

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
9 November 2006 (09.11.2006)

PCT

(10) International Publication Number
WO 2006/117331 A1

(51) International Patent Classification:

F27D 3/15 (2006.01) **E21B 17/042** (2006.01)
C21B 7/12 (2006.01) **F16L 15/00** (2006.01)

(21) International Application Number:

PCT/EP2006/061904

(22) International Filing Date: 27 April 2006 (27.04.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

91168 29 April 2005 (29.04.2005) LU

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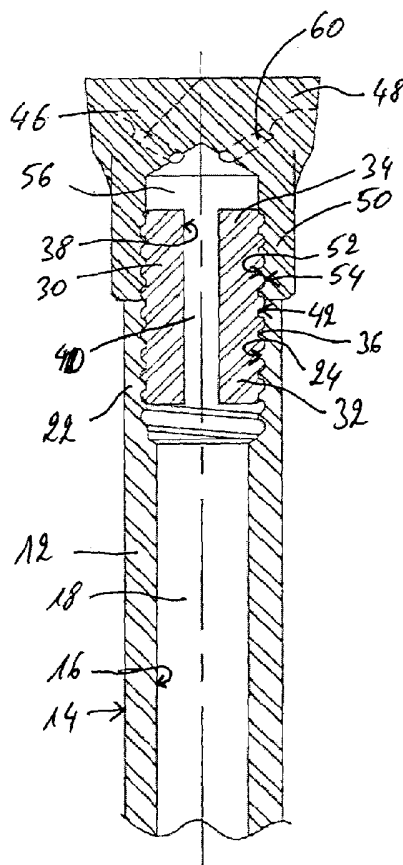
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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(54) Title: DRILL ROD

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(57) Abstract: According to the present invention, a drill rod (10) comprises an elongate hollow shaft (12) with a first shaft end and a second shaft end (22), the first shaft end having a first connector for connecting the drill rod (10) to a drive mechanism, the second shaft end (22) having a first female thread (24); and an adapter (30) with a first adapter end (32) and a second adapter end (34), the first adapter end (32) having a first male thread (42) cooperating with the first female thread (24) of the second shaft end (22), the second adapter end (34) having a second connector for connecting a drill bit (46) thereto. When a drill bit (46) is connected to the drill rod (10), the adapter (30) is sandwiched between the hollow shaft (12) and the drill bit (46). The above configuration of drill rod allows a great variety of drill bits to be used in conjunction with a single hollow shaft. There is hence no need to provide a different hollow shaft if a different drill bit is to be used. Manufacturing costs of drill rods do hence not have to be considerably- increased if a variety of drill bits are to be used.

**Published:**

- *with international search report*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

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Drill rod

Introduction

The present invention relates to a drill rod, in particular to a drill rod of a tapping device for use in the iron and steel making industry.

Historically, blast furnaces, electric arc furnaces, and related vessels used for producing, transporting, or otherwise containing molten material, are opened for releasing the liquefied material, by a drilling process called "tapping". In order to carry out the tapping process, tapping devices are provided. Such tapping devices generally comprise a motor for imparting impact and rotation forces to a drill rod, at the end of which a drill bit is arranged for penetrating into the vessel to be opened. A drill rod comprises a hollow, steel drill shaft, sized and manufactured to adequately transmit the rotary and impact forces to the refractory material allowing effective creation of a drill hole within the vessel or containing body.

The common design of the drill rod comprises a male thread on the driven-end of the hollow drill shaft, i.e. the end of the drill shaft connected to the motor. The opposite end of the drill shaft, i.e. the bit end of the drill shaft, comprises a male thread for receiving the drill bit. The drill bit comprises a female thread cooperating with the male tread of the bit end of the drill shaft, so as to connect the drill bit to the hollow drill shaft. The drill shaft comprises a fluid passage therein, extending from the driven end to the bit end and allowing liquid or gas to be transported through the hollow drill shaft to the drill bit. The supply of liquid or gas to the drill bit permits cooling of the drill bit and clearing debris from the drilled hole. By effectively cooling the drill bit and clearing the drilled hole of debris, the working edge of the drill bit retains its edges longer, and binding caused by collected debris is minimized.

The size of the drill rod is of importance, in particular in view of weight and handling of the drill rod. The outer diameter of the hollow drill shaft is determined to be the smallest possible size according to weight and handling restraints,

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compared against the size of the threaded connections. Generally, the drill shaft is altered to accommodate minimal piece weight, without sacrificing its ability to adequately transfer energy. This alteration is known as forging. Usually, each end of the drill shaft is forged to achieve increases in diameters, without the added weight between the threaded ends.

Currently, the male thread at the bit end of the drill shaft is determined by the thread of the drill bit, i.e. by the drill bit manufacturers. It follows that drill bits from different manufacturers cannot generally be used on the same drill shaft. The material presently used for the manufacture of drill shafts is not commonly available and the necessary raw material is difficult to acquire. It follows that the costs of such drill shafts are therefore relatively high. In addition to the direct purchasing costs of the material, further costs for forging and threading have to be taken into account.

In order to reduce costs, it has been proposed to increase the outer diameter of the drill shaft between the two ends, thereby eliminating the forging operations. In order not to drastically increase the weight of the drill shaft, the inner diameter of the drill shaft is also increased. The larger inner diameter has the further advantage that a greater flow capacity is achieved, leading to better cooling and purging.

However, by increasing the inner diameter of the drill shaft, the material thickness of the drill shaft at the drill bit end is reduced, thereby reducing the strength of the connection between the drill bit and the drill shaft. In case of insufficient strength of the connection between the drill bit and the drill shaft the drill bit can break off the drill shaft during operation and jeopardize the drilling process.

Object of the invention

The object of the present invention is to provide an improved drill rod, which overcomes the aforementioned problems.

Summary of the Invention

According to the present invention, a drill rod comprises an elongate hollow shaft with a first shaft end and a second shaft end, the first shaft end having a first connector for connecting the drill rod to a drive mechanism, the second shaft end having a first female tread; an adapter with a first adapter end and a second adapter end, the first adapter end having a first male thread cooperating with the first female tread of the second shaft end, the second adapter end having a second connector for connecting a drill bit thereto, wherein the adapter is sandwiched between the hollow shaft and a drill bit.

The above configuration of drill rod allows a great variety of drill bits to be used in conjunction with a single hollow shaft. There is hence no need to provide a different hollow shaft if a different drill bit is to be used. Manufacturing costs of drill rods do hence not have to be considerably increased if a variety of drill bits are to be used.

Advantageously, the drill rod further comprises a drill bit with a third connector cooperating with the second connector of the second adapter end.

The second connector of the second adapter end preferably comprises a second male thread and the third connector of the drill bit preferably comprises a second female thread cooperating with the second male thread of the second connector of the second adapter end. This allows easy and fast connection of the drill bit to the adapter.

Advantageously, the adapter comprises a fluid conduit extending from the first adapter end to the second adapter end for delivering fluid from the fluid passage of the hollow shaft to the drill bit for cooling thereof.

Preferably, the adapter further comprises a plurality of orifices in its circumferential wall, the orifices being fluidly connected to the fluid conduit. Such orifices allow fluid to be delivered between the drill rod and the drilled hole in order to further improve cooling of the drill bit and to improve evacuation of debris from the drilled hole.

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According to one embodiment, the orifices are arranged in the second adapter end.

According to one embodiment, the orifices are arranged in a collar between the first male thread of the first adapter end and the second connector of the second adapter end, the collar having a diameter larger than the diameter of the first and second adapter ends. The collar can comprise a chamfered portion with a diameter gradually decreasing in direction of the first adapter end, and the orifices can be arranged in the chamfered portion of the collar. Such an arrangement of the orifices further improves evacuation of debris from the drilled hole.

Advantageously, the adapter further comprises a check valve arranged in the fluid conduit for avoiding that material, such as e.g. pressurized molten material contained in the vessel to be opened, flows through the hollow shaft of the drill rod.

Brief Description of the Drawings

The present invention will be more apparent from the following description of a preferred embodiment with reference to the accompanying drawings, wherein:

- Fig.1 is a longitudinal sectional view through a drill end of a drill rod according to the invention with an adapter according to a first embodiment;
- Fig.2 is an exploded view of a drill end of the drill rod of Fig.1;
- Fig.3a is a longitudinal sectional view through an adapter according to a second embodiment;
- Fig.3b is a longitudinal sectional view through an adapter according to a third embodiment;
- Fig.3c is a longitudinal sectional view through an adapter according to a fourth embodiment;
- Fig.3d is a longitudinal sectional view through an adapter according to a fifth embodiment;

- Fig.3e is a longitudinal sectional view through an adapter according to a sixth embodiment;
- Fig.3f is a longitudinal sectional view through an adapter according to a seventh embodiment;
- 5 Fig.3g is a longitudinal sectional view through an adapter according to a eighth embodiment; and
- Fig.3h is a longitudinal sectional view through an adapter according to a ninth embodiment.

Detailed description of the shown embodiments

A drill end of a drill rod according to the invention is shown in Figs 1 and 2. The
10 drill rod 10 comprises a generally cylindrical elongate hollow shaft 12 having an external shaft wall 14 and an internal shaft wall 16, the latter defining within the hollow shaft 12, a fluid passage 18 extending from a first shaft end (not shown) to a second shaft end 22. The drill rod 10 comprises a first female thread 24 arranged on the internal shaft wall 16 of the second shaft end 22.

15 An adapter 30 having a first adapter end 32 and a second adapter end 34 is provided. The adapter 30 has an external adapter wall 36 and an internal adapter wall 38, the latter defining, within the adapter 30, a fluid conduit 40 extending from the first adapter end 32 to the second adapter end 34.

The adapter 30 comprises a first male thread 42 arranged on the external
20 adapter wall 36 of the first adapter end 32. The first male thread 42 of the first adapter end 32 is formed so as to cooperate with the first female thread 24 of the second shaft end 22, such that the adapter 30 can be screwed onto the second shaft end 22 of the hollow shaft 12.

The adapter 30 further comprises a second connector for connection a drill bit
25 46 thereto. The drill bit 46 comprises a drill head 48 and a third connector 50, the latter preferably comprising a second female thread 52. The adapter 30 then comprises a second male thread 54 on the second adapter end 34 formed so as to cooperate with the second female thread 52 of the drill bit 46, such that the later can be screwed onto the second adapter end 34 of the adapter 30.

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The drill bit 46 is preferably formed so as to, when connected to the adapter 30, form an internal distribution chamber 56 between the adapter 30 and a drill head 48 of the drill bit 46. Fluid channels 60 can be arranged in the drill head 48 so as to allow fluid to flow from the internal distribution chamber 56 to the space
5 between the drill head 48 and the wall to be drilled.

According to a first embodiment of the invention, the adapter 30, as shown in Fig.1 and Fig.2, is a generally cylindrical hollow body with a single thread on its exterior wall extending from one end to the other.

Alternative adapters are shown in Figs.3a to 3h. These adapters 30 comprise a
10 collar 62 between the first and second male threads 42, 54. The collar 62 has a first contact surface 64, a second contact surface 66 and a side face 68. The diameter of the collar 62 is bigger than the diameter of the first and second adapter ends 32, 34. When connected, the first contact surface 64 of the collar 62 comes into contact with a third contact surface 70 (seen of Fig.2) on the
15 second shaft end 22 of the hollow shaft 12 and the second contact surface 66 of the collar 62 comes into contact with a fourth contact surface 72 (seen of Fig.2) on the connection end 50 of the drill bit 46. The collar 62 is not limited in length, i.e. in axial direction, and may be extended or reduced as required. Also, the geometry is not limited to a circular cylindrical shape. Collars having square or
20 hexagonal cross section can also be envisaged.

An adapter according to a second embodiment of the invention is shown in Fig.3a. This adapter comprises a collar 62 having a diameter equal to or smaller than the outer diameter of the hollow shaft 12. Such a "slim-line collar" can be used for added annular clearance when a smaller diameter drill bit 46 is
25 selected.

An adapter according to a third embodiment of the invention is shown in Fig.3b. This adapter comprises a collar 62 having a diameter substantially identical to the diameter of the hollow shaft 12. Such a collar can be used for a standard drill bit 46, wherein the collar 62 of the adapter 30 forms a continuation of the
30 hollow shaft 12.

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An adapter according to a fourth embodiment of the invention is shown in Fig.3c. This adapter comprises a plurality of orifices 80 in the side face 68 of the collar 62. The orifices 80 are fluidly connected to the fluid conduit 40 by means of bores 82. The orifices 80 allow for some of the fluid to be ejected from the adapter 30 into the drilled hole and thereby to improve the purging of debris from the drilled hole. The fluid conduit 40 comprises a narrowed section 84 downstream of where the bores 82 meet the fluid conduit 40. The side face 68 of the collar 62 comprises a chamfered portion 69 so as to gradually decrease the diameter of the collar 62 in direction of the first adapter end 32. The plurality of orifices 80 are arranged in the chamfered portion 69 of the side face 68 so as to direct the fluid ejected from the orifices 80 away from the drill bit 46, thereby aiding the purging of debris from the drilled hole.

An adapter according to a fifth embodiment of the invention is shown in Fig.3d. This adapter comprises a second adapter end 34 having an increased diameter. This shows that adapters with different diameter threads can be used such that other drill bits can be connected. This allows alteration of drill bit threads and geometry by the operator's choice with minimum effort.

An adapter according to a sixth embodiment of the invention is shown in Fig.3e. This adapter comprises a first adapter end 32 having "V" threads, allowing standard 60-degree thread configurations to be adapted to the drill bit thread of choice. The represented 60-degree "V" thread may also be an acme or another "UNC" (Unified National Coarse), "UNF" (Unified National Fine) or metric pitch thread geometry.

An adapter according to a seventh embodiment of the invention is shown in Fig.3f. This adapter comprises a check valve 90 arranged in the fluid conduit 40. Such a check valve 90 prevents pressurized molten material to return through the hollow shaft 12. Furthermore, this adapter comprises orifices 92 in the second adapter end 34, the orifices 94 being fluidly connected to the fluid conduit 40 by means of bores 94.

An adapter according to an eighth embodiment of the invention is shown in Fig.3g. This adapter comprises a plurality of orifices 80 in the side face 68 of the

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collar 62. The orifices 80 are fluidly connected to the fluid conduit 40 by means of bores 82. The orifices 80 allow for some of the fluid to be ejected from the adapter 30 into the drilled hole, thereby providing cooling to the drill bit and purging of debris from the drilled hole. The fluid conduit 40 comprises a
5 narrowed section 84 downstream of where the bores 82 meet the fluid conduit 40. The side face 68 of the collar 62 is substantially parallel to the axis of the adapter 30.

An adapter according to a ninth embodiment of the invention is shown in Fig.3h. This adapter comprises a second male thread 54 in the form of a rope thread,
10 thereby allowing rope thread drill bits to be connected to the hollow shaft 12 having a different standardized drill bit thread configuration.

The above embodiments merely serve to illustrate some of the possible configurations. Many changes, modifications, variations, uses and applications of the subject invention will however become apparent to those skilled in the art
15 after considering the specification and accompanying drawings. All such changes, modifications, variations, uses and applications which do not depart from the spirit and scope of the invention are deemed to be covered by the invention, which is limited only by the claims that follow.

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Reference numerals

10	drill rod	50	third connector
12	hollow shaft	52	second female thread
14	external shaft wall	54	second male thread
16	internal shaft wall	56	internal distribution chamber
18	fluid passage	60	fluid channels
22	second shaft end	62	collar
24	first female thread	64	first contact surface
30	adapter	66	second contact surface
32	first adapter end	68	side face
34	second adapter end	69	chamfered portion
36	external adapter wall	70	third contact surface
38	internal adapter wall	72	fourth contact surface
40	fluid conduit	80	orifices
42	first male thread	82	bores
46	drill bit	90	check valve
48	drill head	92	orifices

Claims

1. Drill rod comprising:

an elongate hollow shaft with a first shaft end and a second shaft end, said first shaft end having a first connector for connecting said drill rod to a drive mechanism, said second shaft end having a first female tread; and

5 an adapter with a first adapter end and a second adapter end, said first adapter end having a first male thread cooperating with said first female tread of said second shaft end, said second adapter end having a second connector for connecting a drill bit thereto;

wherein, when a drill bit is connected to said drill rod, said adapter is

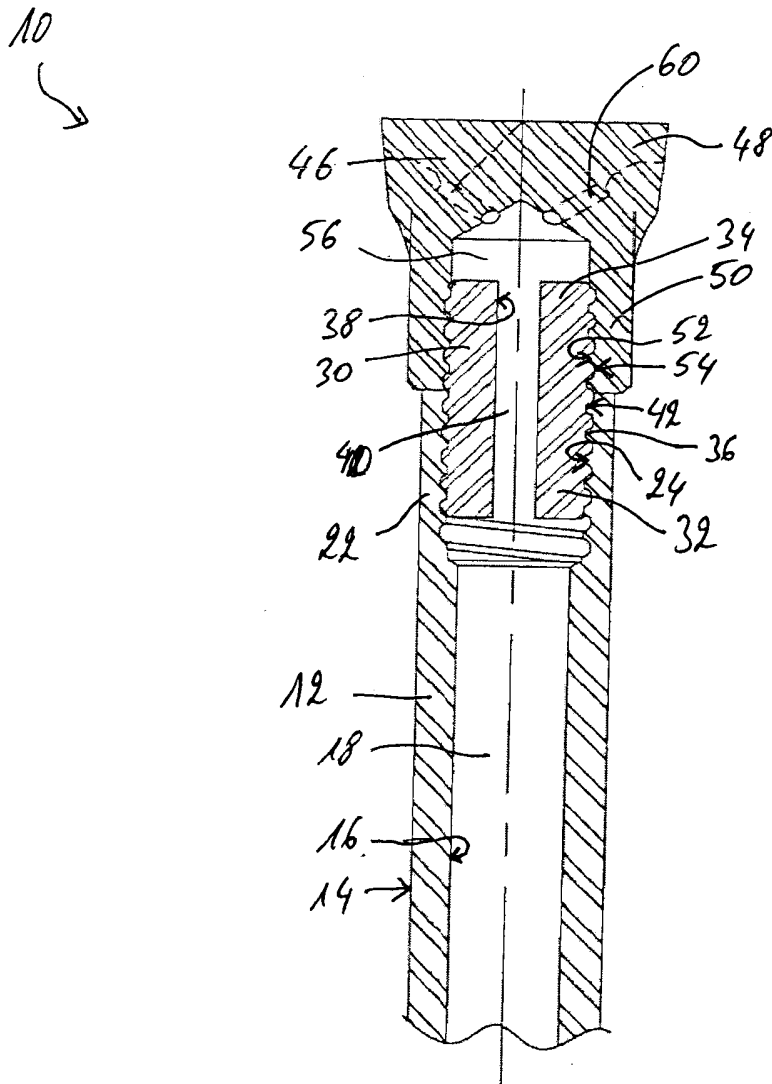
10 sandwiched between said hollow shaft and said drill bit.
2. Drill rod according to claim 1, wherein said drill rod further comprises a drill bit with a third connector cooperating with said second connector of said second adapter end.
3. Drill rod according to claim 2, wherein said second connector of said
- 15 second adapter end comprises a second male thread and said third connector of said drill bit comprises a second female tread cooperating with said second male thread of said second connector of said second adapter end.
4. Drill rod according to any of the preceding claims, wherein said adapter
- 20 comprises a fluid conduit extending from said first adapter end to said second adapter end.
5. Drill rod according to claim 4, wherein said adapter comprises a plurality of orifices in its circumferential wall, said orifices being fluidly connected to said fluid conduit.
- 25 6. Drill rod according to claim 5, wherein said orifices are arranged in said second adapter end.

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7. Drill rod according to any of claims 4 to 6, wherein said adapter comprises a check valve arranged in said fluid conduit between said first adapter end and said orifices.
8. Drill rod according to any of the previous claims, wherein said adapter comprises a collar between said first male thread of said first adapter end and said connector of said second adapter end, said collar having a diameter larger than the diameter of said first and second adapter ends and wherein said orifices are arranged in said collar.
9. Drill rod according to claim 8, wherein said collar comprises a chamfered portion with a diameter gradually decreasing in direction of said first adapter end, and wherein said orifices are arranged in said chamfered portion of said collar.
10. Drill rod according to any of claims 4 to 9, wherein said adapter comprises a check valve arranged in said fluid conduit.

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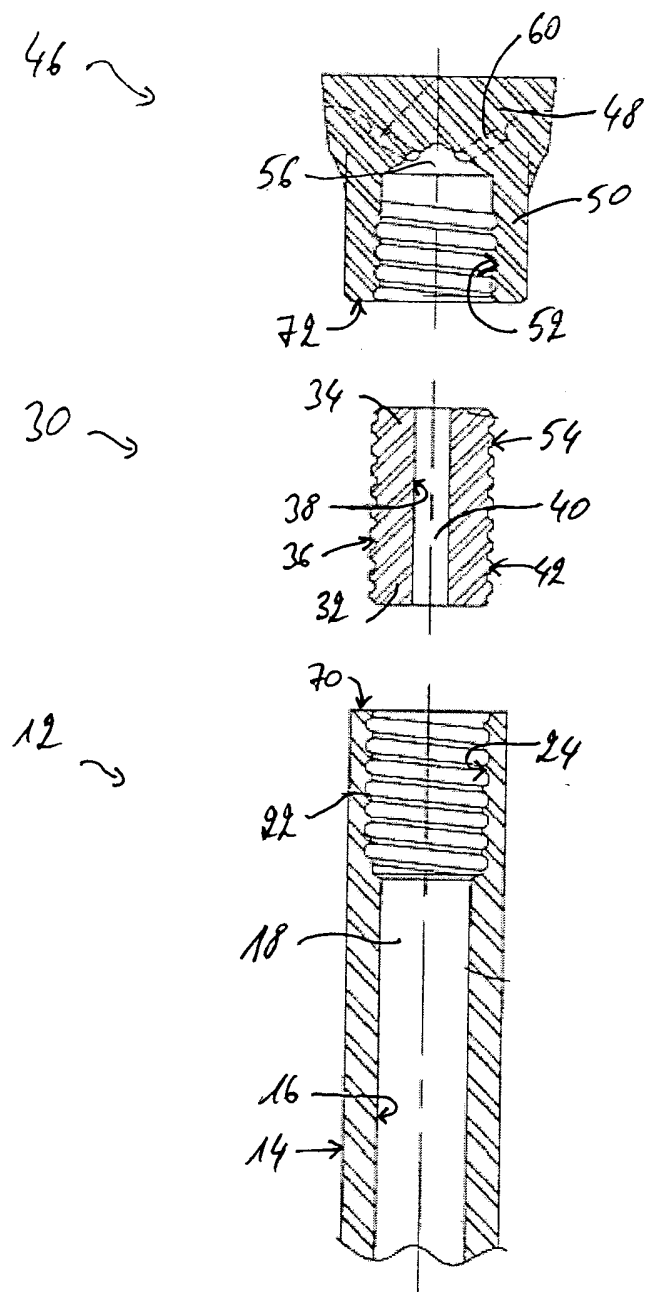


Fig.2

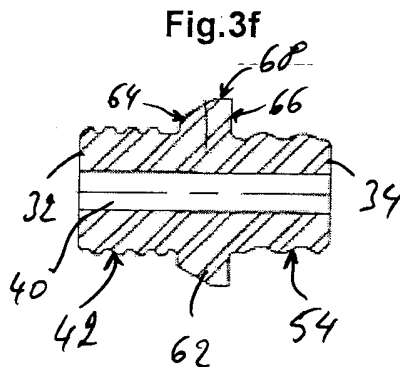
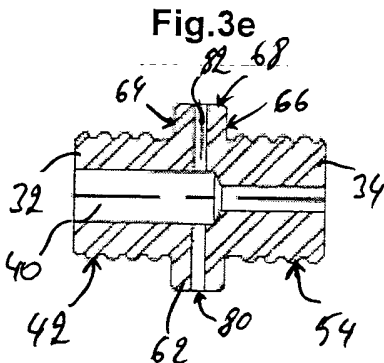
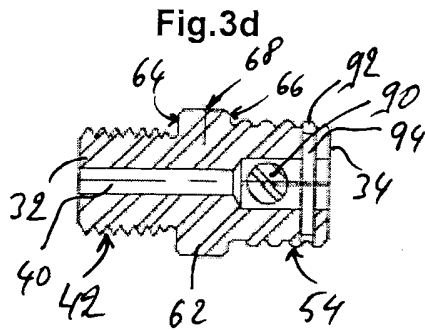
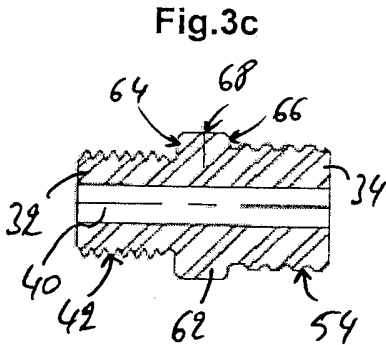
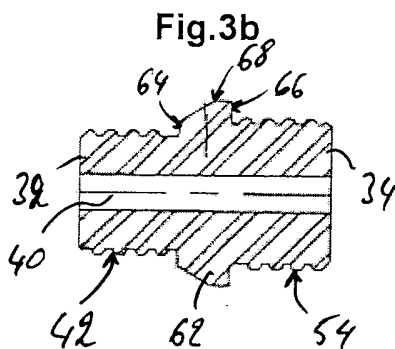
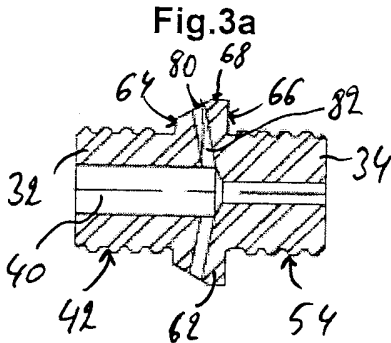
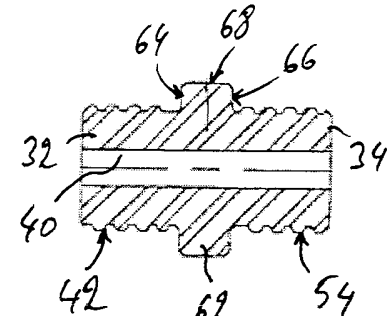
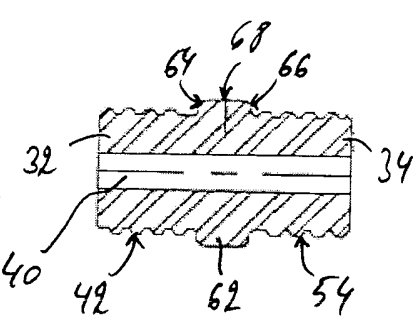


Fig.3g

Fig.3h

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2006/061904

A. CLASSIFICATION OF SUBJECT MATTER

INV. F27D3/15 C21B7/12 E21B17/042 F16L15/00

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)

F27D C21B E21B F16L

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)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 12, 25 December 1997 (1997-12-25) -& JP 09 217580 A (TOHO KINZOKU KK), 19 August 1997 (1997-08-19) abstract; figures 1,8,9	1-4
X	-----	5-10

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Date of the actual completion of the international search

14 August 2006

Date of mailing of the international search report

29/08/2006

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Peis, S

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2006/061904

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 09217580	A	19-08-1997	NONE