion or the second passage portion or where there are at least two outlets, at least one outlet may extend from the first passage portion and at least one outlet may extend from the second passage portion to an external surface of the fitting. In some forms, the at least one outlet is disposed in the second passage portion.

In some forms, the second passage portion has a constant internal diameter along its length.

In some embodiments, the second passage portion may include one or more of:

- a drive receiving region arranged to be engaged with a drive to impart rotation to the fitting about the axis;
- a threaded region; and
- a restricted region having a reduced diameter as compared to at least one of the first passage portion and/or an adjacent region of the second passage portion.

In embodiments where the second passage portion includes the drive receiving region, the drive receiving region may extend from the trailing end of the body. In other embodiments, the drive receiving region may be spaced from the trailing end. This arrangement has particular benefit as it obviates the need for a protruding drive end to be mounted on the fitting thereby enabling a lower profile arrangement to be provided at the rock surface when a rock bolt including the end fitting is installed. The at least one radial outlet may also be positioned in the drive receiving region, which is advantageous because it excludes the need for additional channels or passages to create a grout flow pathway.

In embodiments where the second passage portion includes the threaded region, the threaded region is arranged to receive an attachment with a complementary thread received in the trailing end to threadingly engage the attachment to the fitting. The thread region may be disposed intermediate the drive receiving region and the trailing end. In this regard, the drive receiving region may be disposed well within the second passage which allows for more secure and safer fitting of the drive to the fitting. To allow for ready access to the drive receiving region, in some forms the drive receiving region is disposed radially inwardly of the second thread region. In one form, the drive receiving region is in the form of an internal hex or other non-circular profile.

In some forms, the body of the fitting may also be formed of first and second members. The first and second members may be joined together. In other forms, the body may be made from a unitary construction

5 In some forms, the fitting further comprises an abutment arrangement disposed on the body and forming an external abutment surface that faces the leading end. In such an arrangement, the abutment arrangement may be disposed at or proximate the trailing end and forms an enlarged head on the body. The abutment arrangement may include a bevelled surface that faces the leading end. In use, this allows for a countersink relationship with a rock bolt assembly. In some forms, the abutment arrangement is
10 integrally formed with the body. The abutment arrangement may also be formed separately to the body and attached thereto. The purpose of the abutment arrangement is to provide an arrangement that either directly or indirectly abuts against the rock surface.

15 In one form, the first passage portion extends along the axis of the fitting, and/or the second passage portion extends along the axis of the fitting. In alternative forms, the first and second passage portions may extend along different axes, or they may extend along the same axis that is distinct from the fitting axis. These axes may be parallel to the fitting axis, but in a different plane. As a result, more than two passage portions may be included or the first and second passage portions may be offset from one
20 another. The first and second passage portions may also be interconnected to form a continuous passage between the leading and trailing end of the body of the fitting. The second passage portion may include an interruption (e.g., a solid region).

In some forms of the fitting, the fitting body has a low profile thereby allowing it to locate in a bore containing the shaft without requiring any, or only minimal, enlarging
25 of the bore. Accordingly if the lead portion is sufficiently slim, the fitting can locate in the bore without requiring enlargement of the hole utilising this gap. With the disclosed arrangement grout is pumped through the second passage portion and the at least one outlet through to the rock bolt. This is of particular benefit where the fitting is low profile, and as such no extra materials are required to accommodate additional
30 grout pathways.

Also disclosed is a rock bolt assembly comprising a rock bolt having a shaft, a fitting according to the previous disclosure, and an end of shaft disposed in the first passage

portion and engaged with the fitting; and a sleeve disposed around the shaft with an interior cavity is disposed between the sleeve and the shaft, and wherein the outlet in the fitting is in fluid communication with the interior cavity. The interior cavity may be annular. The sleeve is advantageous as it allows for an enhanced grout flow pathway.

5 Some embodiments of a sleeve design allow for smooth grout flow and improved bond strength.

In some forms, the rock bolt assembly also includes at least one seal provided between the sleeve and the fitting to provide a fluid path that extends along at least a portion of the shaft and in the second passage portion and the interior cavity. The at least one seal
10 may be in any suitable form, such as a mechanical fastening arrangement or an adhesive. The seal allows for safe introduction of the grout to the rock bolt assembly by inhibiting any leakage of grout.

In some forms, at least one sleeve outlet is provided that extends between the interior cavity and an external surface of the sleeve to provide a fluid path from the second
15 passage portion to the external surface of the sleeve. The at least one sleeve outlet may be in the form of the sleeve having one open end, or extend in a wall of the sleeve, or both.

In some forms, the rock bolt assembly may also include a first seal provided between the sleeve and one of the fitting or the shaft, wherein the first seal allows relative
20 movement between the sleeve and the one of the fitting or the shaft. The first seal may include a sealing member that allows for the relative movement whilst maintaining a seal between the sleeve and the one of the fitting or the shaft. The rock bolt assembly may further comprise a liner disposed on an inner side of the sleeve, the liner being fixed to the sleeve and wherein the sealing member is fixed to the liner. This
25 arrangement is beneficial, as it may facilitate the rock bolt to be tensioned via the fitting while the sleeve is disposed about at least a portion of the fitting. In some forms, the first seal is also advantageous as it may provide a fluid path that extends along at least a portion of the shaft and in the second passage portion and the interior cavity.

In some embodiments, the rock bolt assembly may further comprise a second seal
30 provided between the sleeve and the other of the fitting or the shaft to which first seal is in sealing engagement, the first and second seals being spaced apart in the direction of the shaft axis. The sleeve and the other of the fitting or the shaft may be fixed together

at the second seal. In these circumstances, the at least one sleeve outlet is disposed between the first and second seals. The at least one sleeve outlet is beneficial in this arrangement to provide fluid communication from the interior cavity to the rock bolt assembly.

5 In some embodiments, a rock bolt assembly is disclosed where the fitting is engaged with the shaft so as to allow relative axial movement therebetween. The fitting may include a thread formed on an inner surface of the first passage portion which engages a thread formed on the shaft end such that the shaft is able to move axially relative to the fitting in response to relative rotation between the shaft and the fitting about the shaft
10 axis. A torque connection may be formed between the fitting and the shaft, such that fitting and shaft are operative to rotate together on the application of torque applied to the connection up until a threshold loading and wherein above said threshold, the torque connection is operative to allow relative rotation between said fitting and said shaft. The torque connection may be in the form of a shear pin, adhesive or a
15 removable or frangible element that restricts relative axial and/or rotational movement between the shaft and the fitting. This arrangement is advantageous as it allows for tensioning of the rock bolt assembly to provide rock strata support. In these circumstances, the first seal allows for the relative axial movement between the fitting and the shaft.

20 In some forms, the fitting may further comprise an abutment arrangement disposed on the body and forming an external abutment surface that faces the leading end.

In some embodiments, a rock bolt assembly is disclosed that further comprises an end connection that is connected to the trailing end of the fitting. The end connection includes a passage that is in fluid communication with second passage portion. The
25 fitting may be engaged with the end connection so as to allow relative axial movement therebetween. In other arrangements, the fitting and the end connection may be fixed to one another (by for example swaging, welding or adhesive).

In some forms, the end connection may include a thread formed on an inner surface the passage which engages a thread formed on an external surface of the fitting body such
30 that the fitting is able to move axially relative to the end connection in response to relative rotation between the end connection and the fitting about the shaft axis.

A torque connection may be formed between the fitting and the end connection, such that fitting and end connection are operative to rotate together on the application of torque applied to the torque connection up until a threshold loading and wherein above said threshold, the torque connection is operative to allow relative rotation between said fitting and said end connection. The torque connection may be in the form of a shear pin, adhesive or a removable or frangible element that restricts relative axial and/or rotational movement between the end connection and the fitting.

In some forms, the end connection may further comprise an abutment arrangement on an outer surface of the connection that forms an external abutment surface that faces the fitting. The end fitting may include a drive receiving portion that is arranged to receive a drive to impart rotary and/or axial drive to the rock bolt assembly.

In some alternative forms, the sleeve does not extend to the end fitting.

In some embodiments, disclosed is a rock bolt assembly further comprising a distal fitting disposed on the opposite end of the shaft to which the fitting is engaged. The distal fitting may be engaged with the shaft so as to allow relative axial movement therebetween. The distal fitting may include a female thread which engages a thread formed on an external surface of the shaft such that the distal fitting is able to move axially relative to the shaft in response to relative rotation between the shaft and the distal fitting about the shaft axis. A torque connection may be formed between the end fitting and the shaft, such that the end fitting and shaft are operative to rotate together on the application of torque applied to the torque connection up until a threshold loading and wherein above the threshold, the torque connection is operative to allow relative rotation between said end fitting and said shaft. The torque connection may be in the form of a shear pin, adhesive or a removable or frangible element that restricts relative axial and/or rotational movement between the shaft and the end fitting. This arrangement is beneficial as it allows tensioning of the rock bolt assembly, which provides rock strata support.

In some embodiments, the distal fitting is in the form of an anchoring assembly. In some embodiments, the distal fitting is in the form of a mechanical anchor. The mechanical anchor may be in the form of an expansion shell. In some embodiments, the distal fitting is in the form of a resin anchor sleeve. In some embodiments, the sleeve does not extend to the distal end fitting. Some arrangements of the distal fitting

may be beneficial as it may be designed to allow tensioning and promote bonding of the resin.

In some embodiments, a rock bolt assembly is disclosed wherein the rock bolt assembly is able to contract axially without causing relative movement between the sleeve and the shaft and fitting. An advantage of this arrangement is that the sleeve may be fixed to at least one of the fitting and/or the shaft of the rock bolt to facilitate grout introduction to the rock bolt assembly.

In some embodiments, a rock bolt assembly is disclosed wherein the sleeve is formed from a semi-permeable material and in particular a material that is permeable to water but not to more viscous material. The sleeve material may be flexible. For example, a geo fabric may be used to form the sleeve. Using a water permeable material allows for improved bond strength between the grout and the sleeve as a chemical bond is formed.

In alternative embodiments, the sleeve is formed from a self-supporting material. The self-supporting material may not be permeable to water, and thus may provide some corrosion resistance to the rock bolt shaft. The sleeve may be formed from plastic that may be rigid or at least semi rigid. The sleeve may also include an external profile having protrusions. The protrusions allow for smooth grout flow and improved bond strength.

Referring to Figs. 1 to 8b, a first embodiment of a fitting 10 for a rock bolt 12 (Fig. 4) is disclosed. The rock bolt 12 has a shaft 14 which has an external thread 16. The external thread 16 extends along an end portion 18 (or a proximal end 18) of the shaft 14. The fitting 10 is arranged to be coupled to the external thread 16. In alternative embodiments, the fitting may be coupled to the shaft of the rock bolt by adhesive or mechanical fastener. The fitting 10 is adapted to allow rotation to be imparted to the shaft 14 when it is located in a bore 20 formed in rock 22. In particular, the illustrated fitting 10 is designed to be low profile with little or no shaft tail protruding from the rock face 24.

Referring to Figs. 1 to 3, the fitting 10 has an axis A that extends in the longitudinal direction. The fitting 10 generally includes a body 26, a first passage portion 28, a second passage portion 30 and at least one outlet 38 (in the illustrated embodiment

three outlets 38 are provided). The fitting 10 is able to introduce grout (or other fluid) into the bore 20 through to the rock bolt 12.

The body 26 has a leading end 32 and a trailing end 34 spaced apart along the axis A. The first passage portion 28 extends from the leading end 32, and is internally threaded with a first thread region 36. The first thread region 36 allows the first passage portion 28 to threadingly engage the external thread 16 on the shaft 14 of the rock bolt 12. Hence, this allows the end portion 18 of the shaft 14 to be threadingly engaged with the end fitting 10.

The outlets 38 extend in the body 26 to an external surface of the fitting 10. As a result, the outlets 38 are in fluid communication with the second passage portion 30 to introduce grout through the rock bolt 12 via the second passage portion 30 and the outlets 38.

The second passage portion 30 extends from the trailing end 34. In the illustrated embodiment, the second passage portion 30 includes the at outlets 38 extending radially from the second passage portion 30 to an external surface of the fitting 10 to introduce grout through the rock bolt 12 via the second passage portion 30 and the outlets 38. In non-illustrated alternative embodiments, the outlets may extend in any direction from the first passage portion and/or the second passage portion to an external surface of the fitting.

The first and second passage portions 28, 30 extend along the axis A, and are interconnected to form a continuous passage between the leading and trailing end 32, 34 of the body 26. In at least one alternative embodiment, the second passage portion includes an interruption (as shown in Figs. 12a and 12b) or a restricted region (as shown in Figs. 9a, 9b, 10a to 11b). In alternative embodiments, (not shown) the first and second passage portions may also extend along distinct parallel longitudinal axes, in which the axes do not run through the centre of the fitting. In this case, the first and second passage portions are off-centre from the axis A. More than two passage portions may also be included, and in particular, the additional passage portions may extend from the trailing end to introduce grout through the rock bolt as discussed in relation to the second passage portion.

The second passage portion 30 also includes a drive receiving region 40 arranged to be engaged with a drive (not shown) to impart rotation to the fitting 10 about the axis. The drive receiving region 40 may extend from the trailing end or be spaced from the trailing end 34. When the drive receiving region extends from the trailing end, it may
5 be either an external drive or an internal drive. For example, if the drive receiving region is an external drive positioned at the trailing end, then the external surface of the trailing end of the fitting is shaped to receive a female tool, such as a hex screw drive. If the drive receiving region is an internal drive extending from the trailing end, then the internal surface of the second passage portion at the trailing end is shaped to receive
10 a male tool (as shown in Figs. 8a to 12b).

In the illustrated embodiment, the drive receiving region 40 is spaced from the trailing end 34. In this case, the drive is inserted into the second passage portion 30 via the trailing end 34 to impart rotation to the fitting 10 about the axis A. As best shown in Fig. 2, the drive receiving region 40 is in the form of an internal hex, which is disposed
15 radially inwardly of the threaded region so as to be able to receive the drive. In alternative embodiments, the drive receiving region may be in any suitable form provided the drive receiving region is capable of engaging with a drive to impart rotation to the fitting about the axis.

In the illustrated embodiment, the outlets 38 are positioned in the drive receiving region 40. The outlets 38 are located in the centre of the unthreaded drive receiving region 40. The three outlets 38 extend radially from the second passage portion 30 and are equally spaced from one another (shown in Figs. 3 and 4). Any number of outlets may be used and they may be spaced apart in any arrangement. The arrangement, number and size of the outlets will affect the rate at which the grout is introduced, and the ability of the
25 grout to be distributed to the rock bolt. The outlets are not required to be positioned in the drive receiving region and may be positioned anywhere along the second passage portion and/or the first passage portion (provided that in use the outlets are in fluid communication with the second passage portion and not blocked by connection of the shaft to the fitting via the first passage portion). The outlets are adapted to allow grout
30 to be directed to the rock bolt shaft. In use, grout is pumped to a distal end 19 of the rock bolt via the second passage portion and the outlets.

Also, the illustrated second passage portion 30 includes a threaded region 42 arranged to receive an attachment with a complementary thread received in the trailing end 34 to threadingly engage the attachment (such as for example a hanger, or fluid lance) to the end fitting 10. The arrangement of the fitting 10 allows an end portion 18 of the shaft 14 (or the proximal end 18) to be threadingly engaged with the first passage portion 28 of the end fitting 10 while the second passage portion 30 of the fitting 10 extends beyond the end of the shaft 14. Hence, the second passage portion 30 is accessible for engagement with the drive to rotate the shaft 14. This allows for the shaft 14 to be positioned within the bore 20 having little to no tail protruding from the rock face but still allows the fitting 10 to input torque to the shaft 14 and tensioning of the rock bolt 12 as will be described in more detail below.

In the illustrated embodiment, the threaded region 42 is disposed intermediate the drive receiving region 40 and the trailing end 34. The threaded region 42 also extends to the trailing end 34. The drive receiving region 40 is disposed radially inwardly of the threaded region 42 (as shown in Fig. 2) so that the threaded region 42 does not interfere with the engagement between the drive and the drive receiving region 40. In alternative embodiments, the drive receiving region may also be positioned intermediate the trailing end and the threaded region. In this latter arrangement the drive receiving region may be disposed at the trailing end.

The fitting 10 also includes an abutment arrangement 44 disposed on the body 202 and forms an external abutment surface 46 that faces the leading end 32. The abutment arrangement 44 is disposed at or proximate the trailing end 34. The abutment arrangement 44 includes a bevelled surface 48 that faces the leading end 32. In other words, the fitting 10 tapers from the trailing end 34 so that the trailing end 34 forms an enlarged head relative to a major portion of the body 26. The illustrated abutment arrangement 44 is designed to form a countersunk configuration and be low profile when the fitting 10 is located in the bore 20 formed in the rock 22 (or within an washer 102/ abutment plate 104 (Fig. 4) which in turn is designed to be in contact with the rock face 24) with little or no trailing end 34 protruding from the rock face 24.

In the illustrated embodiment, the abutment arrangement 44 is integrally formed with the body, but may be formed separately and attached to the body (say by a separate screw threaded fitting arrangement).

Now turning to Figs. 4 and 5, a rock bolt assembly 100 is shown comprising the fitting 10 of Figs 1 to 3, a washer 102, a plate 104, a sleeve 106 and the shaft 14 of the rock bolt 12. The rock bolt assembly 100 is shown including the fitting 10 assembled on the shaft 14. The end portion 18 of the rock bolt 12 is disposed in the first passage portion 28 and threadingly engaged with end fitting 10. The sleeve 106 allows grout to flow to the rock bolt assembly.

The washer 102 is receivable on the body 26 of the fitting 10 and arranged to locate against the abutment arrangement 44. The washer 102 also has a leading face 108 and a trailing face 110 and defines an aperture 112 extending between the leading face 108 and the trailing face 110. The washer 102 also includes an internal surface forming the wall of the aperture 112. The internal surface is shaped to complement the countersunk abutment arrangement 44 of the fitting 10 such that the enlarged head fits within the washer 102.

The leading face 108 of the washer 102 is arranged to locate against the plate 104. In the illustrated embodiment, the leading face 108 of the washer 102 and the plate 104 are both substantially flat to allow a broad contact area to facilitate load transfer from the fitting 10 to the plate 104. In this way the washer 102 increases the contacting surface 108 against the plate 104. In use, the combination of and fit between the plate 104, the leading face 108 of the washer 102, the internal surface 114 of the washer 102 and the abutment arrangement 44 of the fitting 10 allows for more effective load transfer from the fitting 10 through to the plate 104 in a low profile arrangement.

In alternative embodiments, the washer may include a convex leading end. In this regard, the abutment arrangement and/or washer may be in the form of a dome, and the plate may be in the form of a volcano plate. The dome leading end fits within the volcano plate to allow for any alignment adjustment during tensioning of the rock bolt assembly, as well as to accommodate maximum effective load transfer.

In the illustrated embodiment, the washer 102 is formed separately to the fitting 10, but is formed so as to be a complementary low profile shape to the fitting 10.

Advantageously, the same size washer may be used on various sized rock bolts and in combination with various types of end fittings. This provides cost effective and flexible manufacturing options. In alternative embodiments, the washer is integrally formed with the body of the fitting.

The sleeve 106 is disposed around the shaft 14 of the rock bolt 12. The sleeve 106 is also positioned about a portion of the body 26 of the fitting 10, including the first passage portion 28 and the leading end 32, and abuts the abutment arrangement 44 of the fitting 10. An interior cavity 116 is disposed between the sleeve 106 and the fitting 10. The outlets 38 in the fitting 10 are in fluid communication with the interior cavity 116. The interior cavity 116 is annular, but may be any suitable shape. In some of the illustrated embodiments, the sleeve 106 extends for the whole length of the rock bolt shaft 14 (as shown in Figs. 6a to 9b), providing a barrier to ground water or other fluids along the length of the rock bolt shaft 14. The rock bolt may be made from a corrosion resistant material, such as galvanised steel to protect against any unintended seepage of ground water or other fluids.

In the illustrated embodiment, the sleeve 106 generally includes an attachment portion 118 and an elongate portion 120. The attachment portion 118, may also be known as a skirt 118, is attached to the elongate portion 120 of the sleeve 106 and extends over the fitting 10. In some forms, the skirt is in the form of a steel sheathing attachment and the elongate portion is in the form of a plastic sheathing. Alternative embodiments of sleeves will be discussed in more detail below in relation to Figs. 10a to 12b.

At least one seal 122 provided between the sleeve 106 and the fitting 10 to provide a fluid path that extends along a least a portion of the shaft 14 and in the second passage portion 30 and the interior cavity 116. The seal 122 prevents any grout from leaking from the sleeve 106 towards the leading end 32 of the fitting 10. In some embodiments, the seal is a hermetic seal that may also use adhesive such as LOCTITE, may be fused or may be any type of mechanical seal, for example, a threaded connection or a gasket.

Further, at least one sleeve outlet 123 is provided that extends between the interior cavity 116 and an external surface of the sleeve 106. In the illustrated embodiment, the at least one sleeve outlet 123 is in the form of the sleeve 106 being open-ended at the end that doesn't include the seal 122. The sleeve outlet 123 provides a fluid path from the second passage portion 30 to the external surface of the sleeve 106. Alternative embodiments, of the at least one sleeve outlet will be discussed below.

The elongate portion 120 includes an external profile in the form of a continuous helical protrusion 124. An end portion of the skirt 118 includes a complementary

continuous helical protrusion to attach the skirt 118 to the elongate portion 120 by fitting over (or under in some embodiments) and overlapping a portion of the helical protrusion 124 of the elongate portion 120. In alternative embodiments, the skirt may also be secured to the elongate portion by another connection (e.g., threaded
5 connection, seal, adhesive, or fused connection).

The second passage portion 30 and the outlets 38 extend through the fitting 10 to be in fluid communication with the interior cavity 116 through the interior of the skirt 118 and then into the interior cavity 116 to flow around the rock bolt shaft 14. The grout is introduced to the rock bolt assembly 100 via the second passage portion 30, and the
10 outlets 38 and is able to fill the bore hole 20 from the bottom creating two grout flow pathways, one external to the sleeve 106 and one internal to the sleeve 106 within the cavity 116 between the sleeve 106 and the shaft 14.

The continuous helical protrusion 124 promotes smooth grout flow both between the rock bolt shaft 14 and the sleeve 106, and external to the sleeve 106. The grout flows
15 within the sleeve 106 and between the sleeve 106 and the bore hole wall 20. The continuous spiral profile 124 reduces the occurrence of air pockets in the grout. The large amplitude of the thread profile achieves interlock between the rock bolt shaft 14 and the bore hole wall 20 through the sleeve 106. The large amplitude allows for improved bond strength between the rock bolt shaft 14 and the bore hole wall 20.

The fitting 10 and the rock bolt assembly 100 allow for an advantageous grout flow pathway. The design of the sleeve 106 allows for smooth grout flow and improved bond strength, and an advantageous seal between the fitting and the sleeve, which also improves safety for operators. The rock bolt assembly 100 will now be discussed in use in relation to three embodiments of the installation of the rock bolt assembly. Figs.
20 6a and 6b illustrate using resin to anchor the rock bolt in the bore. Figs. 7a and 7b illustrate using a mechanical anchor, and Figs. 8a and 8b illustrate using the combination of a mechanical anchor and resin.

Referring to Fig. 6a, the rock bolt 12 is inserted in the bore 20 in a rock substrate 22. A resin capsule 126 is used to anchor the distal end 19 of the rock bolt 12 in the bore 20.
30 The sleeve 106 is positioned about the shaft 14 of the rock bolt, and the fitting 10 is positioned on the shaft 14. The fitting 10 is engaged with the shaft 14 so as to allow relative axial movement therebetween. The threaded engagement between the fitting

10 and the shaft 14 is such that the shaft 14 is able to move axially relative to the fitting 10 in response to relative rotation between the shaft 14 and the fitting 10 about the shaft axis A, however, the fitting 10 cannot be rotated any further in one direction with respect to shaft 14.

5 The rock bolt assembly 100 is then inserted into the bore 20. The drive is inserted into the second passage portion 30 via the trailing end 34 to impart rotation to the shaft 14 of the rock bolt 12. A torque connection 126 is formed between the fitting 10 and the shaft 14 such that the fitting 10 and the shaft 14 rotate together on the application of torque applied to the connection up until a threshold loading. In the illustrated
10 embodiment, the torque connection is in the form of the hardened resin. The drive thrusts and rotates the fitting 10 in one direction by engaging the second passage portion 30. The drive imparts corresponding rotation to the shaft 14 which is used to activate the resin capsule 126 to anchor the rock bolt in the bore 20. The threshold loading is reached once the resin hardens. A resin 'dam' washer 128 restricts resin
15 flow from blocking the elongate portion 120.

Once the resin hardens, the torque connection is operative to allow relative rotation between the fitting 10 and the shaft 14. Therefore, the rotation applied to the fitting via the drive causes the shaft to be drawn through end fitting (as a result of engagement between the thread 16 on the shaft and the first thread region 36 in the fitting 10). This
20 causes the plate 104, the internal surface 114 of the washer and the abutment arrangement 44 of the fitting 10 to move into forced engagement with the rock face 24 thereby placing the shaft 14 in tension. In embodiments where grout is not used, rock support is achieved at this point. The resin anchored tensioned bolt is considered enough rock strata support for workers to safely continue mining/ advancing the tunnel.
25 The grout is added for long term corrosion resistance and added reinforcement of the ground.

Now turning to Fig. 6b, grout is shown about the rock bolt shaft 14 and the assembly 100. Once rock support is achieved, grout is pumped into the second passage portion 30 such that the grout flows through the second passage portion 30, through the outlets
30 38, into the interior cavity 116 and to the distal end 19 of the rock bolt shaft 14. The grout fills the rock bore hole from the distal end 19 to the proximal end 18 of the rock bolt shaft 14. The grout fills the interior (i.e., the interior cavity 116) and the exterior of

the sleeve 106. Upon the grout setting and forming a bond between the rock bolt shaft 14, the sleeve 106 and the bore hole wall 20, rock support is achieved.

Referring to Figs. 7a, and 7b, a further embodiment is disclosed with the primary difference being that a mechanical anchor 130 is used as a point anchor rather than a resin capsule. In the illustrated embodiment, the mechanical anchor is in the form of an expansion shell 130. In other words, the torque connection discussed in relation to Figs. 6a and 6b is in the form of an expansion shell 130. The expansion shell 130 and the distal end 19 of the rock bolt shaft 14 are in threaded engagement. The pre-grout steps of the installation of the rock bolt assembly 100 are shown in Fig. 7a. The expansion shell 130 anchors the rock bolt 12 in the bore 20. During rotation, the fitting 10 immediately engages the shaft 14 to rotate the bolt 12 which sets the expansion shell 130. The rock bolt thread in the expansion shell 130 then moves up through the expansion shell 130 to tension the bolt 12 and the fitting 10 against the rock face 24.

Fig. 7b illustrates the post-grouting steps of installation of the rock bolt assembly.

Again, grout is introduced into the second passage portion 30 of the fitting 10. The grout flows through the outlets 38, up between the rock bolt 12 and the elongate portion 120 of the sleeve 106 and back down between the elongate portion 120 and the bore hole 20. Rock support is therefore achieved.

Now turning to Figs. 8a and 8b, a further embodiment is shown where an expansion shell 130 and a resin capsule 126 are both used to act as a point anchor for the rock bolt 12. Fig. 8a illustrates the pre-grouting stages of installation and Fig. 8b illustrates the post-grouting stages of installation. Referring to Fig. 8a, the expansion shell 130 is pushed through the resin capsule 126 to point anchor the bolt 12. The rock bolt 12 spins via the drive to mix the resin components, engage the expansion shell 130 against the bore hole wall 20 and tension the rock bolt 12. Again, the resin dam 128 restricts the resin flow from blocking the elongate portion 120 of the sleeve 106 (e.g., plastic sheathing).

Referring to Fig. 8b, grout flows through the second passage portion 30 of the fitting 10, through the outlets 38, up between the rock bolt 12 and the elongate portion 120 of the sleeve 106 and back down between the elongate portion 120 of the sleeve 106 and the bore hole wall 20.

Grout sleeves promote bonding between disclosed embodiments of the rock bolt assembly, embodiments of the sleeve and the bore hole wall, which assists to achieve rock strata support. Alternative embodiments of sleeves will now be discussed as well as the installation of the respective embodiment of rock bolt assembly. Like reference numerals will be used for like features.

Figs. 9a to 9c illustrate using the sleeve 106 discussed above in combination with an alternative embodiment of the rock bolt assembly. Figs. 10a and 10b illustrate an alternative embodiment of sleeve with the rock bolt assembly discussed in Figs. 9a to 9c. Figs. 11a and 11b illustrate the sleeve of Figs. 10a and 10b with an alternative embodiment of the rock bolt assembly. Figs. 12a and 12b illustrate the sleeve of Figs. 10a and 10b with a further embodiment of the rock bolt assembly.

Referring to Figs. 9a and 9b, the sleeve 106 discussed above is shown in use with an alternative embodiment of rock bolt assembly 200.

The fitting 202 includes similar first and second passage portions 204, 206 as discussed above. The primary difference between the fitting 202 and the fitting 10 is that the fitting 202 includes a drive receiving region 208 extending from the trailing end 34. In the illustrated embodiment, the drive receiving region 208 is an internal drive that is shaped to receive a male tool.

The first 204 and second 206 passage portions are interconnected to form a continuous passage. The second passage portion 204 includes a restricted region 210, which extends to the first passage portion 204. The restricted region 210 includes one outlet 212, but may include more than one outlet. In the illustrated embodiment, the outlet 212 extends radially in the body 26 of the fitting 202 to an external surface of the fitting 202 and creates a flow pathway to allow grout or any other flowable substance to be introduced via the second passage portion 206 and the restricted region 210 to the rock bolt assembly 200. The outlet 212 may have the same variations as the outlets 38 discussed above.

The restricted region 210 has a reduced diameter as compared to at least one of the first passage portion and/or an adjacent region of the second passage portion. In the illustrated embodiment, the restricted region 210 is unthreaded and is of a reduced diameter in relation to both the first passage portion 203 and an adjacent region of the

second passage portion 206. Advantageously, when threadingly engaged the proximal end 18 of the rock bolt 12 can abut an end surface of the first passage portion 204 or an end surface of the restricted region 210 and as such the reduced diameter of the restricted region prevents the end of the rock bolt from covering or blocking the radial outlet 212.

The illustrated sleeve is the sleeve 106 as discussed in relation to Figs. 8a to 10b. A seal 214 is provided between the sleeve 106 and the fitting 202 to provide a fluid path that extends along at least a portion of the shaft and in the second passage portion 206 and the interior cavity 116. The seal 214 is used to secure and position the sleeve 106 about the body 26 of the fitting 202. The seal 214 may be in any suitable form providing the seal 214 is water tight, such as a heat shrink plastic or the sleeve may be crimped to the fitting. The sleeve 106 is positioned in relation to the outlet 212 to direct the flow of grout to the rock bolt assembly 200.

Referring to Fig. 9b, the rock bolt assembly 200 also includes an integrally formed washer and plate 216, otherwise known as a bearing member 216. In the previously discussed rock bolt assembly 100, the washer and the plate were formed as separate components.

Referring to Fig. 9c, the rock bolt assembly 200 also includes a distal fitting 220 disposed on the opposite end of the shaft to which the fitting 202 is engaged. In the illustrated embodiment, the distal fitting is in the form of an anchoring assembly 220, but may also be known as a resin anchor sleeve or an anchor cylinder. The anchoring assembly 220 includes a resin sleeve or anchor 222 and a seat 224 that locates a resin capsule in use and is designed to shed the capsule on rotation of the rock bolt. The external surface of the anchor 222 is threaded or includes a projections (for example, a helical protrusion) to promote mixing of the resin and creates a surface having irregularities optimal for resin bonding. The illustrated anchor 222 includes an external thread 226. The pitch direction of the thread is opposite to the resin mixing direction to ensure the resin is pumped to the back of the hole 20 to minimise losses of resin and create a solid bond between the resin, the anchor 222 and the wall of the bore 20. In alternative embodiments, the anchor has a neutral or substantially smooth profile, and thus does not include any irregularities.

Furthermore, the anchoring assembly 220 is engaged with the shaft so as to allow relative axial movement therebetween. The anchoring assembly 220 also includes an internal surface 228 or female thread 228 that is threaded for engagement with the external surface or male thread of the distal end 19 of the shaft 14 of the rock bolt 12.

5 The anchoring assembly 220 is able to move axially relative to the shaft 14 in response to relative rotation between the shaft and the anchoring assembly about the shaft axis. The shaft axis extends longitudinally through the centre of the shaft.

The torque connection 130 is formed between the fitting 202 and the shaft 14, such that fitting 202 and shaft 14 are operative to rotate together on the application of torque
10 applied to the torque connection 130 up until a threshold loading. In the illustrated embodiment, the torque connection 230 is in the form of a shear pin 230. The shear pin 230 extends between the anchor 222 and the shaft 14 of the rock bolt 12 to prevent relative movement between the anchor 222 and the rock bolt 12. Once this threshold is exceeded, the shear pin 230 breaks and allows relative rotation between the fitting 202
15 and the shaft 14.

In the illustrated embodiment, the rock bolt 12 is formed from galvanised steel, and the elongate portion 120 of the sleeve is formed from plastic. The galvanised steel and the sleeve help to protect the bolt against corrosion from seeping ground water.

During installation, the rock bolt assembly 200 is inserted into the bore 20 in the rock
20 substrate 22. A resin capsule (not shown) is located on the seat 224 at the distal end of the assembly 200, and includes resin 126 that anchors the assembly 200 in the bore 20.

The fitting 202 is threadingly connected to the proximal end of the shaft 14 of the rock bolt. The threaded engagement between the fitting 202 and the shaft 14 is such that the fitting cannot be rotated any further in one direction with respect to shaft 14 and the end
25 of the rock bolt abuts the end surface of the first passage portion 204. The sleeve 106 is positioned about a portion of the fitting and a portion of the shaft 14. The rock bolt assembly 200 is then inserted into the bore 20.

A drive is inserted into the drive receiving region 208 at the trailing end 34 of the fitting to impart rotation to the shaft 14 of the rock bolt 12. On rotation of the shaft 14, the
30 sleeve 106 concurrently rotates as does the seat 224. The seat 224 may also be in the form of a resin shredder. On continued drive, the resin shredder 224 bursts the resin

capsule and promotes mixing of the resin 126 to anchor the anchoring assembly 220 and thus the rock bolt 12 in the bore 20. Although not shown in Figs 9a to 9c, a resin 'dam' washer may be used to restrict resin flow, and contain the resin within a specific volume. This allows for strong bonding between the anchoring assembly and the hardened resin.

In non-illustrated alternative embodiments, the resin dam may be formed integrally either with the distal fitting or the sleeve, or formed separately and fixed either to the distal fitting or the sleeve.

Advantageously, the anchoring assembly 220 is of similar diameter to the bore hole 20 such that it creates an annular cavity 232 with a reduced volume in comparison to embodiments solely including the rock bolt shaft 14 shown in Figs. 6a to 8b and 11a to 12b. The reduced volume promotes bonding between the anchoring assembly and the hardened resin.

Once the resin hardens, continued rotation of the assembly causes the shear pin 230 to break and the rotation applied to the fitting via the drive causes the distal end 19 of the shaft 14 to wind into the anchoring assembly 220 (as a result of the threaded engagement between the shaft 14 and the anchor 222). This causes the bearing member 216 and the abutment arrangement 44 of the fitting 202 to move into forced engagement with the rock face 24 thereby placing the shaft 14 in tension. Tension is placed on the rock bolt shaft 14 by rotating the fitting to bear against the bearing member 216. In embodiments where grout is not used, rock support is achieved at this point.

Once rock support is achieved, grout is pumped into the second passage portion 206 such that the grout flows through the second passage portion 206, through the outlet 212, into the interior cavity 116 and towards the distal end 19 of the rock bolt shaft 14. Although not shown in this embodiment, a resin dam may also prevent the grout from mixing with the resin and direct the grout flow back to the proximal end 18 of the bolt 12. The grout fills the rock bore hole 20 from the distal end 19 to the proximal end 18 of the rock bolt shaft 14. The grout fills the interior (i.e., the interior cavity 116) and the exterior of the sleeve 106. Upon the grout setting, it forms a bond between the rock bolt shaft 14, the sleeve 106 and the bore hole wall 20. Rock support is therefore reinforced by the hardened grout and the rock bolt assembly is fully installed.

Now turning to Figs. 10a and 10b, a further embodiment of a rock bolt assembly 300 is illustrated. The primary difference between the assembly shown in Figs. 10a and 10b and the assembly shown in Figs. 9a and 9b is that an alternative embodiment of grout sleeve 302 is shown. The fitting 202 and installation process is the same as discussed
5 in relation to Figs. 9a to 9c.

In the illustrated embodiment, the sleeve 302 may also be known as a grout sock 302. The grout sock 302 is formed from a water permeable material that facilitates a chemical bond between the grout and the rock bolt assembly. Enough porosity is required to allow the grout to chemically bond through the sock, but not so much
10 porosity that too much water seeps through the sock so that the grout being pumped through the interior cavity 116 of the sock will be “wetted out”. For example, the grout sock may be made of any type of woven fabric, such as a fabric with polymer strands or a geo fabric which has little rigidity or is flexible. In this regard, the grout sock 302 allows water to seep through so the bond between the grout, the rock bolt 12, the grout
15 sock 302 and the bore hole wall 20 is improved as compared to when a rigid impermeable sleeve is used. As the grout sock 302 is permeable it does not provide protection against corrosion. As such the rock bolt 12 is preferably made of a corrosion resistant material, such as stainless steel.

Each end of the sock 304, 306 is held in position about other components of the rock
20 bolt assembly 300. At least one seal 303 is provided between the sock 302 and the fitting 202 to provide a fluid path that extends along at least a portion of the shaft 14 in the second passage portion 206 and the interior cavity 116. The sock 302 has a proximal end 304 and a distal end 306. In the illustrated embodiment, the seal 303 fixes the proximal end 304 of the sock 302 to the fitting 202 to direct the flow of grout
25 along the shaft 14.

The rock bolt assembly 300 may also include a second seal 305 that is provided between the sock 302 and the other of the fitting or the shaft to which the first seal 303 is in sealing engagement. In the illustrated embodiment, the second seal 305 fixes the
30 distal end 306 of the sock 302 to the shaft 14 of the rock bolt 12. As a result, the first and second seals 303, 305 are spaced apart in the direction of the shaft axis. The sock 302 is required to be fixed at each end 304, 306 because it is made of a flexible material more susceptible to relative movement in relation to the rock bolt 12.

The sock 302 also includes at least one outlet 308 that is disposed between the first and second seals 303, 305. The at least one outlet 308 extends between the interior cavity 116 and an external surface of the sock 302 to provide a fluid path from the second passage portion 206 to the external surface of the sock 302. The at least one outlet 308 allows the grout to flow external the sock 302 between the rock bolt assembly 300 and the bore hole wall 20. In the illustrated embodiment, the at least one sock outlet 308 is positioned toward the distal end 306 of the sock 302 but may be positioned anywhere and in any pattern along the length of the sock 302.

Although, not illustrated the sock may also include a resin dam positioned towards the distal end of the sock. The resin dam may be formed integrally with the sock.

The rock bolt assembly 300 of Figs. 10a and 10b is installed to provide rock strata support in the same way as described in relation to Figs. 9a to 9c.

Now turning to Figs. 11a and 11b, a further embodiment of a rock bolt assembly 400 is illustrated. The grout sock 302 as discussed in relation to Figs. 10a and 10b is used in combination with an alternative arrangements of tensioning.

Figs. 11a and 11b show the rock bolt assembly 400 in a configuration prior to tensioning. A fitting 402 shown which includes an elongate body 404, having a more elongated first passage portion 406 and second passage portion 407 in comparison to the previously disclosed embodiments of fittings 10, 202. The first passage portion 406 includes a first thread region 408 of a length to allow tensioning of the rock bolt assembly 400 within the fitting 402. In the illustrated embodiment, a torque connection in the form of the shear pin 230 extends between the fitting 402 and the proximal end 19 of the rock bolt shaft 14.

In the illustrated embodiment, a first seal 416 is provided between the sock 302 and the fitting 402. The first seal 416 allows relative movement between the sock 302 and the fitting 402. The first seal 416 includes a sealing member 417 that allows for the relative movement whilst maintaining a seal between the sock 302 and the fitting 402. The sealing member 417 may be in any suitable form that allows relative movement, for example, a wiper seal, or rubber seal such as an o-ring, or rubber gasket.

A liner 410 is disposed on an inner side of the sock 302. The liner 410 is positioned between the fitting 402, and the sock 302 and extends along a portion of the fitting 402

and the shaft 14 of the rock bolt 12. The liner is fixed to the sock 302 so as to providing some rigidity to the sock in the vicinity of the first seal 416 and the seal member 417 is fixed to the liner 410. In the illustrated embodiment, the liner 410 has a proximal end 412 and a distal end 414, and the seal member 417 is fixed to the proximal end 412 of the liner 410.

The distal end 414 of the liner 410 includes a female thread to couple the distal end 414 of the liner 410 to the rock bolt shaft 14. The distal end 414 of the liner 410 also includes a liner outlet 418 extending in the longitudinal or axial direction to provide a fluid path from the second passage portion 407 to the external surface of the sock 302. More than one liner grout outlet 418 may be included, and the outlet 418 may extend in any suitable direction, such as radially through both the liner and the sock. The liner may be made from any inert material such as plastic or stainless steel.

Advantageously, the liner 410 separates the fitting 402 from the grout sock 302 and is capable of moving over the fitting 402 during the tensioning process whilst allowing the sealing member to remain in sealing engagement with the fitting. The liner 410 also allows for the fitting 402 to rotate relative to the shaft of the rock bolt without twisting the grout sock 302.

In the illustrated embodiment, the distal end 19 of the rock bolt includes the resin seat 224 but may, in other embodiments, also include the distal fitting as shown in Figs 9a to 10b.

In the illustrated embodiment, the rock bolt assembly 400 is inserted in the bore 20. The drive is inserted into the trailing end 34 of the fitting 402 to impart rotation to the shaft 14. The drive thrusts and rotates the fitting 402 in one direction, which imparts corresponding rotation to the shaft 14 and the resin sleeve 224. This causes the sleeve 224 to burst and shred the resin capsule mounted on the end of the sleeve 224 thereby activating the resin capsule to anchor the rock bolt 12 in the bore 20. Although not shown in this embodiment, a resin dam may be included (between the thread 16 on the shaft 14 and the first thread region 408 in the fitting 402). This causes the liner 410 and sock 302 to move along the body of the fitting 402. Once the resin hardens, continued rotation of the rock bolt assembly causes the shear pin 230 to break and rotation applied to the fitting 402 via the drive causes the shaft 14 to be drawn through the fitting 402 (as a result of engagement between the end portion 18 of the shaft and the second

passage portion 407 of the fitting 402). This movement also causes the bearing member 216 and the abutment arrangement 44 of the fitting 402 to move into forced engagement with the rock face 24 thereby placing the shaft 14 in tension.

5 Grout is pumped into the second passage portion 407 such that the grout flows through the second passage portion 407, through the restricted region 210, through the outlet 212, and through the liner outlet 418 into the interior cavity 116 and finally through the outlets 308 in the sock 302 to the distal end 19 of the rock bolt shaft 14. The grout fills the rock bore hole 20 from the distal end 19 to the proximal end 18 of the rock bolt shaft 14. The grout fills the interior (i.e., the interior cavity 116) and the exterior of the
10 sock 302.

A further embodiment of a rock bolt assembly 500 is illustrated in Figs. 12a and 12b. In this embodiment, the fitting 502 is in the form of an intermediate fitting 502. The intermediate fitting 502 includes the first and second passage portions 504, 506, and is adapted to be indirectly connected to the drive via an end connection 508 (or an end
15 fitting 508) that is connected to the trailing end 34 of the fitting 502. The end fitting 508 includes a passage 509 that is in fluid communication with the second passage portion 506.

Furthermore, the fitting 502 is engaged with the end fitting 508 to allow relative axial movement therebetween. In this regard, the end fitting 508 includes a thread 514
20 formed on an inner surface of the passage 509. An external thread 512 extends from the trailing end 34 of the intermediate fitting 502 and is designed to mate with the internal thread 514 of the end fitting 508 such that the fitting 502 is able to move axially relative to the end connection 508 and the fitting 502 about the shaft axis. A torque connection (again as illustrated in the form of a shear pin 230) extends between
25 the intermediate fitting 502 and the end fitting 508.

The intermediate fitting 502 also includes a first thread region 510 in the first passage portion 504 which is threadingly engaged with the end portion 18 of the rock bolt shaft 14.

30 The second passage portion 506 of the intermediate fitting 502 includes a grout flow pathway. The first and second passage portions 504, 506 are not interconnected as the second passage portion includes an interruption 516, but could be interconnected as

previously disclosed. One grout outlet 518 is illustrated, which extends in an L-shape that is radially and then longitudinally. More than one outlet may be included and the outlets may extend in any suitable direction.

5 The grout sock 302 is fixed at its proximal end 304 to the intermediate fitting 502 via the first seal 303 and at its distal end 306 to the shaft 14 of the rock bolt 12 via the second seal 305. The sock 302 will rotate during installation.

Advantageously, the intermediate fitting 502 separates the end fitting 508 from the grout sock 302 to allow for tensioning of the rock bolt assembly without having to prevent any twisting of the sock (through the use of a seal that accommodates relative movement as occurred in a previous embodiment). In contrast in the illustrated form
10 the grout sock 302 is “fixed” at both ends 304, 306 to the intermediate fitting 502 and the rock bolt 12 respectively.

During the installation of the rock bolt assembly 500, once the resin hardens, the shear pin 230 breaks and rotation applied to the end fitting 508 via the drive causes the
15 intermediate fitting 502 to wind into the end fitting 508. This movement also causes the abutment arrangement 44 of the end fitting 508 to move into forced engagement with the rock face 24 thereby placing the shaft 14 in tension.

Grout is pumped into the passage portion 509 of the end fitting 508 such that the grout flows into through the end fitting 508, through the second passage portion 506 of the
20 intermediate fitting 502, and through the outlet 518 into the interior cavity 116 and finally through the outlets 308 in the sock 302 to the distal end 19 of the rock bolt shaft 14. The grout fills the rock bore hole 20 from the distal end 19 to the proximal end 18 of the rock bolt shaft 14. The grout fills the interior (i.e., the interior cavity 116) and the exterior of the sock 302. The grout sets and forms a bond between the rock bolt
25 shaft 14, the sock 306 and the bore hole wall 20. Rock support is therefore achieved.

In non-illustrated alternative embodiments, the intermediate fitting may be formed in two parts having a hollow externally threaded part for mating with the end fitting and a second part for mating with the shaft of the rock bolt. The two parts could be fixed together in any suitable manner, such as a threaded connection, or adhesive.

30 Accordingly, embodiments of fittings and rock bolt assemblies are provided which allow for fluid flow, the transfer of torque and tensioning of rock bolts. Furthermore, in

at least one form, the fitting is multifunctional and also provides an arrangement to allow easier fitting of related attachments for use in such operations, as well as various embodiments to allow grout to be introduced to the rock bolt assemblies and drive to be imparted to the assemblies.

5 As will be understood, variations of the above described rock bolt assemblies can be made without departing from the scope of the claims.

While the fittings and rock bolt assemblies have been described in reference to its preferred embodiments, it is to be understood that the works which have been used are descriptive rather than limiting and that changes may be made without departing from
10 its scope as defined by the claims.

It is to be understood that a reference herein to a prior art document does not constitute an admission that the document forms part of the common general knowledge in the art in Australia or in any other country.

15 In the claims which follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word “comprise” or variations such as “comprises” or “comprising” is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

Claims

1. A fitting for a rock bolt having a shaft, the fitting having an axis and the fitting comprising:

a body having a leading end and a trailing end spaced apart along the axis;

a first passage portion extending from the leading end, the first passage portion being arranged to engage the shaft of the rock bolt;

a second passage portion extending from the trailing end, the second passage portion being spaced from the first passage portion in the direction of the axis; and

at least one outlet extending in the body to an external surface of the fitting, the at least one outlet being in fluid communication with the second passage portion.

2. A fitting according to claim 1, wherein the outlet is disposed in the second passage portion.

3. A fitting according to either claim 1 or claim 2, wherein the second passage portion has a constant internal diameter along its length.

4. A fitting according to any one of the preceding claims, wherein the second passage portion includes one or more of:

a driving receiving region arranged to be engaged with a drive to impart rotation to the fitting about the axis;

a threaded region; and

a restricted region having a reduced diameter as compared to at least one of the first passage portion and/or an adjacent region of the second passage portion.

5. A fitting according to claim 4, wherein the second passage portion includes the drive receiving region extending from the trailing end of the body.

6. A fitting according to claim 4, wherein the second passage portion includes the drive receiving region, the drive receiving region being spaced from the trailing end.

7. A fitting according to claim 5 or 6, wherein the at least one outlet is positioned in the drive receiving region.

8. A fitting according to any one of the preceding claims, wherein the at least one outlet extends radially in the body to an external surface of the fitting.
9. A fitting according to any one of claims 4 to 8, wherein second passage portion includes the threaded region, the threaded region being arranged to receive an attachment with a complementary thread received in the trailing end to threadingly engage the attachment to the fitting.
10. A fitting according to claim 9, when dependent on claim 6, wherein the threaded region being disposed intermediate the drive receiving region and the trailing end.
11. A fitting according to claim 10, wherein the drive receiving region is disposed radially inwardly of the threaded region.
12. A fitting according to claim 4, wherein the second passage portion includes the threaded region, the threaded region extending from the trailing end.
13. A fitting according to any one of the preceding claims, wherein the second passage portion includes external threading extending from the trailing end.
14. A fitting according to any one of claims 4 to 13, wherein the second passage portion includes the restricted region, the restricted region extending to the first passage portion.
15. A fitting according to claim 4, wherein the second passage portion includes the restricted region, and the at least one outlet is positioned in the restricted region.
16. A fitting according to any one of the preceding claims wherein the first passage portion extends along the axis.
17. A fitting according to any one of the preceding claims wherein the second passage portion extends along the axis.
18. A fitting according to any one of the preceding claims, wherein the first and second passage portions are interconnected to form a continuous passage between the leading and trailing end of the body.

19. A fitting according to any one of the preceding claims, wherein the body is formed of first and second members.
20. A fitting according to any one of the preceding claims, wherein the first passage portion includes a first threaded region, the first threaded region being arranged to threadingly engage a complementary external thread on the shaft of the rock bolt.
21. A fitting according to any one of the preceding claims, further comprising an abutment arrangement disposed on the body and forming an external abutment surface that faces the leading end.
22. A fitting according to claim 21, wherein the abutment arrangement is disposed at or proximate the trailing end and forms an enlarged head on the body.
23. A rock bolt assembly comprising:
 - a shaft;
 - a fitting according to any one of claims 1 to 19, an end of the shaft disposed in the first passage portion and engaged with the fitting; and
 - a sleeve disposed around the shaft with an interior cavity is disposed between the sleeve and the shaft, and wherein the outlet in the fitting is in fluid communication with the interior cavity.
24. A rock bolt assembly according to claim 23, further comprising at least one seal provided between the sleeve and the fitting to provide a fluid path that extends along at least a portion of the shaft and in the second passage portion and the interior cavity.
25. A rock bolt assembly according to claim 24, wherein at least one sleeve outlet is provided that extends between the interior cavity and an external surface of the sleeve to provide a fluid path from the second passage portion to the external surface of the sleeve.
26. A rock bolt assembly of any one of claims 23 to 25, further comprising a first seal provided between the sleeve and one of the fitting or the shaft, wherein the first seal allows relative movement between the sleeve and the one of the fitting or the shaft.

27. A rock bolt according to 26, wherein the first seal includes a sealing member that allows for the relative movement whilst maintaining a seal between the sleeve and the one of the fitting or the shaft.

28. A rock bolt assembly of 27, further comprising a liner disposed on an inner side of the sleeve, the liner being fixed to the sleeve and wherein the sealing member is fixed to the liner.

29. A rock bolt assembly according to claim 26 to 28, further comprising a second seal provided between the sleeve and the other of the fitting or the shaft to which first seal is in sealing engagement, the first and second seals being spaced apart in the direction of the shaft axis.

30. A rock bolt assembly according to claim 29, wherein the sleeve and the other of the fitting or the shaft are fixed together at the second seal.

31. A rock bolt assembly according to claim 29 or 30, when dependent on claim 25 wherein the at least one sleeve outlet is disposed between the first and second seals.

32. A rock bolt assembly according to any one of claims 23 to 31, wherein the fitting is engaged with the shaft so as to allow relative axial movement therebetween.

33. A rock bolt assembly according to claim 32, wherein the fitting includes a thread formed on an inner surface of the first passage portion which engages a thread formed on the shaft end such that the shaft is able to move axially relative to the fitting in response to relative rotation between the shaft and the fitting about the shaft axis.

34. A rock bolt assembly according to claim 33, further comprising a torque connection formed between the fitting and the shaft, such that fitting and shaft are operative to rotate together on the application of torque applied to the connection up until a threshold loading and wherein above said threshold, the torque connection is operative to allow relative rotation between said fitting and said shaft.

35. A rock bolt assembly according to claim 34, wherein the torque connection is in the form of a shear pin, adhesive or a removable or frangible element that restricts relative axial and/or rotational movement between the shaft and the fitting.

36. A rock bolt assembly according to any one of claims 32 to 35, when dependent on claim 26, where in the first seal allows for the relative axial movement between the fitting and the shaft.
37. A rock bolt assembly according to any one of claims 23 to 36, wherein the fitting further comprises an abutment arrangement disposed on the body and forming an external abutment surface that faces the leading end.
38. A rock bolt assembly according to any one of claims 23 to 36, further comprising an end connection that is connected to the trailing end of the fitting, the end connection including a passage that is in fluid communication with second passage portion.
39. A rock bolt assembly according to claim 38, wherein the fitting is engaged with the end connection so as to allow relative axial movement therebetween.
40. A rock bolt assembly according to claim 39, wherein the end connection includes a thread formed on an inner surface the passage which engages a thread formed on an external surface of the fitting body such that the fitting is able to move axially relative to the end connection in response to relative rotation between the end connection and the fitting about the shaft axis.
41. A rock bolt assembly according to claim 40, further comprising a torque connection formed between the fitting and the end connection, such that fitting and end connection are operative to rotate together on the application of torque applied to the torque connection up until a threshold loading and wherein above said threshold, the torque connection is operative to allow relative rotation between said fitting and said end connection.
42. A rock bolt assembly according to claim 41, wherein the torque connection is in the form of a shear pin, adhesive or a removable or frangible element that restricts relative axial and/or rotational movement between the end connection and the fitting.
43. A rock bolt assembly according to any one of claims 38 to 42, wherein the end connection further comprises an abutment arrangement disposed that forming an external abutment surface that faces the fitting.

44. A rock bolt assembly according to any one of claims 38 to 43, wherein the end fitting includes a drive receiving portion that is arranged to receive a drive to impart rotary and/or axial drive to the rock bolt assembly.

45. A rock bolt assembly according to any one of claims 38 to 44, wherein the sleeve does not extend to the end fitting.

46. A rock bolt assembly according to any one of claims 23 to 45, further comprising a distal fitting disposed on the opposite end of the shaft to which the fitting is engaged.

47. A rock bolt assembly according to claim 46, wherein the distal fitting is engaged with the shaft so as to allow relative axial movement therebetween.

48. A rock bolt assembly according to claim 47, wherein the distal fitting includes a female thread which engages a thread formed on an external surface of the shaft such that the distal fitting is able to move axially relative to the shaft in response to relative rotation between the shaft and the distal fitting about the shaft axis.

49. A rock bolt assembly according to claim 48, further comprising a torque connection formed between the end fitting and the shaft, such that end fitting and shaft are operative to rotate together on the application of torque applied to the torque connection up until a threshold loading and wherein above said threshold, the torque connection is operative to allow relative rotation between said end fitting and said shaft.

50. A rock bolt assembly according to claim 49, wherein the torque connection is in the form of a shear pin, adhesive or a removable or frangible element that restricts relative axial and/or rotational movement between the shaft and the end fitting.

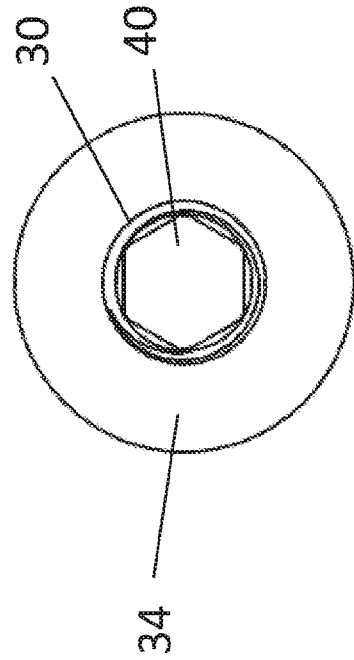
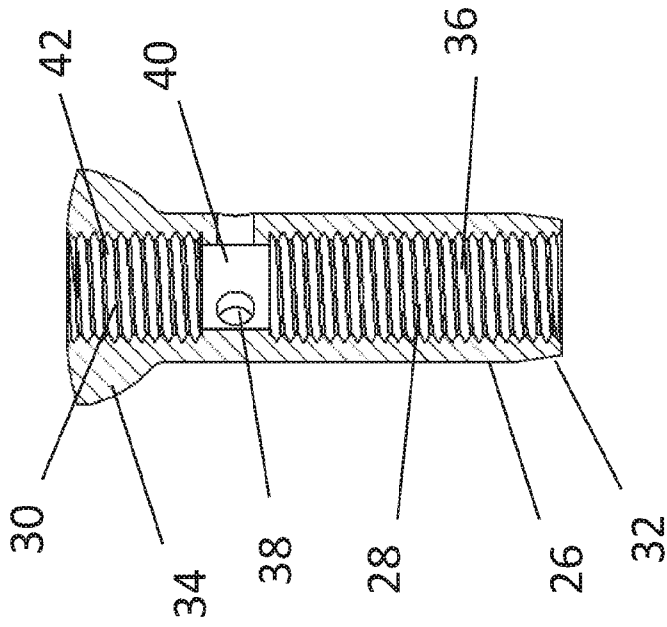
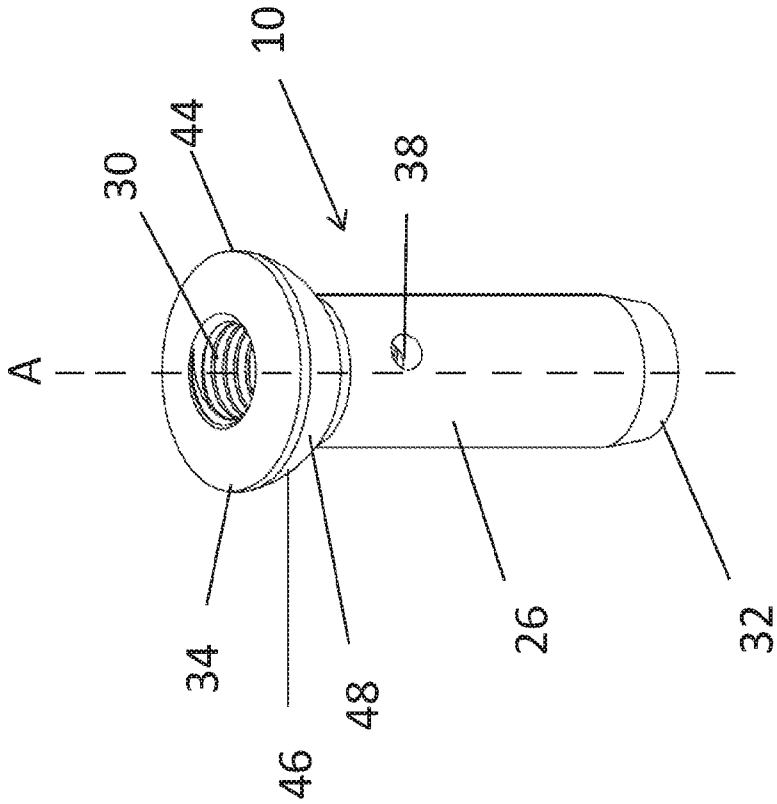
51. A rock bolt assembly according to any one of claims 46 to 50, wherein the distal fitting is in the form of a mechanical anchor.

52. A rock bolt assembly according to any one of claims 46 to 50, wherein the distal fitting is in the form of a resin anchor sleeve.

53. A rock bolt assembly according to any one of claims 46 to 50, wherein the sleeve does not extend to the distal end fitting.

54. A rock bolt assembly according to any one of claims 23 to 25, wherein the rock bolt assembly is able to contract axially without causing relative movement between the sleeve and the shaft and fitting.
55. A rock bolt assembly according to any preceding claim, wherein the sleeve is formed from a water permeable material.
56. A rock bolt assembly according to any one of claims 23 to 55, wherein the sleeve is flexible.
57. A rock bolt assembly according to any one of claims 23 to 55, wherein the sleeve is formed from a self-supporting material.
58. A rock bolt assembly according to any preceding claim, wherein the sleeve is formed from plastic and includes an external profile having protrusions.

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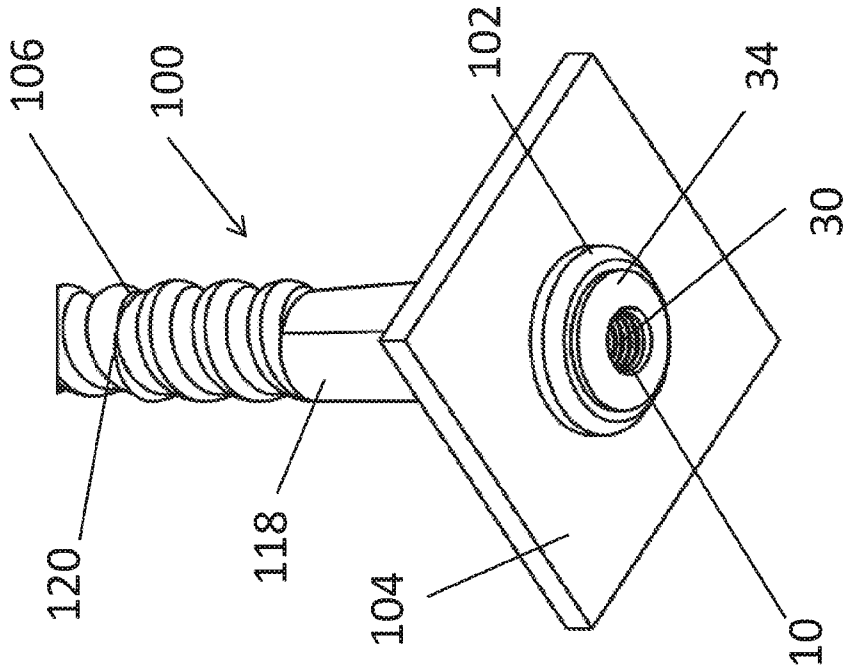


Fig. 5

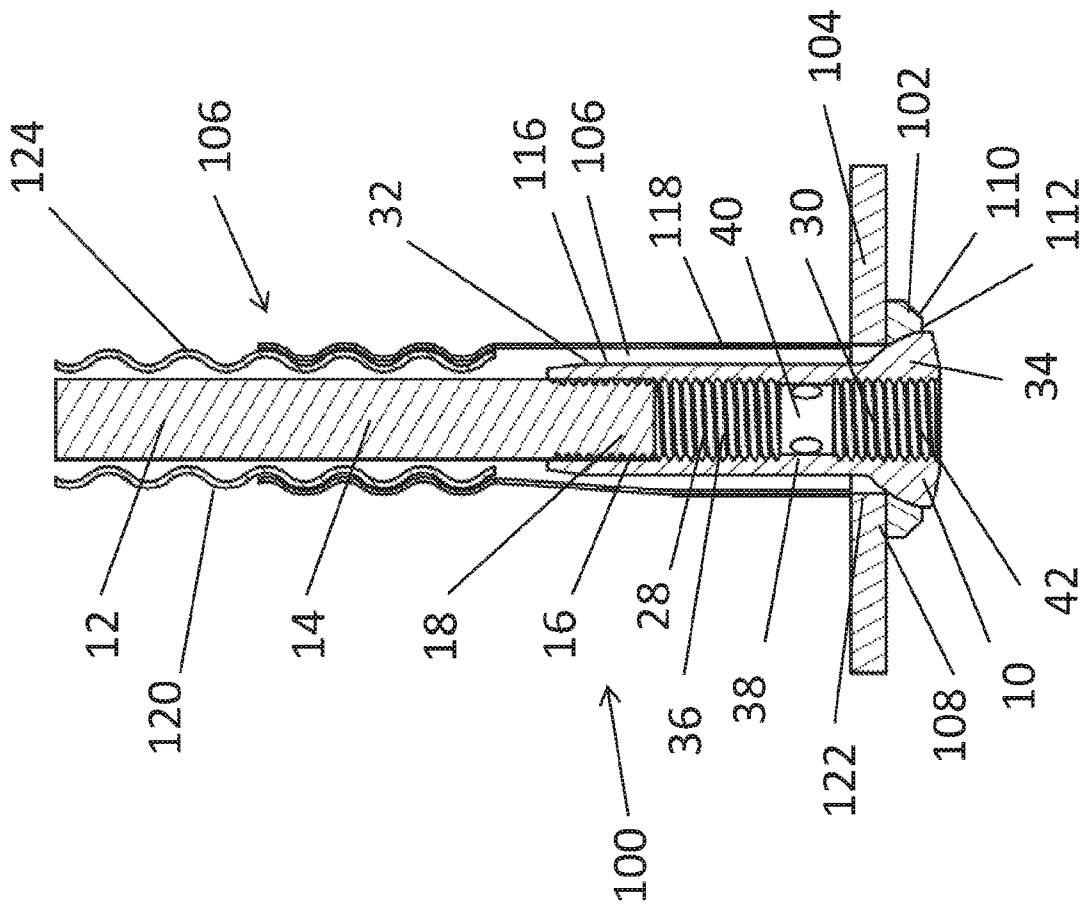


Fig. 4

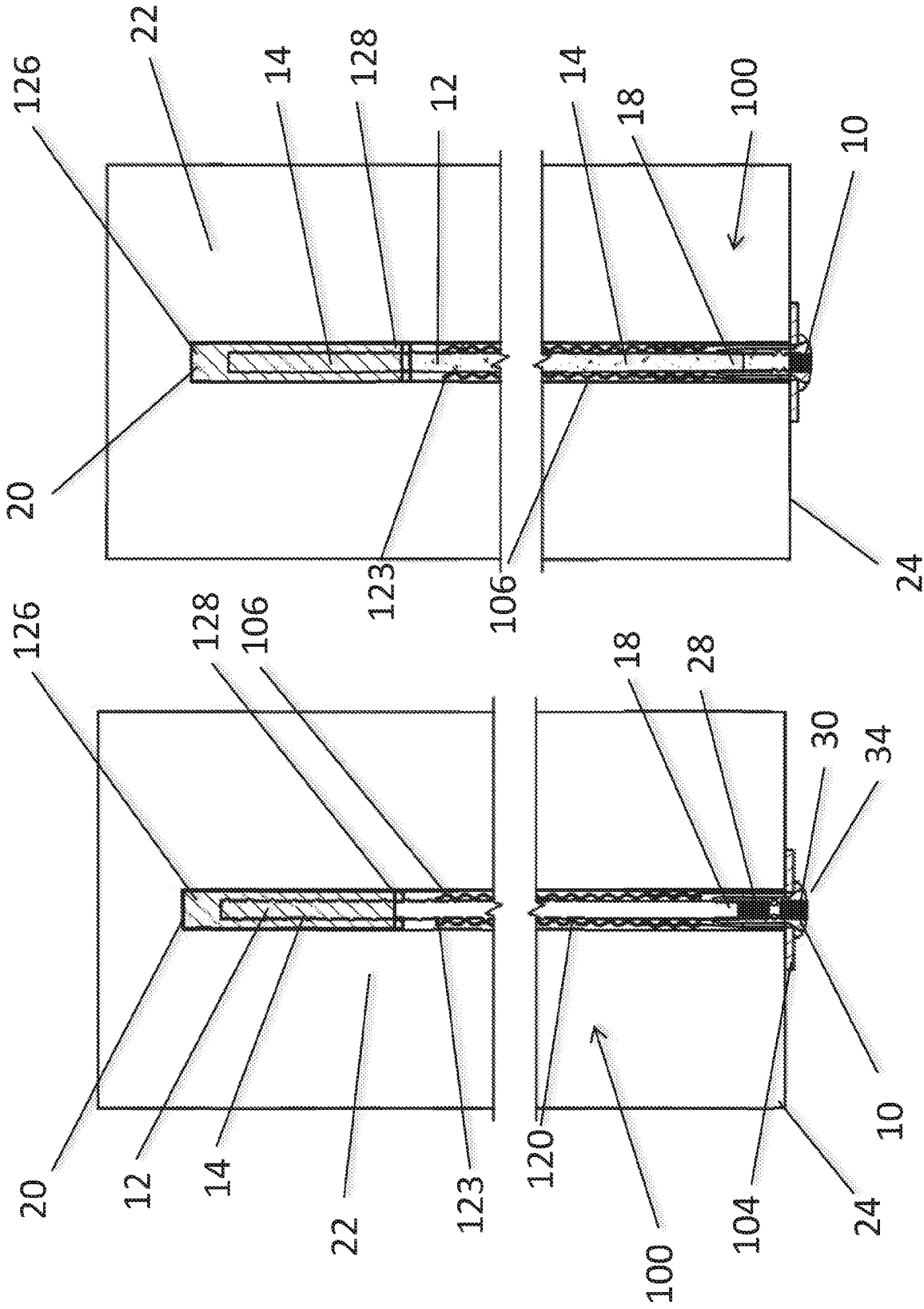


Fig. 6b

Fig. 6a

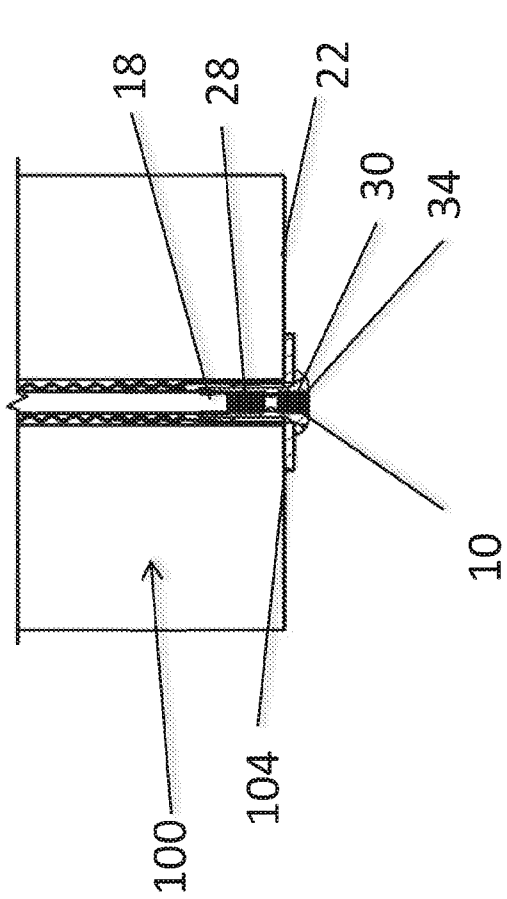
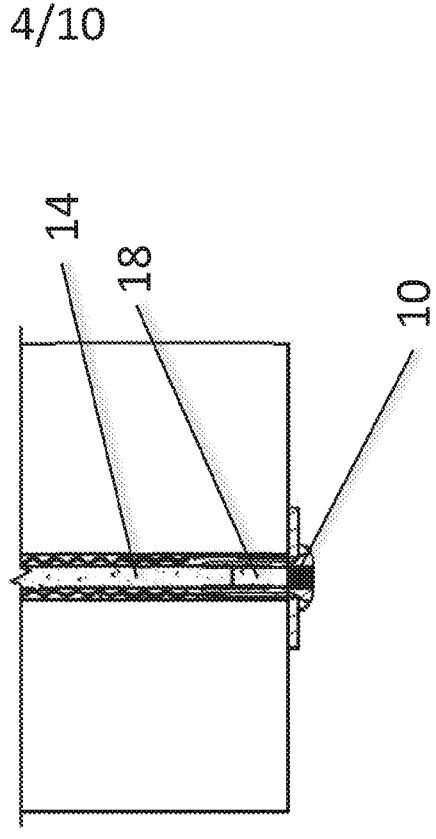
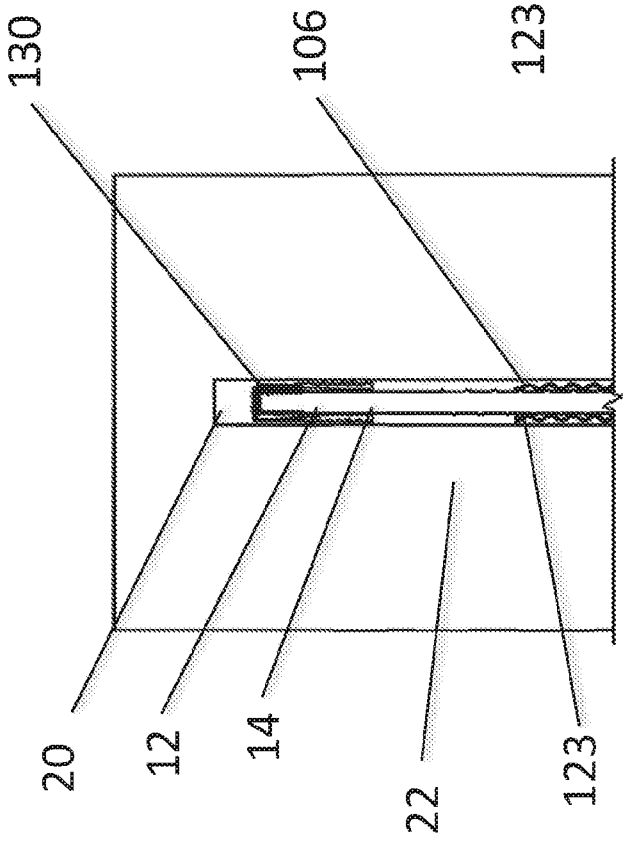
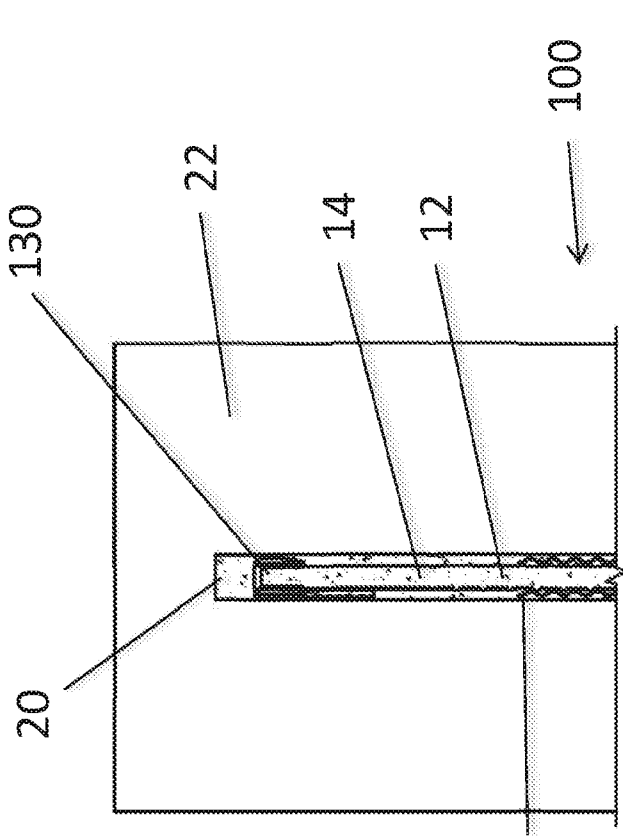
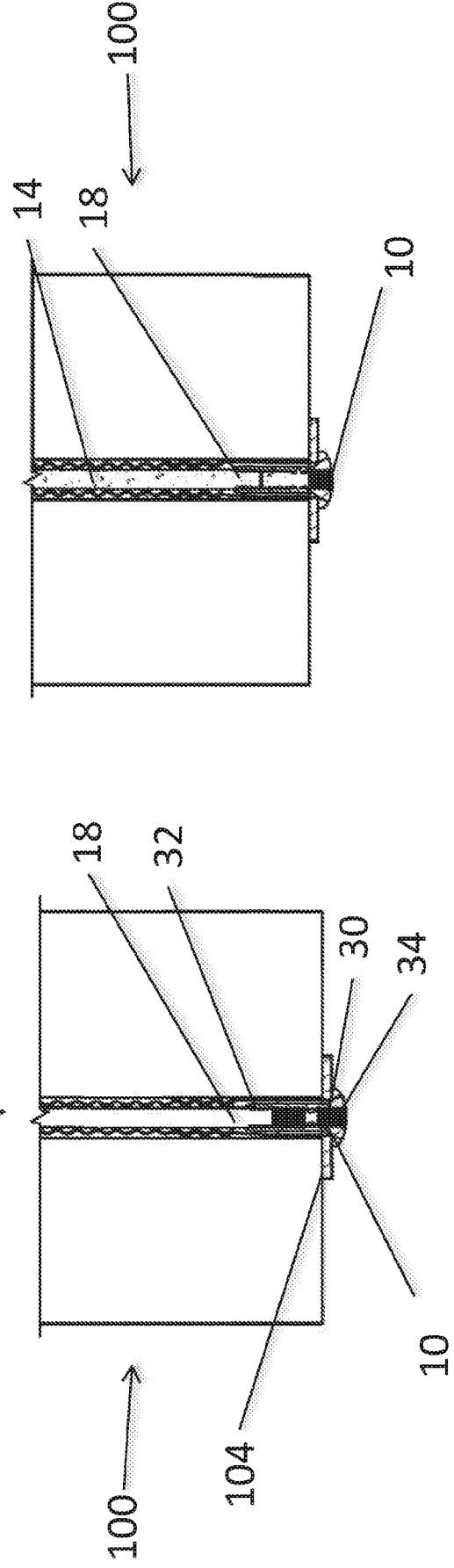
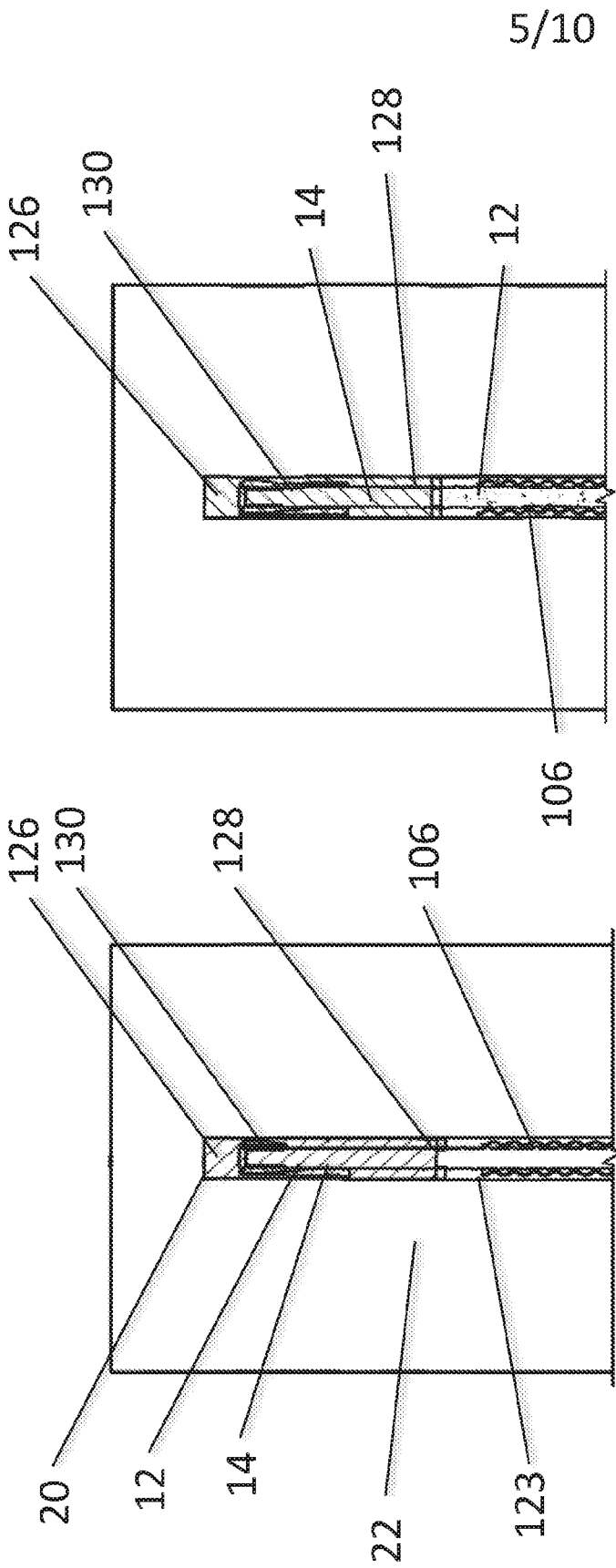


Fig. 7a

Fig. 7b



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Fig. 8b

Fig. 8a

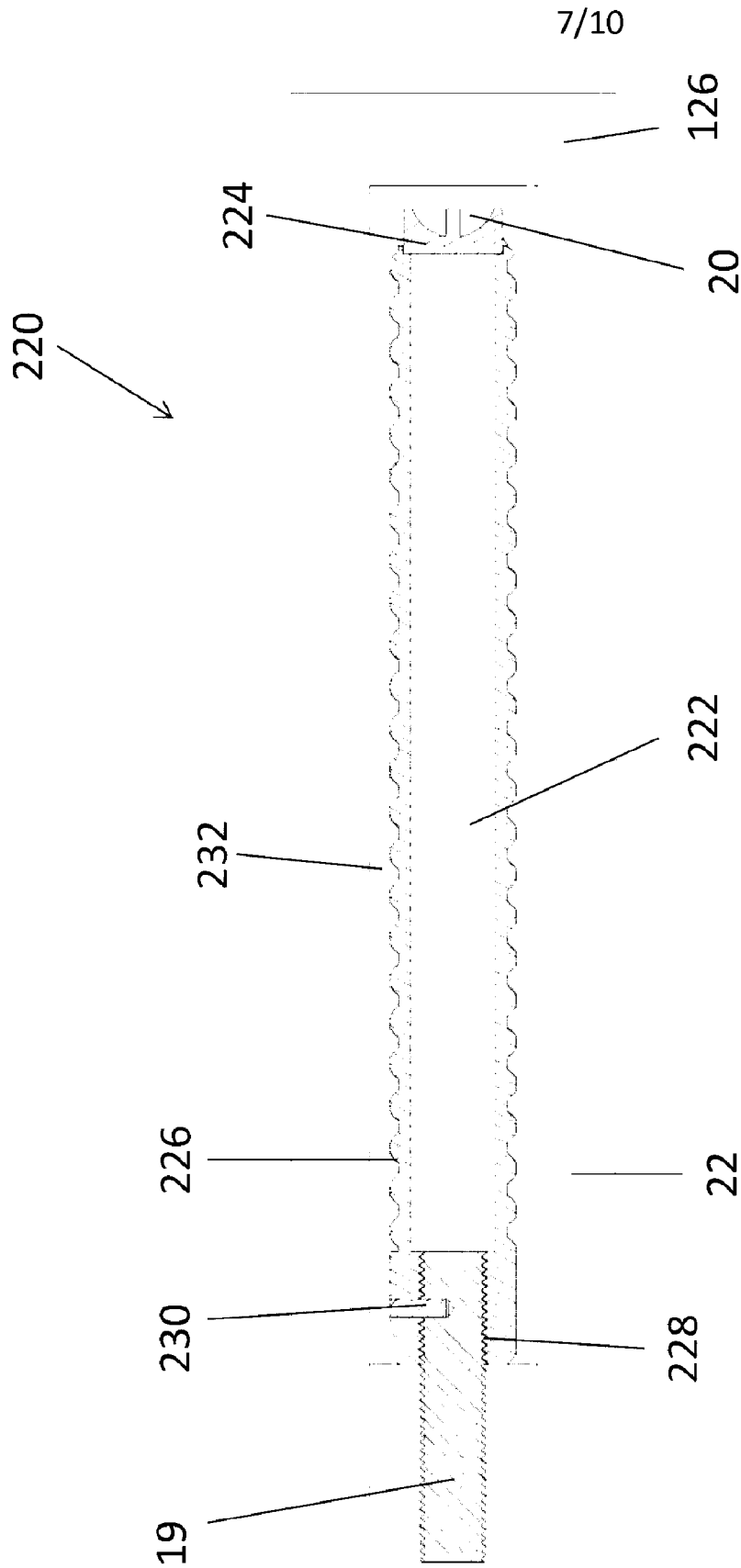
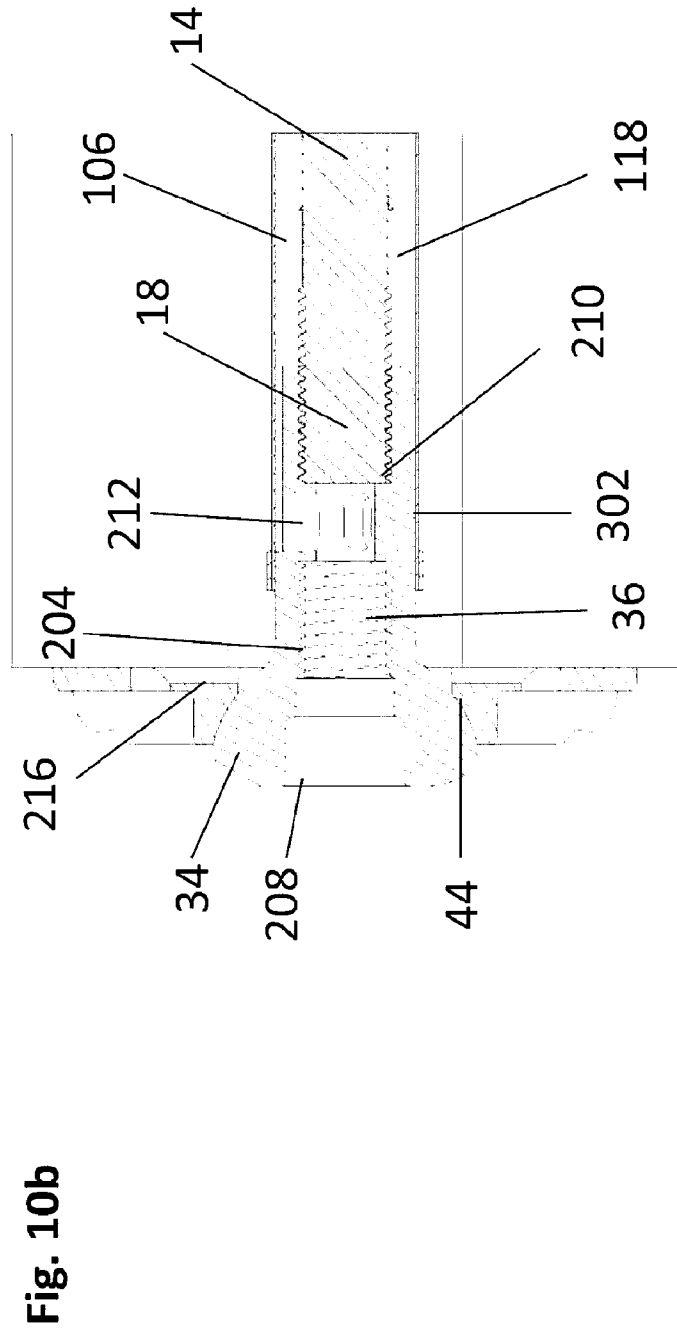
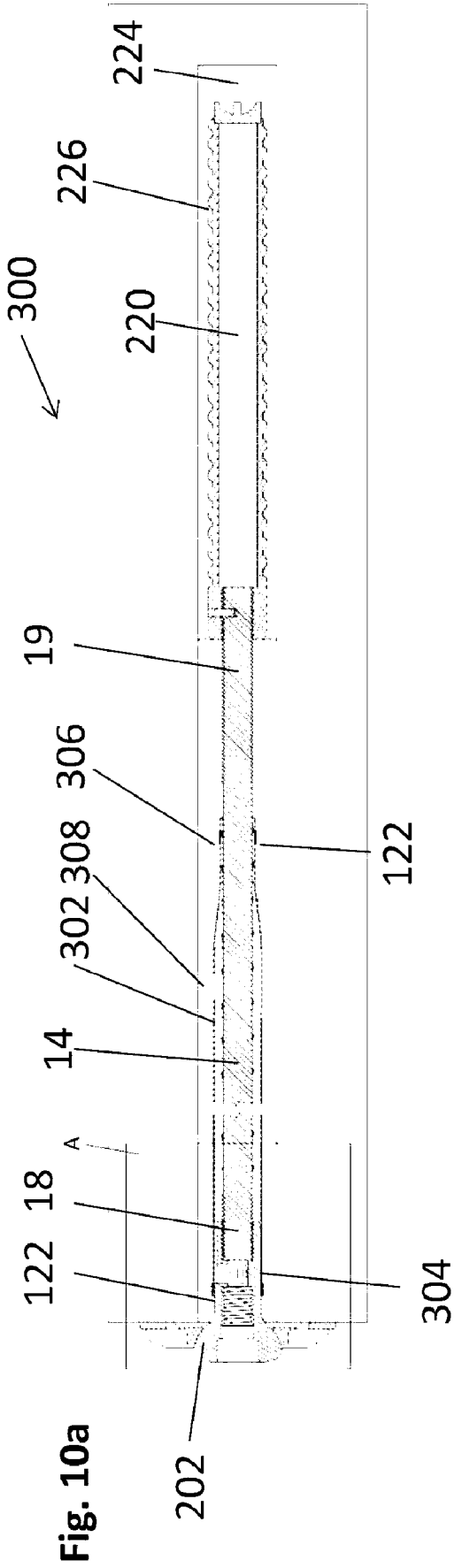


Fig. 9c



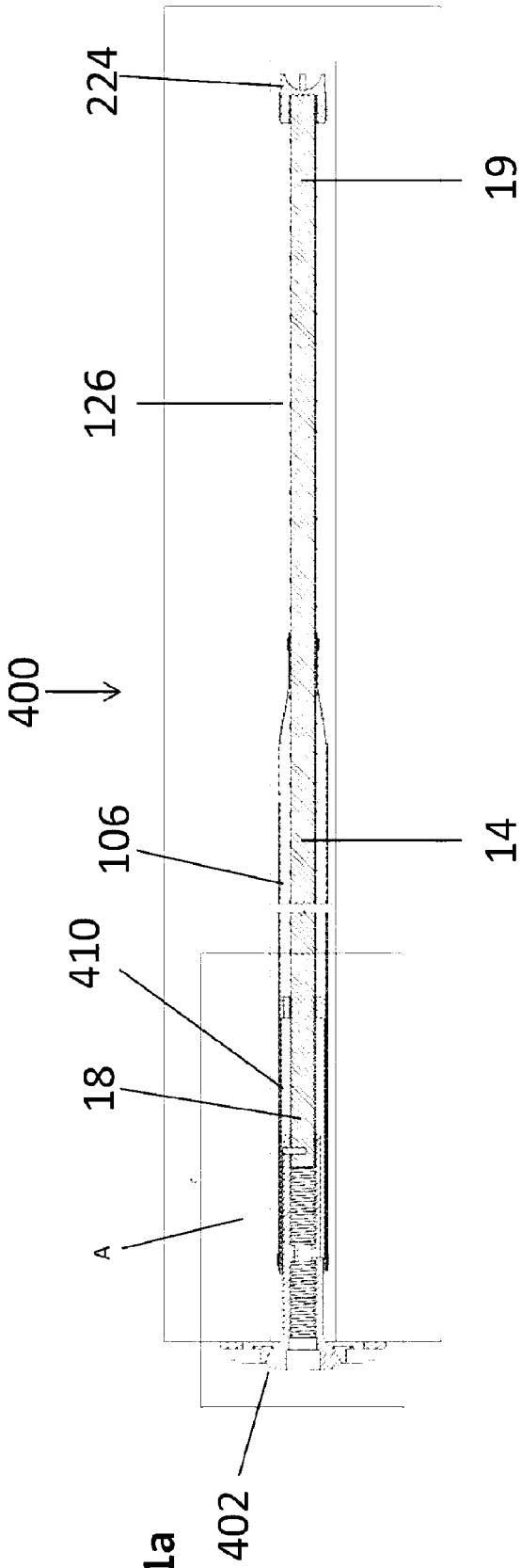


Fig. 11a

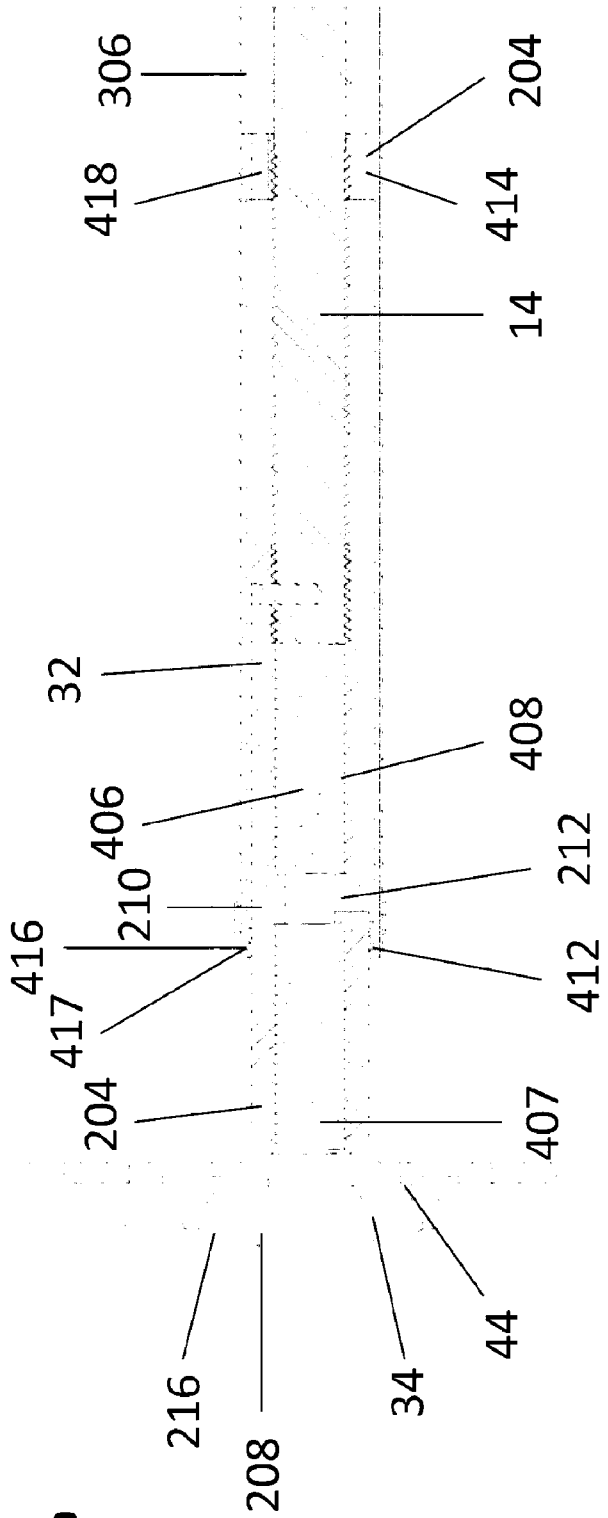


Fig. 11b

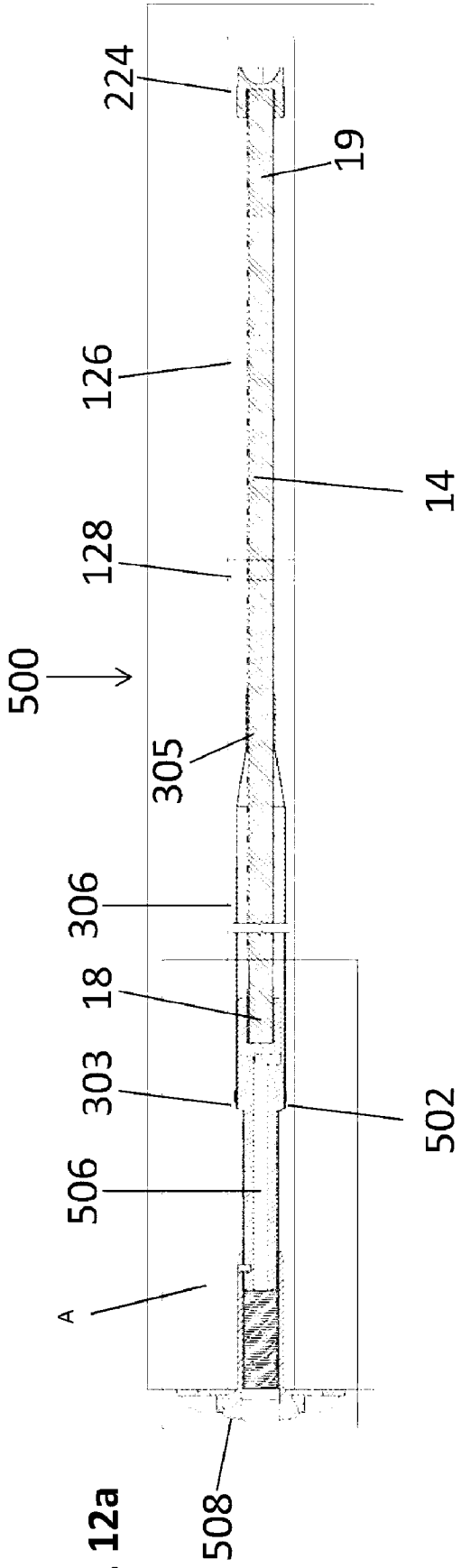


Fig. 12a

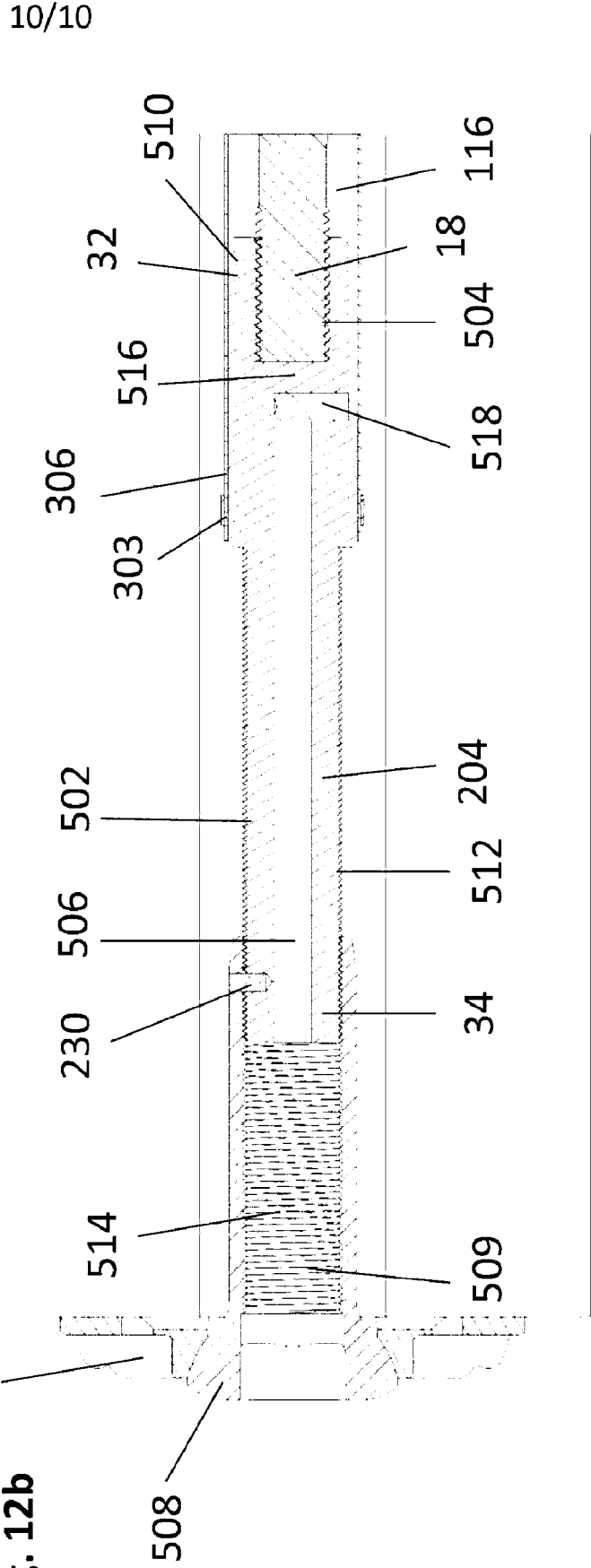


Fig. 12b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2016/050151

A. CLASSIFICATION OF SUBJECT MATTER

E21D 20/00 (2006.01) E21D 20/02 (2006.01) E21D 21/00 (2006.01) F16B 13/00 (2006.01) F16B 13/14 (2006.01)
F16B 23/00 (2006.01) F16B 35/00 (2006.01)

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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

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

Database used: EPODOC, WPIAP, TXTE (cluster), Espacenet, Google/Google patents and AusPat

IPC/CPC marks used: E21D20/-, E21D20/02/low, E21D21/-, F16B13/-, F16B13/14/low, F16B23/-, F16B35/-

Keywords used: rock, bolt, fitting, passage, outlet and the like terms.

Applicant/inventor name searched on Espacenet, AusPat and internal databases provided by IP Australia.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

Further documents are listed in the continuation of Box C

See patent family annex

* Special categories of cited documents:		
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	
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"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	
"P" document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search
27 April 2016

Date of mailing of the international search report
27 April 2016

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INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. PCT/AU2016/050151
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 8137032 B2 (GROCHOLEWSKI et al.) 20 March 2012 Abstract; Figs.1, 2; col.3 line 58	1-58
X	US 2009/0052995 A1 (ERIKSSON et al.) 26 February 2009 Abstract; Figs.1, 2, 7, 8	1-58
A	US 8172485 B2 (CRAIG) 08 May 2012	
A	AU 2007221783 A1 (DYWIDAG - SYSTEMS INTERNATIONAL PTY LTD) 13 March 2008	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU2016/050151

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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		ZA 200807536 A	29 Apr 2009
AU 2007221783 A1	13 March 2008	AU 2007221783 A1	13 Mar 2008
		AU 2007221783 B2	02 Aug 2012

End of Annex