(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 September 2008 (25.09.2008)

PCT

(10) International Publication Number
WO 2008/113843 A1

(51) International Patent Classification:
*E21B 7/18* (2006.01)

(21) International Application Number:
PCT/EP2008/053340

(22) International Filing Date: 20 March 2008 (20.03.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
07104670.0 22 March 2007 (22.03.2007) EP

(71) Applicant *(for all designated States except CA, US)*: **SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V.** [NL/NL]; Carel van Bylandtlaan 30, NL-2596 HR The Hague (NL).

(71) Applicant *(for CA only)*: **SHELL CANADA LIMITED** [CA/CA]; 400 - 4th Avenue S.W., Calgary, Alberta T2P 2H5 (CA).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **BLANGÉ, Jan-Jette** [NL/NL]; Kesslerpark 1, NL-2288 GS Rijswijk (NL).

(74) Agent: **SHELL INTERNATIONAL B.V.**; Intellectual Property Services, PO Box 384, NL-2501 CJ The Hague (NL).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, 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, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Declaration under Rule 4.17:**

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

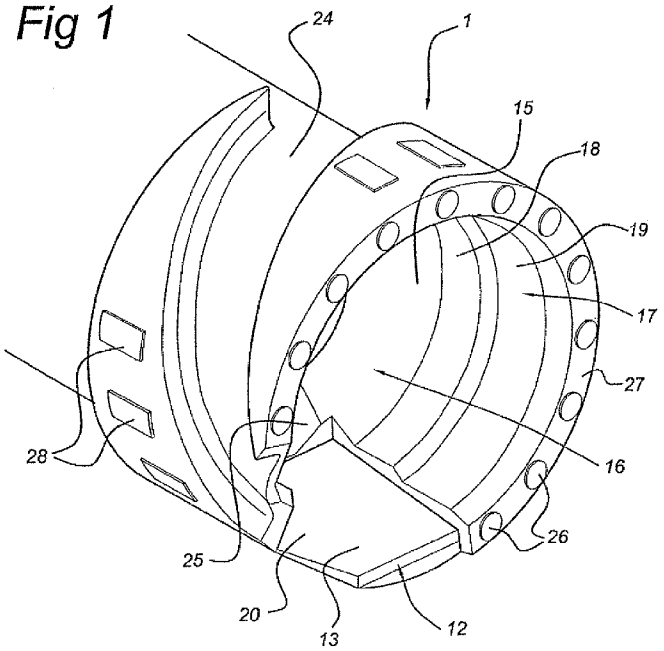
**Published:**

— *with international search report*

*[Continued on next page]*

(54) **Title:** DISTANCE HOLDER WITH JET DEFLECTOR

Fig 1




(57) **Abstract:** A distance holder (1) for connection to, and rotation with, a drill string (2) in an earth formation drilling device arranged to supply a jet of abrasive fluid for the purpose of providing a borehole (2) by removing earth formation material through abrasion, comprises a chamber (16) which is essentially rotational symmetric and which is to face the earth formation material, and a jet nozzle (S) arranged for discharging a jet of the abrasive fluid in said chamber. The chamber comprises a deflector (12) positioned in the path of the fluid jet discharged from the jet nozzle.

WO 2008/113843 A1

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

# DISTANCE HOLDER WITH JET DEFLECTOR

The invention is related to a distance holder for connection to, and rotation, with a drill string in an earth formation drilling device arranged to supply a jet of abrasive fluid for the purpose of providing a borehole by removing earth formation material through abrasion, said distance holder comprising a chamber which is essentially rotational symmetric and which is to face the earth formation material, and a jet nozzle arranged for discharging a jet of the abrasive fluid in said chamber.

Such a distance holder is disclosed in WO-A-2005/040546. Said prior art distance holder provides an abrasive fluid jet which is directed towards a slot in the circumference of the chamber. The jet, which is directed through the slot, exerts an abrasive action on the earth formation within the chamber whereby a cone shaped bottom is obtained. Subsequently, the jet direction is reversed by the lowest part of the bottom into an upward direction. The cuttings or abraded particles as well as the abrasive particles are transported to the surface by the fluid; at some height above the bottom the abrasive particles are extracted from the fluid and fed back into the jet nozzle. By means of the fluid which is jetted through the nozzle, said abrasive particles enter a new cycle of abrasive action, and so on.

In practice it appears that the wall of the hole thus obtained lacks a certain smoothness. A good borehole quality is however important for obtaining earth formation data by means of sensors. Pad-type down-hole evaluation sensors are applied onto the wall of the

borehole, and the contact between such sensors and said wall is gravely impaired by a less than smooth borehole wall quality. Moreover, parasitic pressure losses may occur, and furthermore borehole cleaning by the fluid flow through the annulus towards the surface may be impaired. Also, energy is lost when forming grooves in the rough borehole wall.

The object of the invention is therefore to provide a distance holder of the type described before which allows the drilling of a smoother borehole. Said object is achieved by providing the chamber with a deflector positioned in the path of the fluid jet discharged from the jet nozzle.

The distance holder according to the invention, first of all allows the borehole bottom to be abraded by the fluid jet which is issued from the jet nozzle. Subsequently, as said abrasive fluid jet collides with the deflector, the direction of the jet is changed to an orientation which comes closer to the vertical direction. The jet thus obtains an almost vertically downwardly orientated direction, which is decisive for obtaining a smooth borehole wall instead of a grooved one.

The prior art distance holder comprises a jet nozzle which is oriented obliquely with respect to the axis of rotation for making the jet of abrasive fluid intersect the borehole axis. Thus, a borehole bottom is formed which has the cone shape. According to the invention however, a borehole bottom is formed which has a first cone with a certain top angle, and underneath a second, truncated cone with a smaller top angle than the top angle of the first cone. These top angles can be influenced by the orientation of the jet nozzle and by the orientation of the deflector. In this connection,

preferably the deflector is oriented for deflecting the jet of abrasive fluid in a direction enclosing an angle with the axis of rotation which is smaller than the angle enclosed by the jet nozzle and said axis of rotation.

More preferably, the angle enclosed by the jet nozzle and the axis of rotation is approximately twice the angle enclosed by the deflector and the axis of rotation, when seen in a section according to a radial plane which includes the center line of the jet nozzle.

After abrading the earth formation, the abrasive fluid jet reaches the lowest parts of the borehole bottom at the foot of the lowermost cone and will have subsequently to flow back in upward direction through the annulus. As a result of the limited play between the outer surface of the distance holder and the borehole wall, the fluid could continue upwardly along the outside of the distance holder. However it is preferred to make the fluid flow in circumferential direction, and to this end the deflector and the radial plane which includes the center line of the jet nozzle may enclose an angle which differs from 90 degrees.

The circumferential flow component may in particular be applied in an embodiment of the distance holder wherein the outermost end of the chamber comprises an essentially cylindrical skirt which extends over at least a part of the circumference of the chamber, said skirt being provided with at least one slot, said deflector adjoining said slot.

The deflector directs the fluid flow in circumferential direction through said slot towards the outside of the distance holder, after which the fluid flow will be oriented upwardly. In this connection, the deflector may extend slantingly between an end adjoining

the skirt and an end adjoining the slot. Said skirt has an outer surface and an inner surface; preferably the distance of the deflector, near or at the end adjoining the skirt, to the axis of rotation is approximately the same as the radius of the skirt inner surface. At the end adjoining the slot, the distance of the deflector to the axis of rotation is approximately the same as the radius of the skirt outer surface.

The deflector itself can be carried out in several ways; preferably said deflector comprises at least one plate, e.g. of tungsten carbide. However, the deflector may also comprise assembled plates.

Good results are obtained in case the size of the deflector, when seen in circumferential direction, is approximately the same as the width of the abrasive fluid jet at the position of the deflector and issued by the jet nozzle. Preferably, the deflector comprises an inwardly facing planar deflector surface.

Reference is made to the jet cutting device with deflector as disclosed in WO-A-02/092956. Said prior art deflector does not form part of the chamber included in a distance holder. Thus, the effects obtained by said prior art deflector are not the same and cannot provide the required smoothness of the borehole wall.

The invention will now be described further with reference to an embodiment of the distance holder as shown in the drawings.

Figure 1 shows a first view in perspective of the distance holder according to the invention.

Figure 2 shows a second view in perspective of the distance holder.

Figure 3 shows a vertical cross-section through the distance holder during service in a borehole.

Figure 4 shows a bottom view of the distance holder.

The distance holder 1 as shown in the drawings 1-4 forms part of an earth formation drilling device and is connected to the drill string 2 as shown in figure 3. Said drill string 2 contains a feed channel 3 by means of which the pressurized fluid is fed to the bottom of the borehole 4 in the earth formation 5. The distance holder 1 comprises a jet nozzle 6 which on the one hand is connected to the feed channel 3 in the drill string 2 and on the other hand to the abrasive particles supply 7. This abrasive particles supply 7 is supplied with abrasive particles 8 which originate from the collecting surface 9, onto which said abrasive particles 8 are attracted by means of a magnet (not shown) beneath said surface 9.

As shown in figure 1-4, the distance holder 1 comprises a chamber 16, which has a trumpet shaped upper part 15 as well as a generally cylindrical skirt 17. The jet nozzle 12 discharges in a recess 25 provided in said trumpet shaped surface 15. In the embodiment shown, said cylindrical skirt 17 has concentric parts 18, 19 of different diameters; other embodiments are possible as well. As shown in figure 3, the center line of the jet nozzle 6 and the axis of rotation 10 enclose an angle Alpha. Moreover, the jet nozzle 6 is positioned in such a way that the jet of abrasive fluid intersects the axis of rotation 10. Thereby, a first cone 11 is formed under the influence of the abrasive action of the particles 8.

After forming the first cone 11, the jet of drilling fluid collides with the deflector 12, in particular the flat inner surface 13 thereof. Said deflector 12, or the flat inner surface 13 thereof, and the vertical enclose an angle Beta which is smaller than the angle Alpha

enclosed by the jet nozzle axis and the axis of rotation 10. In particular, said angle Beta can be half the angle Alpha. After colliding with the deflector 12, the abrasive fluid continues its path downwardly into the borehole, but at a steeper angle. Thereby, a truncated cone 14 is formed, which has a smaller top angle than the first cone 11. This path of the abrasive fluid jet provides a smooth character to the wall 4 of the borehole.

The skirt 17 has a slot 20 through which the fluid flows out of the chamber 16. Said slot is bordered by the deflector 12. As shown in the figures, and in particular in figure 4, at the end of the deflector 12 bordering said slot 20, the inner surface 13 of the deflector 12 has a certain radial distance D1 to the axis of rotation 10. At the opposite end of the deflector 12, as seen in circumferential direction, the inner surface 13 has a distance D2 to the axis of rotation which is smaller than the distance D1. The distance D1 is about equal to the diameter of the outer surface 22 of the skirt 17; the distance D2 is about equal to the diameter of the inner surface 23 of the skirt 17. Thus, the inner surface 13 of the deflector runs slantingly between said inner surface 22 and said outer surface 23 of the skirt.

This orientation of the deflector 12 promotes the fluid flow as indicated by the arrow 21 in figure 4. After colliding with the deflector surface 13, the fluid does not only obtain a more steeply downwardly oriented direction, but also a component in circumferential direction. As the deflector surface 13 reaches a diameter D1 which is about equal to the diameter of the outer surface 22 of the skirt 17, the abrasive fluid is able to

generate a hole with a sufficiently large diameter for accommodating the distance holder 12.

After said deflection of the abrasive fluid in circumferential and in upward direction, it is guide further through the helically extending part 24 of the slot 20.

The bottom surface 27 of the skirt 17 is provided with inserts 26 of an abrasion resistant material so as to promote the drilling of the borehole further and so as to protect said bottom surface against excessive wear during the rotation of the distance holder 1 together with the drill string 2. Similarly, the outer surface 22 of the skirt is provided with abrasion resistant material deposits 28. Examples of these materials include tungsten carbide, polycristalline diamond (PDC) and thermally stabilised polycristalline diamond (TSP). Preferably, the deposits 28 comprise tungsten carbide, and the inserts comprise TSP.

C L A I M S

1. Distance holder (1) for connection to, and rotation with, a drill string (2) in an earth formation drilling device arranged to supply a jet of abrasive fluid for the purpose of providing a borehole (4) by removing earth formation material through abrasion, said distance holder (1) comprising a chamber (16) which is essentially rotational symmetric and which is to face the earth formation material, and a jet nozzle (6) arranged for discharging a jet of the abrasive fluid in said chamber (16), characterized in that the chamber (16) comprises a deflector (12) positioned in the path of the fluid jet discharged from the jet nozzle (6).

2. Distance holder (1) according to claim 1, wherein the jet nozzle (6) is oriented obliquely with respect to the axis of rotation for making the jet of abrasive fluid intersect the borehole axis (10).

3. Distance holder (1) according to claim 2, wherein the deflector (12) is oriented for deflecting the jet of abrasive fluid in a direction having an angle Beta with respect to the axis of rotation (10) which is smaller than the angle Alpha enclosed by the jet nozzle (6) and said axis of rotation (10).

4. Distance holder (1) according to claim 2 or 3, wherein the angle Alpha enclosed by the jet nozzle (6) and the axis of rotation (10) is approximately twice the angle Beta enclosed by the deflector (12) and the axis of rotation (10), when seen in a section according to a radial plane which includes the center line of the jet nozzle.

5. Distance holder (1) according to claim 2, 3 or 4, wherein the deflector (12) and the radial plane which includes the center line of the jet nozzle enclose an angle which differs from 90 degrees.

6. Distance holder(1) according to claim 5, wherein the outermost end of the chamber (16) comprises a skirt (17) which extends over at least a part of the circumference of the chamber (16), said skirt (17) being provided with at least one slot (20), said deflector (12) adjoining said slot (20).

7. Distance holder (1) according to claim 6, wherein the deflector (12) extends slantingly between an end adjoining the skirt (17) and an end adjoining the slot (20).

8. Distance holder (1) according to claim 6 or 7, wherein the skirt (17) has an outer surface (22) and an inner surface (23), and the deflector (12) near or at the end adjoining the skirt (17) has a radius which is approximately the same as the radius of the skirt inner surface (23) and at the end adjoining the slot (20) has a radius which is approximately the same as the radius of the skirt outer surface (22).

9. Distance holder (1) according to any of the preceding claims, wherein the deflector (12) comprises at least one plate.

10. Distance holder (1) according to any of the preceding claims, wherein the deflector (12) comprises a tungsten carbide.

11. Distance holder (1) according to any of the preceding claims, wherein the size of the deflector (12), when seen in circumferential direction, is approximately the same as the width of the abrasive fluid jet at the

position of the deflector (12) and issued by the jet nozzle (6).

12. Distance holder (1) according to any of the preceding claims, wherein the chamber (16) has a trumpet shaped inner surface (15).

13. Distance holder (1) according to claim 12, wherein the trumpet shaped surface (15) comprises a radially extending recess (25), the jet nozzle (6) discharging in said recess (25).

14. Distance holder (10 according to any of the preceding claims, wherein the deflector (12) comprises an inwardly facing planar deflector surface (13).

Fig 1

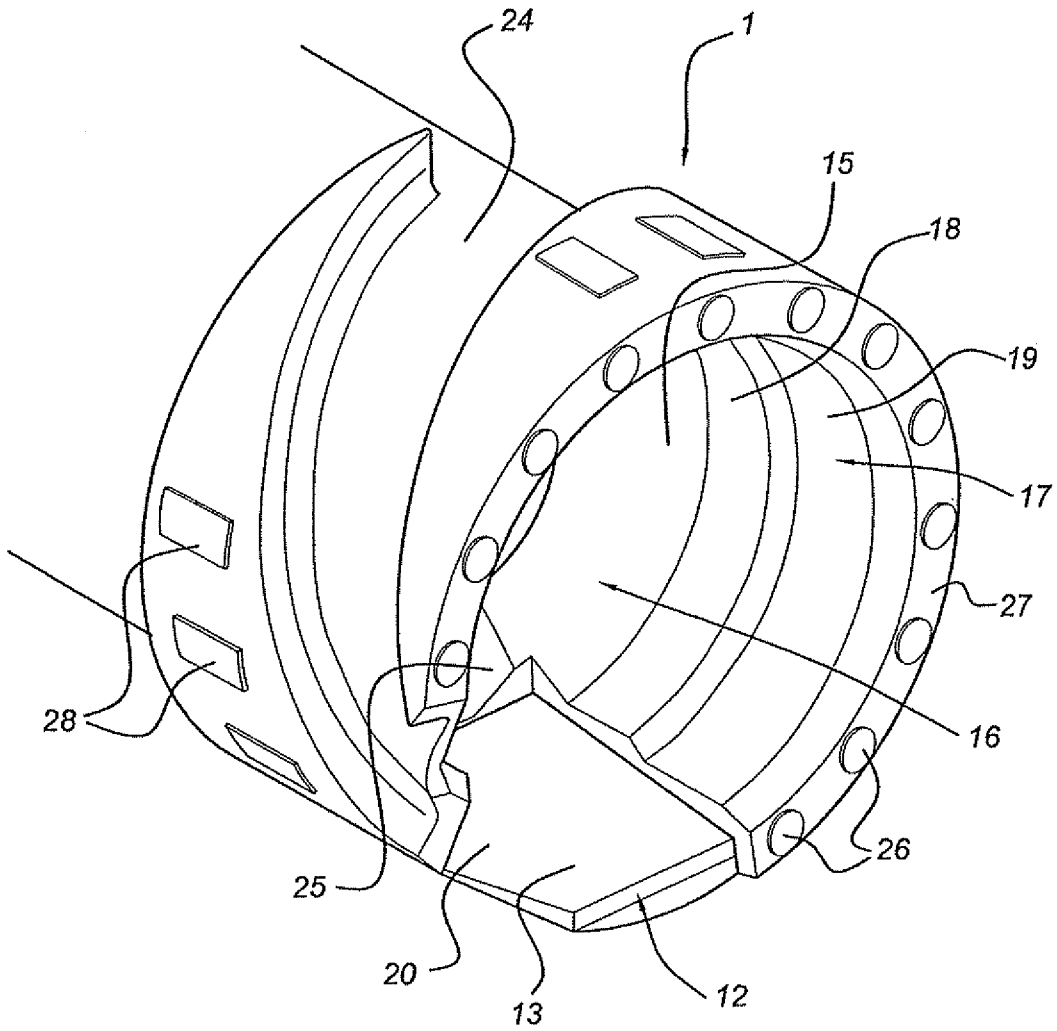


Fig 2

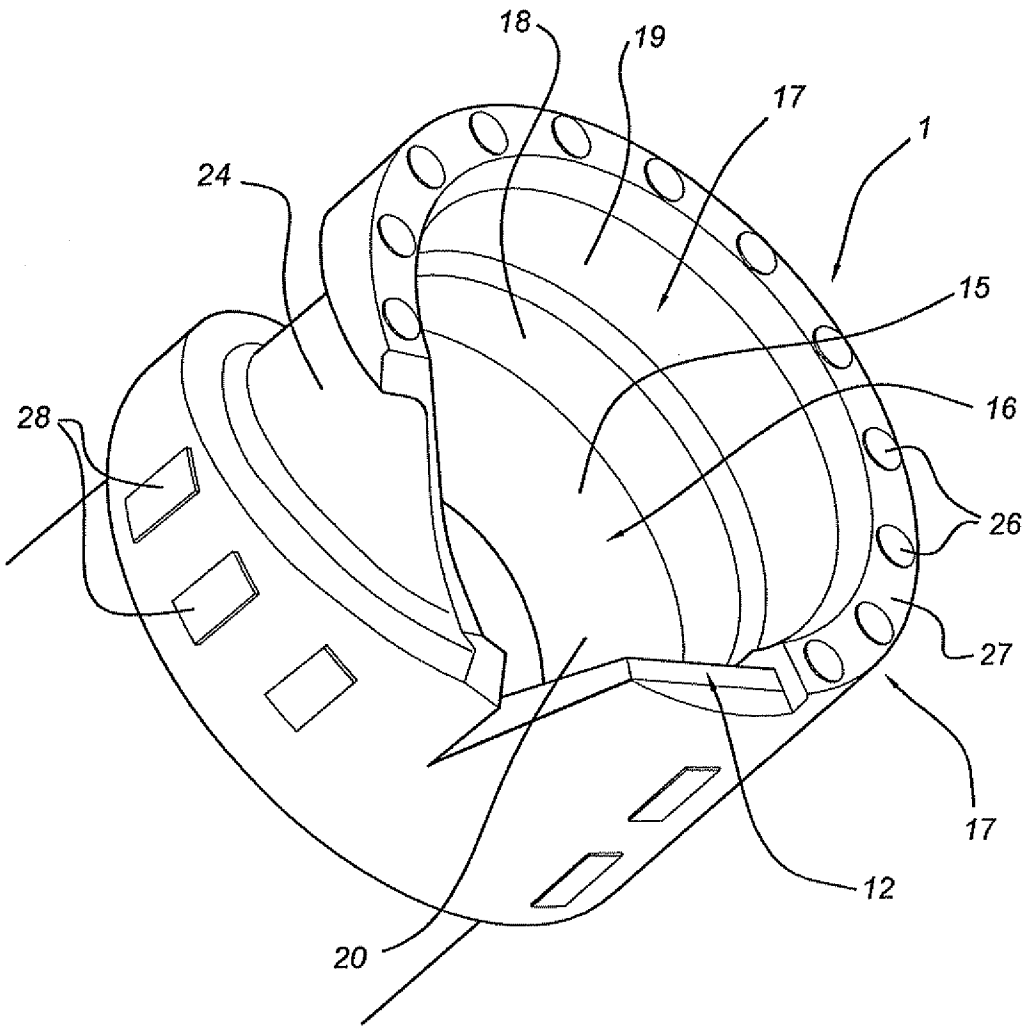


Fig 3

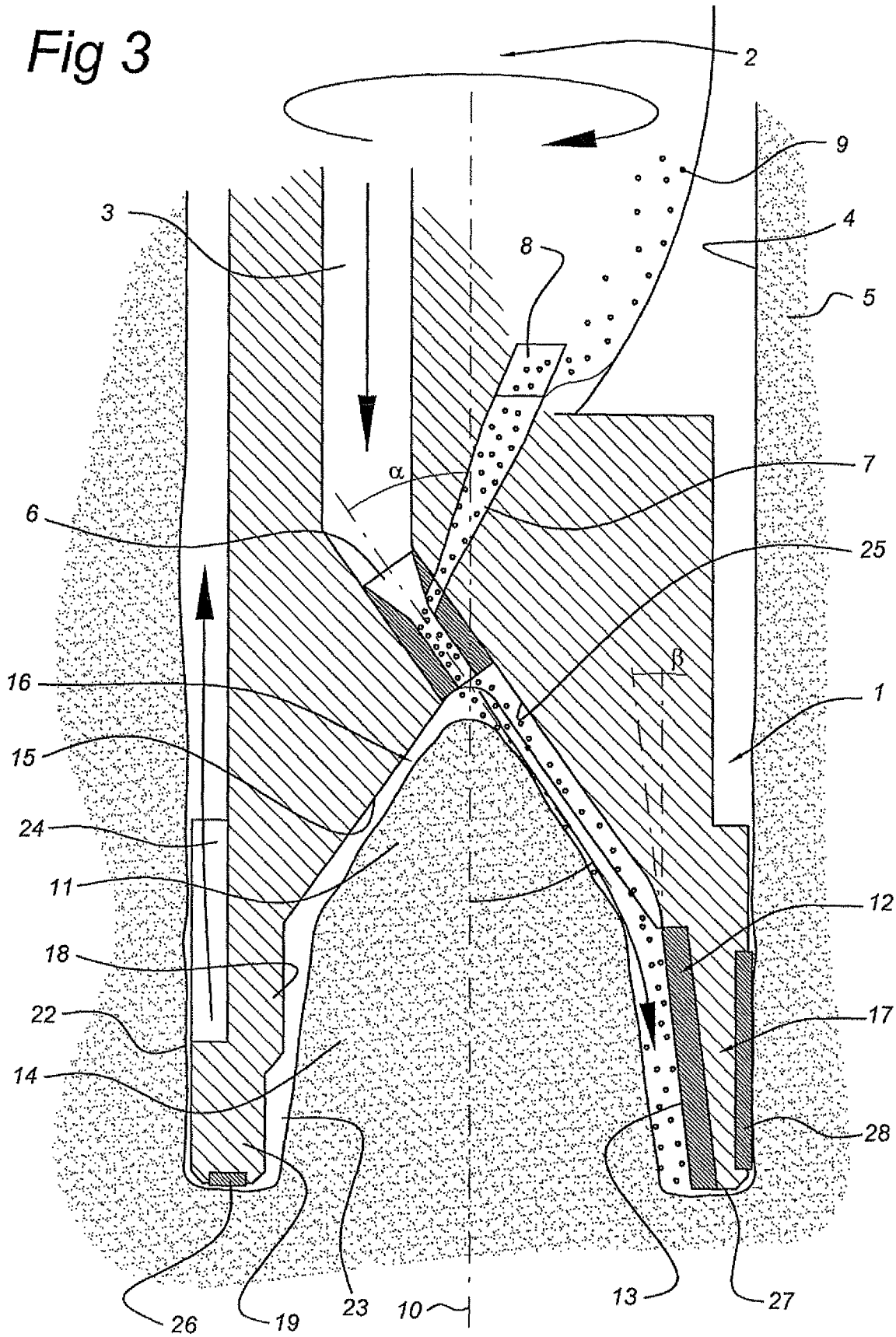
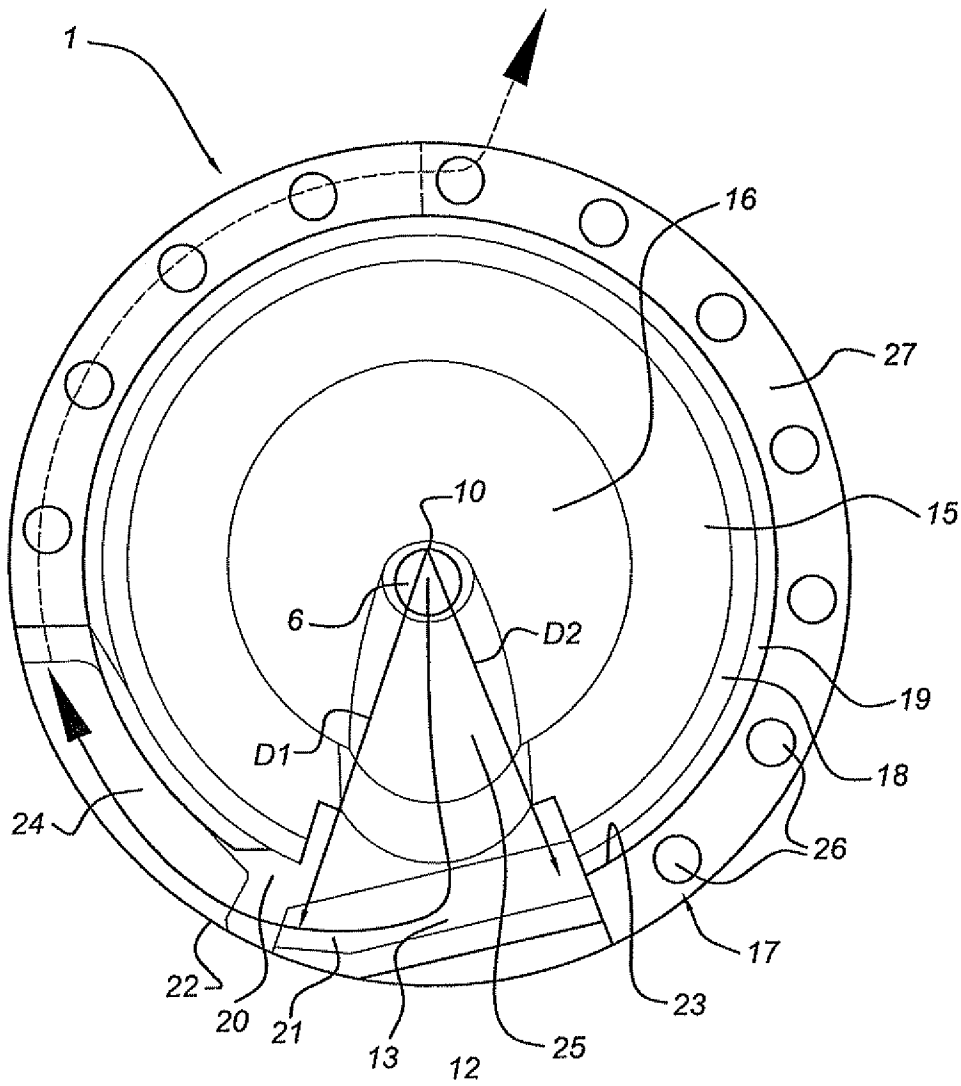


Fig 4



# INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/053340

A. CLASSIFICATION OF SUBJECT MATTER
INV. E21B7/18

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)
E21B

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)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | WO 2005/040546 A (SHELL INT RESEARCH [NL]; SHELL CANADA LTD [CA]; BLANGE JAN-JETTE [NL]) 6 May 2005 (2005-05-06) cited in the application abstract; figures 1,2 | 1 |
| A | WO 02/092956 A (SHELL INT RESEARCH [NL]; SHELL CANADA LTD [CA]; BLANGE JAN JETTE [NL]) 21 November 2002 (2002-11-21) cited in the application abstract; figure 1 | 1 |

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

[X] See patent family annex.

* Special categories of cited documents :

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

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 29 July 2008 | 05/08/2008 |

| Name and mailing address of the ISA/ | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL – 2280 HV Rijswijk<br>Tel. (+31–70) 340–2040, Tx. 31 651 epo nl,<br>Fax: (+31–70) 340–3016 | Dantinne, Patrick |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2008/053340

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| WO 2005040546 A | 06-05-2005 | CA 2544093 A1 | 06-05-2005 |
| | | DE 602004009212 T2 | 24-01-2008 |
| | | EP 1687505 A1 | 09-08-2006 |
| WO 02092956 A | 21-11-2002 | AT 327405 T | 15-06-2006 |
| | | BR 0207892 A | 23-03-2004 |
| | | CA 2439912 A1 | 21-11-2002 |
| | | CN 1608165 A | 20-04-2005 |
| | | EA 4567 B1 | 24-06-2004 |
| | | EG 23135 A | 28-04-2004 |
| | | MX PA03007979 A | 04-12-2003 |
| | | US 2004094332 A1 | 20-05-2004 |