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(54) **Title:** PERCUSSIVE DRILL BIT FOR ROCK DRILLING AND METHOD FOR THE MANUFACTURE OF SUCH DRILL BIT

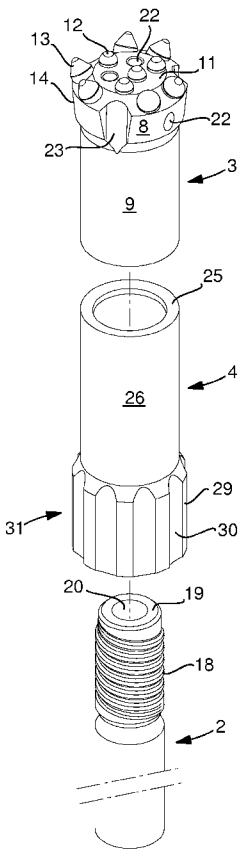

Fig1

(57) **Abstract:** The invention relates to a drill bit intended for percussive rock drillingof the type that comprises a front head (5) and a tubular skirt (6), whichextends rearward from the head to a rear, ring-shaped end and includesan internalthread(17) for the transfer ofcombined impact and rotary motions to the drill bit. Therear endof the skirt(6) is, viaan unelastic joint (24), e.g., a friction weld, united to a front end of a sleeve(4) havingan envelope surface, from which a plurality of projections (29) being peripherically spaced-apartfrom each other project, e.g., ridges, having the purpose of guiding the drill bit inthe drill hole. By assemblingthe drill bit oftwo parts, the internal thread(17) can be turned with high accuracy and smoothness, at the same time as the drill bit is givenan inherent good controllability. In anadditional aspect,the invention also relates to a method for the manufacture of such a drill bit.

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PERCUSSIVE DRILL BIT FOR ROCK DRILLING AND METHOD FOR THE MANUFACTURE OF SUCH A DRILL BIT

Field of the Invention

In a first aspect, the present invention relates to a percussive drill bit intended for percussive rock drilling of the type that comprises a front head and a tubular skirt, which extends rearward from the head to a rear, ring-shaped end, and includes an internal thread for the transfer of combined impact and rotary motions to the drill bit, the head including a rotationally symmetrical envelope surface in which chipways are countersunk and which defines the greatest outer diameter of the drill bit.

In addition, the invention relates to a method for the manufacture of drill bits of the kind in question.

Background Art

For the boring of deep holes in rock or earth, drill strings are used, which comprise a plurality of rods and coupling sleeves, which are assembled as the depth of the hole increases. A terrestrial machine having a shank adapter has the purpose of transferring combined impact and rotary motions to the upper end of the drill string, the lower end of which carries a drill bit, which performs the active operation to crush

the rock and form the hole. By flushing fluid through the drill string to the drill bit, the detached drill cuttings can be conveyed to the hole entry by passing between the outside of the drill string and the inside of the hole.

In rock drilling equipment of this type, a number of requirements and needs are made, one of which is that the recessed hole should be as straight as possible, for instance in order to in the best way impinge on a predetermined target deep down in the rock. For this purpose, a number of control devices have previously been proposed, which make use of tubular controlling elements adjacent to those coupling sleeves, which couple together the different rods, or alternatively along the proper rods. Disadvantages of this type of control devices are that the drilling equipment in its entirety becomes complicated, expensive and ungainly to handle. A previously known rock drill bit, which to a certain extent has improved the straightness of drilled holes is shown in U.S. 7,281,594. A number of steps have there been provided on the skirt of the drill bit, which steps guide the bit in succession.

Another requirement is that the components included in a rock drilling equipment, and in particular the expensive drill bit, should have an optimum service life. In order to provide for this requirement, it is among other things important that the internal thread of the rear skirt of the drill bit is turned by smooth and precision-shaped thread ridges and thread grooves, because otherwise tendencies to crack and other phenomena may arise, which result in early corrosion fatigue.

Summery of the Invention

The present invention aims at obviating the above-mentioned disadvantages of the previously known technique by providing an improved drill bit for percussive rock drilling. Therefore, a primary object of the invention is to provide a drill bit, which on one hand has a considerably improved, inherent controllability in comparison with previously known drill bits, and on the other hand can be made with a precision-shaped female thread having smooth surfaces with the purpose of guaranteeing a long service life of the same. More precisely, the thread should be possible to be turned by means of turning tools, the bars of which are comparatively short with the purpose of avoiding vibrations and bending phenomena in the tool during turning. An additional object is to provide a drill bit, which in spite of the inherent good controllability thereof has a moderate mass and which enables that the intermittent shock

waves are transferred directly from the drill string to the head of the drill bit and the buttons positioned in the same way as in conventional drill bits.

According to the invention, at least the primary object is attained by means of the features defined in the characterizing clause of claim 1. Preferred embodiments of the drill bit according to the invention are furthermore defined in the dependent claims 2–9.

In a second aspect, the invention also relates to a method for the manufacture of drill bits of the kind in question. The features of this method are defined in the independent claim 10.

Brief Description of the Drawings

In the drawings:

Fig. 1 is a perspective exploded view showing two components included in the drill bit according to the invention separated from each other, as well as a portion of a drill rod for connection with the drill bit,

Fig. 2 is an exploded longitudinal sectional view showing the two parts of the drill bit in separated state,

Fig. 3 is a longitudinal sectional view through the drill bit in assembled state and separated from the drill rod, and

Fig. 4 is a corresponding longitudinal sectional view showing the drill rod connected with the drill bit.

Detailed Description of Preferred Embodiments

In the drawings, 1 generally designates a drill bit made in accordance with the invention (see Figs. 3 and 4), which is intended to be coupled together with a drill rod 2 included in a drill string. In Figs. 1 and 2, it is seen that the drill bit 1 is manufactured by being assembled of two parts, viz. a front part 3 and a rear part 4. Of these parts 3, 4, the front one is made as a conventional drill bit. Thus, the part 3 includes a front head 5 and a tubular skirt 6, which extends rearward from the head 5 to a rear, ring-shaped end 7. The part 3 has a rotationally symmetrical basic shape by including a rotationally symmetrical envelope surface, which is assembled of a

cone surface 8 on the outside of the head 5, as well as a cylinder surface 9 on the outside of the skirt 6. The cone surface 8 converges in the backward direction from a circular borderline 10 along which the cone surface transforms into a front surface 11, in which buttons of cemented carbide or the like are mounted, viz. a set of centre buttons 12 and a set of peripheral buttons 13. On a level with the borderline 10, the head 5 has the greatest outer diameter OD_1 thereof. The corresponding outer diameter OD_2 for the cylinder surface 9 is less than OD_1.

The skirt 6 delimits a hollow space 15, which has a cylindrical shape and opens in an opening 16 surrounded by the ring-shaped end surface 7. In the inside of the skirt 6, a female thread 17 is provided to co-operate with a male thread 18 of the drill rod 2. As may be best seen in Fig. 1, the male thread is formed in close connection to the front end of the drill rod, which end consists of a plane, ring-shaped surface 19, which surrounds a duct 20 running centrally in the drill rod for the feed of flush water to the drill bit. The inner end of the hollow space 15 of the part 3 consists of a plane, ring-shaped shoulder surface 21, which is impinged on by the end surface 19 of the drill rod when impulsive forces are transferred to the drill bit. The hollow space 15 communicates with the outside of the drill bit via ducts 22, which terminate in the front surface 11, as well as in the cone surface 8.

Concerning the part 3, it should in conclusion be mentioned that a number of chipways 23 are countersunk in the cone surface 8. A vital task of the flushing fluid is to evacuate the crushed cuttings via the grooves 23 to the ground surface.

In contrast to unelastically tightenable threaded joints of the type that is found in machine details of different types, the joint that is formed of the female and male threads 17, 18 is formed in such a way that the male thread intermittently is screwed into and unscrewed of, respectively, the male thread in order to after each impact motion rotate the drill bit to a new rotation angle position in relation to the rock. The impact motions of the drill string are transferred to the drill bit primarily via the surfaces 19, 21, while the principal task of the threaded joint is to provide for the stepwise rotation of the drill bit. It should also be mentioned that the described part 3 is manufactured by chip removing machining (turning, milling and boring, respectively), the female thread 17 being formed by internal turning.

As far as the shown part 3 hitherto has been described, the same does not differ on any substantial points from previously known rock drill bits.

According to the invention, the rear end 7 of the skirt 6 is, via an unelastic joint 24 (see Figs. 3 and 4), united or rigedly connected to a front end 25 of the part 4, which is in the form of a sleeve, the external surface or envelope surface 26 of which is formed with projections in order to guide the drill bit in the hole recessed by the head 5 and the buttons thereof. Also the sleeve 4 has a rotationally symmetrical basic shape. More precisely, the same is in the example cylindrical by the fact that the external surface or the envelope surface 26, as well as the internal surface 27 are cylindrical. Thus, the sleeve delimits an axially through-going hollow space, which opens in the hollow space 15, as well as in a rear opening, which is surrounded by a rear and in this case cone-shaped end surface 28 of the sleeve. Alternatively, said end surface may be provided with so-called retrac teeth. The cylinder surface 26 of the sleeve 4 and the envelope surface 9 of the skirt 6 are preferably smooth and cylindrical in the area of the joint 24.

In the shown, preferred embodiment, the guiding projections on the outside of the sleeve consist of a number of peripherically spaced-apart ridges 29, which may run axially along the sleeve and are mutually spaced-apart by grooves 30, which like the grooves 23 form chipways. The total cross-sectional area of the chipways 30 should be at least as great as the total cross-sectional area of the grooves 23. The crest surfaces facing outward of the ridges 29 together form a ring formation, which in the example is cylindrical by the fact that each crest surface has a part-cylindrical shape. Together the crest surfaces of the ridges 29 define the greatest outer diameter OD_3 of the sleeve, which is greater than the outer diameter OD_4 of the envelope surface 26. More precisely, the grooves 30 are in this case formed, e.g., by milling, in a collar in its entirety designated 31, the grooves being identical and delimiting ridges, which are uniform so far that they have one and the same length as well as one and the same width. In this connection, the ridges are somewhat deeper than the grooves, i.e., the bottoms of the grooves do not reach into an imaginary extension of the envelope surface 26. It should also be observed that the collar 31, i.e., the set of ridges 29, is located at the rear end of the sleeve 4. In the shown, preferred embodiment, the outer diameter OD_3 of the collar 31 and the outer diameter OD_1 of the head 5 are equally large. However, OD_3 may be somewhat smaller, but never greater, than

OD_1. Alternatively, the ridges 29 may form an angle with the rotational axis of the drill bit.

Advantageously, the sleeve 4 has, in the front part thereof along the envelope surface 26, an outer diameter OD_4, which is as great as the outer diameter OD_4 of the skirt 6. However, the inner diameter ID_1 is greater than the inner diameter ID_2 of the skirt 6 such as this is represented by the outer diameter of the thread 17, i.e., the greatest diameter of the thread grooves.

Suitably – however not necessarily – the length L_1 of the sleeve 4 is greater than the length L_2 of the front part 3. Within given presumptions regarding the optimal mass of the finished drill bit, a maximal controllability is accordingly attained because the guiding ridges 29 are located at greatest feasible distances from the head 5.

In practice, the sleeve may advantageously be permanently united to the front part 3, in order to form together with the same an integrated drill bit, which is discarded after wear. Therefore, the joint 24 between the parts 3, 4 may be metallurgical and consist of, for instance, a friction weld or another suitable weld. However, within the scope of the invention, it is feasible to unite the parts 3, 4 via a semi-permanent joint, e.g., an unelastic threaded joint having suitable lock means, or a metallic joint, which easily may be disengaged.

In the embodiment shown, a ring-shaped groove 32 for a sealing ring 33 is recessed in the internal surface 27 of the sleeve 4. More precisely, said sealing ring 33 is situated in the immediate vicinity of the rear end 28 of the sleeve, with the purpose of avoiding penetration of cuttings in the gap between the envelope surface of the drill rod 2 and the interior of the sleeve.

It should also be mentioned that the axial extension or length L_3 of the ridges 29 suitably is smaller than half of the length L_1 of the sleeve. In the example, L_3 amounts to approximately 35 % of L_1.

The manufacture of the two parts 3, 4, which together form the drill bit ready for use, is carried out in separate steps by cutting or chip removing machining of workpieces of steel, above all turning, but also milling and boring. The very forming of the internal thread 17 of the part 3 may be carried out by internal turning by means of a turning tool, the bar of which has very moderate length. In such a way, the turning

operation can be carried out without risk of troublesome vibrations, which could jeopardize the desired precision and the surface smoothness of the thread. The machining of the sleeve 4 is reasonably simple and consists primarily of turning, as well as certain milling of the grooves of the rear collar. After completion of the part 3 (with or without buttons) and the part 4, the same are permanently united by welding together the rear end of the skirt 6 with the front end of the sleeve 4. Suitably – however not necessarily – this is carried out by friction welding.

A fundamental advantage of the drill bit according to the invention is that the internal thread of the drill bit can be given desired precision and smoothness at the same time as the ridges or projections, which have the purpose of guiding the drill bit, can be located at an advantageously great axial distance from the head of the drill bit. In addition, it is construction-wise simple to form the extension sleeve in such a way that the assembled drill bit obtains a total mass, which does not lead to unbalances. In addition, the improved controllability of the operating drill string is exclusively attained by means of the drill bit, i.e., other controlling elements being difficult to handle do not need to be resorted to. Expressed in another way, it can be said that the drill bit by itself improves the conditions for the boring of straight holes without the transfer of the requisite shock waves needing to be altered. Thus, the shock waves can be transferred from rod end to rock surface via cemented-carbide buttons in the same advantageous way as in conventional drill bits.

The invention is not limited only to the embodiment described above and shown in the drawings. Thus, the shape and the placement of the external, guiding projections of the sleeve may be modified in miscellaneous ways. Instead of only long narrow ridges, the projections may consist of, for instance, semi-spherical knobs or combinations of knobs and ridges. Instead of one single rear set of ridges or projections, such as has been exemplified in the drawings, two or more axially spaced-apart sets may be formed on the sleeve. It is even feasible to displace the different ridges or projections axially in relation to each other. In other words, they need not necessarily be collected in a ring-shaped formation or collar.

The disclosures in the Swedish patent application No. 0702638-8, from which this application claims priority, are incorporated herein by reference.

CLAIMS

1. Percussive drill bit for rock drilling, comprising a front head (5) and a tubular skirt (6), which extends rearward from the head to a rear, ring-shaped end (7), and includes an internal thread (17) for the transfer of combined impact and rotary motions to the drill bit, the head (5) including a rotationally symmetrical envelope surface (8) in which chipways (23) are countersunk, and which defines the greatest outer diameter (OD_1) of the drill bit, **characterized in** that the rear end (7) of the skirt (6) is, via an unelastic joint (24), united to a front end (25) of a sleeve (4) having an envelope surface (26), from which a plurality of projections (29) being peripherically spaced-apart from each other project, in order to guide the drill bit in a hole recessed by the head.

2. Drill bit according to claim 1, **characterized in** that the projections consist of ridges, which run axially along the sleeve (4) and together form a ring formation, the outer diameter (OD_3) of which is not more than the outer diameter (OD_1) of the head (5).

3. Drill bit according to claim 2, **characterized in** that the ridges (29) are included in a collar (31), the axial length (L_3) of which is smaller than the length (L_1) of the sleeve.

4. Drill bit according to claim 2 or 3, **characterized in** that the outer diameters (OD_1, OD_3) of the head (5) and of the ring formation formed by the ridges (29) are equally large.

5. Drill bit according to claim 3 or 4, **characterized in** that the collar (31) is placed in the immediate vicinity of the rear end (28) of the sleeve (4).

6. Drill bit according to any one of the preceding claims, **characterized in** that the length (L_1) of the sleeve (4) is greater than the total length (L_2) of the head (5) and of the skirt (6).

7. Drill bit according to any one of the preceding claims, **characterized in** that the sleeve (4) is permanently united to the skirt (6) via a metallurgical joint (24) in order to form an integrated part of the drill bit.

8. Drill bit according to any one of the preceding claims, **characterized in** that the part of the sleeve (4) united to the skirt (6) has an outer diameter (OD_4), which is as great as the outer diameter (OD_2) of the skirt (6) but has an inner diameter (ID_1), which is greater than the inner diameter (ID_2) of the skirt (6) such as this is represented by the outer diameter of the thread (17).

9. Drill bit according to any one of the preceding claims, **characterized in** that the cylinder surface (26) of the sleeve (4) and the envelope surface (9) of the skirt (6) are smooth and cylindrical in the area of the joint (24).

10. Method for the manufacture of drill bit intended for percussive rock drilling, which comprises a front head (5) and a tubular skirt (6), which extends rearward from the head to a rear, ring-shaped end (7), and includes an internal thread (17) for the transfer of combined impact and rotary motions to the drill bit, the head (5) including a rotationally symmetrical envelope surface (8), in which chipways (23) are countersunk, and which defines the greatest outer diameter (OD_1) of the drill bit, **characterized by** the steps of:

a) turning the thread (17) at the inside of the skirt (6), and

b) after that, via an unelastic joint (24), uniting the rear end of the skirt to a front end (25) of a sleeve (4) having an envelope surface (26) from which a plurality of projections (29) being peripherically spaced-apart from each other project having the purpose of guiding the drill bit in a hole recessed by the head.

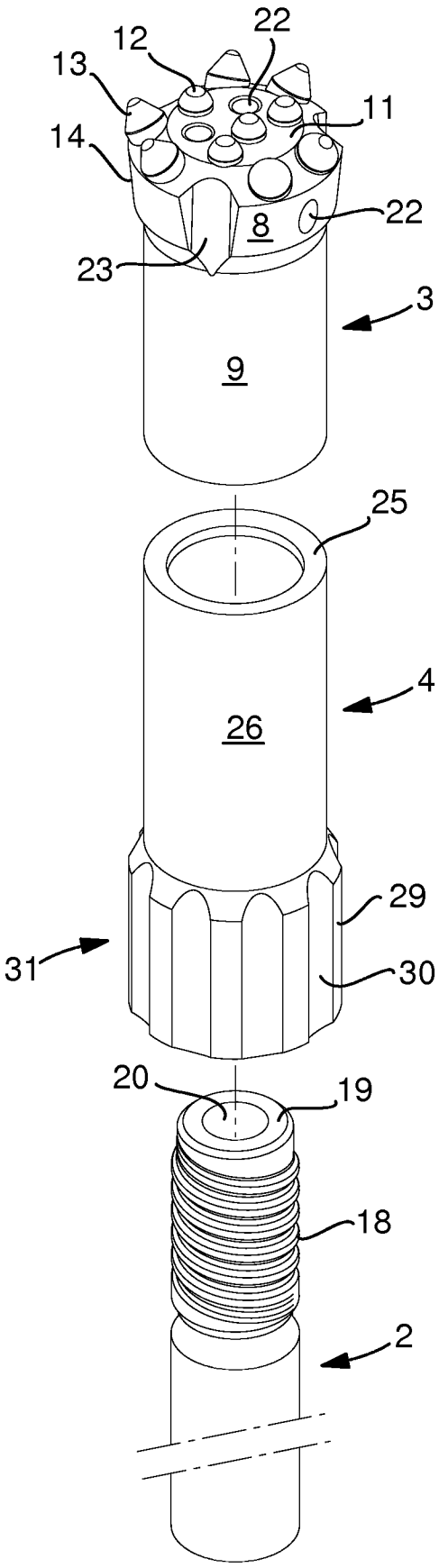

Fig1

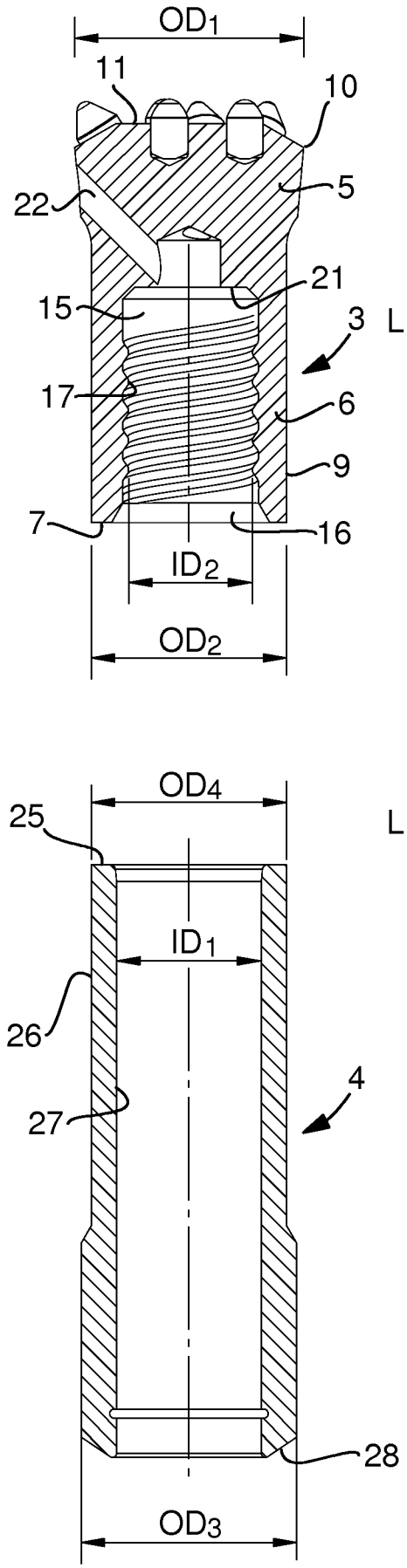

Fig 2

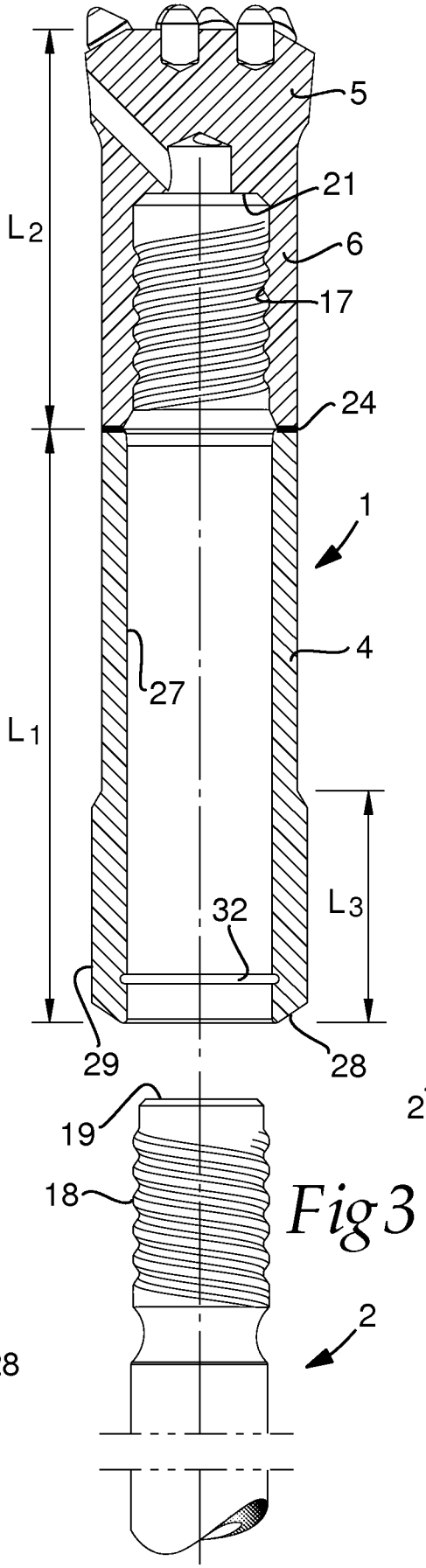

Fig 3

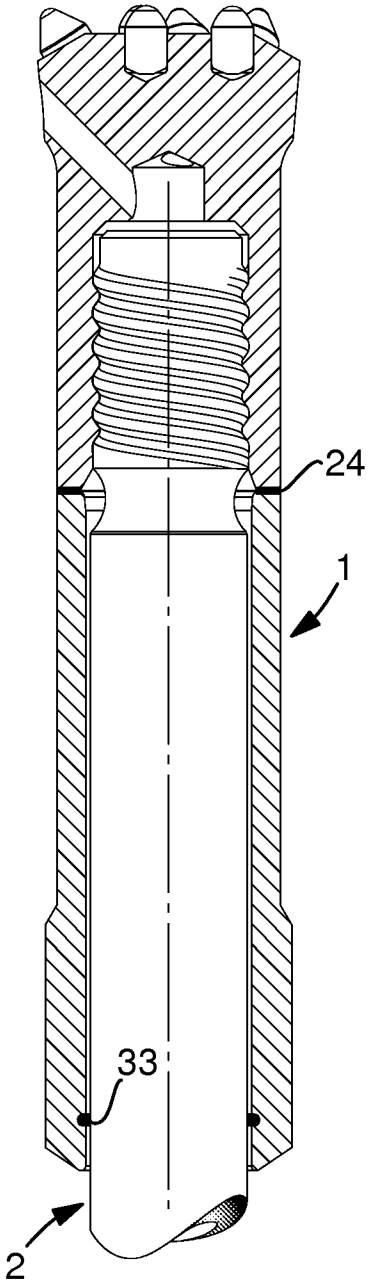

Fig 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2008/051297

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
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: E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	SE 530602 C2 (SANDVIK INTELLECTUAL PROPERTY AB), 15 July 2008 (15.07.2008), abstract ---	1-10
A	US 20040163852 A1 (G.R. BROOM), 26 August 2004 (26.08.2004), figure 2, abstract ---	1-10
P,A	WO 2007147257 A1 (BOART LONGYEAR GLOBAL HOLDCO INC.), 27 December 2007 (27.12.2007), abstract --- --------	1-10

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Date of the actual completion of the international search	Date of mailing of the international search report
2 February 2009	06-02-2009
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Anders Toll / MRo Telephone No. +46 8 782 25 00

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Cited literature, if any, will be enclosed in paper form.

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US	20040163852	A1	26/08/2004	US	6892831	B	17/05/2005
				US	6732820	B	11/05/2004
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