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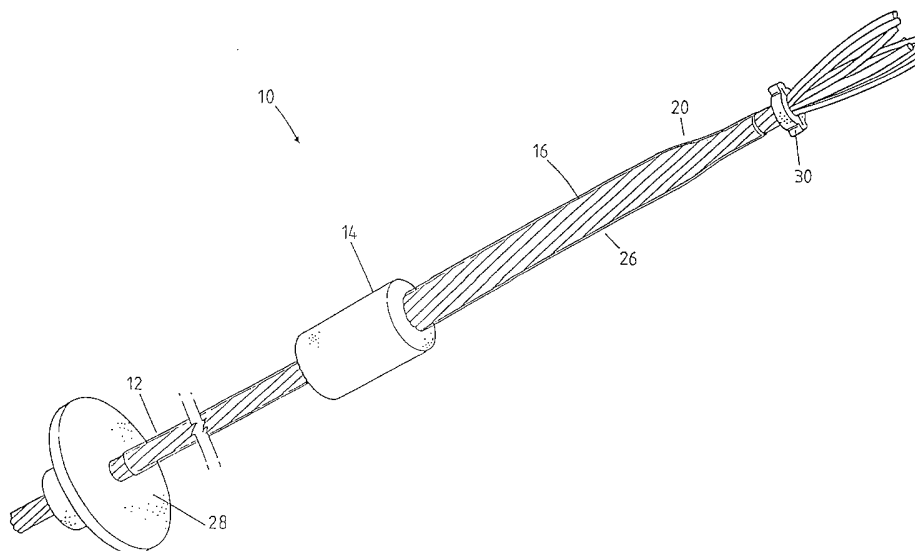
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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: A YIELDING ROCK BOLT



(57) **Abstract:** A yielding rock bolt (10) arranged to be inserted into a hole in a rock surface. The rock bolt comprises a shaft (12) having a widened portion (26) adjacent a first end (20) thereof, arranged, in use, adjacent an inner end of the hole. The rock bolt (10) also includes an anchor member (14) arranged to be secured within the hole in the rock surface. A longitudinal bore is provided in the anchor member (14) to receive a second end of the shaft (12), the longitudinal bore being of a diameter slightly less than that of the widened portion (20) of the shaft (12). A rock face engaging means (28) is provided adjacent a second end of the shaft (12) to secure the second end of the shaft (12) adjacent the rock face. Movement of the rock face causes the widened portion (26) of the shaft (12) to be pulled through the longitudinal bore in the anchor member (14).



WO 03/021081 A1

**TITLE**

“A YIELDING ROCK BOLT”

**BRIEF DESCRIPTION OF THE INVENTION**

The present invention relates to a yielding rock bolt.

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**FIELD OF THE INVENTION**

Seismic disturbances in underground mines are common. The forces involved in such disturbances can cause the tunnels of these underground mines to collapse and the use of rock bolts to prevent catastrophic collapse of the tunnel walls is known. The rock bolts are secured into holes drilled in tunnel walls and are designed to yield to a certain extent to prevent collapse of the tunnel walls. The movement which occurs as the rock bolt yields then provides warning to persons in the mine of possible collapse of the tunnel.

**SUMMARY OF THE INVENTION**

In accordance with one aspect of the present invention there is provided a yielding rock bolt arranged to be inserted into a hole in a rock surface characterised by comprising:

- a shaft having a widened portion adjacent a first end thereof, the first end being arranged, in use, adjacent an inner end of the hole;
- an anchor member arranged to be secured within the hole in the rock surface;
- a longitudinal bore provided in the anchor member, the longitudinal bore being arranged to receive a second end of the shaft and being of a diameter less than that of the widened portion of the shaft; and
- a rock face engaging means adjacent a second end of the shaft to secure the second end of the shaft adjacent the rock face;

wherein movement of the rock face causes the widened portion of the shaft to be pulled through the longitudinal bore in the anchor member.

### **DESCRIPTION OF THE DRAWINGS**

The present invention will now be described, by way of example, with reference to  
5 the accompanying drawings, in which:

Figure 1 is a perspective view of a yielding rock bolt in accordance with the present invention; and

Figure 2 is a cross sectional view of the rock bolt of Figure 1.

### **DESCRIPTION OF THE INVENTION**

10 Referring to the Figures, there is shown a yielding rock bolt 10 comprising a shaft 12 and an anchor member 14. The shaft 12 comprises a plurality of peripheral cable strands 16 spirally wrapped around a centre wire 18 (commonly referred to as a 'king wire').

The centre wire 18 may comprise more than one sections and includes a segment  
15 having an increased diameter adjacent a first end 20 thereof. The centre wire 18 of the rock bolt 10 shown in the Figures comprises a first centre wire 22 adjacent the first end 20 and a second centre wire 24 extending from the first centre wire 22 to a second end of the shaft 12. The second centre wire 24 is of a diameter generally equal to that of the peripheral cable strands 16. The first centre wire 22 has a diameter greater than  
20 that of the second centre wire 24 such that the shaft has a widened portion 26 adjacent the first end 20 thereof.

The anchor member 14 includes a longitudinal bore such that the shaft 12 is receivable in the longitudinal bore. The diameter of the longitudinal bore is arranged to be slightly less than that of the widened portion 26. The first centre wire 22 and

internal surfaces of the longitudinal bore of the anchor member 14 may be of a material that is softer than that of the peripheral cable strands 16. The peripheral cable strands 16, the first and second centre wires 22 and 24 and anchor member 14 in this case will generally be made of steel with the first centre wire 22 and the anchor member 14 being of a softer steel than the second centre wire 24 and the peripheral cable strands 16.

The softer material of the first centre wire 22 and internal surfaces of the longitudinal bore of the anchor member 14 allow the first centre wire 22 and internal surfaces to deform as the shaft 12 is pulled through the anchor member 14. Alternatively, if the first centre wire 22 and internal surfaces of the longitudinal bore are not constructed of a softer material then a first centre wire 22 of a slightly smaller diameter will be required.

The longitudinal bore may include an outwardly tapered portion at an end arranged adjacent the widened portion 26 in use. Further, the internal surfaces of the longitudinal bore will preferably be metallurgically treated, such as nitrocarburised to prevent molecular welding to the shaft 12 as the shaft 12 is drawn through the anchor member 14.

The rock bolt 10 also includes a rock-face engaging means 28 adjacent the second end of the shaft 12. The rock face engaging means 28 as shown in the Figures is in the form of a generally conical shaped plate member. The plate member is arranged such that when the rock bolt 10 is inserted into a hole drilled into the tunnel wall with the first end 20 of the shaft 12 entering the hole first, the plate member engages with the rock face around the hole.

The rock bolt 10 further includes a clamp member 30 adjacent the first end 20 of the shaft 12. The clamp member 30 holds the peripheral cable strands 16 together and the peripheral cable strands 16 are preferably splayed outwardly at the first end 20 of the shaft 12. The splayed peripheral cable strands 16 may engage with internal surfaces of the hole when the rock bolt 10 is inserted into the hole, to hold the rock bolt 10 in the hole until it is secured with grout in a known manner. The shaft 12 is also provided with a de-bonding sheath 32 along the length of the shaft 12. The de-bonding sheath 32 causes the shaft 12 to not bond with the grout so that the shaft 12 is slidable within the grout while the anchor member 14 is secured in place by the grout.

Further, the centre wire may also include an end segment adjacent the first end 20 (not shown) of diameter greater than the first centre wire 22. The end segment is of a diameter whereby the resulting diameter of the shaft 12 around the end segment is such that the shaft 12 cannot pass through the longitudinal bore of the anchor member 14. Thus when the shaft 12 has been pulled through the anchor member 14 until the anchor member 14 approaches the end segment, the portion of the shaft 12 around the end segment will seize against the anchor member 14 allowing the rock bolt 10 to achieve its maximum load.

In use, a hole is drilled into the wall of a tunnel and the first end 20 of the rock bolt 10 is inserted into the hole until the plate member adjacent the second end of the shaft 12 engages with the rock face around the hole. The anchor member 14 is located around the shaft 12 adjacent an end of the widened portion 26 remote from the first end 20 of the shaft 12.

The hole around the rock bolt 10 is then filled with grout in a known manner. The anchor member 14 is secured in place by the grout while the shaft 12 may to slide within the hole due to the presence of the de-bonding sheath 32.

If movement of the rock around the rock bolt 10 causes a portion of the rock face to begin to break away, the portion of the rock face is held in place by rock bolt 10 being secured at the anchor member 14. The movement however, will cause the widened portion 26 of the shaft 12 to be pulled through the anchor member 14. The rock bolt 10 therefore yields as the rock face moves, reducing the possibility of sudden failure of the rock face. In the case where softer steel is used for the centre wire 22 the softer steel will allow the internal surfaces of the longitudinal bore in the anchor member 14 and the first centre wire 22 to deform as the shaft 12 is pulled through the anchor member.

It will be appreciated that while the present invention has been described with reference to a rock bolt comprising a plurality of peripheral cable strands, the invention could also be applied to a solid type rock bolt.

Modifications and variations as would be apparent to a skilled addressee are deemed to be within the scope of the present invention.

**CLAIMS**

1. A yielding rock bolt arranged to be inserted into a hole in a rock surface characterised by comprising:
- a shaft having a widened portion adjacent a first end thereof, the first end being
- 5 arranged, in use, adjacent an inner end of the hole;
- an anchor member arranged to be secured within the hole in the rock surface;
- a longitudinal bore provided in the anchor member, the longitudinal bore being arranged to receive a second end of the shaft and being of a diameter less than that of the widened portion of the shaft; and
- 10 a rock face engaging means adjacent a second end of the shaft to secure the second end of the shaft adjacent the rock face:
- wherein movement of the rock face causes the widened portion of the shaft to be pulled through the longitudinal bore in the anchor member.
- 15 2. A yielding rock bolt in accordance with claim 1, characterised in that the shaft comprises a plurality of peripheral cable strands spirally wrapped around a centre wire, the centre wire including a first segment adjacent the first end of the shaft and a second segment extending from the first segment toward the second end of the shaft, wherein the first segment has a diameter greater than the second segment such that the
- 20 first segment causes the peripheral cable strands to be forced outwardly, thus creating the widened portion of the shaft.

3. A yielding rock bolt in accordance with claim 2, characterised in that the diameter of the second centre wire segment is generally equal to the diameter of the peripheral cable strands.
- 5 4. A yielding rock bolt in accordance with either claim 2 or 3, characterised in that the first segment of the centre wire is constructed of a material softer than the peripheral cable strands such that the first segment of the centre wire is deformed as the widened portion of the shaft is pulled through the longitudinal bore of the anchor member.
- 10 5. A yielding rock bolt in accordance with any one of claims 2 to 4, characterised in that the centre wire includes a third segment adjacent the second end of the shaft, the third segment of the centre wire having a diameter greater than that of the first segment such that the longitudinal bore of the anchor member is not able to slide over
- 15 the portion of the shaft around the third segment of the centre wire.
6. A yielding rock bolt in accordance with any one of the preceding claims, characterised in that inner surfaces of the longitudinal bore are constructed of a material softer than the shaft such that the inner surfaces of the longitudinal bore are
- 20 deformed as the widened portion of the shaft is pulled through the longitudinal bore of the anchor member.

7. A yielding rock bolt in accordance with any one of the preceding claims, characterised in that inner surfaces of the longitudinal bore are metallurgically treated to prevent molecular welding to the shaft.

5 8. A yielding rock bolt in accordance with claim 7, characterised in that the metallurgical treatment includes nitrocarburising.

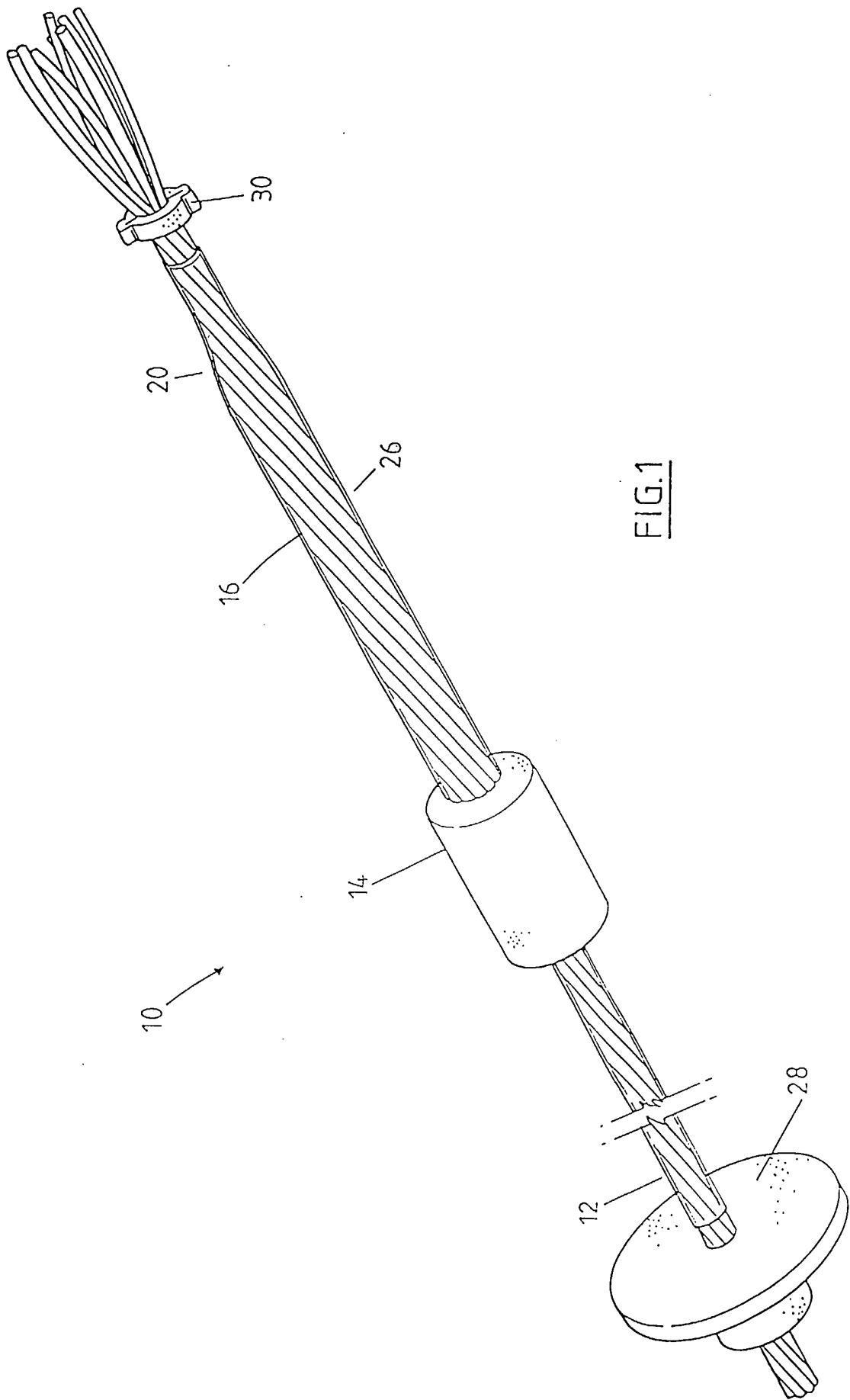
9. A yielding rock bolt in accordance with any one of the preceding claims, characterised in that the longitudinal bore of the anchor member includes an  
10 outwardly tapered portion adjacent a first end of the anchor member, the first end of the anchor member being adjacent, in use the widened portion of the shaft.

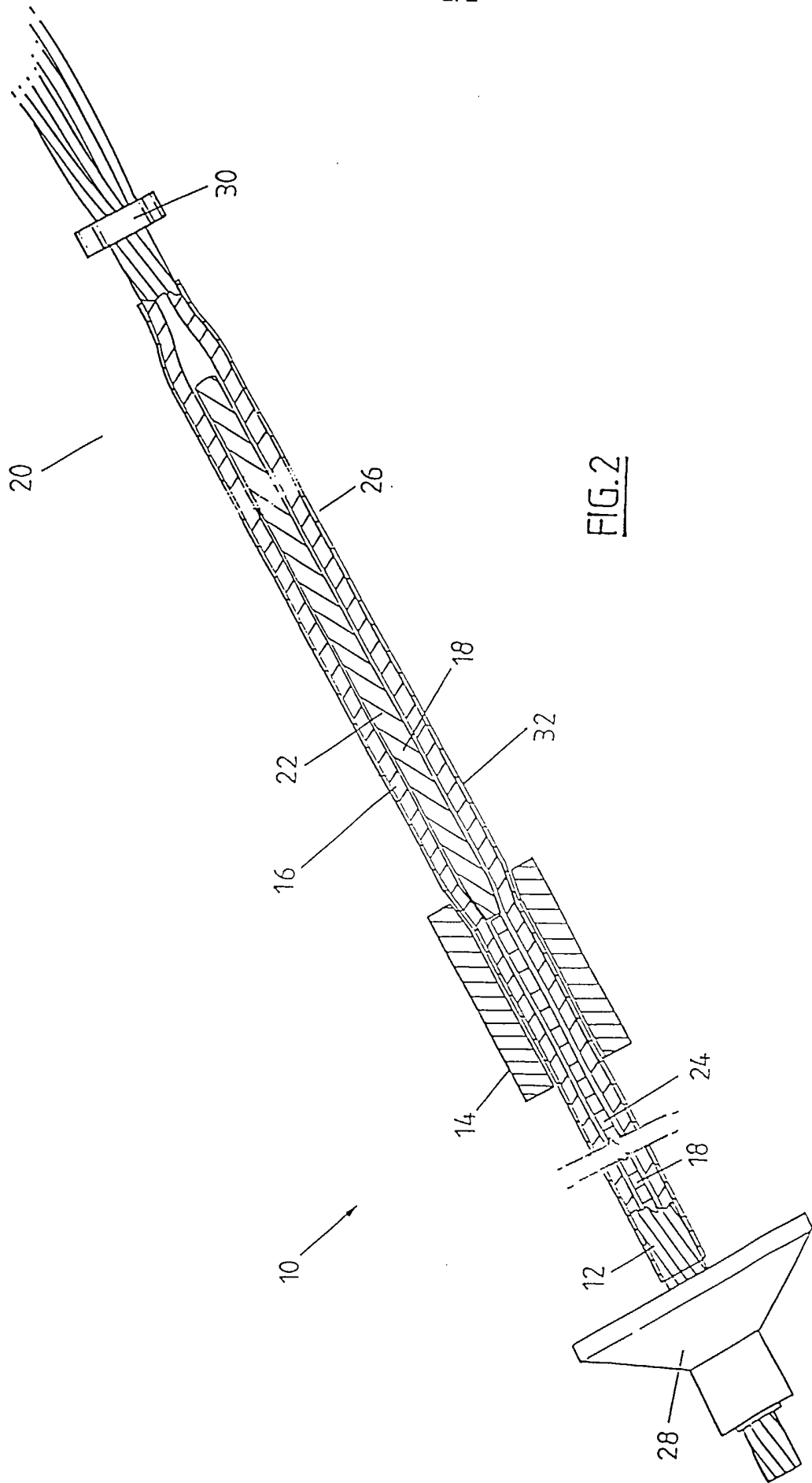
10. A yielding rock bolt in accordance with any one of the preceding claims, characterised in that the shaft is provided with a de-bonding sheath to allow the shaft  
15 to slide within the hole in the rock.

11. A yielding rock bolt in accordance with any one of the preceding claims, characterised in that the rock face engaging means comprises a conical shaped plate member.

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12. A yielding rock bolt in accordance with any one claims 2 to 11, characterised in that the peripheral cable strands are secured together adjacent the first end of the shaft by a clamp member and the peripheral cable strands are splayed outwardly at the first end of the shaft to engage with side walls of the hole in the rock.





# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/AU02/01223

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| <b>A. CLASSIFICATION OF SUBJECT MATTER</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                    |                                                                     |
| Int. Cl. <sup>7</sup> : E21D 21/00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                    |                                                                     |
| According to International Patent Classification (IPC) or to both national classification and IPC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                    |                                                                     |
| <b>B. FIELDS SEARCHED</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                    |                                                                     |
| Minimum documentation searched (classification system followed by classification symbols)<br>IPC : E21D 21/00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                    |                                                                     |
| 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)<br>WPAT : yield+, move+, relief, relieve, deform+                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                    |                                                                     |
| <b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                    |                                                                     |
| Category*                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No.                                               |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | AU 59356/98 (722997) B (DMHS RESOURCES PTY LTD) 21 October 1999                    |                                                                     |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | GB 2202600 A (BOART (UK) LTD) 28 September 1988                                    |                                                                     |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 3967455 A (CONWAY) 6 July 1976                                                  |                                                                     |
| <input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                    |                                                                     |
| <p>* Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"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</p> <p>"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</p> <p>"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</p> <p>"&amp;" document member of the same patent family</p> |                                                                                    |                                                                     |
| Date of the actual completion of the international search<br>26 September 2002                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                    | Date of mailing of the international search report<br>7 OCT 2002    |
| Name and mailing address of the ISA/AU<br>AUSTRALIAN PATENT OFFICE<br>PO BOX 200, WODEN ACT 2606, AUSTRALIA<br>E-mail address: pct@ipaustalia.gov.au<br>Facsimile No. (02) 6285 3929                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                    | Authorized officer<br><br>S. GHOSH<br>Telephone No : (02) 6283 2163 |

## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/AU02/01223**

| <b>C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT</b> |                                                                                           |                              |
|--------------------------------------------------------------|-------------------------------------------------------------------------------------------|------------------------------|
| <b>Category*</b>                                             | <b>Citation of document, with indication, where appropriate, of the relevant passages</b> | <b>Relevant to claim No.</b> |
| A                                                            | US 5556233 A (KOVAGO) 17 September 1996                                                   |                              |
| P, A                                                         | US 6390735 B1 (GAUDREAU et al) 21 May 2002                                                |                              |

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
**PCT/AU02/01223**

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<br>Search Report |         | Patent Family Member |           |    |           |
|-------------------------------------------|---------|----------------------|-----------|----|-----------|
| AU                                        | 5935698 | AU                   | 59356/98  |    |           |
| GB                                        | 2202600 | NONE                 |           |    |           |
| US                                        | 3967455 | NONE                 |           |    |           |
| US                                        | 5556233 | AU                   | 81693/94  | CA | 2138940   |
|                                           |         | EP                   | 659976    | ZA | 9410102   |
| US                                        | 6390735 | AU                   | 200170371 | SE | 200200615 |
|                                           |         |                      |           | WO | 200202910 |
| END OF ANNEX                              |         |                      |           |    |           |