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(54) **Title:** METHOD FOR FIXING A CABLE OR TENDON

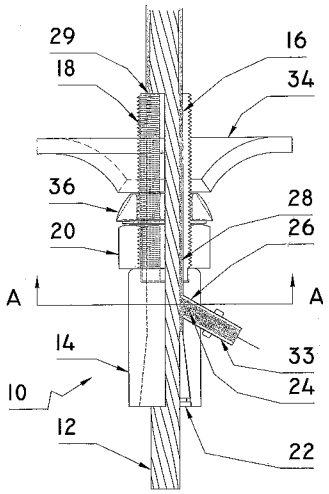

FIGURE 1

(57) **Abstract:** The present invention relates broadly to a tensioning device through which a strata support cable 12 or tendon passes. The cable 12 is installed into an elongate cavity drilled into a geological strata (not shown). The tensioning device 10 includes a tensioning member 14 which has a central elongate bore 16. The elongate bore 16 is adapted to receive the strata support cable 12. The tensioning member 14 has a threaded portion 18 for threaded engagement with an actuator member or relatively large nut 20. The tensioning member 14 also includes a wedge assembly 22 for securing the table 12 or tendon to the tensioning member 14 to prevent the cable 12 or tendon pulling through the elongate bore 16.

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METHOD FOR FIXING A CABLE OR TENDON

FIELD OF THE INVENTION

The invention relates generally to a method of installing a strata support cable or tendon and a tensioning device for a strata support cable or tendon. The invention relates particularly, although not exclusively, to a post grouting method for a cable or tendon. The invention also relates broadly to a cutting or piercing tool for a strata support cable or tendon.

BACKGROUND OF THE INVENTION

In underground mining and strata control, bolting is generally recognised as the primary support system. Bolting usually involves grouting of a rock bolt within a bolt hole formed in the strata of an underground mine. The bolt is commonly tensioned using a 2-speed resin capsule so that the strata surrounding the bolthole is held in compression. This technique has been extended to cables or tendons where generally a barrel and wedge fitting is attached to the cable and is tensioned using hydraulically actuated equipment.

The typical practice for post-grouting to achieve full encapsulation involves:

(i) Clamping or clipping an air return tube or hose along the length of the cable or tendon;

(ii) Filling the annulus space surrounding the cable or tendon with grout from the bottom up and venting air from the enclosed upper space of the hole via the air return tube or hose.

The grout is typically pumped into the hole via a port provided in a strata plate which surrounds the opening to the hole. The cable or tendon may also require bulbing to improve its anchor strength due to the larger hole to fit the air return tube.

SUMMARY OF THE INVENTION

According to one aspect of the present invention there is provided a method of installing a strata support cable or tendon having multiple strands or wires, the method comprising the steps of:

drilling an elongate cavity in a geological strata;

locating the strata support cable or tendon in the cavity; and

injecting grout or resin into the cavity and displacing air exhausted from the cavity

through an interstitial passageway between the strands or wires of the cable or tendon itself.

Generally most or all of the strands or wires are wound or braided.

Preferably the method also comprises a pre-grouting step of pushing the cable or tendon through grout or resin capsules within the cavity. More preferably the pre-grouting step involves breaking the capsules with the advancing cable or tendon to release the resin or grout which sets to secure a distal end of the cable or tendon within the cavity. Even more preferably the method further comprises the step of tensioning the cable or tendon via a tensioning device attached to the cable or tendon and thereby compressing the strata about the cavity. Still more preferably the step of injecting grout or resin into the cavity is performed as a post-grouting step subsequent to the pre-grouting and tensioning step(s).

According to another aspect of the invention there is provided a tensioning device for a strata support cable or tendon having multiple strands or wires and being adapted to be installed in an elongate cavity of a geological strata, the tensioning device comprising:

a tensioning member having an elongate bore being adapted to receive the strata support cable or tendon, the tensioning member defining a fluid passageway between it and the cable or tendon; and

a fluid inlet formed in the tensioning member and opening into the fluid passageway, the fluid inlet being adapted for injection of grout or resin into the elongate cavity via the fluid passageway whereby air is displaced from the cavity through an interstitial passageway between the strands or wires of the cable or tendon itself.

Generally most or all of the strands or wires are wound or braided.

Preferably the tensioning device also comprises cable retaining means connected to the tensioning member and being adapted to secure the cable or tendon to the tensioning member and prevent the tensioned cable or tendon pulling through the elongate bore. More preferably the cable retaining means includes a wedge assembly.

Preferably the cable or tendon is air permeable along its length where the interstitial passageway is one of a plurality of interstitial passageways. More preferably, each of the strands or wires is a steel or plastic strand or wire.

Preferably the interstitial passageway includes an internal air-venting passageway. More preferably the interstitial passageway is defined by the plurality of strands or wires wherein the passageway runs along the length of the cable or tendon.

Preferably the fluid inlet is threaded for attachment of a non-return valve coupled to a conduit, hose or pipe conducting the grout or resin from a grout or resin supply.

Preferably the settable grout or resin is a thixotropic grout or resin. More preferably the grout or resin is of a sufficiently high viscosity not to pass inwardly through the cable or tendon and block the internal air-venting passageway.

According to yet another aspect of the invention there is provided a strata support cable or tendon having one end shaped asymmetric including an oblique surface defining a cutting edge for cutting or piercing a resin or grout capsule located within a cavity drilled into a geological strata.

Preferably said one end of the cable or tendon is tapered or cut at an acute angle to define the cutting edge.

According to still another aspect of the invention there is provided a cutting or piercing tool being adapted to attach to an end of a strata support cable or tendon, said tool comprising cutting means being shaped asymmetric and adapted to cut a resin or grout capsule located within a cavity drilled into a geological strata.

Preferably the cutting means includes an asymmetric shaped cutting head including one or more oblique surfaces defining one or more cutting edges. More preferably the cutting head is tapered or truncated at an acute angle.

Preferably the tool also comprises mounting means connected to the cutting head and adapted to provide detachable attachment to the cable or tendon. More preferably the mounting means is formed integral with the cutting head and includes a threaded portion.

Preferably the tool also comprises a coupling element being adapted to secure to the cable or tendon and provide detachable connection to the mounting means. More preferably the coupling element is in the form of a threaded socket secured to the cable or tendon. Alternately the coupling element is a threaded spigot secured to the cable or tendon.

According to still yet another aspect of the invention there is provided a method of grouting an elongate cavity adapted to locate a strata cable or tendon, the method

comprising the steps of:

inserting a capsule containing grout or resin lengthwise into the cavity; and

laterally displacing the capsule by inserting into the cavity a cable or tendon having a cutting tool being shaped asymmetric and including an oblique surface attached to an end of the cable or tendon; and

rupturing the displaced capsule by cutting or piercing it with a cutting edge defined by the oblique surface of the cutting tool.

According to even still yet another aspect of the invention there is provided a method of grouting an elongate cavity adapted to locate a strata cable or tendon, the method comprising the steps of:

inserting a capsule containing grout or resin lengthwise into the cavity;

laterally displacing the capsule by inserting into the cavity a cable or tendon having one end shaped asymmetric including an oblique surface; and

rupturing the displaced capsule by cutting or piercing it with a cutting edge defined by the oblique surface of the cable or tendon.

Preferably the capsule is one of multiple capsules inserted into the cavity.

Preferably the capsule includes an outer membrane containing the grout or resin and the step of laterally displacing the capsule involves advancing the cable or tendon within the cavity pushing the membrane aside with the oblique surface.

BRIEF DESCRIPTION OF THE FIGURES

In order to achieve a better understanding of the nature of the present invention preferred embodiments of the various aspects relating to installation of a strata support cable or tendon and the cable or tendon itself will now be described, by way of example only, with reference to the accompany figures within which:

Figure 1 shows a schematic partial X-ray elevational view of a tensioning device for a strata support cable or tendon according to one embodiment of the invention;

Figure 2 shows a schematic partial X-ray elevational view of a typical barrel & wedge type tensioning member being adapted for the methodology of another embodiment of the invention;

Figure 3 is cross-sectional view A-A through the tensioning member and cable shown in figure 1; and

Figure 4 is a cross sectional view B-B through figure 2;

Figure 5 is a schematic illustration of an end of a strata support cable or tendon shaped according to an embodiment of another aspect of the invention;

Figure 6 is a schematic illustration of a cutting or piercing tool of an embodiment of yet another aspect of the invention detachably attached to an end of a strata support cable or tendon;

Figure 7 is various views of the cutting head of the cutting or piercing tool of Figure 6; and

Figure 8 shows a side view of a tensioning member with a non-detachable threaded portion..

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows one embodiment of a tensioning device, generally indicated by the reference numeral 10 through which a strata support cable 12 or tendon passes. The cable 12 is installed into an elongate cavity drilled into a geological strata (not shown). The tensioning device 10 includes a tensioning member 14 which has a central elongate bore 16. The elongate bore 16 is adapted to receive the strata support cable 12, and preferably has a slightly larger diameter than the cable 12. In this embodiment, the tensioning member 14 has a threaded portion 18 for threaded engagement with an actuator member or relatively large nut 20. This embodiment of the tensioning member 14 also includes a wedge assembly 22 for securing the cable 12 or tendon to the tensioning member 14 to prevent the cable 12 or tendon pulling through the elongate bore 16.

A fluid inlet 24 is defined by a transverse aperture 26 in a sidewall of a head of the tensioning member 14. The aperture 26 is threaded and the inlet 24 opens into the elongate bore 16.

When the cable 12 passes through the elongate bore 16 a fluid passageway 28 is formed in the annulus between the cable 12 and the tensioning member 14. Thus, the fluid inlet 24 formed in the tensioning member 14 opens into the annular fluid passageway 28. In use, the fluid inlet 24 allows injection of a preferably thixotropic grout or resin (shaded regions of figures) into the elongate cavity of the geological structure surrounding the

cable or tendon 12. This post grouting is via the annular fluid passageway 28 that runs along the length of the tensioning member 14, and out of an opening 29 at a distal end of the tensioning member 14.

The cable 12 or tendon is in the form of wire rope and comprises a plurality of steel strands or wires, such as 30 in figure 3, rendering the cable 12 permeable to air. One or more of the strands or wires 30 can be wound or braided, whereas others can be straight. Because air is less viscous than the grout or resin the cable is substantially more permeable to the air than the grout or resin. Thus, the cable 12 or tendon includes a plurality of internal air vents or interstitial passageways 32 between the strands or wires as shown in figure 3. The passageways 32 are oriented generally longitudinally of the cable or tendon 12 and are generally shaped in the form of a helix.

As shown in figure 3, on injection of the grout or resin into the elongate cavity (filling from the bottom up) the air that is displaced by the grout or resin is exhausted from the cavity through the cable 12 or tendon itself via one or more of the passageways such as 32. This means that the use of a breather tube or air return tube or hose (of the prior art) is not necessary. Furthermore the multiplicity of interstitial passageways 32 is advantageous because some of the interstitial passageways may be blocked by, for example, the grout or resin. In this circumstance, air from the cavity can still be exhausted via the unblocked interstitial passageways. The threaded fluid inlet 24 permits attachment of a non-return valve coupled to a conduit, hose or pipe fitting 33 conducting the grout or resin from a grout or resin supply separate from the tensioning device 10.

In the preferred embodiment of the method, the elongate cavity is in a pre-grouting step partly loaded or filled with capsules containing grout or resin. The capsules are broken with the advancing cable 12 or tendon to release the resin or grout which sets to secure a distal end of the cable 12 or tendon within the cavity. After this pre-grouting or anchoring step the cable 12 or tendon is tensioned by rotating the nut 20 around the thread portion 18 which drives a strata or volcano plate 34 against the strata to compress it about the cavity. An intermediate domed washer and bearing assembly 36 is located between the nut 20 and the volcano plate 34. Operation and construction of the tensioning device 10 is otherwise described in some detail in the applicant's international patent application no. PCT/AU2007/01141 the disclosure of which is incorporated herein by way of reference. Of particular relevance to this present application is the disclosure of two different configurations in which the threaded portion is integrated with the tensioning member.

Figure 1 shows a configuration where the threaded portion 18 is detachable from the tensioning member 14. Figure 8 shows another configuration where the threaded portion 180 is non-detachable from the tensioning member 140. The two configurations are otherwise substantially identical and either configuration can be used in place of the other. Specifically, the tensioning member 140 also has a fluid inlet 240 defined by a transverse aperture 260 in a sidewall of a head of the tensioning member 140.

Figure 2 shows a typical tensioning device 100 of the barrel and wedge type of the prior art. For ease of reference and to avoid repetition, like components of this embodiment and that of figure 1 have been designated with an addition "0". The strata or volcano plate 340 of this embodiment includes a threaded opening 102 for attachment of the pipe fitting 330. The device 100 otherwise includes the dome-shaped barrel 104 and wedge assembly 220 for securement of the cable or tendon 120. In this embodiment and as best shown in figure 4 the device 100 is adapted to allow post grouting and air venting via the interstitial air passageways 320 of the cable or tendon 120, in a similar manner to the previous embodiment.

Figure 5 shows three (3) views of an embodiment of an end of a strata support cable or tendon 50 according to another aspect of the invention. The cable or tendon 50 has its end shaped asymmetric for laterally displacing and thereafter cutting or piercing of a resin or grout capsule located within a cavity drilled into a geological strata (not shown). In this example the cable 50 is cut at an acute angle to define three (3) cutting edges 54, 55 & 56 terminating at a rounded tip 52, and an oblique surface or asymmetric wedge 57.

Figure 6 illustrates an embodiment of a cutting or piercing tool 60 according to yet another aspect of the invention. The tool 60 comprises cutting means in the form of a cutting head 62 which is shaped asymmetric and adapted to laterally displace and thereafter cut a resin or grout capsule located within a cavity drilled into a geological strata (not shown). Figure 7 illustrates different views (perspective view, front view and side view) of the cutting head 62 shown in Figure 6. The cutting head 62 is generally cylindrical and truncated at an acute angle to define a pair of oblique surfaces 64 & 66 together defining a cutting edge 67 terminating at a rounded tip 68. The cutting head 62 is formed integral with mounting means in the form of a threaded spigot 70. The tool 60 also comprises a coupling element in the form of internally threaded socket 72 being configured to provide threaded attachment for the tool 60 to the cable or tendon 73 via the threaded spigot 70. The tool may be fabricated of hard plastic, metal or any other suitable material.

The asymmetric shaped cable or tendon 50 or the cutting or piercing tool 60 allows the cable or tendon to be pushed through the resin capsule easier. The tendon 50 or tool 60 pushes the resin capsule to the side and avoids concertina of the capsule or sausage packaging lining the hole and forming a glove about the tendon 50. This means that it may be possible to include multiple resin capsules in the cavity or hole to achieve better pre-grout encapsulation. The tendon 50 may also be advanced into the cavity for the majority of its length without rotation. This means that the exposed length of tendon 50 on rotation of the tendon 50 is minimised. In some applications this use of multiple resin capsules may eliminate or lessen the need for post-groutings.

In another embodiment of the method, one or more capsules each having an outer membrane containing resin are inserted lengthwise into the cavity. The capsule membrane is then ruptured by inserting a cable or tendon 12 into the cavity, the end of the cable 12 having a penetration tool such as 50 or 60 attached or formed therein. The tool has an oblique surface or asymmetric wedge, such as 57 or 67, that pushes the membrane to one side of the cavity as the tool 50, 60 and cable 12 are advanced into it. This prevents the concertina or collapse of the membrane before the tool which would form an impassable plug blocking further advance of the cable 12 into the cavity. The rounded tip 52, 68 of the tool 50, 60 aids in the penetration of the tool 50, 60 deep into the cavity containing elongate resin capsules. Once a sufficient length of cable 12 has been inserted, the cable 12 can be rotated to promote the final advance of the cable 12 into the cavity and break up the membrane. The cavity diameter and depth is typically around 30 millimetres and 10 metres respectively, and the capsule is typically sausage-like with a diameter and length that are typically around 24 millimetres and 1 metre respectively.

Now that a preferred embodiment of the present invention has been described in some detail it will be apparent to those skilled in the art that the tensioning device and method of installing a strata support cable or tendon have at least the following advantages:

1. There is no longer a need for the traditional air return tube or hose and cable bulbing and therefore there are cost savings both in terms of labour and materials for the assembly and installation;

2. The hole or elongate cavity drilled into the geological strata need not be sized or sufficiently large to accommodate the air return tube or hose, and can therefore be drilled faster;

3. The smaller hole size reduces the need for cable bulbing to compensate for the reduced pull out strength in the larger holes;

4. The post-grouting procedure is simplified by exclusion of the return tube or hose and venting via the cable or tendon itself;

5. There is no need to protect the breather or air return tube of the prior art from damage or blocking up from the initial pre-grouting and anchoring steps;

6 In the event that some of the interstitial passageways are blocked, the multiplicity of the interstitial passageways allows air to be exhausted from the cavity via the unblocked interstitial passageways; and

7. The asymmetric shaped cable or tendon or cutting tool displaces the capsule packaging increasing the anchorage strength of the tendon.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. For example, although the tensioning device of this embodiment is preferably fabricated from steel, any suitable material such as plastic or alloy would suffice. The tensioning device may also provide for a different porting or grout/resin entry point to that described. The cutting or piercing to is not limiting to the shape described but may extend to other asymmetric shapes and configurations. The steel strands of the braided cable or tendon may be fabricated of other materials such as plastics. The present embodiments are, therefore, to be considered in all respects as illustrated and not restrictive.

CLAIMS

1. A method of installing a strata support cable or tendon having multiple strands or wires, the method comprising the steps of:

drilling an elongate cavity in a geological strata;

locating the strata support cable or tendon in the cavity; and

injecting grout or resin into the cavity and displacing air exhausted from the cavity through an interstitial passageway between the strands or wires of the cable or tendon itself.

2. A method as claimed in claim 1 wherein the method also comprises a pre-grouting step of pushing the cable or tendon through grout or resin capsules within the cavity.

3. A method as claimed in claim 2 wherein the pre-grouting step involves breaking the capsules with the advancing cable or tendon to release the resin or grout which sets to secure a distal end of the cable or tendon within the cavity.

4. A method as claimed in any one of the preceding claims wherein the method further comprises the step of tensioning the cable or tendon via a tensioning device attached to the cable or tendon and thereby compressing the strata about the cavity.

5. A method as claimed in claim 4 wherein the step of injecting grout or resin into the cavity is performed as a post-grouting step subsequent to the pre-grouting and tensioning step(s).

6. A method as claimed in any one of the preceding claims wherein at least one or more of the strands or wires are wound or braided.

7. A tensioning device for a strata support cable or tendon having multiple strands or wires and being adapted to be installed in an elongate cavity of a geological strata, the tensioning device comprising:

a tensioning member having an elongate bore being adapted to receive the strata support cable or tendon, the tensioning member defining a fluid passageway between it and the cable or tendon; and

a fluid inlet formed in the tensioning member and opening into the fluid passageway, the fluid inlet being adapted for injection of grout or resin into the elongate cavity via the fluid passageway, whereby air is displaced from the cavity

through an interstitial passageway between the strands or wires of the cable or tendon itself.

8. A tensioning device as claimed in claim 7 wherein the tensioning device also comprises cable retaining means connected to the tensioning member and being adapted to secure the cable or tendon to the tensioning member and prevent the tensioned cable or tendon pulling through the elongate bore.

9. A tensioning device as claimed in claim 8 wherein the cable retaining means includes a wedge assembly.

10. A tensioning device as claimed in any one of claims 7 to 9 wherein the cable or tendon is air permeable along its length.

11. A tensioning device as claimed in claim 10 wherein each of the strands or wires is a steel or plastics strand or wire.

12. A tensioning device as claimed in any one of claims 7 to 11 wherein the interstitial passageway includes an internal air-venting passageway.

13. A tensioning device as claimed in any one of claims 7 to 12 wherein the interstitial passageway is defined by the plurality of strands wherein the passageway runs along the length of the cable or tendon.

14. A tensioning device as claimed in any one of claims 7 to 13 wherein the fluid inlet is threaded for attachment of a non-return valve coupled to a conduit, hose or pipe conducting the grout or resin from a grout or resin supply.

15. A tensioning device as claimed in any one of claims 7 to 14 wherein the grout or resin is a thixotropic grout or resin.

16. A tensioning device as claimed in any one of claims 7 to 15 wherein the grout or resin is of a sufficiently high viscosity not to pass inwardly through the cable or tendon and block the interstitial passageway.

17. A tensioning device as claimed in any one of claims 7 to 16 wherein at least one or more of the strands or wires are wound or braided.

18. A strata support cable or tendon having one end shaped asymmetric including an oblique surface defining a cutting edge for cutting or piercing a resin or grout capsule located within a cavity drilled into a geological strata.

19. A strata support cable or tendon as claimed in claim 18 wherein said one end of the cable or tendon is tapered or cut at an acute angle to define the cutting edge.

20. A cutting or piercing tool being adapted to attach to an end of a strata support cable or tendon, said tool comprising cutting means being shaped asymmetric and adapted to cut a resin or grout capsule located within a cavity drilled into a geological strata.

21. A cutting or piercing tool as claimed in claim 20 wherein the cutting means includes an asymmetric shaped cutting head including one or more oblique surfaces defining one or more cutting edges.

22. A cutting or piercing tool as claimed in claim 21 wherein the cutting head is tapered or truncated at an acute angle.

23. A cutting or piercing tool as claimed in any one of claims 20 to 22 wherein the tool also comprises mounting means connected to the cutting head and adapted to provide attachment to the cable or tendon.

24. A cutting or piercing tool as claimed in claim 23 wherein the mounting means is formed integral with the cutting head and includes a threaded portion.

25. A cutting or piercing tool as claimed in either of claims 23 or 24 wherein the tool also comprises a coupling element being adapted to secure to the cable or tendon and provide detachable connection to the mounting means.

26. A cutting or piercing tool as claimed in claim 25 wherein the coupling element is in the form of a threaded socket secured to the cable or tendon.

27. A cutting or piercing tool as claimed in claim 25 wherein the coupling element is in the form of a threaded spigot secured to the cable or tendon.

28. A method of grouting an elongate cavity adapted to locate a strata cable or tendon, the method comprising the steps of:

inserting a capsule containing grout or resin lengthwise into the cavity;

laterally displacing the capsule by inserting into the cavity a cable or tendon having a cutting tool being shaped asymmetric and including an oblique surface attached to an end of the cable or tendon; and

rupturing the displaced capsule by cutting or piercing it with a cutting edge defined by the oblique surface of the cutting tool.

29. A method of grouting an elongate cavity adapted to locate a strata cable or tendon, the method comprising the steps of:

inserting a capsule containing grout or resin lengthwise into the cavity;

laterally displacing the capsule by inserting into the cavity a cable or tendon having one end shaped asymmetric including an oblique surface; and

rupturing the displaced capsule by cutting or piercing it with a cutting edge defined by the oblique surface of the cable or tendon.

30. A method as claimed in claim 29 wherein the capsule includes an outer membrane containing the grout or resin and the step of laterally displacing the capsule involves advancing the cable or tendon within the cavity pushing the membrane aside with the oblique surface.

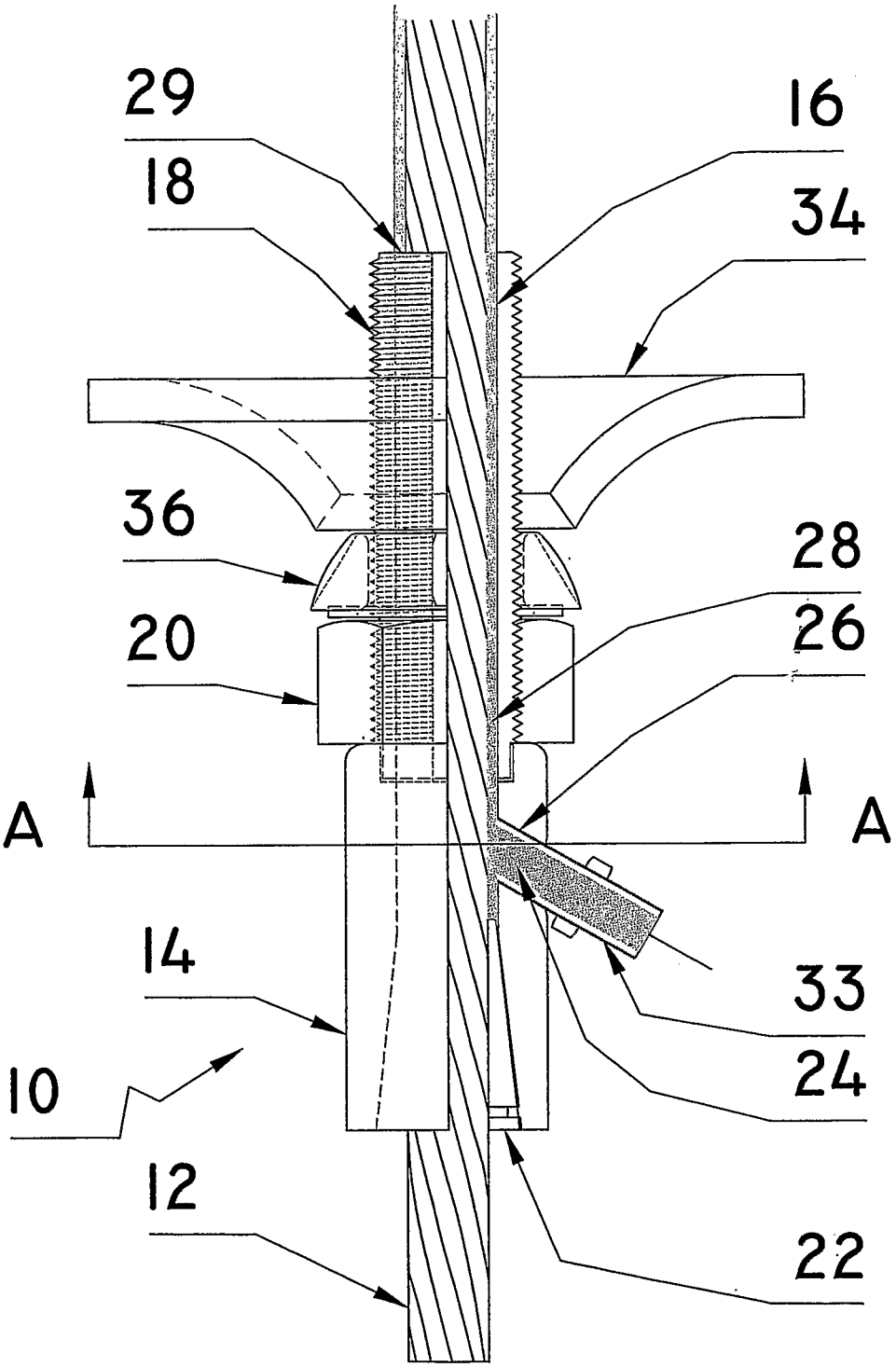

FIGURE 1

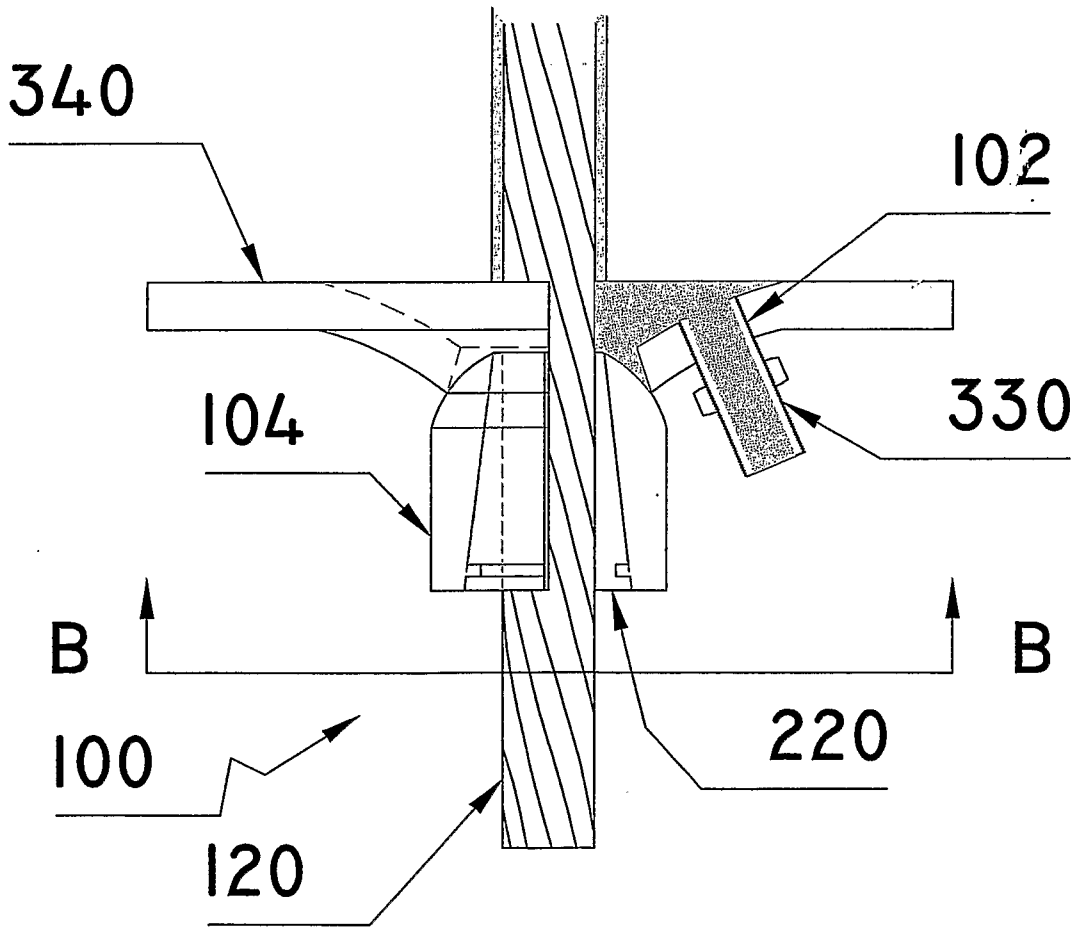

FIGURE 2

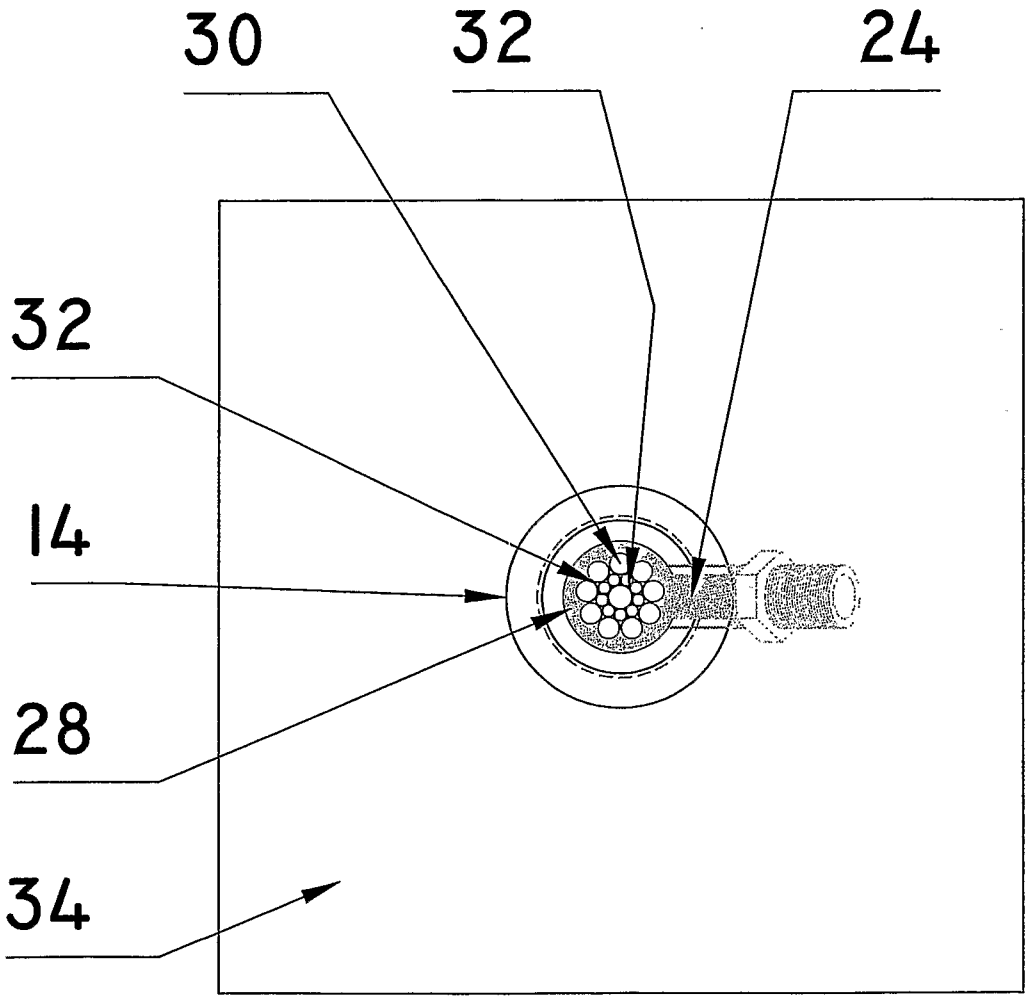

FIGURE 3

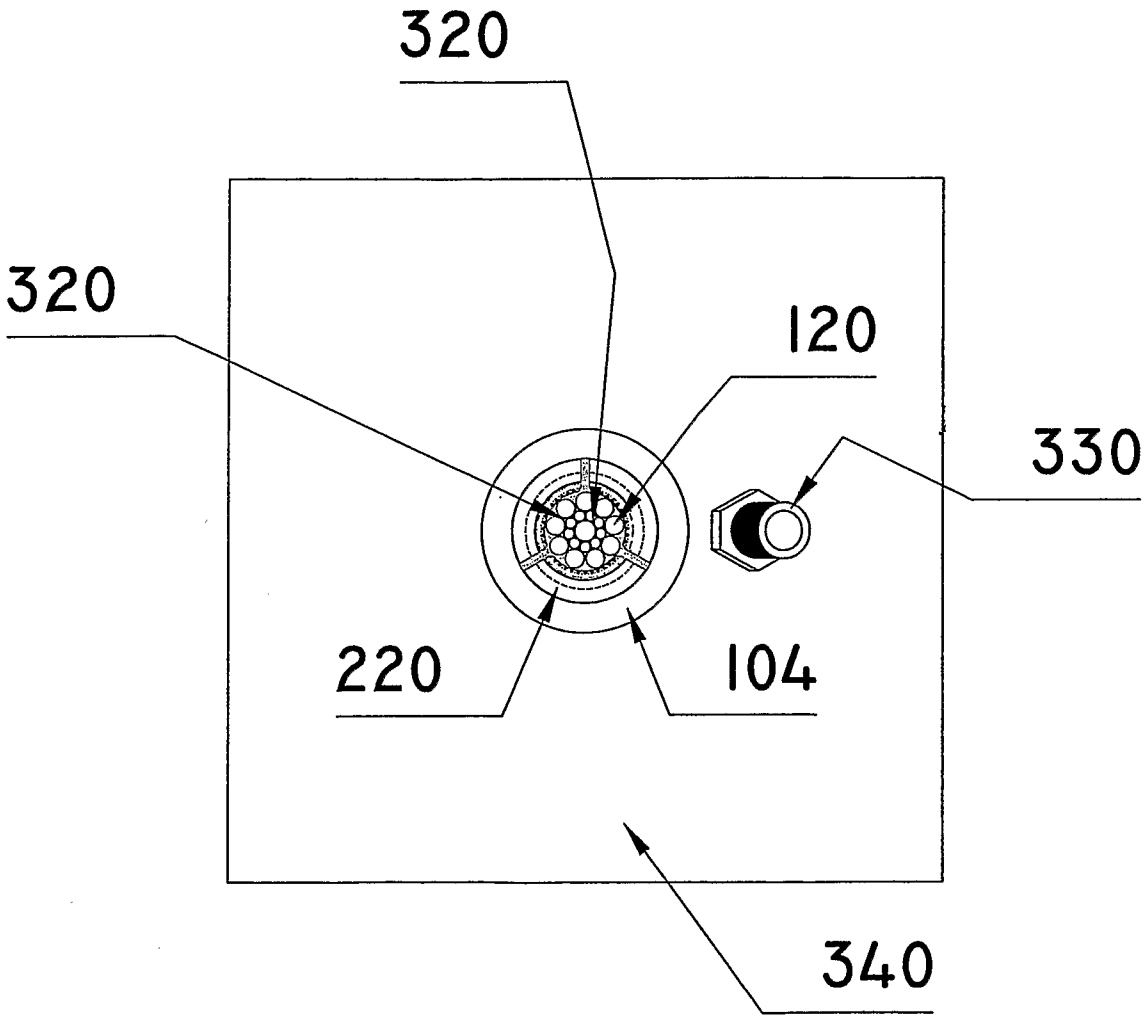

FIGURE 4

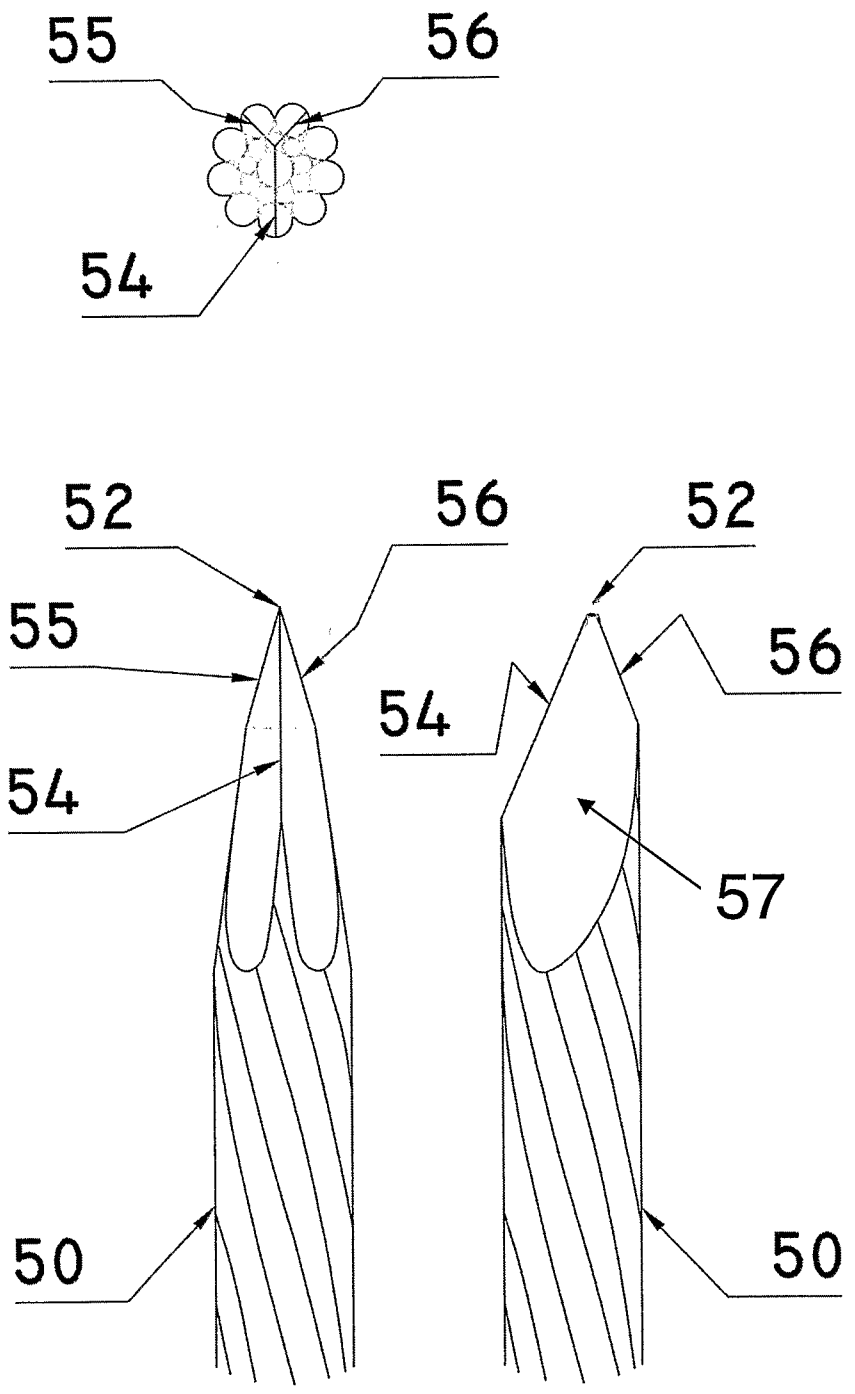

FIGURE 5

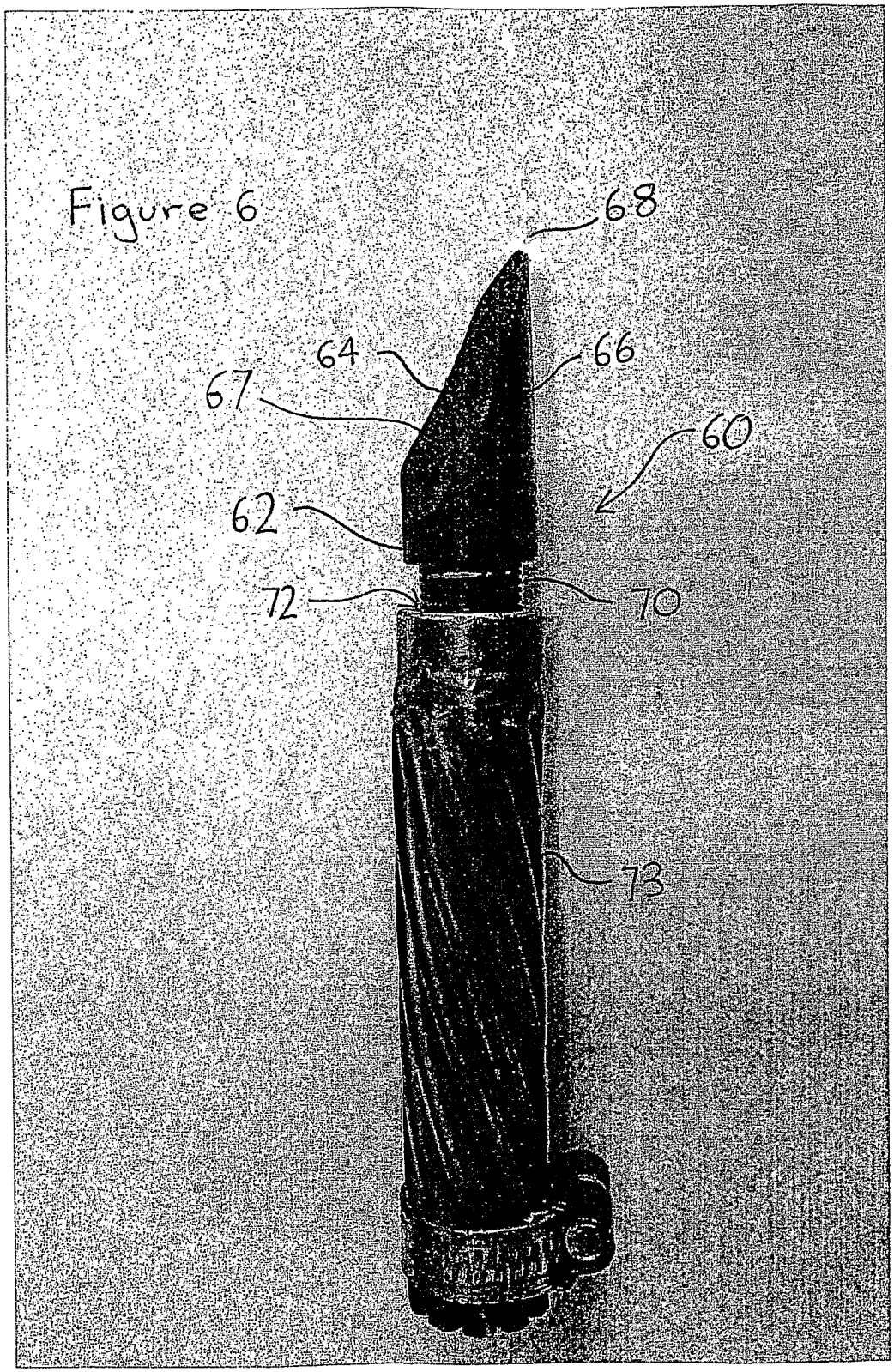
Figure 6
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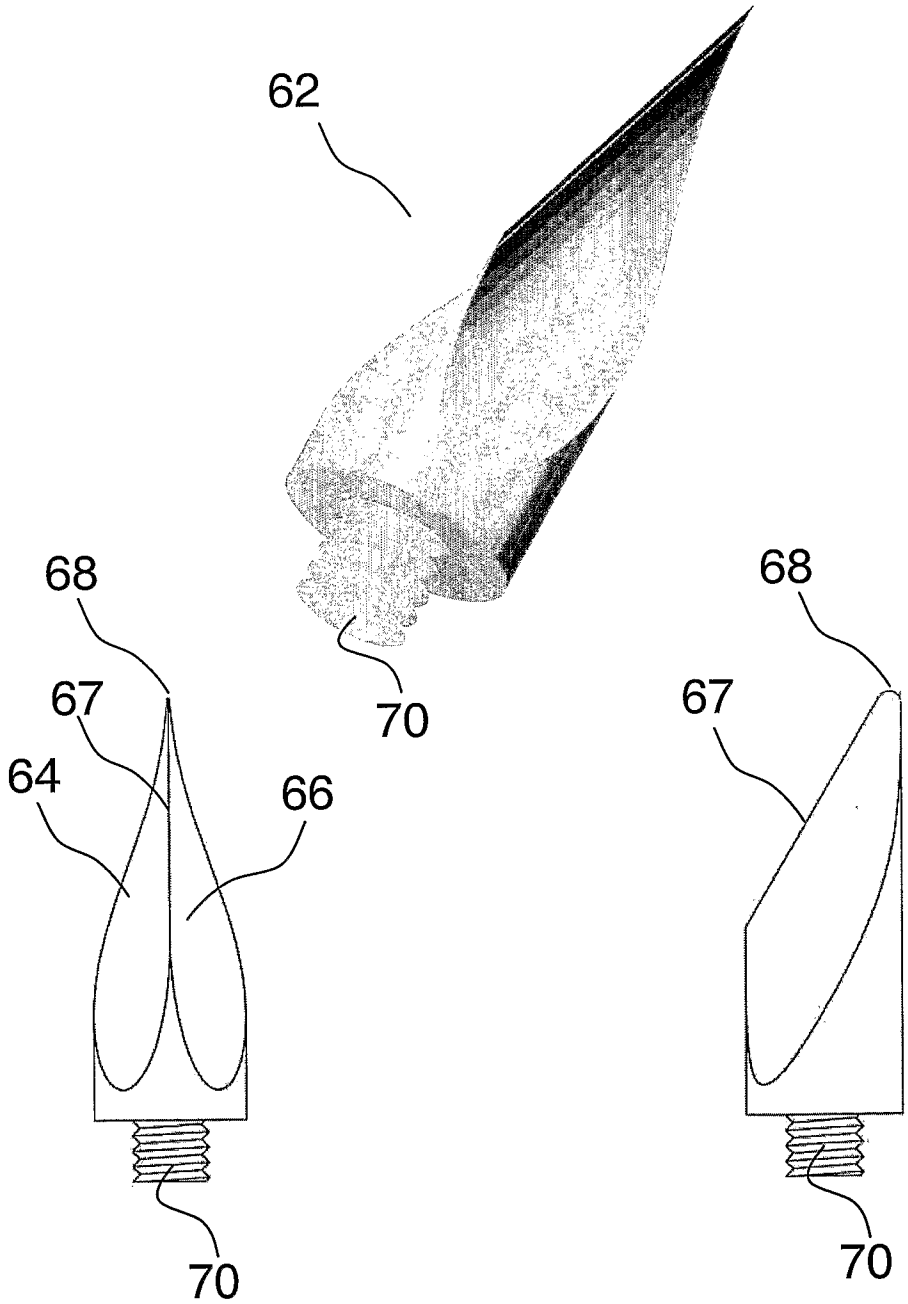

FIGURE 7

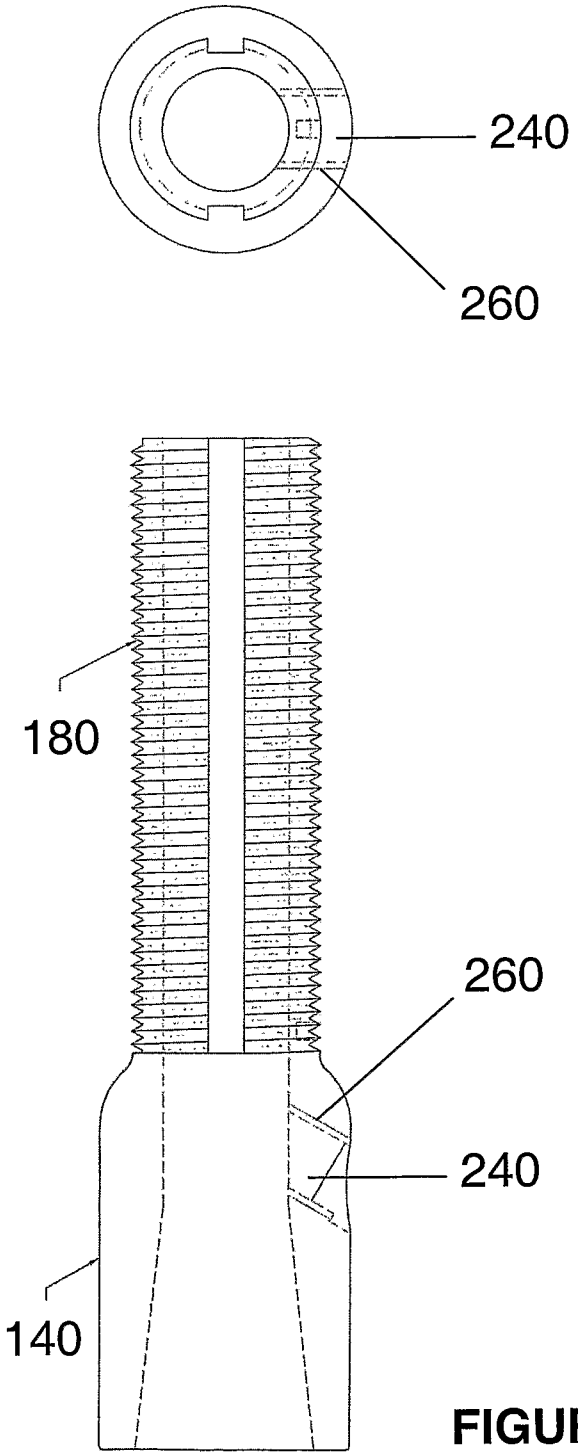

FIGURE 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2008/001423

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

E21D 20/02 (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)
EPOQUE: E21D-20/02/IC/EC, Keywords cable+, air+ and like terms
Google Patents: Piggybacking on US 4289427, Keywords cutting roof bolt oblique and like terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	US 4092814 A (KERN) 6 June 1978	
X	column 1 lines 9-18, column 3 lines 3-17, figure 2-3	1, 14-16
Y	column 2 lines 29-39	2-3, 5, 7-13 and 17
	US 4289427 A (ROLSTON) 15 September 1981	
X	figure 1-4, See Abstract	1, 4, 6, 14-16
Y	Figure 2	2-3, 5, 7-13 and 17
	US 20060093438 A1 (FERGUSSON) 4 May 2006	
Y	figure 10, paragraphs 43, 45 and 51	7-13 and 17
	AU 2006200094 A1 (JENNMAR CORPORATION) 26 July 2007	
Y	Page 11 lines 20-26, Page 12 lines 21-28, Page 13 lines 1-17	2-3, 5

[X] Further documents are listed in the continuation of Box C [X] 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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"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

"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

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 November 2008	21 NOV 2008
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. +61 2 6283 7999	Authorized officer **SACHIN.MARWAHA** AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : +61 2 6225 6136

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2008/001423

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3698196 A (JANKOWSKI et al) 17 October 1972 Column 4 lines 40-62, figures 3-4	20-27 and 28
X	US 4140429 A (HERBST) 20 February 1979 Column 4 lines 1-18, figure 1	18-19, 29 and 30
A	US 5301763 A (PEAY et al) 12 April 1994 See figure 5, column 4 lines 20-35	18-30
A	WO 2000/068544 A1 (GURLITA MASKIN AKTIEBOLAG) 16 November 2000 See Abstract	1-17

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2008/001423

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

Supplemental Box
(To be used when the space in any of Boxes I to IV is not sufficient)

Continuation of Box No: II

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

In assessing whether there is more than one invention claimed, I have given consideration to those features which can be considered to potentially distinguish the claimed combination of features from the prior art. Where different claims have different distinguishing features they define different inventions.

This International Searching Authority has found that there are different inventions as follows:

I. Claims 1-6 are directed to a method of installing a support cable or tendon with multiple strands in a cavity by injecting grout or resin in the cavity. It is considered that displacing air through an interstitial passageway between the strands of the cable comprises a first distinguishing feature.

II. Claims 7-17 are directed to a tensioning device that receives a strata support cable or tendon having multiple strands. It is considered that the tensioning member that defines a fluid passageway for injecting grout wherein the air is displaced from the cavity through an interstitial passageway defined by the cable strands comprises a second distinguishing feature.

II. Claims 18-30 are directed to a strata support cable, cutting tool & grouting method wherein a grout or resin capsule is inserted lengthwise inside a cavity and laterally displaced by inserting the cable. It is considered that the cable defines a cutting edge at one of its ends or is adapted to attach to a cutting tool with said cutting edge for rupturing said grout or resin capsule comprises a third distinguishing feature.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

Each of the abovementioned groups of claims has a different distinguishing feature and they do not share any feature which could satisfy the requirement for being a special technical feature. Because there is no common special technical feature it follows that there is no technical relationship between the identified inventions. Therefore the claims do not satisfy the requirement of unity of invention *a priori.*

The feature common to the inventions I and II defined by the claims 1-17 is the use of an *interstitial passageway between the cable strands for displacing air.* However this concept is not novel in light of:

US 4092814 A (KERN) 6 June 1978

This means that the common feature can not constitute a special technical feature within the meaning of PCT Rule 13.2, second sentence, since it makes no contribution over the prior art.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU2008/001423

This Annex lists the known "A" publication level 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.

Patent Document Cited in Search Report		Patent Family Member					
US	4092814	AR	203326	CA	1007826	DE	2412459
		JP	50127426	SE	7502771		
US	4289427	NONE					
US	2006093438	CA	2490111	NO	20050269	WO	2004001192
AU	2006200094	AU	2003262444				
US	3698196	DE	2010140	DE	2065472	DE	2065473
		FR	2084181	GB	1286782		
US	4140429	AT	117678	CA	1064745	CH	630439
		DE	2707238	FR	2381167	GB	1586550
		ZA	7800332				
US	5301763	NONE					
WO	0068544	AU	28381/00	SE	9901414		

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX