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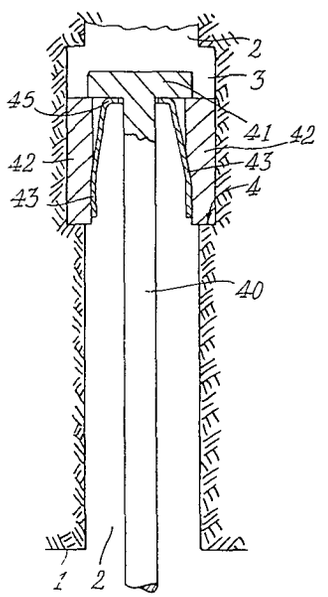
(54) Anchoring of roof bolts.

(57) This invention relates to the anchoring of roof bolts in drill holes by the reaming of enlarged sections (3) within a preformed drill hole (2) so that a shoulder (4) of rock is formed at the junction of the drilled and reamed sections of the hole.

The expansion head of a roof bolt is expanded within the hole so that the segments (42) of the expansion shell engage and positively lock against the shoulder (4).

In this way an improved lock for a roof bolt in a drill hole is obtained and the roof bolt resists dislodgement under load.



EP 0 029 354 A1

ANCHORING OF ROOF BOLTS

The present invention relates to the anchoring of roof bolts. "Roof bolt" is a term of the art and refers to any load support device which comprises a shank, which is usually called a "stud" or "bolt", and an expandable head for the shank which is intended to be secured in a drill hole whether this be in the roof of a structure, a wall thereof or anywhere else.

Roof bolts are conventionally anchored in drill holes by means of the said expandable head, also known as an expansion shell, composed of a plurality of segments which are urged radially outwardly by force applied to the stud sections of the bolt in a direction tending to extricate the stud from the hole. The stud moves relative to the head causing a wedging action of the segments between the stud and the wall of the hole until the head and stud are firmly anchored. Grout may be used to plug the hole and assist the anchorage and in some cases a tough polyester or other resin is used for this purpose.

It will be appreciated that the wedging action on the segments of the expansion shell does not give a positive lock and it is not unknown for roof bolts to work loose, especially through the action of earth tremors, and to be dragged out of their drill holes with attendant danger to personnel and equipment.

Proposals have been made to improve the grip of expansion shells or heads in drill holes. Thus White has, in U.S. Patents Nos. 3,104,582; 3,211,044; 3,454,118 and 3,555,960 described the

anchoring of an expansion shell in a drill hole formed to have an enlarged recess. The expansion shell in these arrangements is expanded against the wall of the enlarged recess to provide an improved grip.

In these prior proposals the enlarged recess is obtained by a reaming process which gives rise to a progressively increasing hole diameter from a starting point inward from the mouth of the drill hole. In other words a normal constant diameter drill hole is formed which is then reamed from a starting point intermediate the mouth and the base of the drill hole to provide a conical enlargement in which the base or largest diameter is inward from the starting point of the enlarged recess. There is accordingly a gradual increase in the diameter of the hole from the said starting point without a shoulder formation. Consequently, although an improved grip is afforded by an expansion shell in such an enlarged recess there is still no positive lock between the expansion shell and the wall of the drill hole.

It is an object of the invention to provide for a manner of anchoring roof bolts in drill holes which will give a positive lock of the expansion shell in the drill hole.

According to the invention a method of forming a hole which is to receive the expansion head of a roof bolt comprising the steps of drilling a hole in a rock body and thereafter reaming a section of the hole, characterised in that the reamed section is located inward from the mouth of the hole to provide

a cavity (3) of larger diameter than the drilled section (2) of the hole and a shoulder (4) of rock at the junction between the reamed and drilled sections of the hole.

Preferably the cavity is reamed out at or towards the base of the drill hole. In this way the shoulder that is defined at the junction between the drilled and reamed sections of the hole is spaced from the mouth of the hole by a substantial body of rock.

It will be appreciated that roof bolts are employed primarily in the mining industry but could also be used in concrete structures in the civil engineering industry. The term "rock" is therefore to be construed to include concrete or like hard masses.

In one arrangement the drill hole is reamed to provide a substantially constant diameter cavity.

In an alternative arrangement the drill hole is reamed to provide a substantially conical shaped cavity, with the larger diameter thereof adjacent the drilled section of the hole.

The size of the shoulder formation is not critical and in practical embodiments its size varies according to the diameter of the hole. The critical aspect of the shoulder is that it provides a positive lock for the segments of the expansion shell.

When the roof bolt is inserted into the hole the initial expansion of the segments of the head is effected in the cavity so that the segments engage

the shoulder. With a roof bolt of the kind incorporating a wedge member to spread the segments of the expansion shell, outwardly directed force applied to the stud will give rise to limited movement between the wedge and the segments of the shell so that the segments spread outwardly until a situation is reached when the segments engage the positive stop provided by the shoulder and there is thus no way in which the expansion unit can be dislodged except by spalling of the rock.

Further according to the invention there is provided a reamer for the formation of a cavity in a hole drilled in a rock body comprising a reaming tool formed of at least two elongated sections which define a tapered socket between them, rock cutting and/or grinding means on the periphery of each section, rotatable ram means providing a wedge formation receivable in the socket to hold the tool captive on the ramrod which is operative to impart rotary movement to the sections, while forward sliding movement of the wedge within the socket acts to urge the sections radially apart, and spring means which biases the sections towards one another.

The ram means may be threaded or otherwise adapted to engage the end of a rockdrill stem so that by inserting the reamer into a predrilled hole and progressively expanding the reamer sections by means of the drill, a suitable cavity is ultimately reamed out to receive the expansion shell of a roof bolt. The rockdrill may be percussive or merely rotatable.

If desired the sections of the reamer and the wedge of the ramrod may co-operate to force the sections

apart so that they remain parallel thereby forming a circular cylindrical shaped cavity. As an alternative the sections could be connected for example by hinging them together at their forward ends so that they spread under the action of the wedge on the ramrod to form a conical shaped cavity with its base adjacent the drilled section of the hole. In either case a shoulder of rock is formed which provides for the positive locking of the expansion shell of a roof bolt in the cavity. As an alternative to hinging the sections in order to obtain a conical cavity the sections of a reaming tool incorporating parallel moving sections may be provided with inclined cutting or grinding means. An advantage of a conical cavity is that the vital shoulder formation is obtained with a minimum of reaming. Again the angle of the conical cut is not critical and depends upon the nature of the rock.

After the cavity has been reamed out, the ramrod is retracted. This allows the spring on the sections to pull them together so that the reamer can be withdrawn from the hole. In order to assist this action the ramrod is provided with a water duct through which water may be pumped to flush the cavity during the reaming process and especially to remove grit from between the sections. In some rock formations, particularly softer rock such as may be encountered in coal mines, axial water ducts may not be required.

Note that there may be no forward cutting bits so that the tool bottoms in the hole. However, in soft rock, the reamer may include a spacer member which spaces the tool from the base of the hole and

which is rotatable relative to the reaming tool so that the reamed cavity is spaced from the base of the hole.

Conveniently there are two sections to a tool and each may have a leading and a trailing longitudinally extending blade mounted on the periphery thereof. As stated above these blades may be parallel to the axis or inclined to ream at various angles.

The invention also includes within its scope an expansion shell for a roof bolt including a plurality of segments defining a bore between them for a bolt member which is to be suspended from the segments so that it extends from the segments out of the drill hole, characterised in a spring formation associated with the segments, the spring being adapted to spread the segments radially outwardly to engage the wall of a drill hole.

Preferably the spring comprises an annular plate with a plurality of legs depending therefrom so that the spring is conically shaped at rest, the plate being receivable over the bolt or stud member with the legs located between the segments and the bolt so as to urge the segments radially outwardly from the bolt.

The stud or bolt may take the form of a rigid rod or the like or it could be a steel rope or any other suitable elongated member. If desired the roof bolt assembly can be secured by a grout, resin or other settable plug material.

In order to illustrate the invention examples thereof

will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a diagrammatic sectional view of a conventional drill hole in the roof of a mine working;

Figure 2 is a similar view of the drill hole of Figure 1 which has been reamed in accordance with the invention;

Figure 3 is also a view similar to that of Figure 1 showing the hole reamed in an alternative fashion according to the invention;

Figure 4 is a sectional view, on the line IV-IV in Figure 5, of a reamer according to the invention which may be used to form the reamed hole of Figure 2;

Figure 5 is an inverted plan view of the reaming tool sections of the reamer of Figure 4;

Figure 6 is a sectional view of an alternative form of reaming tool portion of a reamer which may be used to form the reamed hole of Figure 3;

Figure 7 is a sectional view of yet a further alternative form of reaming tool portion of a reamer which may be used to form the reamed hole of Figure 3;

Figure 8 is a section through portion of a roof bolt assembly located in a hole formed according to Figure 2 above, the assembly including an expansion shell and being positioned so that the

expansion shell of the roof bolt is expanded into the reamed section of the hole;

Figure 9 is a further section through portion of a roof bolt incorporating a modified form of stud and expansion shell; and

Figure 10 is a perspective view of a spring part of the expansion shell for the roof bolt illustrated in Figures 8 and 9.

Referring to Figures 1 to 3 of the drawings a mine working having a roof 1 is drilled with a conventional percussive rock drill machine to provide a drilled hole 2. The drill jumper is then removed and in place of the drill bit a reamer, of a kind which will be described below with reference to Figures 4 and 5 is attached to the jumper. The reamer is then inserted into the drilled hole 2 and by operation of the percussive rock drill machine the reamer acts to ream a cavity 3 which has a larger diameter than the drilled section of the hole and a shoulder of rock 4 is formed at the junction between the reamed section 3 and drilled section 2 of the hole. The action of the reamer is to form a cavity or reamed section 3 of substantially constant diameter as illustrated in Figure 2.

If a modified form of reamer is used, as will be described below with reference to Figures 6 and 7, there is formed a cavity 5 which is substantially conical, as illustrated in Figure 3. The large diameter side of the cavity is disposed adjacent the drilled section 2 of the hole so that in this embodiment a shoulder of rock 6 is still formed

even though the shoulder is not square. In practice chipping and breaking of the rock will occur during the reaming process and the smooth finish of the diagrammatic illustrations of Figures 1 to 3 is unlikely to be obtained. The important aspect however is the attainment of a shoulder 4 or 6 against which the segments of an expansion shell can positively lock.

The reamer as illustrated in Figures 4 and 5 comprises a tool in the form of two substantially semicircular sections 11 and 12 each carrying a leading rock cutting blade 13 and a trailing blade 14 in suitable longitudinal slots in the sections. The sections 11 and 12 are held together by spaced spring clips 15 and 16 which encircle the sections and are located in suitable peripheral grooves therein so that the spring clips are located beneath the cutting blades as shown in Figure 4, and the sections are each internally recessed to define a tapered socket 17 between them. In this socket 17 there is located the wedge shaped head 18 of a ramrod 19 having a threaded end 20 to engage the jumper or stem of a percussive drilling machine. As may be seen from Figure 4 the sections 11 and 12 have stop formations 21 and 22 at their lower ends which engage the shoulder 23 of the wedge shaped head 18 of the ramrod so that the reaming tool is held captive on the ramrod 19.

In use the clips 15 and 16 hold the sections 11 and 12 firmly together so that the reamer can be inserted into a predrilled hole 1 until its forward end abuts against the blind end of the hole. Operation of the percussion drilling machine

effects rotation of the reaming tool and also applies a force to the ramrod which tends to slide the wedge 18 forwardly in the socket 17 and so urge the sections 11 and 12 radially apart. The reaming tool thus progressively cuts deeper and deeper into the rock until a cavity as illustrated in Figure 2 has been formed. During the reaming process in hard rock, sludge and rock chips are flushed from the hole by the action of water under high pressure passed along an axial duct 24 which duct also has lateral outlets 25.

At the end of the reaming process the ramrod 19 is retracted so sliding the wedge head 18 backwardly in the socket 17 and allowing the clips 15 and 16 to bring the sections 11 and 12 together once more until the reaming tool can be withdrawn from the cavity 3 and hole 2.

The cutting tool of Figure 6 is similar to that of Figures 4 and 5 except that the sections 30 and 31 are hingedly connected at 26 so that a cavity as illustrated in Figure 3 is reamed out.

The cutting tool of Figure 7 also reams a conical cavity. In this case the tool sections 32, 33 are provided with blades 34 and 35 suitably inclined to provide the conical reaming effect. A spacer member 36 is rotatably mounted in a dovetail cavity formed between the sections 32 and 33 so that the cavity reamed is spaced from the base of the drill hole 2. Although the sections 32 and 33 part during the reaming operation the spacer 36 remains trapped in its dovetail cavity.

Referring now to Figures 8 to 10 of the drawings a roof bolt to be anchored in the hole of Figure 2 or Figure 3 includes a stud 40 having a head 41. The head may be of any suitable shape such as conical or cylindrical and may be fast with the stud in fact to form a bolt or it may screw onto a threaded stud as illustrated in Figure 9. An expansion shell is mounted on the end of the stud 40 and comprises several segments 42, in this case three segments are provided, each of which is loosely attached to a leg 43 of a spring member 44. The spring 44 has an annular plate 45 to which the legs 43 are attached and the plate 45 is located over the stud 40 and may be spot welded or otherwise attached to the head 41 of the stud.

In use when the stud is inserted into a hole such as that illustrated in Figure 2 the segments are urged together by the relatively small diameter drilled section 2 of the hole. When the cavity 3 of the hole is reached the spring 44 acts to spread the segments apart as shown in Figure 8 and the segments thereby engage and positively lock against the shoulder of rock 4 with the head 41 supported on the segments 42.

As shown in Figure 9 a modified expansion shell has segments 42 which taper upwardly and a conical head 41 which tapers correspondingly downwardly so that the head 41 wedges between the segments 42 and actually forces them against the sides of the cavity 3. In this modification the head 41 screws onto the threaded end of the stud 40 and incorporates longitudinally extending grooves in the periphery thereof to accommodate the legs 43 of the spring 44.

In either modification the segments 42 engage the shoulder 4 at the junction of the reamed cavity 3 and drill hole 2 so that the roof bolt is positively locked in the drill hole. Even in the case of earth tremors it is impossible to dislodge the expansion shell and the roof bolt cannot therefore be dragged out of the hole without spalling of the rock in which it is located.

The stud 40 of the roof bolt will normally be tensioned and held in tension by a known means located at the mouth of the drill hole. This arrangement enhances the positive locking effect of the expansion shell in the cavity 3.

As shown in Figures 8 and 9 the reamed section 3 of the hole is spaced from the end of the drilled section 2 which may be achieved by the use of a spacer such as the spacer 36 illustrated in Figure 7.

CLAIMS:

1. A method of forming a hole which is to receive the expansion head of a roof bolt comprising the steps of drilling a hole in a rock body and thereafter reaming a section of the hole, characterised in that the reamed section is located inward from the mouth of the hole to provide a cavity (3) of larger diameter than the drilled section (2) of the hole and a shoulder (4) of rock at the junction between the reamed and drilled sections of the hole.

2. The method of claim 1, characterised in that the drill hole is reamed to provide a substantially constant diameter cavity (3).

3. The method of claim 1, characterised in that the drill hole is reamed to provide a substantially conical shaped cavity (5), with the larger diameter thereof adjacent the drilled section of the hole.

4. A method of anchoring a roof bolt comprising the steps of drilling a hole in a rock body, reaming a section of the hole, and expanding the expansion shell of the roof bolt within the hole, characterised in that the reamed section is located inward from the mouth of the hole to provide a cavity (3) of larger diameter than the drilled section (2) of the hole and a shoulder (4) of rock at the junction between the reamed and drilled sections of the hole, and that the segments of the expansion shell (42) engage and positively lock against the shoulder (4).

5. A reamer for the formation of a cavity in a hole drilled in a rock body characterised in that it comprises a reaming tool having at least two elongated sections (11,12) which define a tapered socket (17) between them, rock cutting and/or grinding means on the periphery of each section, rotatable ram means providing a wedge formation (18) receivable in the socket (17) to hold the tool captive on the ramrod which is operative to impart rotary movement to the sections, while forward sliding movement of the wedge within the socket acts to urge the sections radially apart, and spring means to bias the sections towards one another.

6. The reamer of claim 5, characterised in that the reaming tool comprises two substantially semi-circular sections each of which has a leading (13) and a trailing (14) longitudinally extending rock cutting blade mounted on the periphery thereof.

7. The reamer of claim 5 or claim 6, characterised in that the ram means is adapted for connection to a rock drill stem.

8. The reamer of any one of claims 5 to 7, characterised in that the spring means comprises spring clips (15,16) encircling the sections.

9. The reamer of any one of claims 5 to 8, characterised in that the sections provide stop means (21,22) at their lower ends to engage a shoulder (23) on the ram when the sections are drawn together by the spring means.

10. The reamer of any one of claims 5 to 9, characterised in that the ramrod includes a water

duct (24) which has at least one opening located in the socket between the sections.

11. An expansion shell for a roof bolt including a plurality of segments defining a bore between them for a bolt member which is to be suspended from the segments so that it extends from the segments out of the drill hole, characterised in that the expansion shell comprises a spring formation (44) associated with the segments (42), the spring being adapted to spread the segments radially outwardly to engage the wall of a drill hole.

12. The expansion shell of claim 11, characterised in that the spring comprises an annular plate (45) with a plurality of legs (43) depending therefrom so that the spring is conically shaped at rest, the plate being receivable over the bolt member with the legs located between the segments and the bolt so as to urge the segments radially outwardly from the bolt.

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Fig 1.

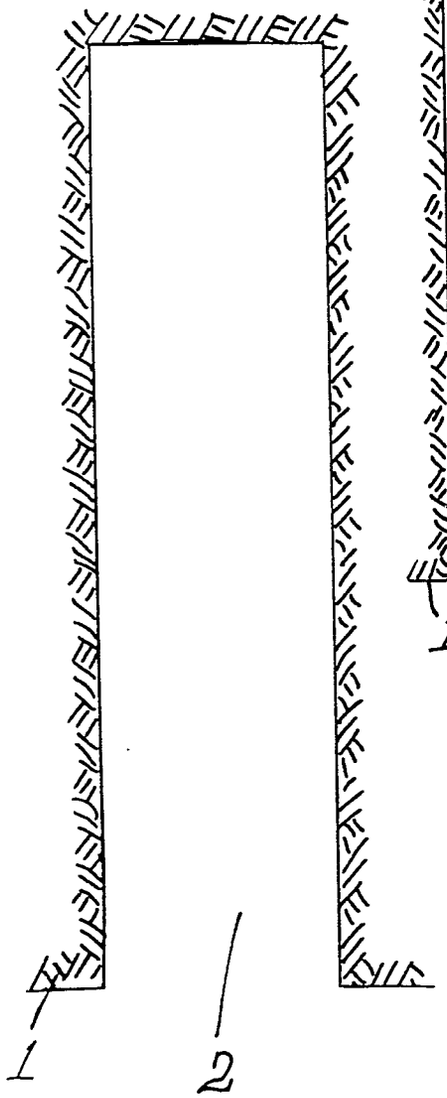


Fig 2.

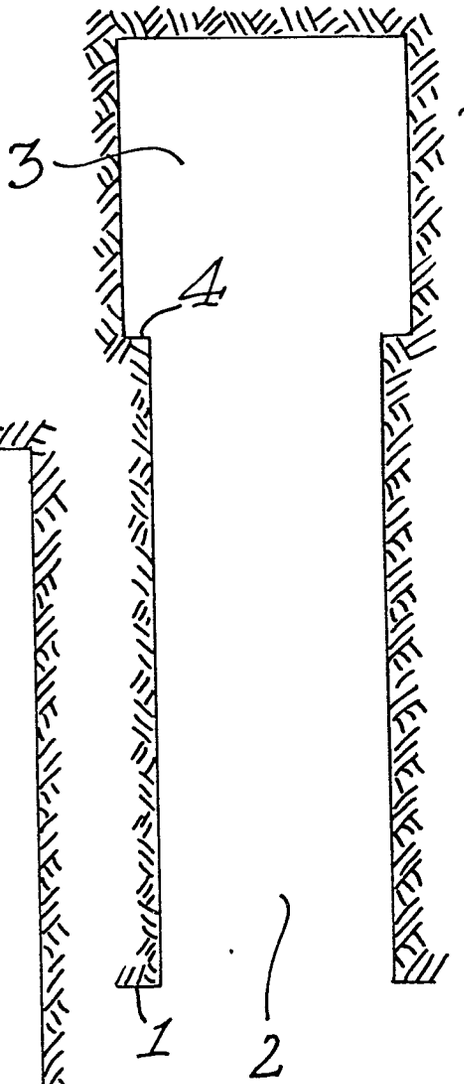


Fig 3.

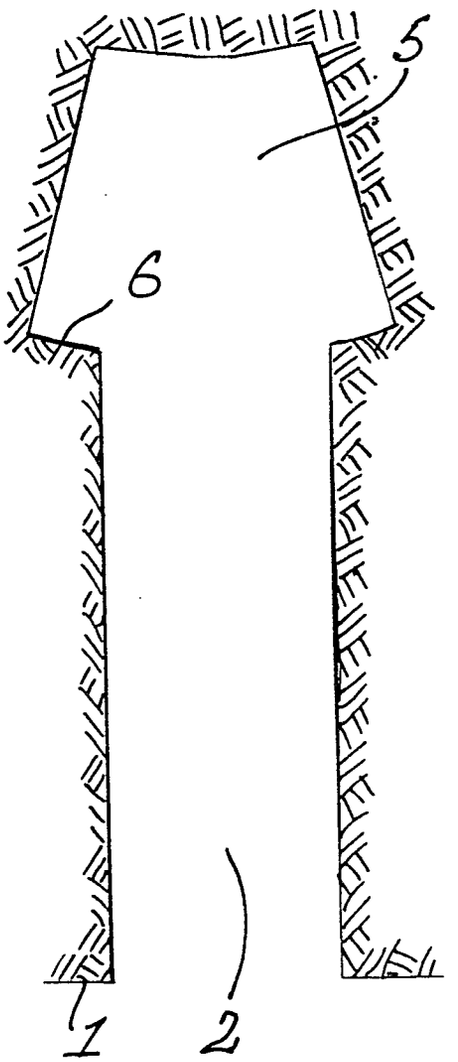


Fig 4.

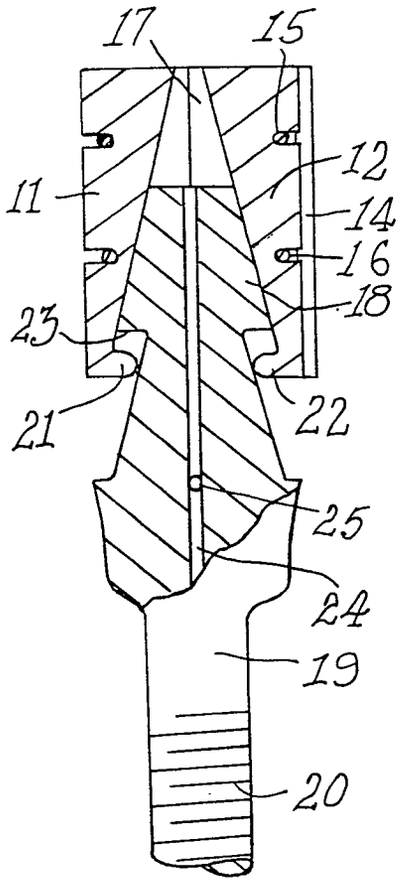


Fig 5.

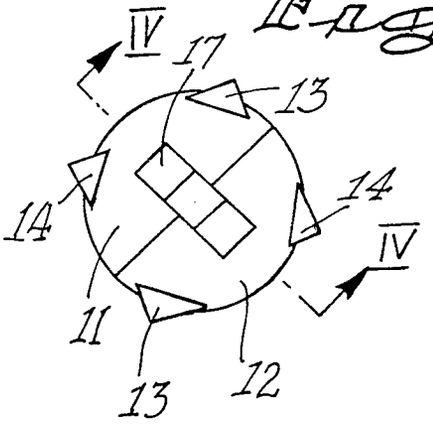
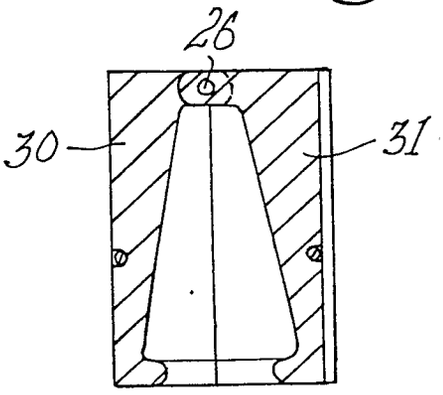


Fig 6.



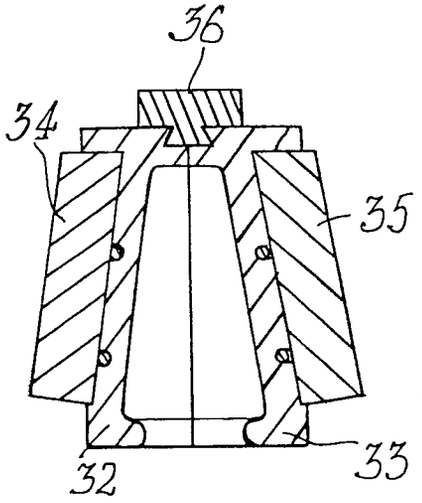


Fig 7.

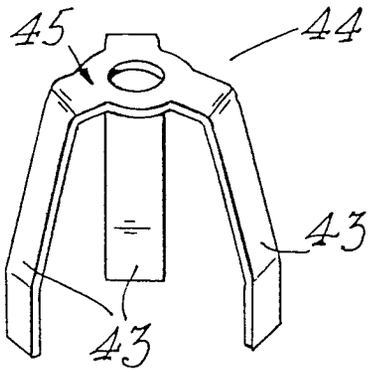


Fig 10.

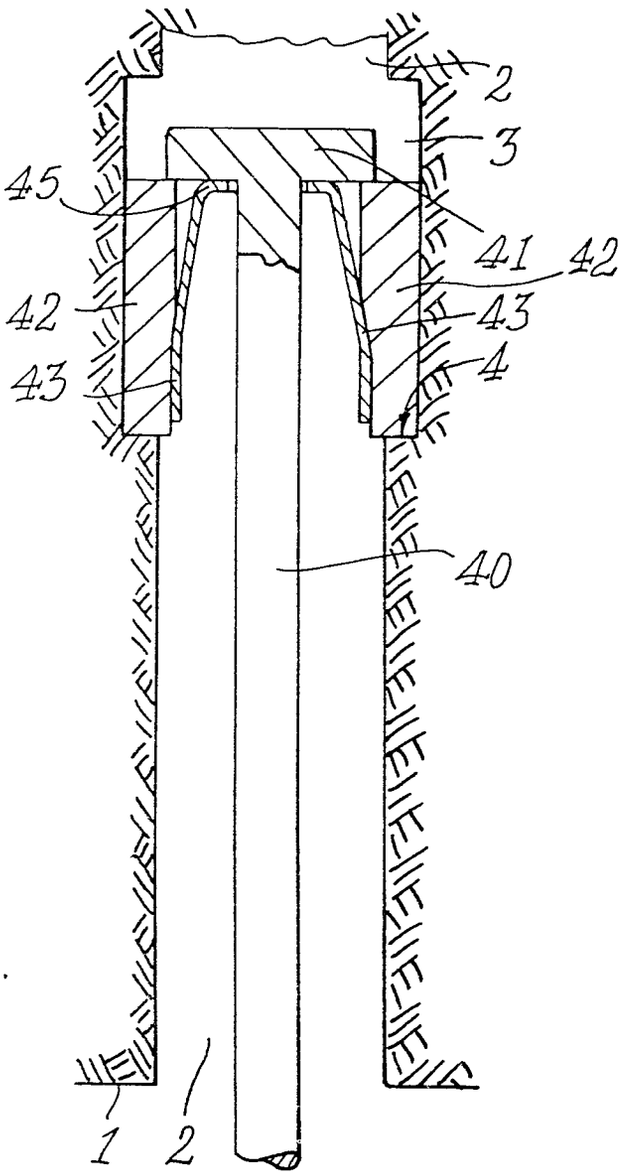


Fig 8.

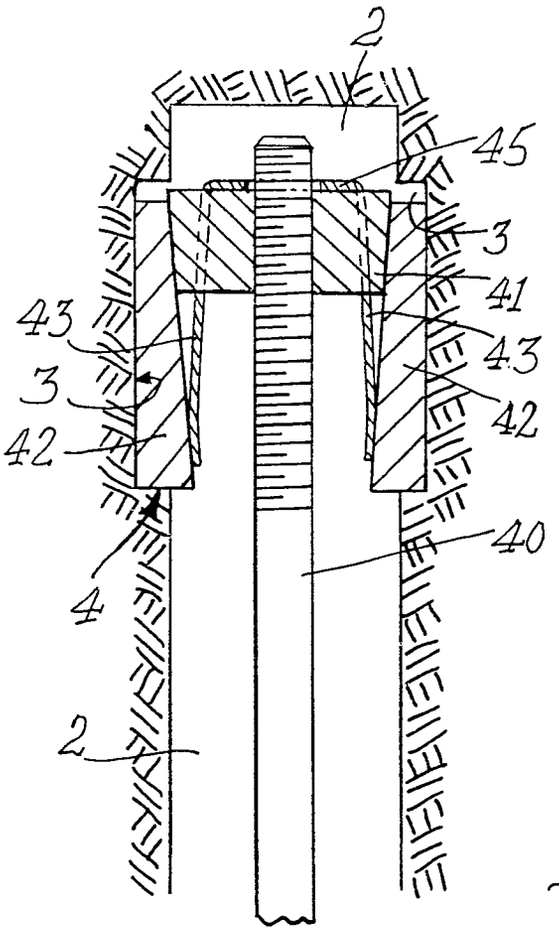


Fig 9.

European Patent Office

EUROPEAN SEARCH REPORT

Application number 0029354

EP 80 30 4087.2

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	DE - A1 - 2 730 026 (J. McDONALD et al.) * fig. 1 to 4 *	1-4
	DE - U - 7 805 430 (A. MILLICH) * fig. 5 *	1-4
	CH - A5 - 608 565 (BATTELLE MEMORIAL INSTITUTE) * page 2, line 14 *	1-4
	US - A - 2 771 746 (A. FISCHER et al.) * fig. 6 *	1-4
	US - A - 1 338 345 (E.C. WILSON et al.) * fig. 1 *	5-10
	US - A - 1 347 469 (S. TOTH) * fig. 1, 2 *	5-10
	US - A - 1 362 513 (C.P. SKINNER) * fig. 1 *	5-10
	US - A - 1 372 917 (F. SWAN) * fig. 1 *	5-10
	US - A - 1 578 482 (F. SWAN) * fig. 1, 2 *	5-10

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CLASSIFICATION OF THE APPLICATION (Int. Cl.³)

E 21 D 20/00

TECHNICAL FIELDS SEARCHED (Int. Cl.³)

E 21 B 10/00
E 21 D 20/00
E 21 D 21/00

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	28-01-1981	ZAPP

EPO Form 1503.1 06.78

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	FR - A - 1 327 260 (J.A.L. PIERRARD) * fig. 8 * --	11	
	BE - A - 643 734 (R. STUTZ) * fig. 4 to 7 * --	12	
A	CH - A5 - 579 207 (STUMPP & KURZ) ----		
			TECHNICAL FIELDS SEARCHED (Int. Cl.3)