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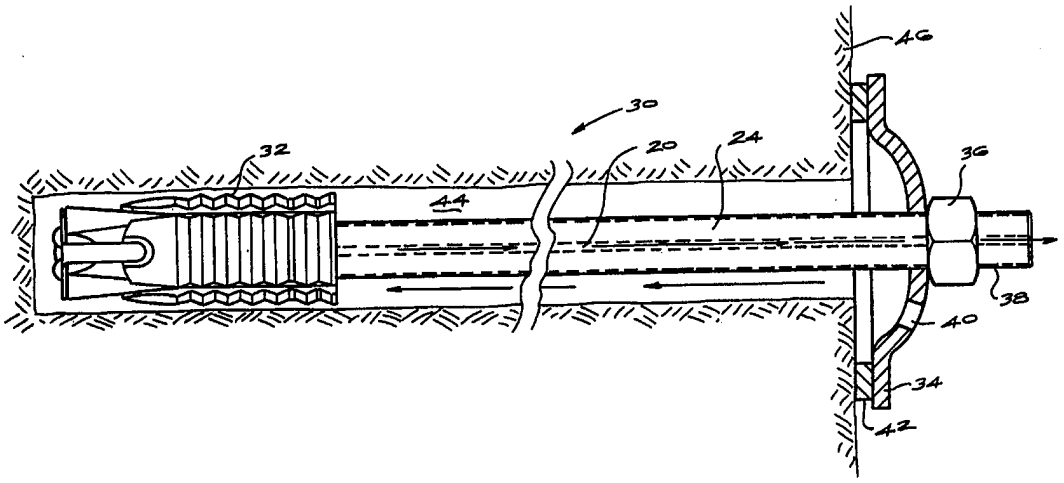

(57) Abstract

A rock bolt (30) which includes a shank (24), at least one longitudinally extending slot (18) in the shank, an expanding anchor mechanism (32) at one end of the shank, a washer (34) at an opposed end of the shank, and a nut (36) which is engaged with thread (38) formed at least at the said opposed end of the shank.

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A ROCK BOLT

This invention relates to a rock bolt.

Mechanical rock bolts e.g. of the expanding head type are sometimes categorised as temporary supports. After these bolts have been installed to provide immediate support in an underground excavation it is quite commonplace to provide what is referred to as permanent support by fixing shepherd crooks or similar devices in place using grouting techniques or appropriate resins.

The use of the aforementioned two types of supports does provide adequate rock reinforcement but at significant additional expense attributable to the drilling of two sets of holes in the rock body and the placing of two sets of rock anchors.

SUMMARY OF THE INVENTION

The invention provides, in the first instance, a rock bolt shank which includes an elongate member in which is formed at least one longitudinally extending slot.

The slot may spiral along the length of the elongate member or may extend in any other appropriate way. Preferably however the slot is straight and extends substantially parallel to a longitudinal axis of the elongate member.

The slot may have any suitable profile in cross section. The slot may for example by U-

shaped.

Alternatively the slot is substantially closed on itself with a relatively narrow slit at a surface of the elongate member and forms a substantially closed passage inside the elongate member. The slot, in this example of the invention, may have a substantially tear-drop shape in cross-section.

The elongate member may be threaded around at least part of the slot.

The slot may have a tube in it.

Alternatively the slot may be at least partially covered or closed in any suitable way for example by making use of tape or any closing mechanism or substance in order to form a substantially closed passage inside the elongate member.

The shank may include a washer which is engaged with the elongate member and sealing means on an inner face of the washer to enable the washer to be brought into substantial sealing contact with a rock face during use of the rock bolt shank.

The washer may include a hole or an inlet device through which a settable substance such as a grout or resin may be injected.

The invention extends, in the second instance, to a rock bolt which includes a shank, at least one longitudinally extending slot in the shank, an expanding anchor mechanism at

one end of the shank, a washer at an opposed end of the shank, and a nut which is engaged with thread formed at least at the said opposed end of the shank.

The shank is preferably of the aforementioned kind.

The invention also extends to a method of forming a rock bolt shank which includes the steps of rolling at least one longitudinally extending slot in an elongate member and forming thread on at least part of the member.

The method may include the step of locating a tube in the slot.

The method may include the step of subjecting the elongate member to a rolling process in order to cause the slot to close substantially onto itself. In this way the slot may be shaped to form a substantially enclosed passage inside the shank.

The method may include the steps of engaging an expanding anchor mechanism with the shank at one end of the shank and a washer and a nut with a threaded opposing end of the shank.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is further described by way of example with reference to the accompanying drawings in which:

Figure 1 schematically illustrates successive stages in the formation of a profiled shank

for use in a rock bolt according to the invention;

Figure 2 is a side view of a rock bolt shank according to one form of the invention;

Figure 3 is a cross-sectional view of the shank of Figure 2;

Figure 4 is a side view of a rock bolt shank according to a different form of the invention;

Figure 5 is a cross-sectional view of the shank shown in Figure 4; and

Figure 6 is a side view of an assembled rock bolt according to the invention illustrating its manner of use.

DESCRIPTION OF PREFERRED EMBODIMENT

Figure 1 of the accompanying drawings schematically illustrates five sets of rollers 10A, 10B, 10C, 10D and 10E, respectively and a rotatable sheave 12 which is driven through a gear mechanism by means of an electric motor, not shown.

An elongate member 14 of appropriate composition and cross-section, e.g. round bar 14 of an appropriate diameter, is fed from a coil, not shown, through the rollers and around the sheave. The round bar 14 is formed from steel which can be processed, as described hereinafter, and which possesses the necessary qualities for use as a rock bolt shank.

Each pair of the rollers 10A to 10E is designed to shape the round bar into a predetermined cross-sectional profile.

The respective profiles produced by the pairs of rollers, are shown alongside the rollers, designated 14A to 14E respectively. The rollers 10A produce a shallow longitudinally extending slot 16 in the round bar and this slot is deepened by the rollers 10B. Successive rollers gradually close the slot onto itself. The profile 14D has a slot 18 which is substantially U-shaped. In a final step carried out by the rollers 10E the U-shaped slot is closed substantially onto itself and has a tear- drop shape 20 in cross section. A relatively narrow slit 22 extends on the outer surface of the round bar along the length of the round bar at the junction of the side walls of the slot.

Apart from forming the slot to the desired shape the rollers ensure that the round bar is deformed appropriately so that it has a substantially circular cross section.

The rotating sheave 12 draws the bar through the rollers in a manner which is known in the art and which consequently is not further described herein.

The round bar is formed continuously with the slot and thereafter is straightened and cut into straight sections each of a predetermined length. A thread can be rolled over all or part of each section using standard thread rolling equipment, according to requirement, to form a shank of a rock bolt.

Figure 2 illustrates a portion of a shank 24 of a rock bolt according to one form of the invention while Figure 3 illustrates the shank in cross section. In this case use is made of a profile which is substantially similar to the profile 14E. It is apparent that through the rolling process a substantially closed and continuous passage 20 is formed along the

length of the shank.

Figures 4 and 5 are views similar to Figures 2 and 3 respectively and illustrate a shank 26. In this case, though use is made of a profile which is similar to the profile 14D. A thin walled plastic tube 28 is located in the slot along the length of the shank 26.

Thus in the Figure 4 embodiment a closed passage is provided along the length of the shank by means of the tube 24 which is located in the slot 16.

A substantially closed passage can be provided in any other way. For example once a slot has been formed along the length of the shank the mouth of the slot can be closed by means of tape which is wrapped around the shank. Any other closing mechanism can be employed. Another possibility is to provide a tubular sheath over the shank which encases the shank and effectively provides a closed passage inside the shank. The shank could also be closed using an adhesive or other suitable settable composition, or by means of welding. The invention is not restricted in this way.

Once the slot has been formed and processed according to requirement thread is rolled at least over a portion of the length of the shank. This is done using conventional thread rolling machinery.

Figure 6 illustrates from the side a rock bolt 30 constructed using a shank 24 of the kind shown in Figure 2. The rock bolt has an expanding anchor mechanism 32 engaged with one end of the shank. A washer 34 is engaged with an opposed end of the shank and a

nut 36 is threadedly engaged with thread 38 on this end of the shank.

The washer 34 is domed and includes an inlet aperture 40 which may, in practice, accommodate a filler valve of any appropriate kind e.g. a one-way valve. An inner surface of the washer has a flexible sealing disc 42, made for example of foam rubber, or rubber, secured to it.

In use the rock bolt is inserted into a hole 44 formed in a rock face 46. The nut 36 is tightened and the mechanism 32 is expanded into frictional contact with a wall of the hole. This is substantially in accordance with conventional techniques and provides the so-called "temporary" support. Thereafter a grout or any other suitable settable medium is injected through the aperture 40 in the washer. The medium flows into the hole 44 filling the entire volume thereof, and comes into close contact with the shank 24 and the opposing surface of the wall of hole 44. Air in the hole 44 is expelled through the passage 20 in the shank of the rock bolt. The sealing ring 42 prevents the settable medium from escaping from the hole. The medium, when it sets, bonds the shank to the wall of hole 44 and provides what is referred to as "permanent" support.

The rock bolt of the invention thus makes it possible to provide a temporary support of the kind referred to in the preamble of this specification and to make use of the same installation assembly and to inject grout or resin or any other settable substance into the hole, occupied by the rock bolt, to provide what is referred to in the art as a permanent support. It is therefore not necessary to make use of two sets of anchors to provide temporary and permanent supports. A substantial saving in cost in the drilling of holes

and the use of steel is therefore achieved.

Another benefit results from the work hardening of the round bar 14 as it progresses through the rollers. This increases the tensile strength of the shank of the rock bolt.

5

CLAIMS

1. A rock bolt shank (24) which includes an elongate member and which is characterised in that at least one longitudinally extending slot (18) is formed in the elongate member.

2. A shank according to claim 1 characterised in that the slot (18) extends substantially parallel to a longitudinal axis of the elongate member (24).

3. A shank according to claim 1 or 2 characterised in that, in cross-section, the slot (18) is U-shaped.

4. A shank according to claim 1 or 2 characterised in that the slot (18) is substantially closed on itself with a relatively narrow slit (22) at a surface of the elongate member and forms a substantially closed passage inside the elongate member.

5. A shank according to any one of claims 1 to 4 characterised in that the elongate member is threaded around at least part of the slot.

6. A shank according to any one of claims 1 to 5 which is characterised in that it includes a tube (28) located in the slot.

7. A shank according to any one of claims 1 to 6 which is characterised in that it includes a washer (34) which is engaged with the elongate member and sealing

means (42) on an inner face of the washer to enable the washer to be brought into substantial sealing contact with a rock face (46) during use of the rock bolt shank.

8. A rock bolt (30) which includes a shank (34), an expanding anchor mechanism (32) at one end of the shank, a washer (34) at an opposed end of the shank, and a nut (36) which is engaged with thread (38) formed at least at the said opposed end of the shank, and which is characterised in that at least one longitudinally extending slot (18) is formed in the shank.

9. A rock bolt according to claim 8 characterised in that the shank (24) is according to any one of claims 1 to 7.

10. A method of forming a rock bolt shank which is characterised in that it includes the steps of rolling at least one longitudinally extending slot (18) in an elongate member (24) and then forming thread (38) on at least part of the member.

11. A method according to claim 10 which is characterised in that it includes the step of locating a tube (28) in the slot (18).

12. A method according to claim 10 which is characterised in that it includes the step of subjecting the elongate member (24) to a rolling process in order to cause the slot (20) to close substantially onto itself.

13. A method according to any one of claims 10 to 12 which is characterised

in that it includes the steps of engaging an expanding anchor mechanism (32) with the shank at one end of the shank and a washer (34) and a nut (36) with a threaded opposing end (38) of the shank.

AMENDED CLAIMS

[received by the International Bureau on 22 October 1998 (22.10.98); original claims 1-13 replaced by new claims 1-16 (3 pages)]

1. A rock bolt shank (24) which includes an elongate member which is formed from a bar (14) and which has at least one longitudinally extending slot (18) in the elongate member, and which is characterised in that the slot (18) is substantially sealed to form a substantially closed passage (20) inside the elongate member.

2. A shank according to claim 1 characterised in that the passage is adjacent a surface of the elongate member.

3. A shank according to claim 1 or 2 characterised in that the slot (18) is substantially sealed by forming the slot so that it is substantially closed on itself with a relatively narrow slit (22) at a surface of the elongate member.

4. A shank according to claim 1 or 2 which is characterised in that it includes closing means over a mouth of the slot which substantially seals the slot.

5. A shank according to claim 4 characterised in that the said closing means is selected from : tape wrapped around the elongate member; a tubular sheath over the elongate member, an adhesive; a settable composition; welding.

6. A shank according to any one of claims 1 to 5 characterised in that the slot (18) extends substantially parallel to a longitudinal axis of the elongate member (24).

7. A shank according to any one of claims 1, 2, 4 and 5 characterised in that, in cross section, the slot (18) is U-shaped.

8. A shank according to any one of claims 1 to 7 characterised in that the elongate member is threaded over at least a portion of the length.

9. A shank according to any one of claims 1 to 8 which is characterised in that it includes a tube (28) located in the slot.

10. A shank according to any one of claims 1 to 11 which is characterised in that it includes a washer (34) which is engaged with the elongate member and sealing means (42) on an inner face of the washer to enable the washer to be brought into substantial sealing contact with a rock face (46) during use of the rock bolt shank.

11. A rock bolt (30) which includes a shank (24), an expanding anchor mechanism (32) at one end of the shank, a washer (34) at an opposed end of the shank, a nut (36) which is engaged with thread (38) formed at least at the said opposed end of the shank, and at least one longitudinally extending slot (18) which is formed in the shank, and which is characterised in that the slot is substantially sealed to form a substantially closed passage (20) inside the elongate member.

12. A rock bolt according to claim 11 characterised in that the shank (24) is according to any one of claims 1 to 10.

13. A method of forming a rock bolt shank which includes the steps of rolling at least one longitudinally extending slot (18) in an elongate bar (24) and then forming thread (38) over at least a part of the length of the bar,

and which is characterised in that it includes the step of at least substantially sealing the slot to form a substantially closed passage (20) inside the bar.

14. A method according to claim 13 which is characterised in that it includes the step of subjecting the elongate bar (24) to a rolling process in order to cause the slot (20) to close substantially onto itself.

15. A method according to claim 13 which is characterised in that it includes the step of using closing means, over a mouth of the slot, to substantially seal the slot.

16. A method according to claim 15 which is characterised in that the said closing means is selected from : tape wrapped around the elongate member; a tubular sheath over the elongate member; an adhesive; a settable composition; welding.

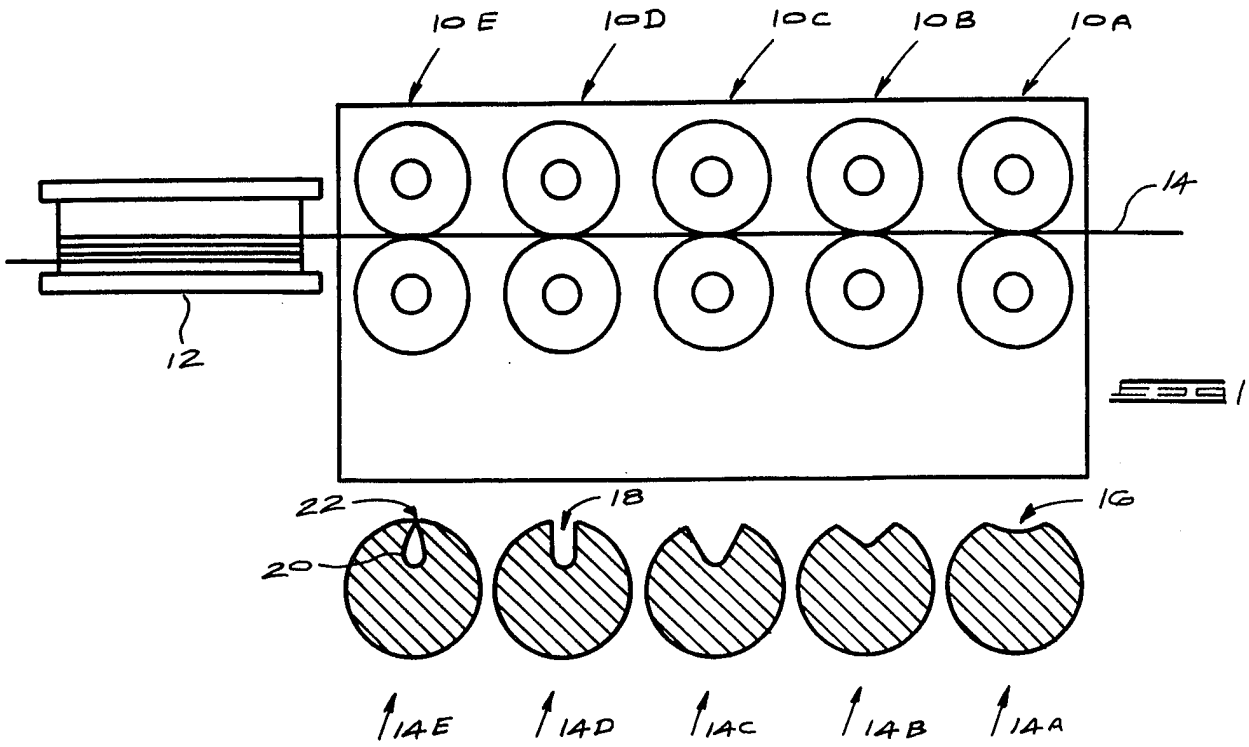

Fig 1

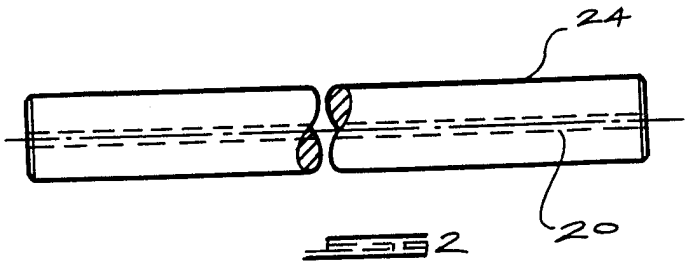

Fig 2

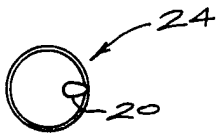

Fig 3

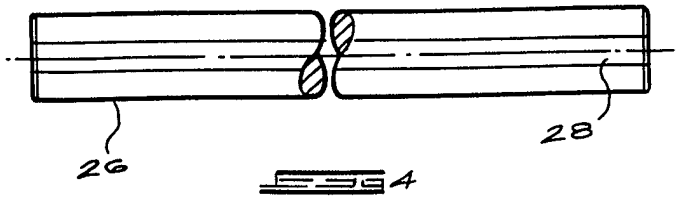

Fig 4

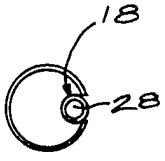

Fig 5

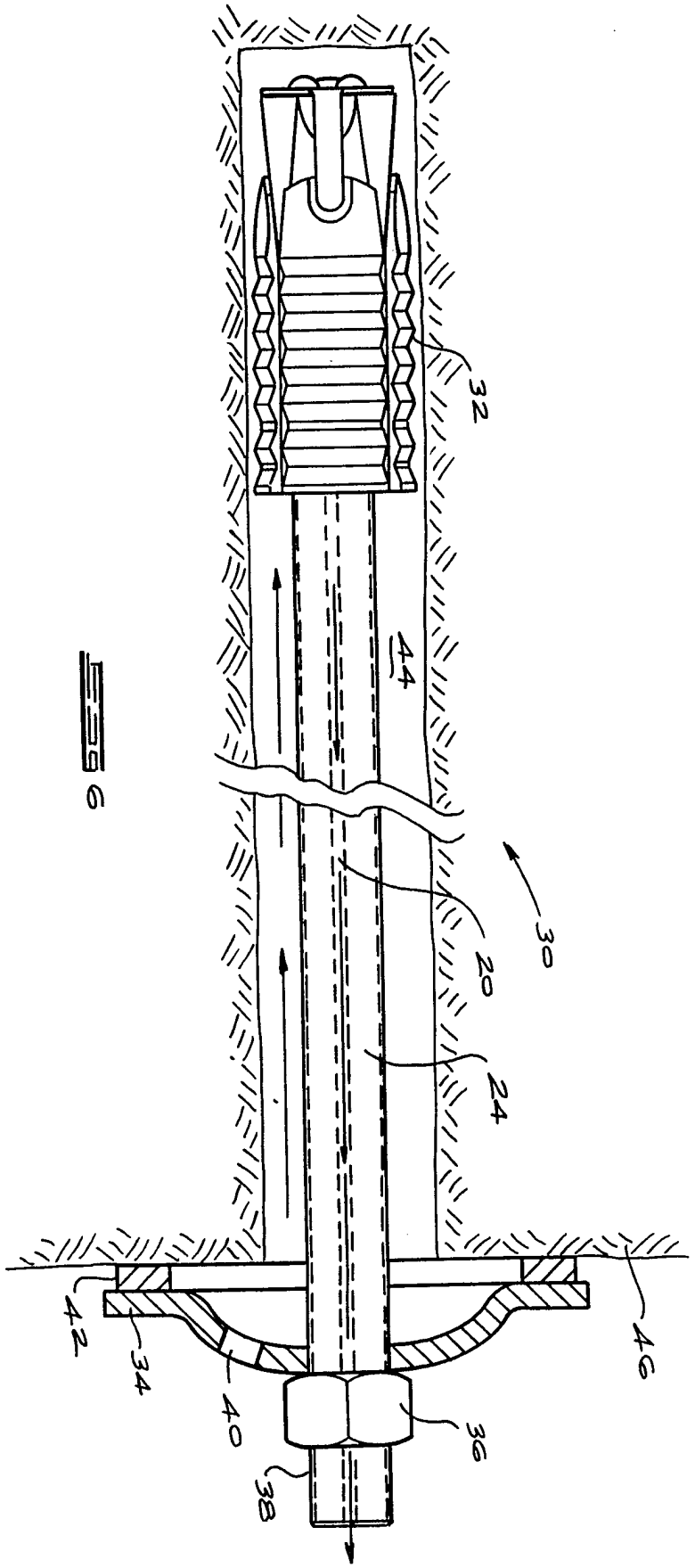

Fig 6

INTERNATIONAL SEARCH REPORT

Inte onal Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 E21D21/00

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

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 practical, 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.
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P,X P,Y	-& US 5 688 077 A (K.D. KYNOCH) 18 November 1997 see the whole document	1-3,5, 10,12 7-9,11, 13
Y	US 5 244 314 A (CALANDRA JR FRANK ET AL) 14 September 1993 see figures	8,9,13
Y	US 4 183 699 A (DONAN DAVID C JR ET AL) 15 January 1980 see claim 1; figure 1	7

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

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
19 August 1998	31/08/1998

Name and mailing address of the ISA	Authorized officer
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Inte onal Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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4

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter ›nal Application No
PCT/GB 98/01569

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