PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : E21D 21/00, 20/00

A1

(11) International Publication Number: **WO 95/26457**

(43) International Publication Date: 5 October 1995 (05.10.95)

(21) International Application Number: PCT/AU95/00167

(22) International Filing Date: 24 March 1995 (24.03.95)

(30) Priority Data:

PM 4737	25 March 1994 (25.03.94)	AU
94/8688	3 November 1994 (03.11.94)	ZA

(81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, MX, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TT, UA, UG, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, MW, SD, SZ, UG).

Published
With international search report.

(71) Applicants *(for all designated States except US)*: DU PONT (AUSTRALIA) LIMITED [AU/AU]; 168 Walker Street, North Sydney, NSW 2060 (AU). THE NEWCASTLE WALLSEND COAL COMPANY PTY. LTD. [AU/AU]; Level 12, 32 Walker Street, North Sydney, NSW 2060 (AU).

(72) Inventors; and

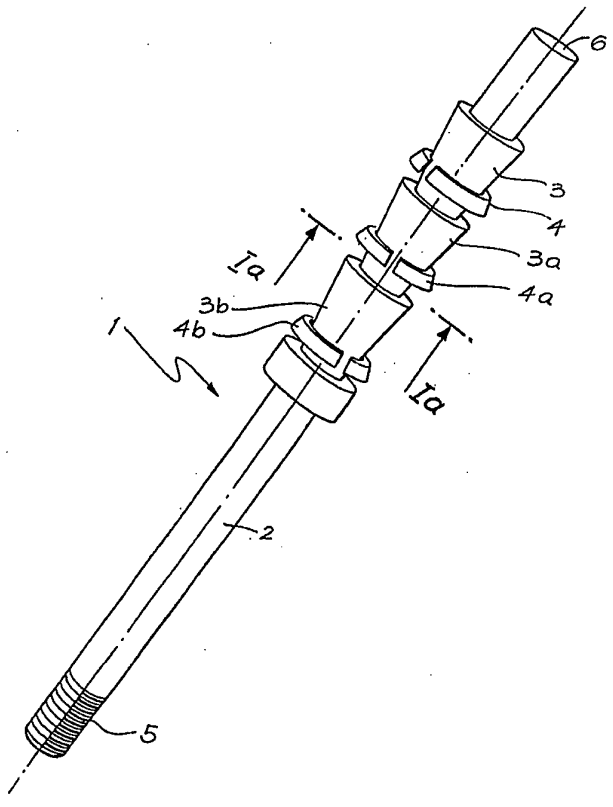
(75) Inventors/Applicants *(for US only)*: SKYBEY, Ghassan [AU/AU]; 6 Hawthorn Street, St Johns Park, NSW 2176 (AU). McCOWAN, Brian [AU/AU]; Dry Creek Road, Ellalong, NSW 2325 (AU).

(74) Agent: SPRUSON & FERGUSON; G.P.O. Box 3898, Sydney, NSW 2001 (AU).

(54) Title: ROCK BOLT

(57) Abstract

This invention relates to a rock bolt or roof anchor (1), in particular to a rock bolt or roof anchor for use in an underground mine, or other tunnel. The invention also relates to a method of reinforcing a wall or ceiling in an underground mine or tunnel. In particular, the invention relates to a dowel, for example, a Rima® dowel or coal rib anchor for use in a coal mine. The rock bolt (1) of one embodiment of the invention comprises: a shaft (2) having one end (5) threaded to receive a nut, the other end (6) being provided with a plurality of surfaces (3, 3a, 3b), each surface extending angularly about and longitudinally of the longitudinal axis of the shaft (2), and converging with respect to the axis towards the one end (5); and a plurality of collars (4, 4a, 4b), each collar (4, 4a, 4b) being associated with a respective one of the surfaces (3, 3a, 3b) and co-operating therewith so that upon relative movement of each collar (4, 4a, 4b) with respect to its associated surface (3, 3a, 3b) toward the other end, each collar (4, 4a, 4b) is caused to radially expand so as to project radially beyond its associated surface (3, 3a, 3b).



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	**GB**	United Kingdom	**MR**	Mauritania
AU	Australia	**GE**	Georgia	**MW**	Malawi
BB	Barbados	**GN**	Guinea	**NE**	Niger
BE	Belgium	**GR**	Greece	**NL**	Netherlands
BF	Burkina Faso	**HU**	Hungary	**NO**	Norway
BG	Bulgaria	**IE**	Ireland	**NZ**	New Zealand
BJ	Benin	**IT**	Italy	**PL**	Poland
BR	Brazil	**JP**	Japan	**PT**	Portugal
BY	Belarus	**KE**	Kenya	**RO**	Romania
CA	Canada	**KG**	Kyrgystan	**RU**	Russian Federation
CF	Central African Republic	**KP**	Democratic People's Republic of Korea	**SD**	Sudan
CG	Congo			**SE**	Sweden
CH	Switzerland	**KR**	Republic of Korea	**SI**	Slovenia
CI	Côte d'Ivoire	**KZ**	Kazakhstan	**SK**	Slovakia
CM	Cameroon	**LI**	Liechtenstein	**SN**	Senegal
CN	China	**LK**	Sri Lanka	**TD**	Chad
CS	Czechoslovakia	**LU**	Luxembourg	**TG**	Togo
CZ	Czech Republic	**LV**	Latvia	**TJ**	Tajikistan
DE	Germany	**MC**	Monaco	**TT**	Trinidad and Tobago
DK	Denmark	**MD**	Republic of Moldova	**UA**	Ukraine
ES	Spain	**MG**	Madagascar	**US**	United States of America
FI	Finland	**ML**	Mali	**UZ**	Uzbekistan
FR	France	**MN**	Mongolia	**VN**	Viet Nam
GA	Gabon				

Rock Bolt

Technical Field

This invention relates to a rock bolt or roof anchor, in particular to a rock bolt or roof anchor for use in an underground mine, or other tunnel. The invention also relates to a method of reinforcing a wall or ceiling in an underground mine or tunnel. In particular, the invention relates to a dowel, for example, a Rima® dowel[1], or coal rib anchor for use in a coal mine.

Background Art

There are various shapes and sizes for rock bolts currently on the market. Similarly there are various means for installing the rock bolts currently on the market.

Object of the Invention

It is an object of the present invention to provide a rock bolt having a unique and soft anchoring device to minimise rock bolt head loads and/or which can be ultimately cut by mining machinery. Another object of the present invention is to provide a method of reinforcing a wall or ceiling in an underground mine or tunnel.

Disclosure of the Invention

According to a first embodiment of the invention there is provided a rock bolt comprising:

a shaft having one end threaded to receive a nut, the other end being provided with a plurality of surfaces, each surface extending angularly about and longitudinally of the longitudinal axis of the shaft, and converging with respect to the axis toward the one end; and

a plurality of collars, each collar being associated with a respective one of the surfaces and co-operating therewith so that upon relative movement of each collar with respect to its associated surface toward the other end, each collar is caused to radially expand so as to project radially beyond its associated surface.

According to a second embodiment of the invention there is provided a method of reinforcing a wall or ceiling in an underground mine or tunnel, comprising:

inserting into a hole drilled in said wall or ceiling, one end of a rock bolt having a plurality of surfaces, which surfaces extend angularly about and longitudinally of the longitudinal axis of said rock bolt, and converge with respect to the axis toward said end; and

screwing a nut onto the other end of said rock bolt which is threaded so that a plurality of collars which are associated with each one of said surfaces and co-

---

[1] Registered Trade Mark by Du Pont

operate therewith is caused to radially expand so as to project radially beyond its associated surface to hold said rock bolt in position.

According to a third embodiment of the invention there is provided a rock bolt comprising:

a shaft having one end threaded to receive a nut, the other end being provided with at least one surface, said surface extending angularly about and longitudinally of the longitudinal axis of the shaft, and converging with respect to the axis toward the one end; and

at least one collar, said collar being associated with said surface and co-operating therewith so that upon relative movement of said collar with respect to its associated surface toward the other end, said collar is caused to radially expand so as to project radially beyond its associated surface.

According to a fourth embodiment of the invention there is provided a method of reinforcing a wall or ceiling in an underground mine or tunnel, comprising:

inserting into a hole drilled in said wall or ceiling, one end of a rock bolt having at least one surface, which surface extends angularly about and longitudinally of the longitudinal axis of said rock bolt, and converge with respect to the axis toward said end; and

screwing a nut onto the other end of said rock bolt which is threaded so that at least one collar which is associated with said surface and co-operates therewith is caused to radially expand so as to project radially beyond its associated surface to hold said rock bolt in position.

A preferred form of the rock bolt of the present invention is one wherein the shaft has a main elongated body and the surface(s) is provided by a frusto-conical portion(s) moulded integral with the body.

Another preferred form of the rock bolt of the present invention is one where each of the collars is a split ring. These rings will close up upon insertion into the hole clamping the rock bolt and stopping it from rotation after installation.

Another preferred form of the rock bolt of the present invention is one which has at least one wing which allows the rotation of the rock bolt in one direction only.

Generally the shaft of the rock bolt is elongated and is moulded from plastics material or machined from metal. The threaded end may also be moulded from plastics material and moulded to the shaft. The plurality of surfaces and collars are also usually moulded from plastics material or may be machined from metal.

The plurality of surfaces is usually moulded in the form of between one and three tapered surfaces which converge toward the threaded end of the shaft. The length of the tapered surface or the combination of tapered surfaces is approximately 50 to 230mm, preferably each tapered surface is 50 to 80mm, most preferably 60 to 75mm in length. Generally the tapered surfaces have a diameter which varies from 10 to 40mm, preferably 10 to 30mm, more preferably the diameter varies from 19 to 40mm, most preferably the diameter varies from 19 to 26mm. In coal mining applications the dimensions of the tapered surfaces is important.

The collars may be shaped as frusto-conical, square, hexagonal or any other shape. The collars are typically shaped as frusto-conical split rings. Usually the split rings are tapered so that the split rings converge toward the threaded end of the shaft. The diameter of the split ring varies from 20 to 40mm, preferably from 26 to 36mm, most preferably 26 to 32mm.

The rock bolt of the present invention may further optionally comprise at least one wing which is attached to the shaft by any suitable means. Alternatively, the wing may be integrally formed with the shaft. If two wings are present, they are arranged so that they are diagonally opposite each other. A great number of wings may be integrally formed with the shaft or attached thereto and the wings would be equally spaced apart. The wings are shaped and angled to allow rotation of the rock bolt in one direction only. An example of one shape of the wing is one that is a blade-like shape, extending substantially tangentially from the shaft, that is a flat structure having two straight edges meeting at one point. Other variations of this shape are possible.

The rock bolt of the present invention may also comprise a series of longitudinal ribs on the tapered surfaces. The length of the longitudinal ribs would vary depending on the length of the tapered surfaces. Typically the longitudinal ribs would be approximately 60 to 75mm in length. The longitudinal ribs would be preferably spaced apart equally around the outer surface of the tapered surfaces.

Should the rock bolt be formed of plastics material, an advantage would be that the rock bolt may be ultimately ground up by a mining machine. Advantageously, the rock bolt is made up of fibre glass material to be cut up by mining machinery.

Brief Description of Drawings

A preferred embodiment of the invention is now described with reference to the following drawings in which:

Figure 1 is a perspective view of the rock bolt having tapered surfaces with split rings;

Figure 1a is a cross sectional view along the line Ia-Ia of Figure 1 showing a split collar on the taper;

Figure 2 is a cross sectional side elevation of the rock bolt having tapered surfaces with split rings; and

Figure 3 is a an end view of the rock bolt illustrating a pair of wings.

Best Mode for Carrying Out the Invention

The rock bolt 1 of the present invention is illustrated in Figure 1 as comprising a shaft 2, a plurality of surfaces 3, 3a, 3b and a plurality of collars 4, 4a, 4b.

Referring to Figures 1 and 2, the shaft 2 is an elongated shaft moulded from plastic. End 5 of shaft 2 is threaded to receive a nut which is not illustrated. The thread may extend a short distance from end 5 or throughout the entire length of the shaft 2.

A plurality of surfaces 3, 3a, 3b is located close to other end 6 of shaft 2. The plurality of surfaces 3, 3a, 3b is illustrated in Figures 1 and 2 as three tapered surfaces. Each tapered surface 3, 3a, 3b is shown as converging toward threaded end 5. Each tapered surface 3, 3a, 3b is shown as a frusto-conical surface. Tapered surface 3b further comprises a flanged end 7 which is integrally moulded with tapered surface 3b. Flanged end 7 acts as a barrier for collar 4b so that collar 4b does not slip toward threaded end 5.

The plurality of collars 4, 4a, 4b are shown in Figures 1 and 1a as split rings. Split rings 4, 4a, 4b are frusto-conical which converge toward end 6. Split rings 4, 4a, 4b are relatively freely movable along respective surfaces 3, 3a, 3b.

Figure 3 is a top plan view of end 6. Flanged end 7 is shown as having a pair of wings 8, 8a which are integrally formed with flanged end 7.

To use a rock bolt 1 of the invention, a hole is drilled in a roof of a mine or coal rib. End 6 is inserted into the hole. A plate is placed around the rock bolt 1 and a nut is screwed onto threaded end 5. As the nut screws onto threaded end 5, the rock bolt 1 is tensioned. This causes the split rings 4, 4a, 4b to slide toward end 6. As split rings 4, 4a, 4b slide, they expand radially, thereby pushing against the walls of the hole. In this way, the split rings 4, 4a, 4b project radially beyond tapered surfaces 3, 3a, 3b to hold the rock bolt in position.

If the rock bolt 1 of the present invention has a pair of wings 8, 8a integrally formed thereon, the wings 8, 8a are arranged in a direction which is opposite that

of threaded end 5. So when a nut is screwed onto threaded end 5, the wings 8, 8a act as an anti-rotating device by gripping to the walls of the hole. Thus the rock bolt 1 is prevented from turning as the nut is being screwed onto threaded end 5.

Industrial Applicability

A rock bolt of the invention can be readily utilised in the mining industry, especially in the coal mining industry.

Claims

1. A rock bolt comprising:

a shaft having one end threaded to receive a nut, the other end being provided with a plurality of surfaces, each surface extending angularly about and longitudinally of the longitudinal axis of the shaft, and converging with respect to the axis toward the one end; and

a plurality of collars, each collar being associated with a respective one of the surfaces and co-operating therewith so that upon relative movement of each collar with respect to its associated surface toward the other end, each collar is caused to radially expand so as to project radially beyond its associated surface.

2. The rock bolt of claim 1, wherein said shaft has a main elongated body and said surfaces are provided by frusto-conical portions moulded integral with said body.

3. The rock bolt of claim 1 or 2, wherein said surfaces are three tapered surfaces which converge toward said threaded end of said shaft.

4. The rock bolt of claim 3, wherein said tapered surface is 50 to 230mm in length.

5. The rock bolt of claim 3, wherein said tapered surface is 50 to 80mm in length.

6. The rock bolt of claim 3, wherein said tapered surface is 60 to 75mm in length.

7. The rock bolt of any one of claims 3 to 6, wherein said tapered surface has a diameter of 10 to 40mm.

8. The rock bolt of claim 7, wherein said tapered surface has a diameter of 10 to 30mm.

9. The rock bolt of claim 7, wherein said tapered surface has a diameter of 19 to 40mm.

10. The rock bolt of claim 7, wherein said tapered surface has a diameter of 19 to 26mm.

11. The rock bolt of any one of claims 1 to 10, wherein each of said collars is a split ring.

12. The rock bolt of claim 11, wherein said split ring is a frusto-conical split ring which converges toward said threaded end of said shaft and said ring closes up upon insertion into a hole clamping said rock bolt and stopping rotation of said rock bolt after installation.

13. The rock bolt of claim 11 or 12, wherein said split ring has a diameter of 20 to 40mm.

14. The rock bolt of claim 11 or 12, wherein said split ring has a diameter of 26 to 36mm.

15. The rock bolt of claim 11 or 12, wherein said split ring has a diameter of 26 to 32mm.

16. The rock bolt of any one of claims 1 to 15, further comprising at least one wing which allows the rotation of said rock bolt in one direction only.

17. The rock bolt of claim 16, wherein said wing is a blade-like shape.

18. The rock bolt of any one of claims 1 to 17, further comprising a series of longitudinal ribs on said surfaces.

19. The rock bolt of claim 18, wherein said ribs are 60 to 75mm in length.

20. A rock bolt comprising:

a shaft having one end threaded to receive a nut, the other end being provided with at least one surface, said surface extending angularly about and longitudinally of the longitudinal axis of the shaft, and converging with respect to the axis toward the one end; and

at least one collar, said collar being associated with said surface and co-operating therewith so that upon relative movement of said collar with respect to its associated surface toward the other end, said collar is caused to radially expand so as to project radially beyond its associated surface.

21. The rock bolt of claim 20, wherein said shaft has a main elongated body and said surface is provided by a frusto-conical portion moulded integral with said body.

22. The rock bolt of claim 20 or 21, wherein said surface is a tapered surface which converges toward said threaded end of said shaft.

23. The rock bolt of claim 22, wherein said tapered surface is 50 to 230mm in length.

24. The rock bolt of claim 22, wherein said tapered surface is 50 to 80mm in length.

25. The rock bolt of claim 22, wherein said tapered surface is 60 to 75mm in length.

26. The rock bolt of any one of claims 20 to 25, wherein said tapered surface has a diameter of 10 to 40mm.

27. The rock bolt of claim 26, wherein said tapered surface has a diameter of 10 to 30mm.

28. The rock bolt of claim 26, wherein said tapered surface has a diameter of 19 to 40mm.

29. The rock bolt of claim 26, wherein said tapered surface has a diameter of 19 to 26mm.

30. The rock bolt of any one of claims 20 to 29, wherein said collar is a split ring.

31. The rock bolt of claim 30, wherein said split ring is a frusto-conical split ring which converges toward said threaded end of said shaft and said ring closes up

upon insertion into a hole clamping said rock bolt and stopping rotation of said rock bolt after installation.

32. The rock bolt of claim 30 or 31, wherein said split ring has a diameter of 20 to 40mm.

33. The rock bolt of claim 30 or 31, wherein said split ring has a diameter of 26 to 36mm.

34. The rock bolt of claim 32 or 33, wherein said split ring has a diameter of 26 to 32mm.

35. The rock bolt of any one of claims 20 to 34, further comprising at least one wing which allows the rotation of said rock bolt in one direction only.

36. The rock bolt of claim 35, wherein said wing is a blade-like shape.

37. The rock bolt of any one of claims 20 to 36, further comprising a series of longitudinal ribs on said surface.

38. The rock bolt of claim 37, wherein said ribs are 60 to 75mm in length.

39. A method of reinforcing a wall or ceiling in an underground mine or tunnel, comprising:

inserting into a hole drilled in said wall or ceiling, one end of a rock bolt of any one of claims 1 to 38; and

screwing a nut onto the other end of said rock bolt which is threaded so that the collar or plurality of collars associated with said surface or each one of said surfaces and co-operate therewith is caused to radially expand so as to project radially beyond its associated surface to hold said rock bolt in position.

40. The method of claim 39, wherein screwing said nut in one direction causes a plurality of wings to rotate in an opposite direction thereby gripping said rock bolt to said wall or ceiling.

FIG. 1

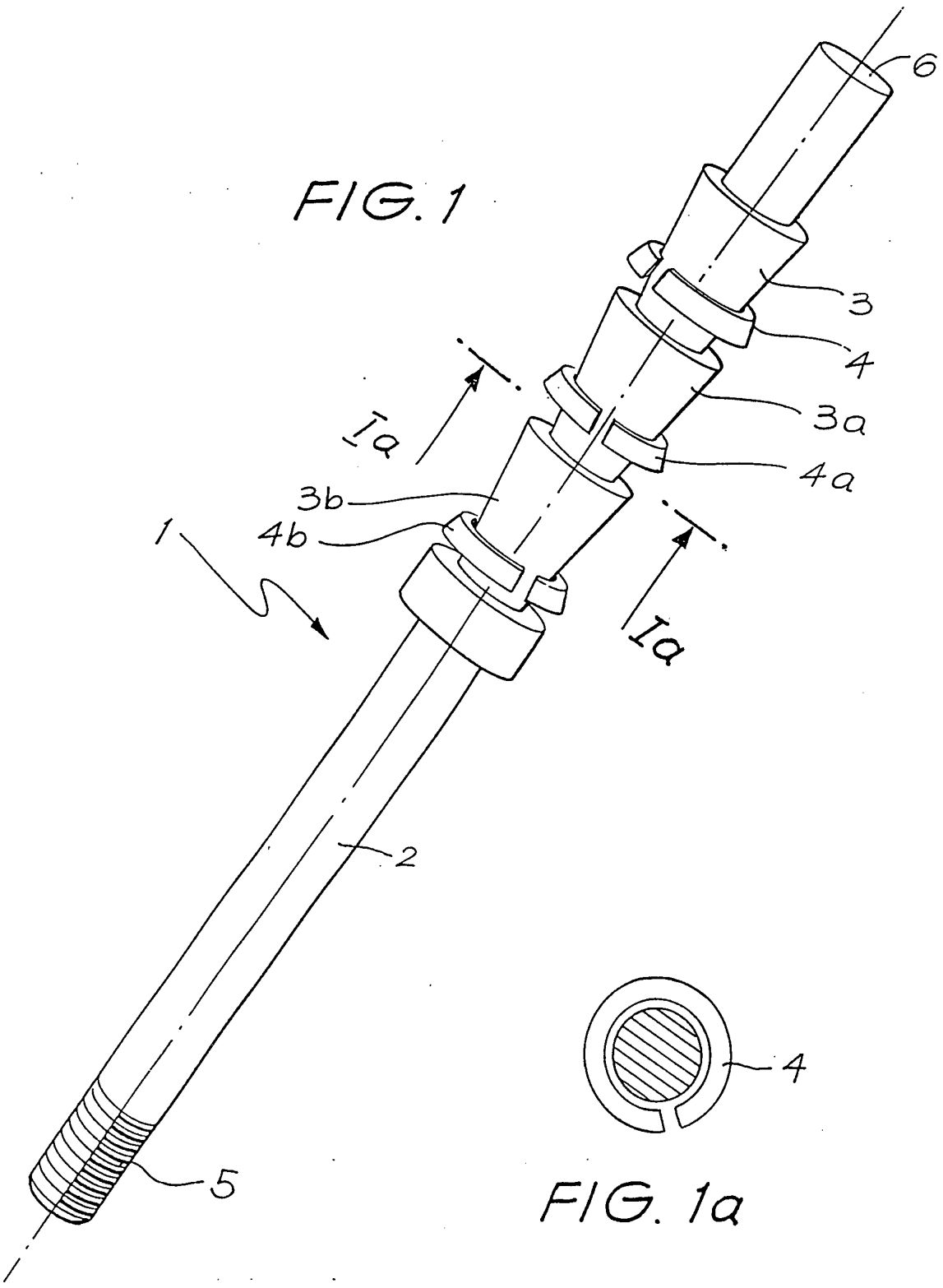


FIG. 1a

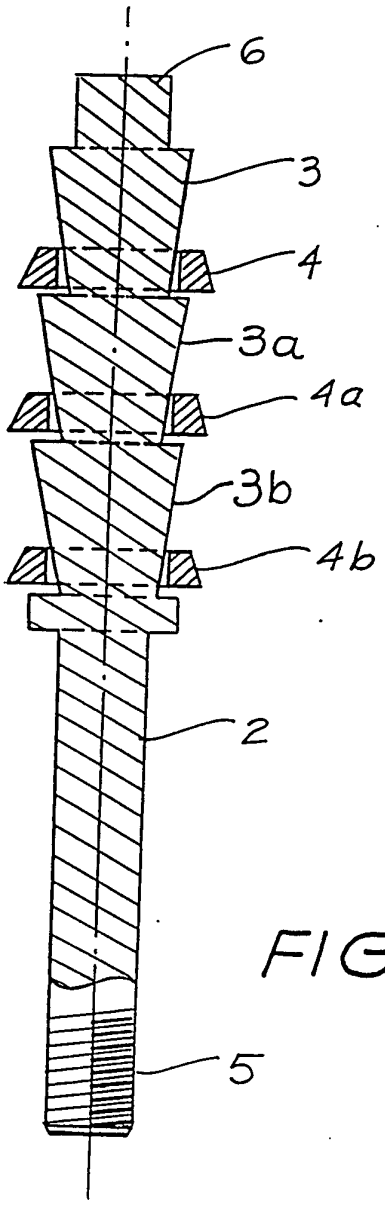


FIG. 2

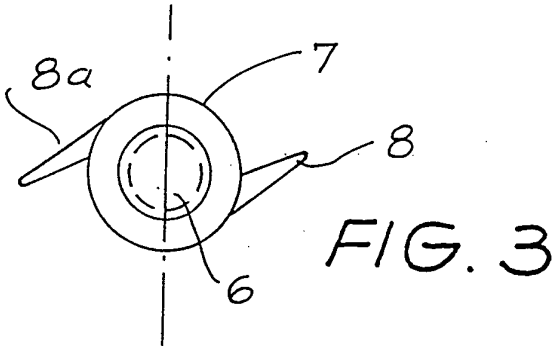


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 95/00167

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6): E21D 21/00, 20/00

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)
IPC(6): E21D 21/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: E21D 21/00

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	EP, 94908, A, (WEIDMANN) 23 November 1983	1-3, 20-22, 39
X	DE, 2733007, A, (HILTI AG) 8 February 1979	1-3, 20-22, 39
X	DE, 3525244, A, (HILTI AG) 15 January 1987	20-22, 39
X	SU, 696160, A, (GOLD BARE METAL RES) 15 November 1979 Derwent English Language Abstract, Accession no. 80-F5291C, class Q49	1-3, 20-22, 39
X	SU, 1065616, A, (GOLD RARE METALS IN) 7 January 1984 Derwent English Language Abstract, Accession no. 84-229490, (SAN, N84-171430). Class Q49.	1-3, 20-22, 39

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document 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
2 May 1995	26 MAY 1995 (26.05.95)
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. 06 2853929	Authorized officer **David Lee** Telephone No. (06) 2832107

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		
EP 94908	AU 14531/83 DE 3317242 JP 58 203206 US 4538940	CA 1214670 DK 2155/83 NO 831500 ZA 8303469	CH 664803 ES 522391 US 4523880
DE 2733007	AT 4164/78 FR 2398209 SE 7806148	AU 38011/78 GB 1588690 US 4193246	CH 626956 JP 54 022911
DE 3525244	CA 1281215	EP 213068	US 4730966
SU 696160	Nil		
SU 1065616	Nil		
			END OF ANNEX