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(54) **ROCK BOLT**

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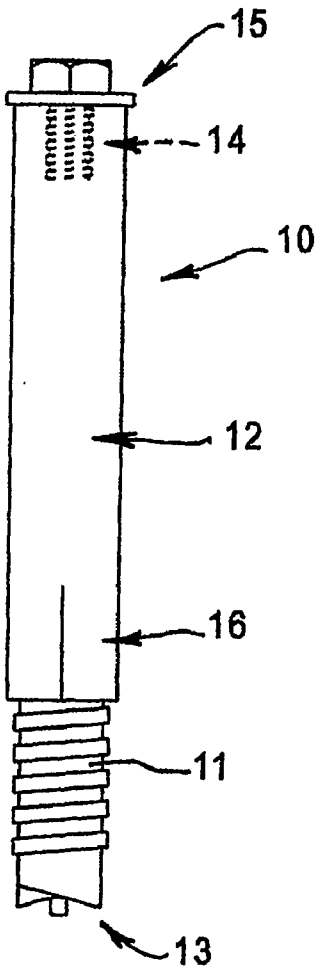
E21B 7/00 (2006.01)

(52) **U.S. Cl.** **405/259.1**; 175/320; 175/327; 175/57

(57) **ABSTRACT**

A rock bolt (**10**) comprising first and second elongate members (**11, 12**) is disclosed. The first elongate member comprises a first end (**13**) adapted to penetrate rock, and a second end (**14**) adapted to provide attachment for actuating means. The first elongate member is disposed at least partially, longitudinally inside the second elongate member. The second elongate member can be adapted for transverse expansion along at least a portion of its length in order to anchor the rock bolt into position. A cavity can be formed between the first and second elongate members extending between the first and second ends of the first elongate member. Methods of drilling with rock bolts according to the invention are also disclosed.



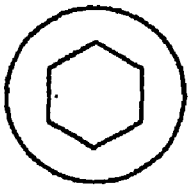


FIG 1b

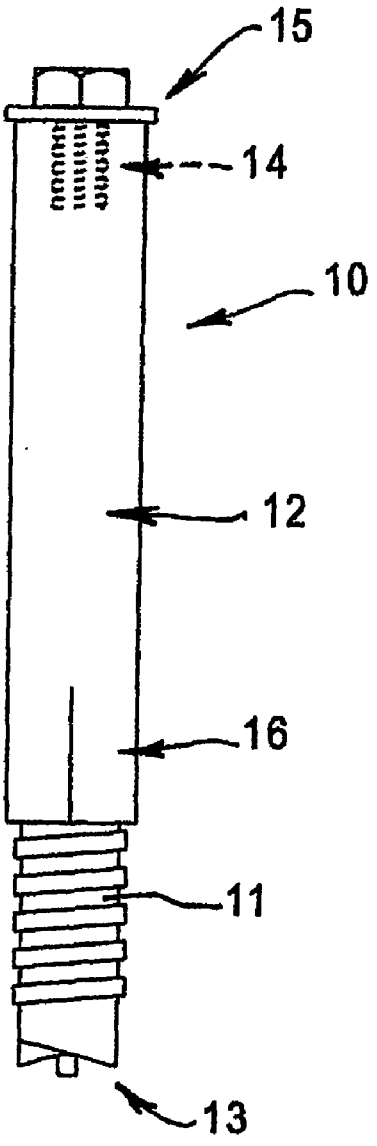


FIG 1a

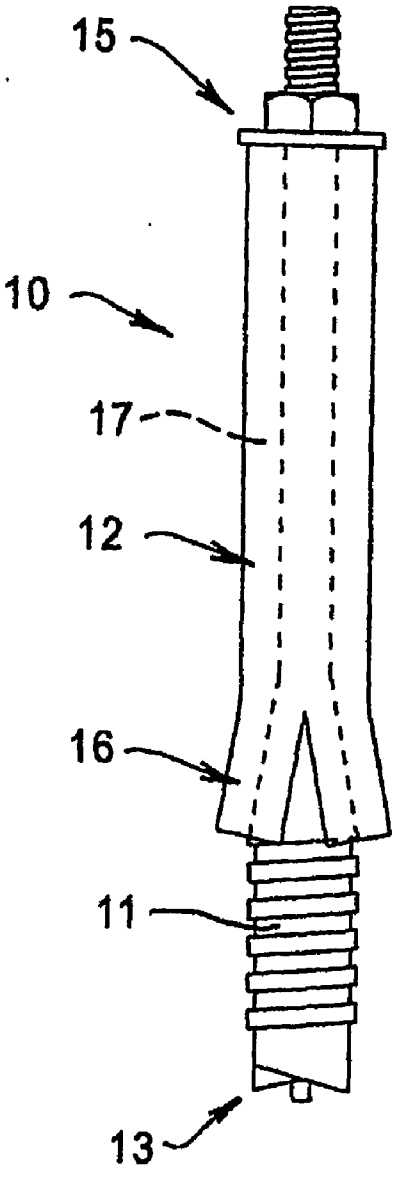


FIG 2

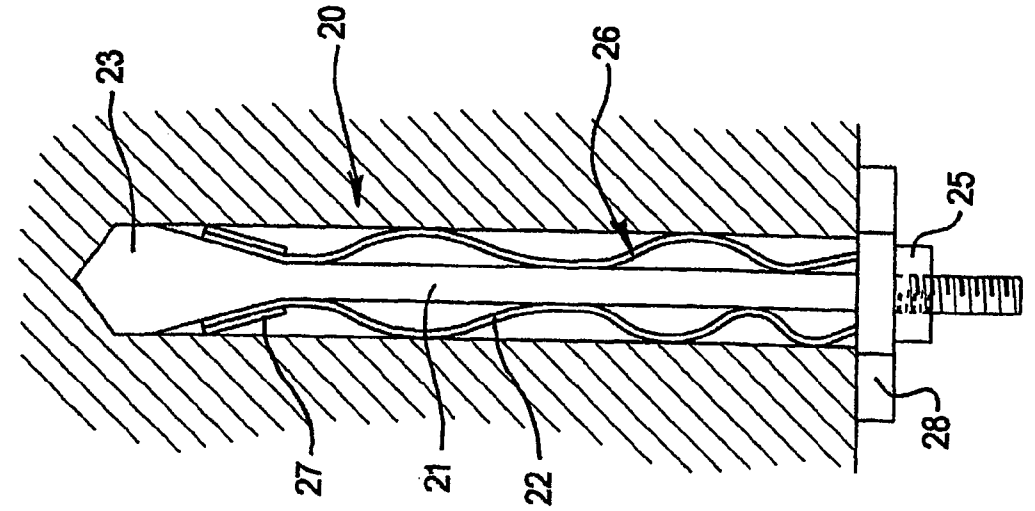


FIG 3c

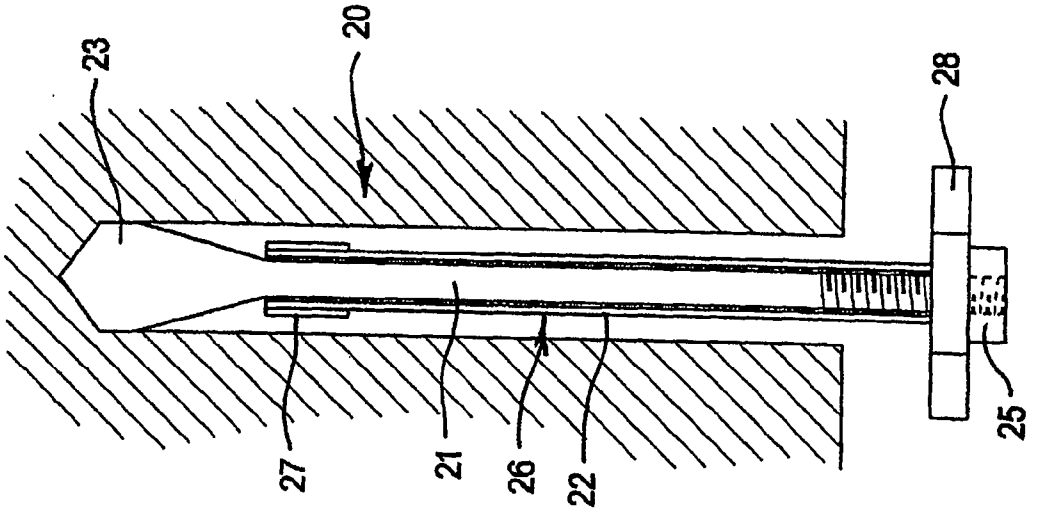


FIG 3b

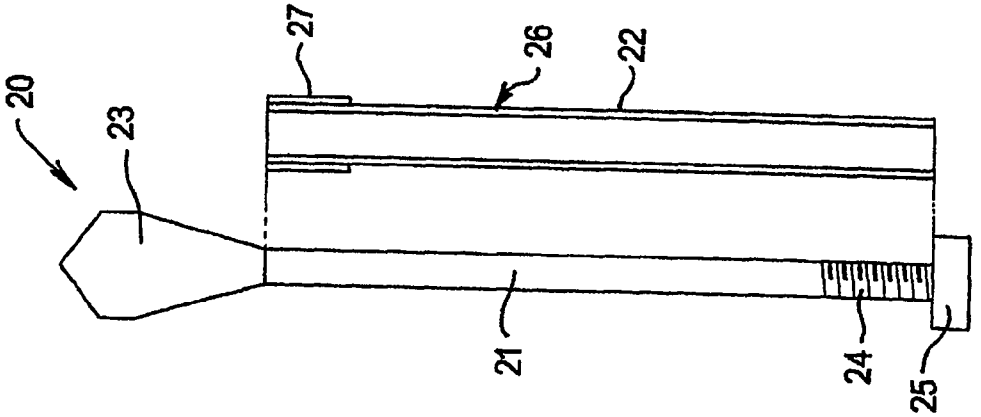


FIG 3a

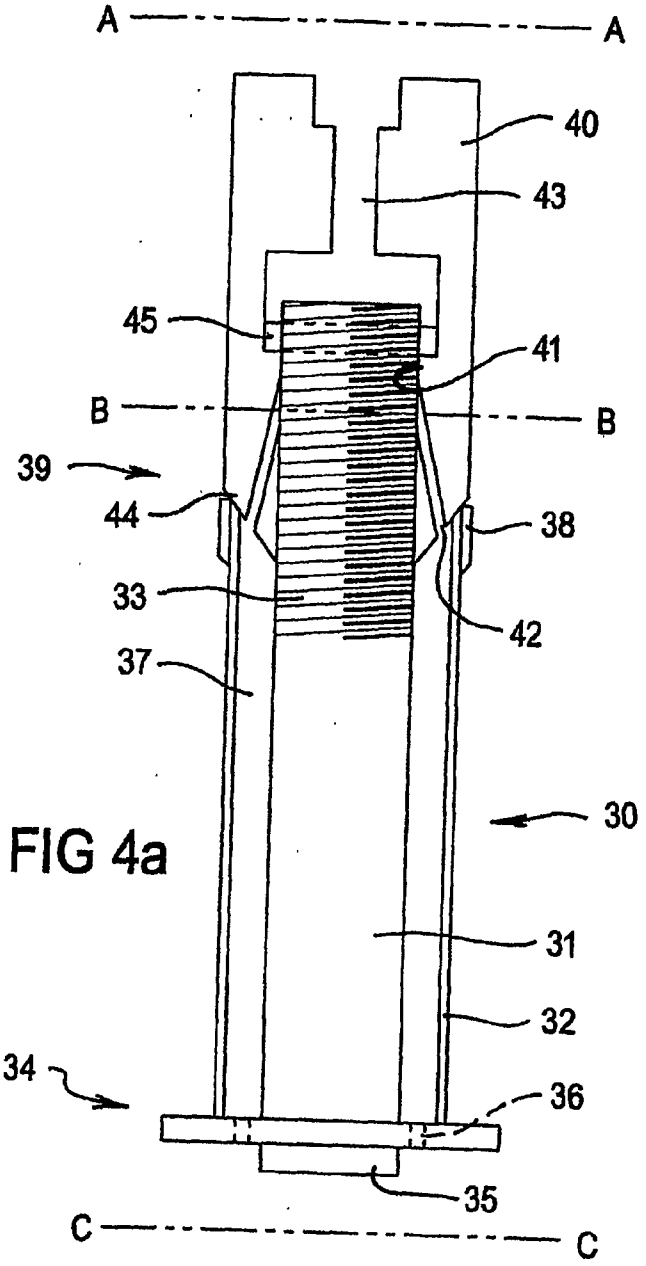


FIG 4a

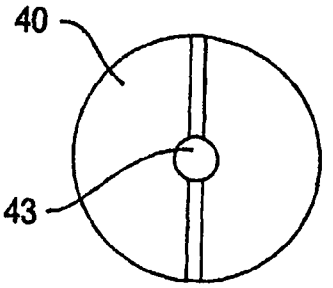


FIG 4c

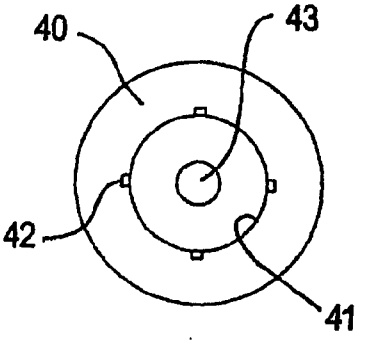


FIG 4d

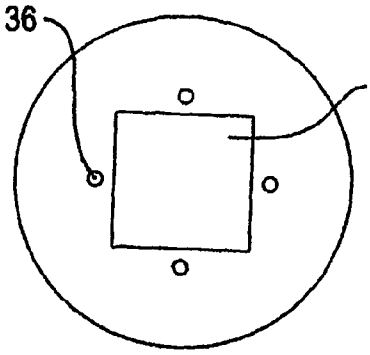


FIG 4b

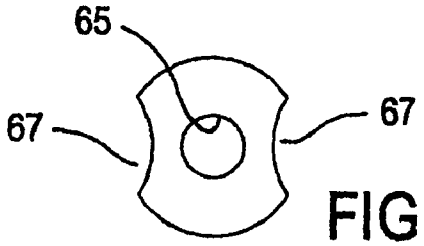


FIG 5c

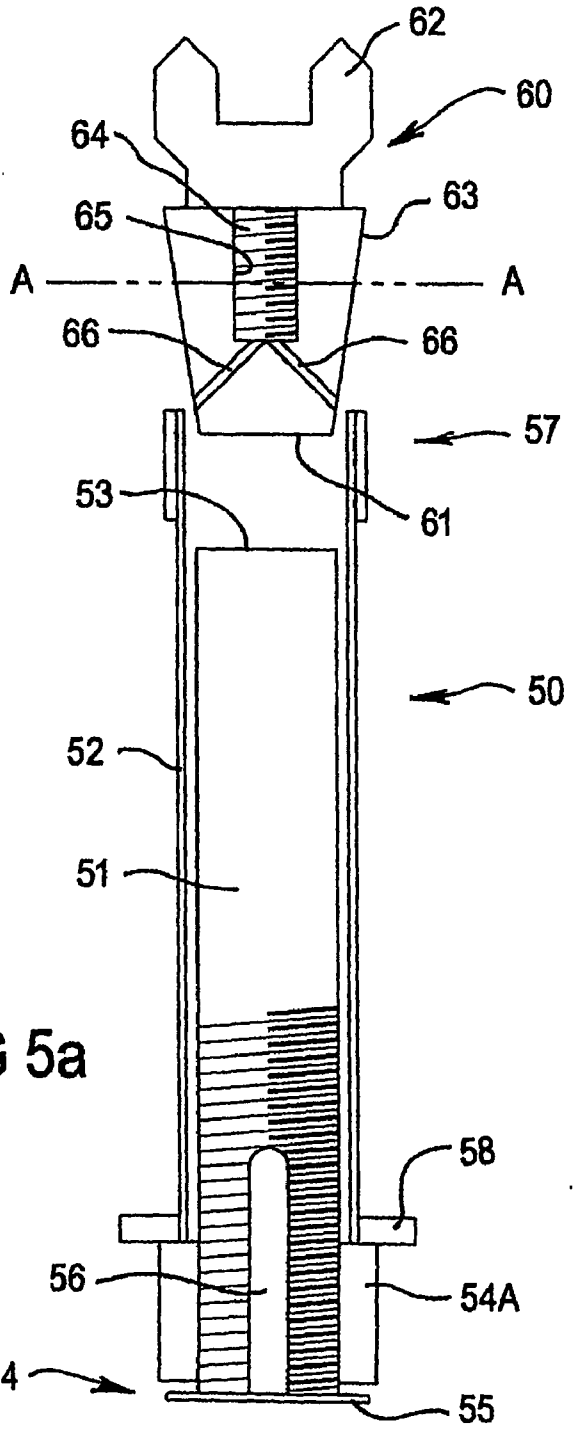


FIG 5a

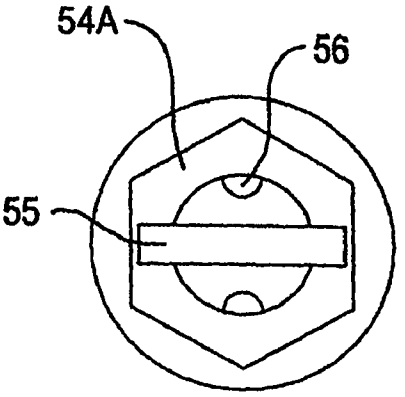


FIG 5b

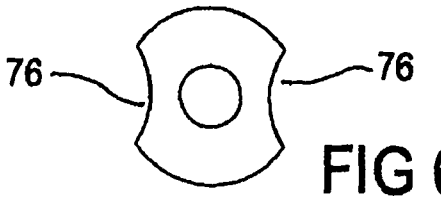


FIG 6c

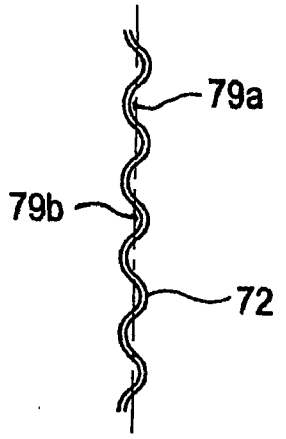


FIG 6d

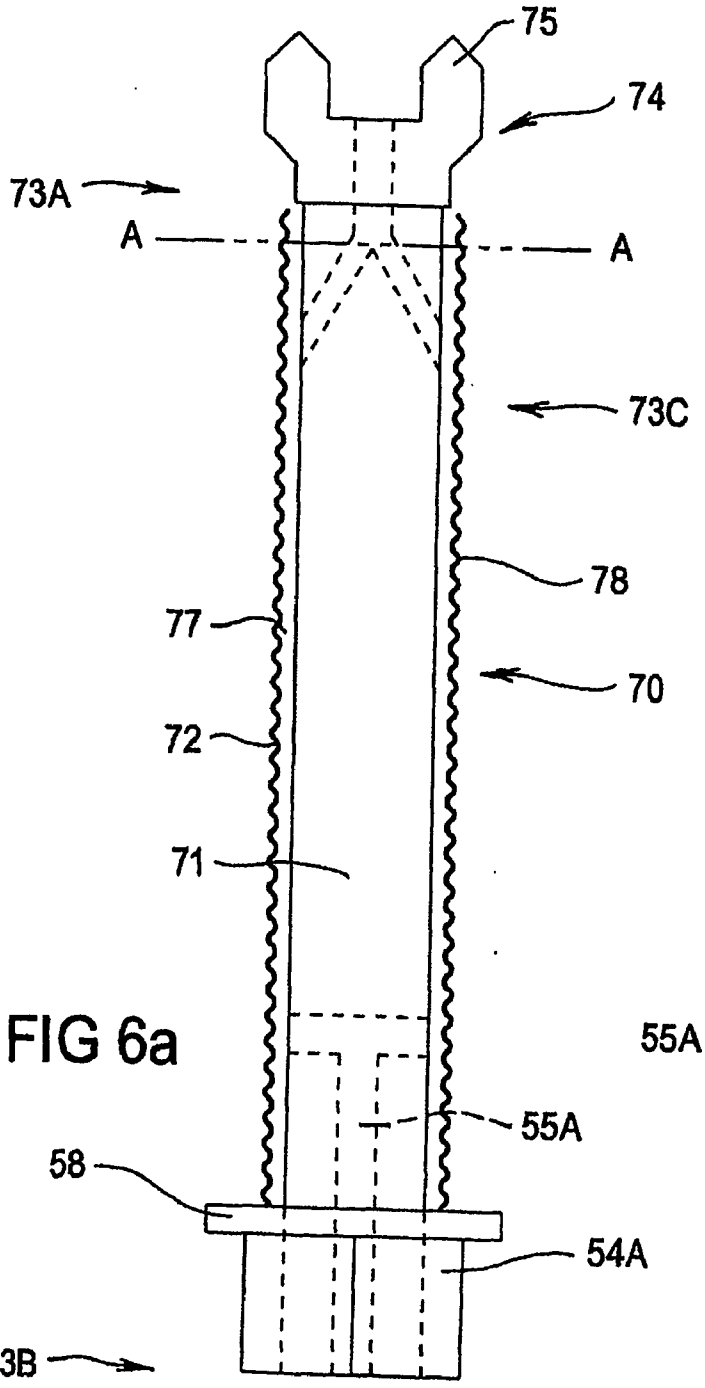


FIG 6a

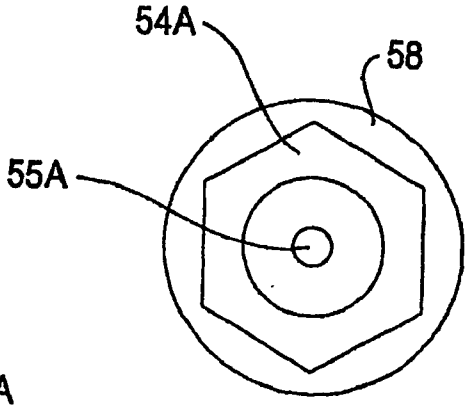


FIG 6b

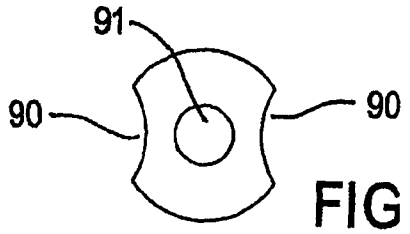


FIG 7c

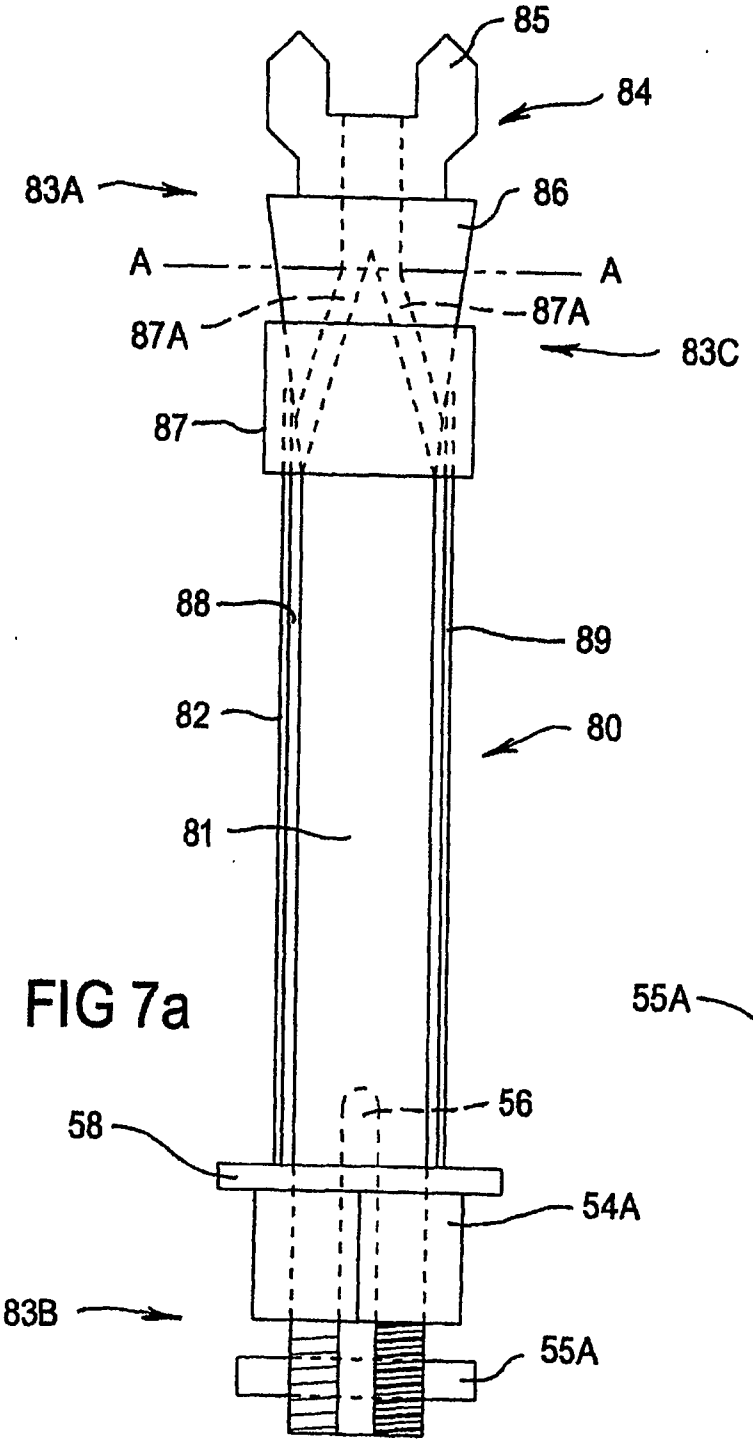


FIG 7a

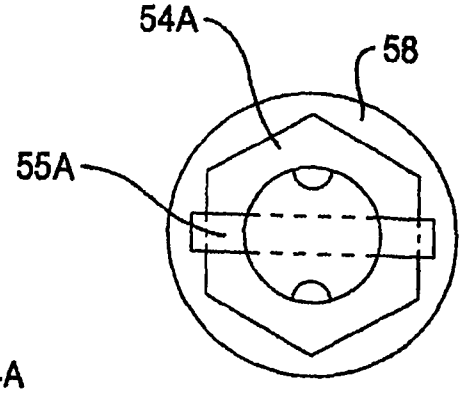


FIG 7b

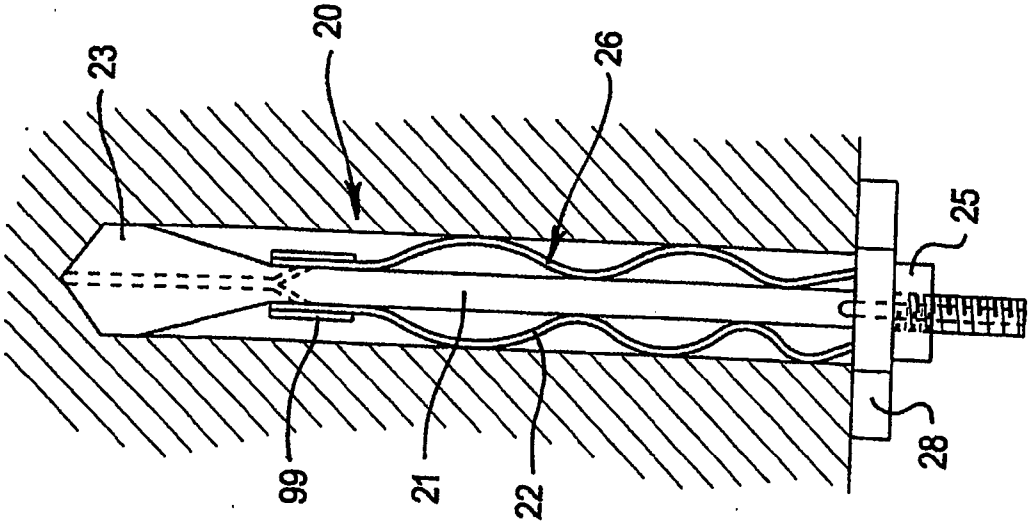


FIG 8c

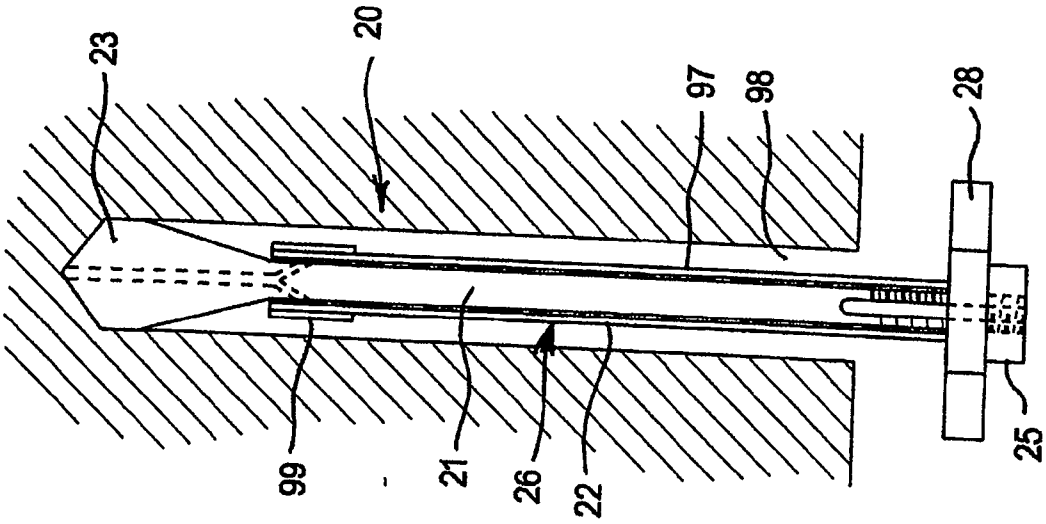


FIG 8b

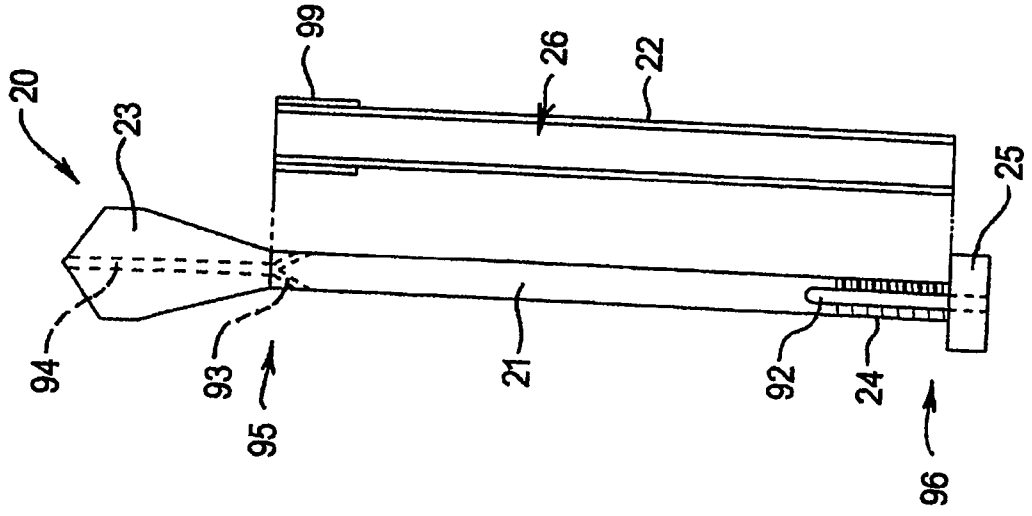


FIG 8a

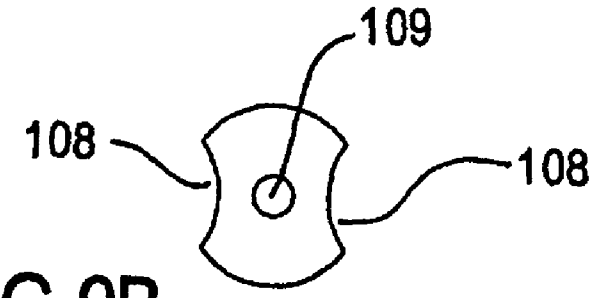

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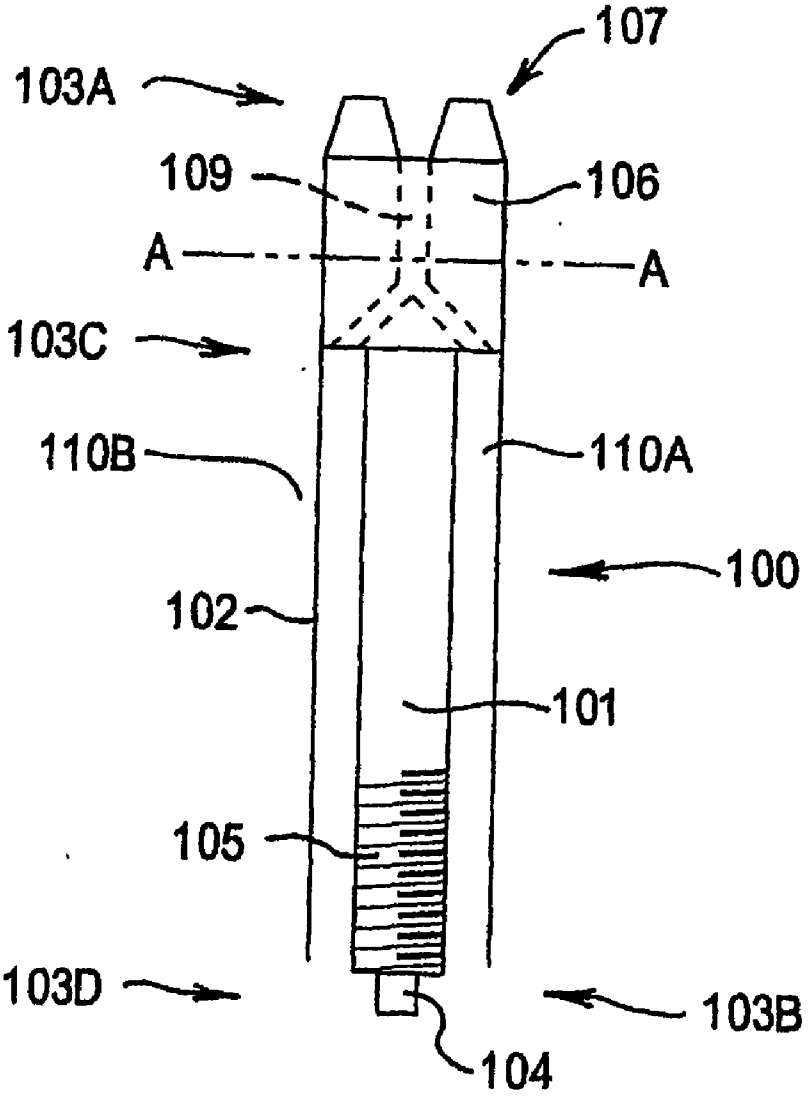
FIG 9B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103D
103B
104

FIG 9A

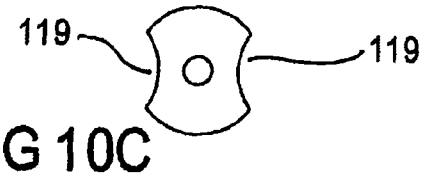

FIG 10C

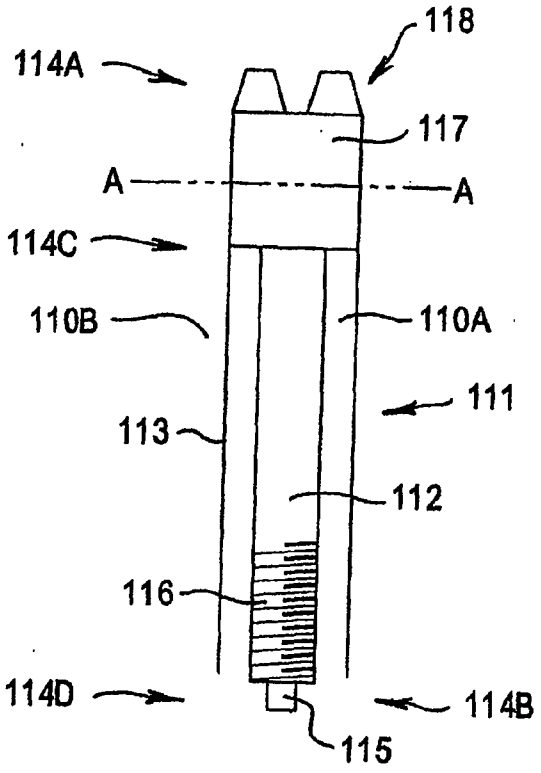

FIG 10A

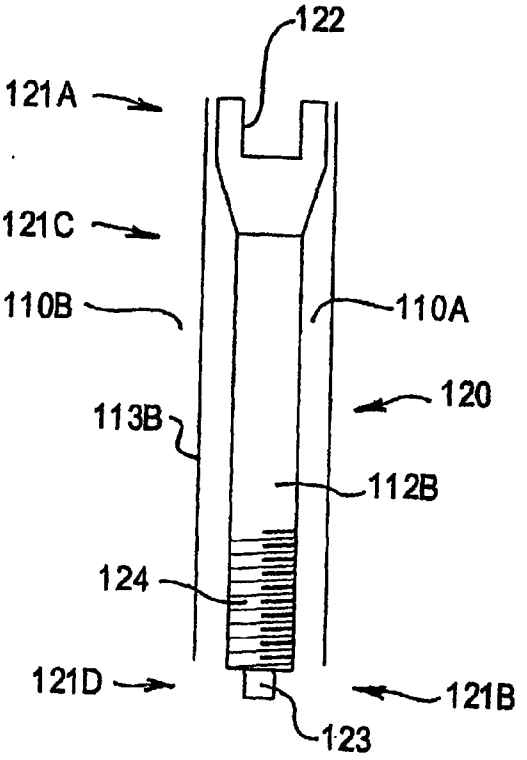

FIG 10B

FIG 11C

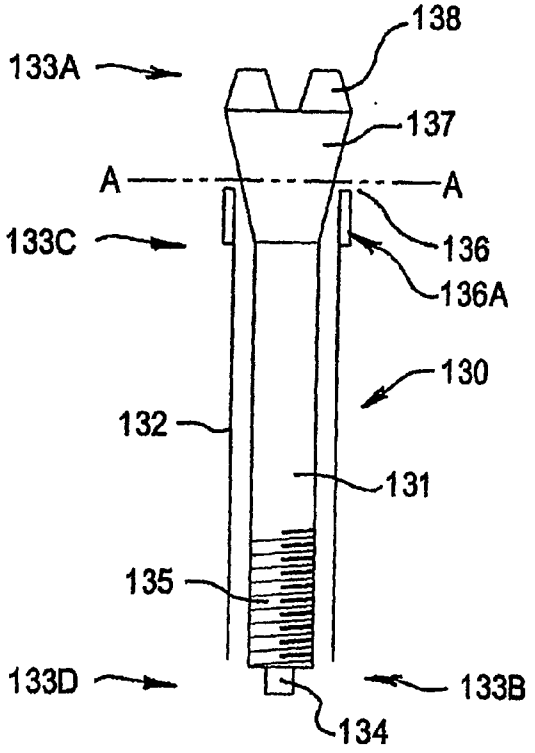

FIG 11A

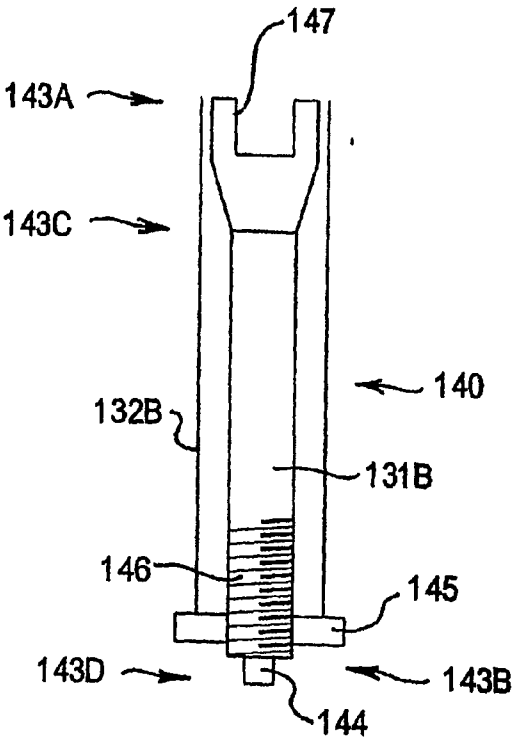

FIG 11B

ROCK BOLT

RELATED APPLICATION DATA

[0001] This application is a national stage filing under 35 U.S.C. § 371 of International Application PCT/AU2004/000736 filed Jun. 3, 2004, which application claims the benefit of priority to Australian Application No. 2003902774 filed Jun. 3, 2003 and to Australian Application No. 2004900773 filed Feb. 16, 2004, the entire disclosure of the each of the prior applications is considered as being part of the disclosure of the present application and is hereby incorporated by reference therein.

TECHNICAL FIELD

[0002] The present invention relates to a drilling member and a rock bolt suitable for use in the mining and tunneling industry.

BACKGROUND ART

[0003] Roof and wall support is a crucial aspect of mining and tunneling-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. A rod is anchored and often tensioned in a hole drilled transversely through the rock strata for this purpose. Typically, the bolt is secured using a resin or cement based grouting fluid, which is inserted around the rod and activated.

[0004] Self drilling rock bolts combine drilling and insertion of the bolt into the drilled hole. Self drilling rock bolts typically have a drilling tip attached to the end of a tubular steel member so that the hole is drilled and the bolt inserted simultaneously. Self drilling rock bolts are not commonly used in the mining industry due to the high cost of the tubular steel that is used to provide both access to flushing and grouting fluids and the structural strength that is required to consolidate the rock.

[0005] The above discussion of background art is included to explain the context of the present invention. It is not to be taken as an admission that any of the documents or other material referred to was published, known or part of the common general knowledge in Australia at the priority date of any one of the claims of this specification.

DESCRIPTION OF THE INVENTION

[0006] Throughout the description and claims of this specification, the word "comprise" and variations of that word, such as "comprising" and "comprises" are not intended to exclude other additives, steps or integers.

[0007] According to a first aspect, the present invention provides a drilling member having opposite first and second ends and a shaft (or first elongate member) extending between the ends, at least one drill tip disposed at the first end and the second end being adapted to be connected to a drilling apparatus to allow rotation of and thrust to the bolt, a sleeve (or second elongate member) extending between along and around the shaft, and a passage formed between the sleeve and the shaft to allow fluid to be passed along the bolt shaft.

[0008] With this arrangement, drilling fluid may be passed along the shaft and across the first end to assist in flushing of material from the rock face during drilling. This fluid may be water, or similar liquid, in a wet drilling process, or may be air in a vacuum drilling process. Also the fluid may be forced along the passage to the first end, or alternatively may be drawn from the first end towards the second end.

[0009] In one embodiment, the first end incorporates at least one drill tip that extends radially from the drilling member axis a distance greater than the sleeve. With this arrangement, in use, an outer passage is formed between the side of the drilled hole and the sleeve. The forming of an outer passage promotes a circulation path in the drilled hole where fluid can be directed towards the first end through one passage and passes from the first end to exit the hole along the other passage.

[0010] In one embodiment, the at least one drill tip is fixed to one end of the shaft. In another embodiment, the drilling member further comprises a drill bit which is connected to an end of the shaft and incorporates the drill tip thereon.

[0011] To allow fluid to be passed along the shaft, openings are provided to the passage. In one form, these openings are provided at, or adjacent the respective ends of the sleeve. Further, a channel may be provided that allows fluid to be introduced into the passage through a collar piece that extends about the shaft adjacent its second end. Another channel may be formed adjacent the first end to facilitate the flow of fluid between the passage and the drill tip. At least part of the channel that extends to the drill tip may be located within the drilling member.

[0012] In one form, the shaft is operative to accommodate the compressive and torsional loading acting on the drilling member during drilling. In a particular form, the sleeve has substantially less strength than the shaft.

[0013] In one embodiment, the shaft is formed from steel rod. In an alternative arrangement, the shaft is formed from a fibre reinforced material such as fiberglass.

[0014] In one form, the sleeve is formed from plastic. In an alternative form, the sleeve is formed from sheet metal, typically a thin gauge sheet metal.

[0015] In a particular embodiment, the drilling member is arranged to be fixed in a hole drilled by the drilling member so as to form a self drilling rock bolt.

[0016] In one form, where inner and outer passages are formed, the passages are used to introduce grout into the drilled hole and are also able to be filled to promote adequate bonding of the bolt to the rock.

[0017] In one form, the outer surface of the self drilling rock bolt is rough or convoluted to promote bonding of grout to the shaft. In one form, the inner and outer surfaces of the sleeve are also rough or convoluted.

[0018] In a particular embodiment, the self drilling rock bolt further comprises an anchoring device which is operative to retain the rock bolt in the drilled hole.

[0019] In a particular form, the anchoring device is movable from a retracted position where the device does not impede drilling of the hole, to an expanded position where the device is arranged to retain the rock bolt in the drilled hole.

[0020] In a particular embodiment, the bolt is operative to be rotated in a first direction to effect drilling, and operative to be rotated in a second opposite direction to move the anchoring device from its retracted to its expanded position.

[0021] The sleeve may be deformable upon the application of an axial force towards the first end of the sleeve and when so deformed, the sleeve extends radially beyond the drill tip.

[0022] The rock bolt may further comprise an engaging surface in which the sleeve is deformed on relative movement of the sleeve across the engaging surface. The engaging surface may be located on the shaft. Alternatively, the engaging surface may be located on the drill bit.

[0023] The sleeve may be deformable under axial compression or the sleeve may incorporate at least one weakened area that facilitates deformation of the sleeve. The at least one weakened area may be in the form of a slit formed in the sleeve.

[0024] In one embodiment, the anchoring device is located proximate the first end and is operative in response to axial movement of the shaft relative to the sleeve.

[0025] In one form, the anchoring device is formed part of, or connected to, the sleeve. In one form, the anchoring device is operative on deformation of the sleeve.

[0026] In one embodiment the anchoring device is in the form of at least one expansion shell that is displaceable radially outwardly. In one form, the rock bolt incorporates an engaging surface and the at least one expansion shell becomes operative on movement of the engaging surface across an inner surface of the at least one expansion shell.

[0027] In one embodiment, the self drilling rock bolt further comprises a collar piece that extends about the shaft adjacent it's second end and is displaceable axially along the bolt shaft.

[0028] The sleeve may be displaceable along the shaft in response to movement of the collar piece along the shaft.

[0029] The collar piece may be connected to the shaft by an external thread on the shaft that engages with a complementary inner thread of the collar piece.

[0030] In one embodiment, the rock bolt is adapted to be connected to the drilling apparatus by connection of the drilling apparatus with the collar piece.

[0031] In one embodiment, the self drilling rock bolt further comprises an abutment member located proximate the second end, the abutment member being displaceable along the shaft and having an abutment surface that faces towards the first end and projects radially from the bolt axis a distance greater than the drill tip.

[0032] In another embodiment, the drill shaft and sleeve of the self drilling rock bolt are each formed from a plurality of sections that are connected together.

[0033] In a further aspect, the invention provides a shaft and sleeve combination for use in a drilling member or rock bolt as described above. The shaft is arranged to receive a drill tip at a first end thereof. The drill tip may be connected directly to the shaft, or alternatively is mounted on a drill bit which is secured to the shaft.

[0034] In a further aspect, the present invention provides a drill bit comprising a bit body having opposite ends and a wall surface extending between the ends, at least one drill tip located at one end and the bit being adapted to be connected to a drill rod at the other end, wherein a least one channel extends from the wall surface to the at least one drill tip.

[0035] The drill bit may further include a wall portion from the wall surface that tapers outwardly towards the one end.

[0036] According to yet a further aspect of the invention, there is provided a method of drilling, comprising: drilling a hole into the rock using a drilling member having a drilling end and an opposite end connected to a drilling apparatus; and providing drilling fluid to the drilling end during drilling of the hole by conveying fluid along the outer surface of the bolt shaft.

[0037] According to yet a further aspect of the invention, there is provided a method of stabilising rock, comprising: drilling a hole into the rock using a self drilling rock bolt having a drilling end and an opposite end connected to a drilling apparatus; providing drilling fluid to the drilling end during drilling of the hole by conveying fluid along the outer surface of the bolt shaft; and fixing the rock bolt within the hole to stabilise the rock.

[0038] The drilling fluid may be guided along the shaft in a passage defined by a sleeve disposed around and along the shaft.

[0039] A further passage may be formed between the sleeve and the side of the hole and drilling fluid is caused to flow to the drilling end through one passage and to be removed from the hole through the other passage.

[0040] The drilling fluid may be pumped to the drilling end from the second end, or the fluid may be drawn towards the second end under a suction arrangement.

[0041] Grout may be introduced into the hole to fix the rock bolt to the rock.

[0042] The rock bolt may be initially anchored within the hole prior to introducing grout into the hole.

[0043] The shaft of the drilling member or the rock bolt described in any form above may be, for example, a hollow rod having a circular cross-section, a solid rod having a circular cross-section, a hollow rod having a non-circular cross-section or a solid rod having a non-circular cross-section. Further, the shaft may feature a smooth axially outer surface or alternatively a rough or irregular surface, the rough or irregular surface providing additional bonding between grout and the first elongate member.

[0044] The sleeve may be, for example, a hollow rod having a circular cross-section or a hollow rod having a non-circular cross-section. The inner and outer surfaces of the sleeve may be smooth or alternatively a rough or irregular surface, the rough or irregular surface providing additional bonding between grout and the sleeve and between the sleeve and the rock face. Further, the sleeve may be corrugated to provide additional bonding between grouting fluid and the sleeve, the corrugation providing stress transfer between the inner and outer surface of the sleeve. The corrugations may be helical or radial and the depth of the corrugations may be proportional to the radius of the sleeve.

[0045] The shaft may be comprised of an elevated tensile strength material, such as steel, suitable for acting as a structural member.

[0046] The shaft may be comprised of an elevated tensile strength material such as fibreglass, suitable for acting both as a structural member and as a structural member which can be cut through once the bolt has been positioned in the rock face by drilling. This allows the rock face that has been bolted to be subsequently excavated.

[0047] The sleeve may be comprised of a material such as a metal or a composite of multiple elongate metal members and a lower cost plastic tube, having enough longitudinal axial rigidity to allow engagement of the expansion shells. Alternatively, the sleeve may comprise a plastic tube with a discontinuous steel end collar.

[0048] The access channels and shaft may be forged.

[0049] In one embodiment, the first end of the shaft comprises a drill bit means, and the drill bit means may include at least one access channel to allow the influx and efflux of materials during drilling and grouting.

[0050] The sleeve may include a material such as a metal or a composite of multiple elongate metal members and a lower cost plastic tube. Alternatively, the sleeve may include a plastic tube. Preferably, the plastic tube is made from a long life plastic such as polyethylene. The plastic is non-corroding and, should a crack form in the grout, the plastic tube acts as a barrier stopping the crack so that it does not allow water to reach the bolt and corrode it, which would reduce the life of the rock bolt.

[0051] In an embodiment, the second end of the shaft is further adapted to provide attachment to a first end of an extension shaft (or third elongate member), and the sleeve includes a second end adapted to provide attachment to the first end of an extension sleeve (or fourth elongate member).

[0052] Typically, the shaft is arranged to be lockable to the extension shaft to substantially prevent relative rotation between the two in at least one rotational direction when locked together.

[0053] The rock bolt may additionally comprise an extension shaft and a extension sleeve in the form described above.

[0054] The drilling apparatus may comprise rotational driving means removably connected to the second end of the shaft (in one form through the collar piece) for advancing the drill bit means rotatably through rock in a first rotational direction and in one form for activating the anchoring device in the first rotational direction.

[0055] Alternatively, the drilling apparatus comprises rotational driving means removably connected to the attachment means for advancing the drill bit means rotatably through rock in a first rotational direction and for activating the anchoring device in a second opposite rotational direction.

[0056] Typically the grout is injected into the cavity between the shaft and sleeve after drilling and transverse expansion of the sleeve.

[0057] A plate may be provided attached to the shaft, the plate being arranged to substantially prevent relative rotation of the attachment means and shaft in a first direction of rotation.

[0058] In yet a further aspect the present invention provides a method of drilling, the method comprising (a) drilling a drill member, the drill member comprising a shaft and sleeve, the shaft comprising a first end adapted to penetrate rock and a second end adapted to provide attachment for actuating means, into a rock face, while flushing a cooling agent between the shaft, sleeve and rock face in the region of the first end of the shaft; and (b) removing the drill member from the rock once a hole of the desired depth has been drilled.

[0059] The cooling and/or flushing fluids may be a liquid (e.g. water) or a gas (e.g. air).

[0060] The cooling and/or flushing fluids and grouting fluid may be injected through one or more access channels.

[0061] The shaft could comprise a first end adapted to receive means to penetrate rock, such as a drill bit. This would allow replacement of the drill bit due to wear or to suit specific conditions.

[0062] In yet a further aspect, the present invention provides a method of supporting rock, the method comprising (a) drilling a rock bolt, the rock bolt comprising a shaft and sleeve, the shaft comprising a first end adapted to penetrate rock and a second end adapted to provide attachment for actuating means, into a rock face, while flushing a cooling agent through a cavity between the shaft and sleeve, and past the rock face in the region of the first end of the shaft, (b) injecting grouting fluid between the shaft, sleeve and rock face, and (c) waiting a preset time period for the grouting fluid to set.

[0063] In yet a further aspect, the present invention provides a method of supporting rock, the method comprising (a) drilling a rock bolt, the rock bolt having a shaft and sleeve, the shaft comprising a first end adapted to penetrate rock and a second end adapted to provide attachment for actuating means, into a rock face while flushing a cooling agent through a cavity between the shaft and sleeve, and past the rock face in the region of the first end of the shaft, (b) providing an extension rod comprising third and fourth elongate members and extending the length of the shaft by locking a third elongate member into the second end of the shaft, the third elongate member comprising a first end adapted to lock with the second end of the shaft so as to substantially prevent relative rotation between the shaft and the third elongate member in at least the rotational direction of drilling, and the fourth elongate member comprising a first end adapted to attach to the second end of the sleeve, (c) extending the length of the sleeve by attaching the first end of the fourth elongate member to the second end of the sleeve, (d) repeating steps a, b and c until a suitable depth has been reached, (e) injecting grouting fluid between the shaft, sleeve, extension rod and rock face; and (f) waiting a preset time period for the grouting fluid to set.

[0064] The method could further include using a rock bolt having a shaft also comprising a first end adapted to penetrate rock and a portion of greater transverse dimension than a portion of the sleeve adapted for transverse expansion.

[0065] The method could further include tensioning the rock bolt via an internally threaded collar.

[0066] The cooling and/or flushing fluids and grouting fluid may be injected through one or more access channels.

[0067] The method could further include passing the flushing, cooling and grouting fluids through a cavity extending between the third and fourth elongate members to the cavity between the shaft and sleeve and past the rock face in the region of the first end of the shaft.

[0068] The sleeve of the rock bolt used in the method may additionally include an anchoring device adapted for transverse expansion. In this case, before (b), the sleeve may be moved longitudinally toward the first end of the shaft, to cause the anchoring device adapted for transverse expansion to expand transversely and retain the bolt in the rock face. The longitudinal movement may be caused by rotation of the shaft and/or sleeve, causing the shaft to push the sleeve toward the first end of the shaft.

[0069] The longitudinal movement may be caused by relative rotation of the shaft and sleeve, pushing the sleeve toward the first end of the shaft, causing expansion of the portion adapted for transverse expansion.

[0070] The rock bolt may then be tensioned by further relative rotation of shaft.

[0071] Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings. It is to be understood that the particularity of the drawings and embodiments does not supersede the generality of the preceding description of the invention.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

[0072] FIGS. **1***a* and *b* show a rock bolt of the invention.

[0073] FIG. **2** shows a rock bolt with expansion shells engaged.

[0074] FIGS. **3***a, b* and *c* show an alternative rock bolt of the invention.

[0075] FIGS. **4***a, b, c* and *d* show a further alternative rock bolt of the invention.

[0076] FIGS. **5***a, b* and *c* show another alternative rock bolt of the invention.

[0077] FIGS. **6***a, b, c* and *d* show an alternative rock bolt of a fifth aspect of the invention.

[0078] FIGS. **7***a, b* and *c* show an alternative rock bolt of a sixth aspect of the invention.

[0079] FIGS. **8***a, b* and *c* show an alternative rock bolt of a seventh aspect of the invention.

[0080] FIGS. **9***a* and *b* show a drill of an eighth aspect of the invention.

[0081] FIGS. **10***a, b* and *c* show a further alternative rock bolt of the invention.

[0082] FIGS. **11***a, b* and *c* show another alternative rock bolt of the invention.

BEST AND OTHER METHODS OF CARRYING OUT THE INVENTION

[0083] Figure Ia shows a rock bolt **10** of an embodiment of the invention comprising:

[0084] a first elongate member, or shaft, **11** and a second elongate member, or sleeve, **12**, wherein the first elongate member **11** is disposed at least partially, longitudinally inside the second elongate member **12**, the first elongate member **11** comprising a first end **13**, at a first end of the bolt **10**, in the form of means, in the present embodiment a drill bit, adapted to penetrate rock and a second end **14**, at a second end of the bolt which is threaded with an external thread and provided with a collar piece **15** which has an internal, or complementary inner, thread adapted to provide attachment for actuating means by a hexagonal engaging region shown in FIG. **1***b*. The second elongate member **12** is adapted for transverse expansion along at least a portion of its length through provision of an anchoring device in the form of expansion shells **16**.

[0085] In operation, as shown in FIG. **2**, the rock bolt **10** of FIG. **1** is drilled into the rock wall by attaching a drilling apparatus (not shown) to the internally threaded collar piece **15** and rotating threaded collar piece **15**, first elongate member **11** and drill bit means **13**. A channel, cavity, or passage, **17** between elongate members **11** and **12** can be provided, and used to transmit water or air while drilling to flush out drilling residue and reduce the temperature of the drill bit means **13**. Following drilling and insertion of the rock bolt **10** into the rock internally threaded collar piece **15** is reverse rotated causing the internally threaded collar piece **15** to advance towards the first end **13** of the first elongate member **11** along the complementary external thread provided thereon. Advancement of collar piece **15** by an axial force thereon forces collinear advancement towards the first end of second elongate member **12**. Advancement of second elongate member **12** brings the anchoring device, in the present embodiment expansion shells **16**, into engagement with a portion of first elongate member **11** of greater transverse dimension than the unexpanded transverse dimension of the expansion shells **16**. The transverse force caused by this engagement causes deformation in the form of transverse expansion of the expansion shells **16** thereby wedging the rock bolt **10** in the hole drilled by drill bit means **13**. The anchoring device in the form of expansion shells **16** incorporates at least one weakened area in the form of a slit in the second elongate member **12**. The second end **14** of first elongate member **11** may be adapted (by providing a pin such as a cotter or spring pin attached through the end of first elongate member **11** for example) so that threaded collar piece **15** cannot be removed.

[0086] Grout can also be injected into the channel, cavity, or passage **17** between the elongate members for additional reinforcement.

[0087] FIGS. **3***a, b* and *c* show a rock bolt **20** of an embodiment of the invention comprising a first elongate member, or shaft, **21** and a second elongate member, or sleeve, **22**. The first end of the first elongate member **21** comprises, as rock penetrating means, or drill bit, an integral drill tip **23** in the form of a wedge cutting head, which extends radially from the bolt axis by a distance greater than that of the second elongate member. The second end of first elongate member **21** comprises an externally threaded por-

tion **24** upon which is threaded internally, or complementary inner, threaded nut, or collar piece, **25**. Second elongate member **22** is comprised of an elongate hollow tube **26** having a low strength wall and higher strength expansion shells, or anchoring device, **27** located at one end. The first ends of the first and second elongate members **21**, **22** correspond to a first end of the bolt **20**.

[**0088**] FIG. **3***a* shows the first elongate member **21** separated from the second elongate member **22**.

[**0089**] FIG. **3***b* shows the rock bolt **20** drilling into a wall in a first rotational direction by means of drill tip **23** and a drill actuating means, or drilling apparatus, (not shown) acting on nut **25**. The end of elongate member **21** is adapted (by providing a washer attached to the end of elongate member **21** for example) so that nut **25** cannot be removed. First elongate member **21** is disposed partially within elongate member **22** with drill tip **23** protruding above expansion shells **27**. Drill tip **23** is dimensioned to drill a hole large enough to receive both the first elongate member **21** and second elongate member **22**. At the desired depth, nut **25** is tightened by turning the nut **25** in a second rotational direction. A washer, or abutment member, **28** extends beyond the hole drilled in the wall so that tightening nut **25** pushes washer **28** into abutment with second elongate member **22** and then urges expansion shells **27** of second elongate member **22** into abutment with drill tip **23**. Washer **28** has an abutment surface that faces toward the first end of the bolt and projects radially from the bolt axis a distance greater than the drill tip **23**. Drill tip **23** has a splayed portion of larger external dimension than the internal dimension of expansion shells **27** so that as tightening nut **25** urges expansion shells **27** against drill tip **23**, expansion shells **27** expand to accommodate drill tip **23**, this expansion forcing expansion shells **27** into contact with the sides of the hole. FIG. **3***c* shows rock bolt **20** at the end of this procedure with elongate hollow tube **26** having a low strength wall distorted, or deformed, by the axial force acting on the tube, and higher strength expansion shells **27** expanded into contact with the hole wall.

[**0090**] FIG. **4***a* shows another rock bolt **30** of an embodiment of the invention. Rock bolt **30** comprises a first elongate member, or shaft, **31** and a second elongate member, or sleeve, **32**. First elongate member, or shaft, **31** is disposed partially, longitudinally inside second elongate member **32**. First elongate member **31** comprises a first end, which comprises an external thread **33**, and a second end **34** comprising a drive element, or attachment means, **35** shown in plan view in FIG. **4***b* in the section taken along line C-C of FIG. **4***a*. As shown in FIG. **4***b*, drive element **35** is surrounded by access holes, or channels, **36**. Second elongate member **32** comprises an anchoring device in the form of expansion shells **38** located at its second end **39**. Rock penetrating means, or drill bit, in the form of drill tip **40** is internally threaded with a thread **41** that matches external thread **33** and comprises access holes **42** adjacent thread **41** and a central flushing hole **43** as shown in the cross sections of FIGS. **4***c* and **4***d* taken along lines A-A and B-B respectively. External thread **33** includes a transversely oriented plate member **45** at the first end of first elongate member **31** to prevent counter rotation of the drill tip **40**. Drill tip **40** comprises a tapered lower edge **44**. Drill tip **40** is attached to the first end, via external thread **33**. Drill tip **40** protrudes beyond expansion shells **38** and is dimensioned to drill a hole of sufficient diameter to receive rock bolt **30**. Flushing hole, or channel, **43** and access holes **36** and **42** allow influx and efflux of materials during drilling to assist the drilling process. Drilling is actuated by attachment of a drilling mechanism, or apparatus, to drive element **35**. When a hole of the required depth has been drilled, the drilling mechanism is counter-rotated, screwing external thread of first end **37** into thread **41** to urge drill tip **40** against expansion shells **38** causing expansion shells **38** to expand. Plate member **45** stops any further relative rotation of the drill tip **40** to prevent first elongate member being rotated out of drill tip **40** during drilling.

[**0091**] FIG. **5***a* shows a further rock bolt **50** of the invention. Rock bolt **50** comprises a first elongate member, or shaft, **51** and a second elongate member, or sleeve, **52**. First elongate member **51** is disposed partially, longitudinally inside second elongate member **52**. First elongate member **51** comprises a first end **53**, and a second end **54**, which is adapted to a receive nut, or collar piece, **54***a* that can receive a drill actuating means, or drilling apparatus, (not shown). Second end **54** comprises transversely oriented plate member **55** installed so that the nut **54***a* cannot be removed. First elongate member **51** also comprises longitudinal grooves **56**. Rock penetrating means in the form of drill bit means **60** is adapted to be butt welded at end **61** to first end **53** of first elongate member **51**. Drill bit means **60** comprises a cutting head, or drill tip, **62** and an external thread **64** that matches internal thread **65** inside tapered collar, or engaging surface, **63**. The wider part of tapered collar **63** is disposed towards cutting head **62** and the narrower part towards end **61** and comprises access holes, or channels, **66**. Further, tapered collar **63** of drill bit means **60**, comprises channels **67** and an internal thread **65** as shown in the cross section of FIG. **5***a* taken along the line A-A. Drill bit means **60** is butt-welded to end **53**. Drill bit means **60** protrudes beyond end **57** of second elongate member **52**. The lower edge of tapered collar **63** allows drill bit means **60** to pass inside second elongate member **52** until the width of tapered collar **63** matches the inner diameter of second elongate member **52**. Drill bit means **60** is dimensioned to drill a hole of sufficient diameter to receive rock bolt **50**. Grooves, or channels, **56** allow influx and efflux of materials during drilling to assist the drilling process. Drilling is actuated by attachment of the drilling apparatus to nut **54***a*. When a hole of the required depth has been drilled, the drilling apparatus is counter rotated to urge nut **54***a* against washer, or abutment member, **58** and washer **58** against the wall. Continued counter rotation of nut **54***a* urges the tapered collar **63** against end **57** of second elongate member **52** by pulling the first elongate member **51** back out of the wall while retaining the second elongate member in position, causing anchoring device, or end, **57** to expand into engagement with the hole wall.

[**0092**] FIG. **6***a* shows a rock bolt **70** of a fifth embodiment of the invention. Where parts of the rock bolt correspond to those of the third aspect, the reference numerals of FIG. **5***a* have been used. The rock bolt **70** comprises: a first elongate member, or shaft, **71** and a second elongate member, or sleeve, **72**. First elongate member **71** is disposed partially, longitudinally inside second elongate member **72**. First elongate member **71** comprises a first end **73**A, and a second end **73**B, which is adapted to receive nut, or collar piece, **54***a* that can receive a drill actuating means (not shown). Second end **73**B comprises a substantially 'T' shaped bore **55**A to allow influx and efflux of materials during drilling to assist

the drilling process. The first and second ends of the first and second elongate members **71**, **72** correspond to first and second ends of the rock bolt **70**. Nut **54***a* is welded to the first elongate member **71** so that the nut **54***a* cannot be removed and so that turning the nut **54***a* also turns the first elongate member **71**. The first end **73**A of first elongate member **71** comprises means **74** adapted to penetrate rock in the form of a drill bit. Drill bit means **74** comprises a cutting head or drill tip **75** and channels **76** to provide a return path for the flushing and grouting fluids, shown in the cross section of FIG. **6***c* taken along the line A-A. Drill bit **74** is suitably attached to the first end **73**A of first elongate member **71** e.g. by brazing, butt-welding, forging or the like. Drill bit **74** protrudes beyond end **73**C of second elongate member **72**. Drill bit **74** is dimensioned to drill a hole of sufficient diameter to receive rock bolt **70**. Second elongate member **71** is corrugated, the corrugation providing stress transfer between the inner and outer surface of the second elongate member **71**. The corrugations may be helical or radial and the depth of the corrugations is proportional to the radius of the second elongate member. FIG. **6***d* shows the corrugations of second elongate member **72** in detail. The second elongate member has corrugations on its inner and outer surface; the corrugation is defined by its peak **79***a* and trough **79***b*. The corrugations have sufficient amplitude so that the notional centre line in FIG. **6***d* enters the regions of both the peak **79***a* and trough **79***b*.

[**0093**] Bolts according to any of the embodiments described above and below may also include the corrugated second elongate member.

[**0094**] Second elongate member **72** is suitably held in place e.g. by a tapered collar, or engaging surface, washer, or abutment member, or the like. Drilling is actuated by attachment of a drilling mechanism or apparatus [not shown] to nut **54***a* and rotating the first elongate member **71** and drill bit **74** in a first rotational direction. Engagement of the drill bit means **74** with the rock requires the application of longitudinal (axial) pressure against the rock face in conjunction with the rotational action of the drilling apparatus. During drilling the drill bit **74** is cooled with a cooling agent, which is injected in a second cavity **78** between the rock face and second member **72**. The cooling agent flows into and out of the second cavity **78** between the rock face and second member. When a hole of the required depth has been drilled, grouting fluid is injected into a first cavity, or passage, **77**, which is annular, between the first and second member until the first cavity **77** is filled with grouting fluid. Grouting fluid may also be injected into the second. cavity **78**. The cooling fluid may also be injected into, or flow out of the first cavity. A circulation path between the first and second cavities may occur. The bolt **70** is then left to set in the grouting fluid. In general, such a T type channel in the first elongate member could be used in any embodiment of the invention shown. Such a channel is particularly used where a cotter pin is not used to secure the nut to the first elongate member.

[**0095**] FIG. **7***a* shows a rock bolt **80** of an alternative version of the sixth embodiment of the invention. Where parts of the rock bolt correspond to those of the fifth and sixth aspects, the reference numerals of FIGS. **5***a* and **6***a* have been used. The rock bolt **80** comprises a first elongate member, or shaft, **81** and a second elongate member, or sleeve, **82**. First elongate member **81** is disposed partially, longitudinally inside second elongate member **82**. Preferably, the expandable end collar **87** is made of an elevated compressive strength material such as steel. First elongate member **81** comprises a first end **83**A, and a second end **83**B, which is adapted to receive nut, or collar piece, **54***a* that can receive a drill actuating means, or drilling apparatus (not shown). First end **83**A of second elongate member **82** comprises an anchoring device in the form of an expandable end collar **87** to expand into contact with the sides of the drilled hole. Second end **83**B comprises transversely oriented pin **55**A such as a cotter or spring pin installed below nut **54***a* and through first elongate member **81** so that the nut **54***a* in one direction cannot be removed and so that turning the nut **54***a* also turns the first elongate member **81**. First elongate member **81** also comprises access channels in the form of longitudinal grooves **56**. The first end **83**A of first elongate member **81** comprises drill bit means **84** adapted to penetrate rock.

[**0096**] Drill bit means **84** comprises a cutting head, or drill tip, **85** and tapered collar, or engaging surface, **86**. The wider part of tapered collar **86** is disposed towards cutting head **85** and the narrower part towards end collar **87** and comprises access holes, or channels, **87**A. Further, tapered collar **86** of drill bit means **84**, comprises channels **90** of lesser radial extent that the rest of the tapered collar **86**, to provide a return path for the flushing and grouting fluids, shown in the cross section of FIG. **7***a* taken along the line A-A. Drill bit means **84** is suitably attached to tapered collar **86** e.g. by brazing, butt welding forging or the like. Tapered collar **86** protrudes beyond end **83**C of second elongate member **82**. The lower edge of the taper of collar **86** allows tapered collar **86** to pass inside second elongate member **82** until the width of collar **86** matches the inner diameter of second elongate member **82**. Drill bit means **84** is dimensioned to drill a hole of sufficient diameter to receive rock bolt **80**. Access channels in the form of grooves **56** allow influx and efflux of materials during drilling to assist the drilling process. Drilling is actuated by attachment of a drilling mechanism, or apparatus, [not shown] to nut, or collar piece, **54***a* and rotating the first elongate member **81** and drill bit means **84** in a first rotational direction. Engagement of the drill bit means **84** with the rock requires the application or longitudinal (axial) pressure against the rock face in conjunction with the rotational action of the drilling apparatus. During drilling, the drill bit means **84** is cooled with a cooling agent, which is injected through access channels **56** at the second end **83**B of the first elongate member **81**. The cooling agent flows in a first cavity, or passage, **88** between the first and second member and flows out of the first cavity **88** through access channels **87**A and a flushing hole **91** in the drill bit means **84** before being flushed back in a second cavity **89** between the rock face and the second elongate member **82**. When a hole of the required depth has been drilled, the drilling mechanism is counter rotated to urge nut **54***a* against washer **58** and washer **58** against the wall, washer **58** urges second elongate member **82** against tapered collar **86**. Alternatively, the drilling mechanism is further rotated to urge nut **54***a* against washer **58** and washer **58** against the wall, washer **58** urges second elongate member **82** against tapered collar **86**. Following drilling and insertion of the rock bolt into the rock, grouting fluid is injected through access channels **56** at the second end **83**B of the first elongate member **81**. The grouting fluid flows in a first cavity, or passage, **88** between the first and second member and flows out of the first cavity **88** through access channels **87**A and

flushing hole **91** in the drill bit means **84** before being flushed back towards washer **58** in a second cavity **89** between the rock face and the second elongate member **82**. The grouting fluid is injected until both cavities **88**, **89** are filled with grouting fluid and the bolt **80** is then left to set in the grouting fluid. Once the grouting fluid has set, the rock bolt can be optionally tensioned using the internally threaded collar.

[**0097**] FIGS. **8***a, b* and *c* show a rock bolt **20** of a seventh embodiment of the invention. Where parts of the rock bolt correspond to those of the second aspect, the reference numerals of FIG. **3** have been used. The rock bolt **20** comprising a first elongate member, or shaft, **21** and a second elongate member, or sleeve, **22**. The first end of the first elongate member **21** comprises, as rock penetrating means, an integral drill tip **23** in the form of a wedge cutting head. The second end of first elongate member **21** comprises an externally threaded portion **24** upon which is threaded internally, or complimentary inner, threaded collar piece **25**. Second elongate member **22** is comprised of an elongate hollow tube **26** having a low strength wall and higher strength end collar, or anchoring device, **99** located atone end.

[**0098**] FIG. **8***a* shows the first elongate member **21** separated from the second elongate member **22**.

[**0099**] FIG. **8***b* shows the rock bolt **20** drilling into a wall in a first rotational direction by means of drill tip **23** and a drill actuating means (not shown) acting on attachment means provided by collar piece **25**. The end of elongate member **21** is adapted (by providing a plate member attached to the end of elongate member **21** for example) so that collar piece **25** cannot be removed. First elongate member **21** is disposed partially within elongate member **22** with drill tip **23** protruding above end collar **99**. Drill tip **23** is dimensioned to drill a hole large enough to receive both the first elongate member **21** and second elongate member **22**. At the desired depth, collar piece **25** is tightened. Washer, or abutment member, **28** extends beyond the hole drilled in the wall so that tightening collar piece **25** pushes washer **28** into abutment with second elongate member **22** and then second elongate member **22** into abutment with end collar **99**. Drill tip **23** has a splayed portion of larger external dimension than the internal dimension of end collar **99** so that as tightening collar piece **25** urges second elongate member **22** against end collar **99**, second elongate member **22** buckles, or deforms, because of the axial force applied to it in the direction of the first end of the first elongate member **21**, forcing itself into contact with the sides of the drilled hole. FIG. **8***c* shows rock bolt **20** at the end of this procedure with elongate hollow tube **26** having a low strength wall distorted by the force acting on the tube and making contact with the hole wall. Following drilling and insertion of the rock bolt **20** into the rock, grouting fluid is injected through access channels **92** at the second end **96** of the first elongate member **21**. The grouting fluid flows in a first cavity, or passage, **97** between the first and second member and flows out of the first cavity **97** through access channels **93** and flushing hole, or channel, **94** in the drill tip **23** before being flushed back towards washer, or abutment member, **28** in a second cavity **98** between the rock face and the second elongate member **22**. The grouting fluid is injected until both cavities **97**, **98** are filled with grouting fluid and the bolt **20** is then left to set in the grouting fluid.

[**0100**] FIG. **9***a* shows a drill **100** of an eighth embodiment of the invention comprising a first elongate member, or shaft, **101** and a second elongate member, or sleeve, **102**. First elongate member **101** is disposed partially, longitudinally inside second elongate member **102**, which has first and second ends, **103**C, **103**D. First elongate member **101** comprises a first end **103**A, and a second end **103**B comprising as attachment means a drive element **104** that can receive a drill actuating means e.g. a drilling apparatus (not shown). Turning the drive element **104** also turns the first elongate member **101**. Second end **103**B of first elongate member **101** further comprises external thread **105**. The first end **103**A of first elongate member **101** comprises drill bit means **106** adapted to penetrate rock. Alternatively, the first end **103**A may be adapted to receive a drill bit means to penetrate rock. Drill bit means **106** comprises a cutting head, or drill tip, **107** and central flushing hole **109**. Drill bit means **106** comprises channels **108** to provide a return path for the flushing and grouting fluids, shown in the cross section of FIG. **9***a* taken along the line A-A. Drill bit means **106** is suitably attached to first elongate member **101** e.g. by brazing, butt welding, forging or the like.

[**0101**] Drilling is actuated by attachment of a drilling mechanism [not shown] to drive element **104** and rotating the first elongate member **101** and drill bit means **106** in a first rotational direction. Engagement of the drill bit means **106** with the rock requires the application of longitudinal pressure against the rock face in conjunction with the rotational action of the drilling apparatus. During drilling the drill bit means **106** is cooled with a cooling agent, which is injected in a first cavity, or passage, **110**A between the first and second members **101**, **102**. The cooling agent flows into first cavity **110**A, through central flushing hole, or channel, **109**, past channels **108** and out second cavity **110**B between the rock face and second member. Alternatively, the direction of flow can be reversed. When a hole of the required depth has been drilled, the drilling mechanism is removed from the hole and the hole can be used for example to insert explosives or reinforcement cables. The drill **100** can then be used to drill a further hole, the drill bit means **106** can be replaced by a further drill bit means **106** if required, e.g. for replacement of a worn cutting head, or drill tip, **107** or for different drilling conditions.

[**0102**] FIG. **10***a* shows a rock bolt **111** of a further embodiment of the invention comprising a first elongate member, or shaft, **112** and a second elongate member, or sleeve, **113**. First elongate member **112** is disposed partially, longitudinally inside second elongate member **113**, which has first and second ends, **114**C, **114**D. First elongate member **112** comprises a first end **114**A, and a second end **114**B comprising, as attachment means, a drive element **115** that can receive a drill actuating means e.g. a drilling apparatus (not shown). Turning the drive element **115** also turns the first elongate member **112**. Second end **114**B of first elongate member **112** further comprises an external thread **116** to rotatably lock internal thread **122** of first end **121**A of third elongate member **112**B as shown in FIG. **10***b*. The first end **114**A of first elongate member **112** comprises drill bit means **117** adapted to penetrate rock. Alternatively, the first end **114**A may be adapted to receive a drill bit means to penetrate rock. Drill bit means **117** comprises a cutting head, or drill tip, **118**. Drill bit means **117** comprises channels **119** to provide a return path for the flushing and grouting fluids, shown in the cross section of FIG. **10***a* taken along the line

A-A. Drill bit means **117** is suitably attached to the first elongate member **112** e.g. by brazing, butt welding forging or the like. Alternatively, the first end **114**A may be adapted to receive a drill bit means to penetrate rock. Drill bit means **117** is dimensioned to drill a hole of sufficient diameter to receive rock bolt **111**.

[**0103**] FIG. **10***b* shows an extension rod **120** comprising a third elongate member **112**B and a fourth elongate member **113**B. Third elongate member **112**B is disposed partially, longitudinally inside fourth elongate member **113**B. First end **121**C of fourth elongate member **113**B comprises a profiled lip adapted to be locked to the second end **114**D of second elongate member **113** in FIG. **10***a*. Further, second end **121**D of fourth elongate member **113**B comprises a profiled lip adapted to be locked to a first end of sixth elongate member [not shown]. Third elongate member **112**B comprises a first end **121**A, and a second end **121**B, comprising as attachment means a drive element **123** that can receive drill actuating means (not shown). Turning the drive element **123** also turns the third elongate member **112**B. First end **121**A of third elongate member **112**B comprises internal thread **122** to engage and rotatably lock with the external thread **116** of FIG. **10***a* in a first rotational direction. The third elongate member **112**B is locked to the first elongate member **112** such that rotation of the third elongate member **112**B in the first rotational direction causes the same rotation of the first elongate member **112**. In this way, rotation of the third elongate member in the first rotational direction rotates the drill bit and causes drilling to occur. Second end **121**B of third elongate member **112**B comprises an external thread **124** to rotatably lock internal thread of the first end of a fifth elongate member [not shown] in the same way as the locking between the first and third elongate members.

[**0104**] FIG. **11***a* shows an alternative rock bolt **130** of the previous embodiment of the invention. Rock bolt **130** comprises a first elongate member, or shaft, **131** and a second elongate member, or sleeve, **132**. First elongate member **131** is disposed partially, longitudinally inside second elongate member **132**. Second elongate member **132** comprises a first end **133**C and a second end **133**D. The first ends of the first and second elongate members **131**, **132** correspond to the first end of the rock bolt **130**. The second elongate member **132** is adapted for deformation in the form of transverse expansion along at least a portion of its length through provision of expansion shells, or an anchoring device, **136**A. First elongate member **131** comprises a first end **133**A, and a second end **133**B that is adapted to receive drive element **134** that can receive a drill actuating means (not shown). Second end **133**B of first elongate member **131** is further adapted to receive a nut, or collar piece, [not shown]. Turning the drive element **134** also turns the first elongate member **131**. Second end **133**B of first elongate member **131** as attachment means further comprises an external thread **135** to rotatably lock internal thread **147** of first end **143**A of a third elongate member **131**B, shown in FIG. **11***b*, when third elongate member **131**B is turned in a first direction. The first end **133**A of first elongate member **131** comprises drill bit means **137** adapted to penetrate rock. Alternatively, the first end **133**A may be adapted to receive a drill bit means to penetrate rock. Drill bit means **137** comprises a cutting head, or drill tip, **138** and a tapered collar, or engaging surface, **136**. The wider part of tapered collar **136** is disposed towards cutting head **138** and the narrower part towards first end **133**C of second elongate member **132**. Further, tapered collar **136** of drill bit means **137** comprises channels **139** to provide a return path for the flushing and grouting fluids, shown in the cross section of FIG. **11***a* taken along the line A-A. Drill bit means **137** is suitably attached first elongate member **131** e.g. by brazing, butt welding forging or the like. Alternatively, the first end **133**A may be adapted to receive a drill bit means to penetrate rock. Drill bit means **137** protrudes beyond end **133**C of second elongate member **132**. The lower edge of the tapered collar **136** allows drill bit means **137** to pass inside second elongate member **132** until the width of tapered collar **136** matches the inner diameter of second elongate member **132**. Drill bit means **137** is dimensioned to drill a hole of sufficient diameter to receive rock bolt **130**.

[**0105**] FIG. **11***b* shows an extension rod **140** comprising a third elongate member **131**B and a fourth elongate member **132**B. Third elongate member **131**B is disposed partially, longitudinally inside fourth elongate member **132**B. First end **143**C of fourth elongate member **132**B comprises a profiled lip adapted to be locked to the second end **133**D of second elongate member, or sleeve, **132** in FIG. **11***a*. Further, second end **143**D of fourth elongate member **132**B comprises a profiled lip adapted to be locked to a first end of sixth elongate member [not shown]. Third elongate member **131**B comprises a first end **143**A, and a second end **143**B, comprising as attachment means a drive element **144** that can receive drill actuating means [not shown]. Second end **143**B of third elongate member **131**B is further adapted to receive the nut, or collar piece, **145**. Turning the drive element **144** also turns the third elongate member **131**B. First end **143**A of third elongate member **131**B comprises internal thread **147** to engage and rotatably lock with the external thread **135** of FIG. **11***a* as described above. The third elongate member **131**B is locked to the first elongate member **131** such that rotation of the third elongate member **131**B in the first direction causes the same rotation of the first elongate member **131**. In this way, rotation of the third elongate member in the first direction rotates the drill bit means and causes drilling to occur. Second end **143**B of third elongate member **131**B comprises an external thread **146** to rotatably lock internal thread of a fifth **15** elongate member [not shown].

[**0106**] It will be appreciated that further extensions can be inserted in the same manner as described above, by connection of further extension rods. Each extension rod is preferably adapted so that it can receive a further identical extension rod at either, or each end, and function as described above to drill deeper boltholes. Additionally, it is possible to use only a single extension rod, to achieve a shallower bolthole. The rock bolt of an embodiment of the invention comprises the combination of first and second elongate members, together with one or more extensions, as described above.

[**0107**] Bolts according to any of the previous embodiments may be combined with extension rods as described above.

[**0108**] Drilling is actuated by attachment of a drilling mechanism, or apparatus, [not shown] to attachment means, or collar piece, provided by drive element **115** of FIG. **10***a* and rotating the first elongate member **112** and drill bit means **117** in a first rotational direction. Engagement of the

drill bit means **117** with the rock requires the application of longitudinal (axial) pressure against the rock face in conjunction with the rotational action of the drilling apparatus. During drilling the drill bit means **117** is cooled with a cooling agent, which is injected in a second cavity **110**B between the rock face and second member **113**. The cooling agent then returns by flowing into and out of a first cavity, or passage, **110**A between the first elongate member **112** and second elongate member **113**.

[**0109**] Alternatively, the cooling agent may be injected into the first cavity **110**A between the first elongate member **112** and second elongate member **113** and return via the second cavity **110**B between the rock face and second elongate member **113**.

[**0110**] The length of the bolt is extended using the extension rod **120** of FIG. **10***b* to extend the rock bolt **111**. The extension rod **120** is attached to the second end **114**B of first elongate member **112** by drilling. Drilling is actuated by attachment of a drilling mechanism, or apparatus, [not shown] to attachment means provided by drive element **123** of the extension rod **120** and rotating the third elongate member **112**B in a first rotational direction. The first end **121**C of the fourth elongate member **113**B is then fitted to the second end **114**D of the second elongate member **113** by attachment means such as a snap fitting.

[**0111**] The depth of the hole is then extended by attachment of the drilling mechanism [not shown] to attachment means provided by drive element **123** which rotates now joined first and third elongate members **112**, **112**B and drill bit means **119** in a first rotational direction. During drilling the drill bit means **119** is cooled with a cooling agent, which is injected in the second cavity **110**A which now extends between the rock face and the first and third elongate members **112**, **112**B. The cooling agent flows into and out of the first and second cavities **110**A, **110**B between the rock face and the first, and second, and third and fourth members **112**, **112**B, **113**, **113**B.

[**0112**] When a hole of the required depth has been drilled, grouting fluid is injected into the first cavity **110**A between the joined first and third elongate members **112**, **112**B and the joined second and fourth elongate members **113**, **113**B until the cavity **110**A is filled with grouting fluid. Grouting fluid may also be injected into the second cavity **78** between the rock face and the joined second and fourth elongate members. The extended bolt **111**, **120** is then left to set in the grouting fluid. A circulation path may be formed, with grout being passed into one of the first and second cavities **110**A, **78** and passing into the other in the region of the first end of the first elongate member and filling both cavities.

[**0113**] The extendible bolt of FIG. **11** is drilled in the same way as described with reference to FIG. **10** except that, when a hole of the required depth has been drilled, nut, or collar piece, **145** is rotated on external thread **146** of third elongate member **131**B causing the nut **145** to advance towards the first end **143**A of the third elongate member **131**B and advance fourth elongate member **132**B (and therefore second attached elongate member **132**). Continued rotation of nut **145** urges the taper of collar **136** against first end **133**C of second elongate member, or sleeve, **132** causing expansion shells **136**A to expand into engagement with the hole wall.

[**0114**] It will be appreciated that further extensions can be inserted in the same manner as described above, by connection of further extension rods. Each extension rod is preferably adapted so that it can receive a further identical extension rod at either, or each end, and function as described above to drill deeper boltholes. Additionally, it is possible to use only a single extension rod, to achieve a shallower bolthole.

[**0115**] It will be appreciated that it is possible to use only the single rock bolt **130** of FIG. **11***a*, to achieve a shallower bolthole. The nut **145**[not shown in FIG. **11***a*] is attached to the external thread **135** of the first elongate member **131**. Nut **145** is rotated on external thread **135** of first elongate member **131** causing the nut **145** to advance towards the first end **133**A of the first elongate member **131** and advance second elongate member **132**. Continued rotation of nut **145** urges the taper of collar **136** against first end **133**C of second elongate member **132** causing expansion shells **136**A to expand into engagement with the hole wall.

[**0116**] It will be appreciated that various alterations and/or additions in the particular construction and arrangement of parts previously described may be made without departing from the spirit or ambit of the present invention.

1-84. (canceled)

85: A drilling member comprising opposite first and second ends and a shaft extending between the ends, at least one drill tip disposed at the first end and the second end being adapted to be connected to a drilling apparatus to allow rotation of and thrust to a bolt, a sleeve extending along and around the shaft, and a passage formed between the sleeve and the shaft to allow fluid to be passed along the shaft.

86-121. (canceled)

122: A drilling member according to claim 85, wherein the at least one drill tip extends radially from an axis of the bolt a distance greater than the sleeve.

123: A drilling member according to claim 85, wherein the at least one drill tip is fixed to one of the first and second ends of the shaft.

124: A drilling member according to claim 85, further comprising a drill bit which is connected to one of the first and second ends of the shaft and incorporates the at least one drill tip thereon.

125: A drilling member according to claim 85, wherein openings are provided to the passage at or adjacent each of the opposite ends of the sleeve.

126: A drilling member according to claim 85, further comprising a collar piece that extends about the shaft adjacent its second end.

127: A drilling member according to claim 126, further comprising at least one channel that allows fluid to flow into or out of the passage through the collar piece.

128: A drilling member according to claim 127, wherein the at least one channel is formed between the shaft and the collar piece.

129: A drilling member according claim 85, further comprising at least one channel formed at the first end to facilitate flow of fluid between the passage and the drill tip.

130: A drilling member according to claim 129, wherein at least part of the channel at the first end is located within the drilling member.

131: A drilling member according to claim 85, wherein the shaft is operative to accommodate the compressive loading acting on the drilling member during drilling.

132: A drilling member according to claim 131, wherein the sleeve has substantially less compressive strength than the shaft.

133: A drilling member according to either claim 131, wherein the shaft is formed from steel rod.

134: A drilling member according to claim 131, wherein the shaft is formed from a fiber reinforced material.

135: A drilling member according to claim 131, wherein the sleeve is formed from plastic.

136: A drilling member according to claim 131, wherein the sleeve is formed from sheet metal.

137: A drilling member according to claim 85, wherein said member is arranged to be fixed in a hole drilled by said drilling member so as to form a self drilling rock bolt.

138: A self drilling rock bolt according to claim 137, wherein an outer surface of the shaft is rough to promote bonding of grout to the shaft.

139: A self drilling rock bolt according to claim 138, wherein the outer surface of the shaft is corrugated.

140: A self drilling rock bolt according to claim 137, further comprising an anchoring device which is operative to retain the rock bolt when located in the drilled hole.

141: A self drilling rock bolt according to claim 140, wherein the anchoring device is movable from a retracted position where the device does not impede drilling of the hole to an expanded position where the device is arranged to retain the rock bolt in the drilled hole.

142: A self drilling rock bolt according to claim 141, wherein the bolt is operative to be rotated in a first direction to effect drilling, and is operative to be rotated in a second opposite direction to move the anchoring device from its retracted to its expanded a position.

143: A self drilling rock bolt according to claim 141, wherein the sleeve is deformable and when so deformed, the sleeve extends radially beyond the drill tip.

144: A self drilling rock bolt according to claim 143, wherein the sleeve is deformable on the application of an axial force to the sleeve.

145: A self drilling rock bolt according to claim 144, wherein the axial force is towards the first end.

146: A self drilling rock bolt according to claim 143, wherein the rock bolt further comprises at least one engaging surface, and wherein the sleeve is deformed on relative movement of the sleeve across the engaging surface.

147: A self drilling rock bolt according to claim 146, further comprising a drill bit which is connected to one of the first and second ends of the shaft and incorporates the at least one drill tip thereon, wherein the engaging surface is located on the drill bit.

148: A self drilling rock bolt according to claim 144, wherein the sleeve is deformable under axial compression.

149: A self drilling rock bolt according to claim 143, wherein the sleeve incorporates at least one weakened area that facilitates deformation of the sleeve.

150: A self drilling rock bolt according to claim 149, wherein the at least one weakened area is in the form of a slit formed in the sleeve.

151: A self drilling bolt according to claim 150, wherein the anchoring device is located proximate the first end and is operative in response to axial movement of the shaft relative to the sleeve.

152: A self drilling rock bolt according to claim 140, wherein the anchoring device forms part of, or is connected to, the sleeve.

153: A self drilling rock bolt according to claim 152, wherein the sleeve is formed from a composite stricture and includes at least one metal member that forms said anchoring device.

154: A self drilling bolt according to claim 140, wherein the anchoring device is in the form of at least one expansion shell that is displaceable radially outwardly.

155: A self drilling rock bolt according to claim 154, wherein the rock bolt comprises at least one engaging surface, and wherein the at least one expansion shell becomes operative on relative movement of the engaging surface across an inner surface of the at least one expansion shell.

156: A self drilling rock bolt according to claim 140, further comprising a collar piece that extends about the shaft adjacent its second end, wherein the collar piece is displaceable axially along the bolt shaft.

157: A self drilling rock bolt according to claim 149, wherein the sleeve is displaceable along the shaft in response to movement of the collar piece along the shaft.

158: A self drilling rock bolt according to claim 155, wherein the collar piece is connected to the shaft by an external thread on the shaft that engages with a complementary inner thread of the collar piece.

159: A self drilling rock bolt according to claim 155, wherein the rock bolt is adapted to be connected at least in part to the drilling apparatus by connection of the drilling apparatus with the collar piece.

160: A self drilling rock bolt according to claim 140, further comprising an abutment member located proximate the second end, the abutment member being displaceable along the shaft and having an abutment surface that faces towards the first end and projects radially from the bolt axis a distance greater than the drill tip.

161: A self drilling rock bolt according to claim 160, wherein in use, the rock bolt is installed in a hole drilled by said bolt, and the abutment member is arranged to abut the rock wall surrounding the drilled hole, and wherein the shaft is able to be tensioned in the hole through engagement of the anchoring device and the abutment member with the rock.

162: A self drilling rock bolt according to claim 160, further comprising a collar piece that extends about the shaft adjacent its second end, wherein the collar piece is displaceable axially along the bolt shaft, wherein the collar piece limits the axial movement of the abutment member towards the second end.

163: A drilling member or self drilling rock bolt according claim 85, further comprising extension means arranged to extend the length of the drilling member or rock bolt, the extension means comprising at least one extension shaft and at least one extension sleeve, wherein the or each extension shaft is operative to be connected to the second end of a member or bolt or to an end of another said extension shaft and the extension sleeve is operative to be connected to the sleeve of a member or bolt or to an end of another said extension sleeve.

164: A drilling member according to claim 163, wherein the extension shaft is connected to the second end of the bolt or shaft or to another said extension shaft in a manner that allows the transmission of torque and thrust through the connection.

165: A self drilling rock bolt according to claim 137, further comprising extension means arranged to extend the length of the drilling member or rock bolt, the extension

means comprising at least one extension shaft and at least one extension sleeve, wherein the or each extension shaft is operative to be connected to the second end of a member or bolt or to an end of another said extension shaft, and the extension sleeve is operative to be connected to the sleeve of a member or bolt or to an end of another said extension sleeve.

166: A drilling member or rock bolt according to claim 165, wherein the extension shaft is connected to the second end of the bolt or shaft or to another said extension shaft in a manner that allows the transmission of torque and thrust through the connection.

167: A shaft and sleeve combination when used in a drilling member according to claim 85, wherein the shaft is arranged to receive at least one drill tip at one end thereof.

168: A shaft and sleeve combination according to claim 167, further comprising a drill bit which is connected to one of the first and second ends of the shaft and incorporates the at least one drill tip thereon, wherein the one end of the shaft is arranged to receive the drill bit.

169: A shaft and sleeve combination according to claim 168, wherein the drill tip comprises a bit body having opposite ends and a wall surface extending between the ends, at least one drill tip located at one end and the bit being adapted to be connected to a drill rod at the other end, wherein at least one channel extends from the wall surface to the at least one drill tip.

170: A drill bit comprising a bit body having opposite ends and a wall surface extending between the ends, at least one drill tip located at one end and the bit being adapted to be connected to a drill rod at the other end, wherein at least one channel extends from the wall surface to the at least one drill tip.

171: A drill bit according to claim 170, wherein the wall surface includes a wall portion that tapers outwardly towards the one end.

172: A method of drilling, comprising:

drilling a hole using a drilling member having a drilling end and an opposite end connected to a drilling apparatus; and

providing drilling fluid to the drilling end during drilling of the hole by conveying fluid along the outer surface of the bolt shaft.

173: A method according to claim 172, wherein the drilling fluid is guided along the shaft in an inner passage defined by a sleeve disposed around and along the shaft.

174: A method of stabilizing rock, comprising:

drilling a hole into rock using a self drilling rock bolt having a drilling end and an opposite end connected to a drilling apparatus;

providing drilling fluid to the drilling end during drilling of the hole by conveying fluid along an outer surface of a bolt shaft; and

fixing the rock bolt within the hole to stabilize the rock.

175: A method according to claim 174, wherein grout is introduced into the hole to fix the rock bolt to the rock.

176: A method according to claim 175, wherein the rock bolt is initially anchored within the hole prior to introducing grout into the hole.

177: A method according to claim 176, wherein the rock bolt an anchoring device to anchor the bolt in the hole, and wherein the bolt is rotated in a first direction during drilling of said hole, and is rotated in a second opposite direction to cause the anchoring device to anchor the bolt in the hole.

178: A method according to claim 175, wherein the rock bolt is placed in tension in the hole prior to introducing grout into the hole.

179: A method according to claim 174, wherein the drilling fluid is guided along the shaft in an inner passage defined by a sleeve disposed around and along the shaft.

180: A method according to claim 179, further comprising the step of forming an outer passage between the sleeve and the side of the hole.

181: A method according to claim 180, wherein fluid is caused to flow to the drilling end through one of either the inner or outer passages, and is removed from the hole through the other of the passages.

182: A method according to claim 180, wherein grout is caused to flow into each of the inner and outer passages.

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