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(54) Title: OIL WELL DRILL BIT

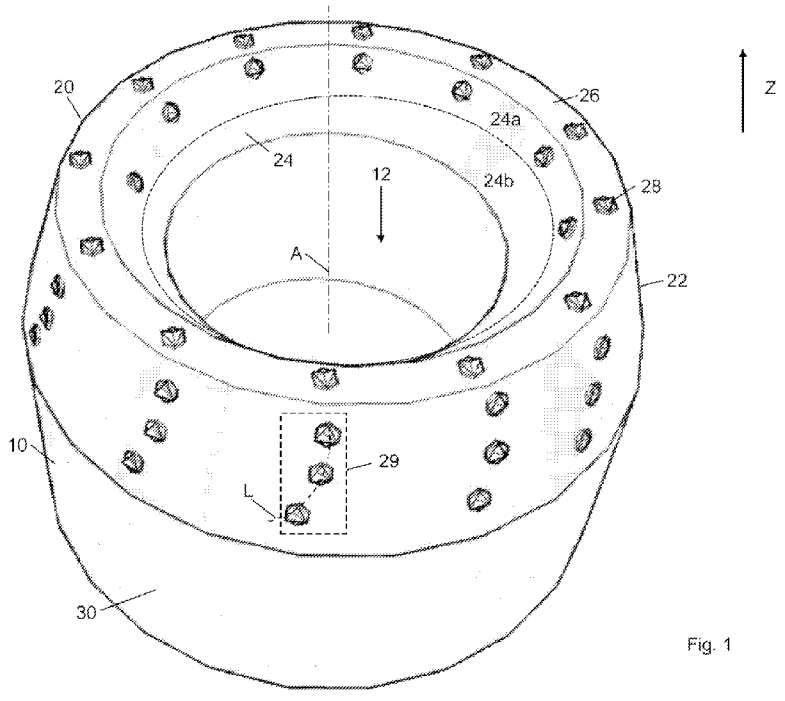

Fig. 1

(57) Abstract: The present invention relates to an oil well drill bit 1, comprising a cylindrical body 10 with a front section 20 facing a drilling direction Z and a rear section 30 for connection of the drill bit 1 with a drill string 40, a circular hole 12 at the center of the cylindrical body 10 extending from the front section 20 to the rear section 30, wherein the rear section 30 comprises threads 32 for the connection with the drill string 40, and the front section 20 comprises a tapered circular ring shape. Furthermore, the present invention relates to a method of oil and/or gas drilling between two casings and the use of a drill bit 1.

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OIL WELL DRILL BIT

1. Field of the invention

The present invention relates to a drill bit for oil and gas exploration. Such a drill bit is screwed to the lower end of a drill string for performing the actual drilling work in the rock.

2. Prior art

Common drill bits for oil and gas exploration work by scraping or crushing rock, or both, usually as part of a rotational motion. Some bits, known as hammer bits, pound the rock vertically in much the same fashion as a construction site air hammer. Drill bits need to be replaced from time to time as they wear. A common version of an oil well drill bit is a roller-cone drill bit. A roller-cone bit has conical cutters or cones that have spiked teeth around them. As the drill string is rotated, the bit cones roll along the bottom of the hole in a circle. As they roll, new teeth come in contact with the bottom of the hole, crushing the rock immediately below and around the bit tooth.

Although common oil and gas exploration drill bits work well in solid rock, they are not applicable in other situations. In the following it is referred to oil well drilling but this also designates gas well drilling.

The document US 2010/0089660 A1 shows a drill bit with axially tapered waterways that is used to drill geological and/or manmade formations. The document US 8,684,111 B2 shows a core drill bit used particularly to provide core samples for geological assessment of mineral content or for testing structural integrity in construction industry.

Applicants found out that the need arises for oil well drilling between two casing strings. Further problems arise, when a casing is in an eccentric position to the other casing. Then damage to an inner casing during a drilling procedure is likely if norm drill bits are used. The unpredictability of the casing locations, or their eccentric position, mean that a ‘hit-and-miss’ approach is usually used when attempting to drill.

3. Summary of the invention

The above-mentioned problem of oil well drilling between two casing strings can be solved by an oil well drill bit according to claim 1 and by a method for oil and/or gas drilling between two casings according to claim 13 and by the use of a drill bit according to claim 14.

Particularly the above-mentioned problem is solved by an oil well drill bit, comprising a cylindrical body with a front section facing a drilling direction and a rear section for connection of the drill bit with a drill string, a circular hole at the center of the cylindrical body extending from the front section to the rear section, wherein the rear section comprises threads for the connection with the drill string, and the front section comprises a tapered circular ring shape.

The shape of this drill bit enables a better, easier and more efficient access to most of the annuals shapes used in oil well drilling. In particular, the drill bit is suited for drilling between two casings and thereby prevents damage to an optionally eccentrical located inner (second) casing, because the tapered shaped at the front section of the drill bit provides for an automatic centering of the drill bit within the outer casing and around the inner casing. This prevents a contact of rock cutters of the drill bit with the preferably metal casing, which would lead to a damaging of the cutters.

Preferably, the tapered circular ring shape comprises an outer circumferential wall slanted towards a rotation axis of the cylindrical body and an inner circumferential wall slanted towards the outside. Thereby, the slanted outer wall is useful in cutting operations to facilitate a sideway drilling in order to follow the downward course of an optionally eccentric second inner casing. Furthermore, the inner surface of the drill bit 'collects' and guides the optionally eccentric second casing towards the center of the drill bit where it enters the inner circular hole of the drill bit. Thus, the orientation of the drill bit is automatically adjusted to the downward course of the second inner casing.

Preferably, an inclination angle of the slanted outer wall is smaller than an inclination angle of the slanted inner wall with respect to the rotation axis. Thereby, the drill bit provides a greater tolerance at its inner wall such that a better centering of the drill bit with the second casing is provided, even if this would be eccentric to the first casing. The smaller inclination angle at the outer wall provides for or leads to a broad planar ring-shaped face at the front of the drill bit. A broad planar face at the front of the drill

bit allows for larger cutting means arranged on this face which in turn facilitate drilling operations.

Preferably, a length of the slanted outer wall is greater than a length of the slanted inner wall in a rotational axis direction. Thus, a larger number of cutting means can be arranged on the outer wall which facilitates the drilling operations.

Preferably, a length of the circular hole is larger than a length of the slanted inner wall in the rotational axis direction. A larger inner wall allows for a greater length of the inner hole of the drill bit that in turn leads to a better and more secure guidance of the drill bit around the second casing.

Preferably, a ratio between an outer diameter of the drill bit and a diameter of the circular hole is larger than 1.1, preferably larger than 1.3. Thus, the drill bit comprises a robust cutting area in order to drill into solid rock sediment and formation, respectively. Furthermore, a ring-shaped drill bit with a significant ring width allows for differently shaped surfaces of the drill bit for facilitating drilling operations.

Preferably, the front section comprises a planar ring-shaped face at the foremost front of the drill bit. The planar front face enables the arrangement of cutting means for the drill operation. Thereby, the number and/or type and shape, respectively, of the cutting means can be adapted to actual needs with regard to the drilling operation and the type of formation, respectively. Furthermore, the planar face allows for a straight vertical drilling.

Preferably, each of the slanted outer and inner wall and the planar ring-shaped face comprise cutting means. The cutting means provide for a cutting into formation, wherein the drill bit comprises a higher endurance due to the plurality of cutters and the big open area in-between.

Preferably, the cutting means include a number of punctual cutters protruding from said walls and face, respectively. Protruding cutters can be added and/or replaced in case of wear to the drill bit easily. The punctual cutters may comprise diamonds for a high cutting power.

Preferably, the cutters on the slanted outer wall are arranged in groups and each group is formed along a convex line arranged in rotational axis direction. The arrangement of the cutters in rotational direction facilitates the drilling operation as it guides cut rock

particles to one side of the drill bit. Further, such arrangement of cutters provides for a good centering of the drill bit within the already generated drill hole.

Preferably, the slanted inner wall includes an outer and an inner circumferential section, the outer section in direction to the front section and the inner section in direction to the rear section of the drill bit, wherein the punctual cutters are only arranged circumferentially spaced apart on the outer section. The arrangement of cutters on the inner wall enables a cutting also in this area and, thus, facilitates drilling operations. The cutters are, however, not arranged at the inner section of the inner wall in order to avoid any contact between the drill bit and the second inner casing which would lead to damages at the second casing and the cutters.

Preferably, the threads at the rear end of the drill bit are male or female threads. In providing threads the drill bit can be easily connected to a drill string that guides and rotates the drill bit. Thereby, the threads can be adapted to the actual used drill strings to which they are connected and can advantageously comprise box (female) or pin (male) threads.

The above-mentioned problem is also solved by a method of oil and/or gas drilling between two casings, with a first casing and a second casing, wherein an inner diameter of the first casing is larger than an outer diameter of the second casing such that the second casing extends down beyond the first casing and a spacing is formed between the inner wall of the first casing and the outer wall of the second casing, the method comprising the step of:

drilling into said spacing with an oil well drill bit as described above.

The above-mentioned problem is also solved by the use of a drill bit as described above for drilling between two consecutive casings in a vertical oil and/or gas well. Thereby, the use of the drill bit with this particular shape allows for an efficient and easy drilling operation between two casings.

4. Short description of the drawings

In the following a preferred embodiment of the invention is described with respect to the figures in which shows:

Fig. 1 a schematic illustration of an embodiment of the drill bit;

Fig. 2 a cross-sectional view of the drill bit of Fig. 1; and

Fig. 3 a schematic illustration of an embodiment of a drilling site using the drill bit of Figs. 1 and 2.

5. Detailed description of preferred embodiments

In the following, preferred embodiments of the invention are described in detail with respect to the figures.

Figs. 1 and 2 show an embodiment of a drill bit 1. The drill bit 1 comprises a cylindrical shape 10 with an outer diameter D1 that fits into a first casing 50 of an oil well. Furthermore, the drill bit 1 comprises an inner circular hole 12 with a diameter D4 to receive a second casing 60 in the circular hole 12. Thereby, a ratio between the outer diameter D1 and the inner diameter D4 is given by D1/D4 and is larger than 1.1, preferably larger than 1.3. As a result, the drill bit 1 comprises a ring shape with a significant ring width that is suitable for the aspired drilling between two casings and comprises a robust structure for drilling into solid rock formations, like e.g. granite and the like.

In order to drill into a rock formation the surfaces at the front section 20 of the drill bit 1 comprise a plurality of punctual cutters 28. In one embodiment the drill bit 1 comprises a high endurance due to its 12 bladed preferably 13 mm cutters 28 and the big open area between the cutters 28. The cutters 28 protrude from the surfaces 22, 24, 26 of the drill bit 1 and are easy to replace in case of wearing. The cutters 28 are made from a durable material like hard metal and may contain diamonds in order to be able to cut into solid rock formation. Thereby, the cutters 28 comprise an edged surface to facilitate working on the formation. In one embodiment the number of cutters 28 on the planar face 26 at the front section 20 is 12, with the same number of cutters 28 on the outer section 24a of the slanted inner wall 24. The inner section 24b of the slanted inner wall 24 is free of cutters 28 in order to avoid any contact between a cutter 28 and an optionally eccentric second casing 60. Furthermore, on the slanted outer wall 22 there are 12 groups 29 of cutters 28 each group 29 comprising three cutters 28. The three cutters 28 in each group 29 are aligned along a convex line L in rotation direction of the drill bit 1 in order to achieve a staggered working on the formation and facilitate the drilling operation.

The slanted outer wall 22 comprises a smaller inclination angle α and greater length L1 than the slanted inner wall 24. Thereby, the slanted outer wall 22 provides for a larger drilling area with a larger number of cutters 28 than the slanted inner wall 24. The slanted inner wall 24, on the other hand, provides for a larger tolerance between a cutter 28 and the second casing 60 due to the more inclined surface angle β. Preferably the inclination angle α is about 10° to 20°, preferably about 12° to 18° and preferably about 15°. The surface angle β is about 30° to 50°, preferably about 35° to 45° and preferably about 40°. Furthermore, because the length L2 of the slanted inner wall 24 is shorter than the length L1, the length L3 of the adjacent circular hole 12 is longer at a given overall length of the drill bit 1. As a result, a longer circular hole 12 facilitates the adjustment of the orientation of the drill bit 1 with respect to the orientation of the optionally eccentric second casing 60.

In order to connect the drill bit 1 to a drill string 40, the drill bit 1 comprises threads 32, 32' at its rear section 30. These threads 32, 32' can be formed as outer threads 32 (pin connection) on the outer circumference of the drill bit 1 or can be formed as inner threads 32' (box connection) along the inner circumference inside the circular hole 12. Optionally a drill bit 1 may comprise both types of threads 32, 32' at the same time in order to be connectable to different types of drill strings 40.

In operation, the drill bit 1 is connected to a drill string 40, see Fig. 3. The drill string 40 will guide and rotate the drill bit 1. The rear section 30 of the lowered drill bit 1 will face upwards to the earth's surface S and allows for a connection to the drill string 40. The connection between the drill bit 1 and the drill string 40 is a threaded connection by means of male and female threads 32, respectively, so called pin or box connections, at the rear section 30 of the drill bit 1.

The front end 20 of the drill bit 1 faces downward in vertical direction Z. During the drilling operation the front section 20 is in direct contact with the sediment and formation below, respectively. In the initial position before the drilling starts the drill bit 1 fits at the lower end of the first casing 50 with its ring shape between the inner wall of the first casing 50 and the outer wall of the second casing 60 into a ring-shaped spacing DS. When the drill bit 1 is set into rotation by the drill string 40 the drill bit 1 cuts into the formation between both casings 50, 60, i.e. into the spacing DS.

In case of an eccentric second casing 60 any common drill bit without a tapered shape at its front end would cut into this eccentric casing while following a straight vertical downward Z course. The tapered shape of the drill bit 1, however, allows for a spacing

between the cutters 28 and the second casing 60 even if the second casing 60 is eccentric to the vertical direction Z. Due to the reception of the second casing 60 inside the inner hole 12 of the drill bit 1, the drill bit 1 will - in a further downward movement - automatically adjust its orientation in order to properly receive the second casing 60. Thereby, the drilling course of the drill bit 1 is instantly adjusted such that any unwanted contact between the cutters 28 of the drill bit 1 and the second casing 60 is avoided.

In a first exemplary embodiment the drill bit 1 is designed to drill behind a 13 3/8" (340 mm) second casing 60 such that the drill bit's 1 inner diameter D4 is about 18" (457 mm) and its outer diameter D1 is about" (609 mm). Furthermore, an outer diameter D2 of the planar face 26 is about 23" (584 mm) and an inner diameter D3 is about 21" (533 mm). A distance between each convex line L of a group 29 of cutters 28 is about 1.9" (48 mm). Moreover, a distance between each cutter 28 on the planar face 26 is about 1.833" (47 mm). The length L1 in this first embodiment is about 141 mm, the length L2 is about 70 mm and the length L3 is about 211 mm.

In a second embodiment the drill bit 1 is designed to drill behind a 30" (76.2 cm) second casing 60 such that the drill bit's 1 inner diameter D4 is 32" (81.28 cm) and its outer diameter D1 is 36" (91.44 cm). The length L1 in this first embodiment is about 211 mm, the length L2 is about 106 mm and the length L3 is about 317 mm.

List of reference signs

1	drill bit
10	cylindrical body
12	circular hole
20	front section
22	outer circumferential wall
24	inner circumferential wall
24a	outer section
24b	inner section
26	ring-shaped face
28	cutting means
29	group
30	rear section
32, 32'	threads
40	drill string

50	first casing
60	second casing
A	rotation axis
D1	diameter (drill bit)
D2	diameter
D3	diameter
D4	diameter (circular hole)
D50	inner diameter (first casing)
D60	outer diameter (second casing)
DS	spacing
L	convex line
L1	length (outer wall)
L2	length (inner wall)
L3	length (circular hole)
S	surface
Z	drilling direction
α	inclination angle (outer wall)
β	inclination angle (inner wall)

CLAIMS 1 to 14

1. Oil well drill bit (1), comprising:

   a. a cylindrical body (10) with a front section (20) facing a drilling direction (Z) and a rear section (30) for connection of the drill bit (1) with a drill string (40);

   b. a circular hole (12) at the center of the cylindrical body (10) extending from the front section (20) to the rear section (30); wherein

   c. the rear section (30) comprises threads (32) for the connection with the drill string (40); and

   d. the front section (20) comprises a tapered circular ring shape.

2. Drill bit according to claim 1, wherein the tapered circular ring shape comprises an outer circumferential wall (22) slanted towards a rotation axis (A) of the cylindrical body (10) and an inner circumferential wall (24) slanted towards the outside.

3. Drill bit according to claim 2, wherein an inclination angle (α) of the slanted outer wall (22) is smaller than an inclination angle (β) of the slanted inner wall (24) with respect to the rotation axis (A).

4. Drill bit according to claim 2 or 3, wherein a length (L1) of the slanted outer wall (22) is greater than a length (L2) of the slanted inner wall (24) in a rotational axis (A) direction.

5. Drill bit according to one of claims 2 - 4, wherein a length (L3) of the circular hole (12) is larger than a length (L2) of the slanted inner wall (24) in the rotational axis (A) direction.

6. Drill bit according to one of claims 1 – 5, wherein a ratio between an outer diameter (D1) of the drill bit (1) and a diameter (D4) of the circular hole (12) is larger than 1.1, preferably larger than 1.3.

7. Drill bit according to one of claims 1 – 6, wherein the front section (20) comprises a planar ring-shaped face (26) at the foremost front of the drill bit (1).

8. Drill bit according to claim 7, wherein each of the slanted outer and inner wall (22, 24) and the planar ring-shaped face (26) comprise cutting means (28).

9. Drill bit according to claim 8, wherein the cutting means (28) include a number of punctual cutters (28) protruding from said walls and face (22, 24, 26), respectively.

10. Drill bit according to claim 8 or 9, wherein the cutters (28) on the slanted outer wall (22) are arranged in groups (29) and each group (29) is formed along a convex line (L) arranged in rotational axis (A) direction.

11. Drill bit according to one of claims 8 - 10, wherein the slanted inner wall (24) includes an outer (24a) and an inner circumferential section (24b), the outer section (24a) in direction to the front section (20) and the inner section (24b) in direction to the rear section (30) of the drill bit (1), wherein the punctual cutters (28) are only arranged circumferentially spaced apart on the outer section (24a).

12. Drill bit according to one of claims 1 – 11, wherein the threads (32, 32') at the rear end (30) are male (32) or female (32') threads.

13. Method of oil and/or gas drilling between two casings (50, 60), with a first casing (50) and a second casing (60), wherein an inner diameter (D50) of the first casing (50) is larger than an outer diameter (D60) of the second casing (60) such that

the second casing (50) extends down beyond the first casing (60) and a spacing (DS) is formed between the inner wall of the first casing (50) and the outer wall of the second casing (60), the method comprising the step:

drilling into said spacing (DS) with an oil and/or gas well ring-shaped drill bit (1) according to one of claims 1 – 12.

14. Use of a drill bit (1) according to one of claims 1 - 12 for drilling between two consecutive casings (50, 60) in a vertical oil and/or gas well.

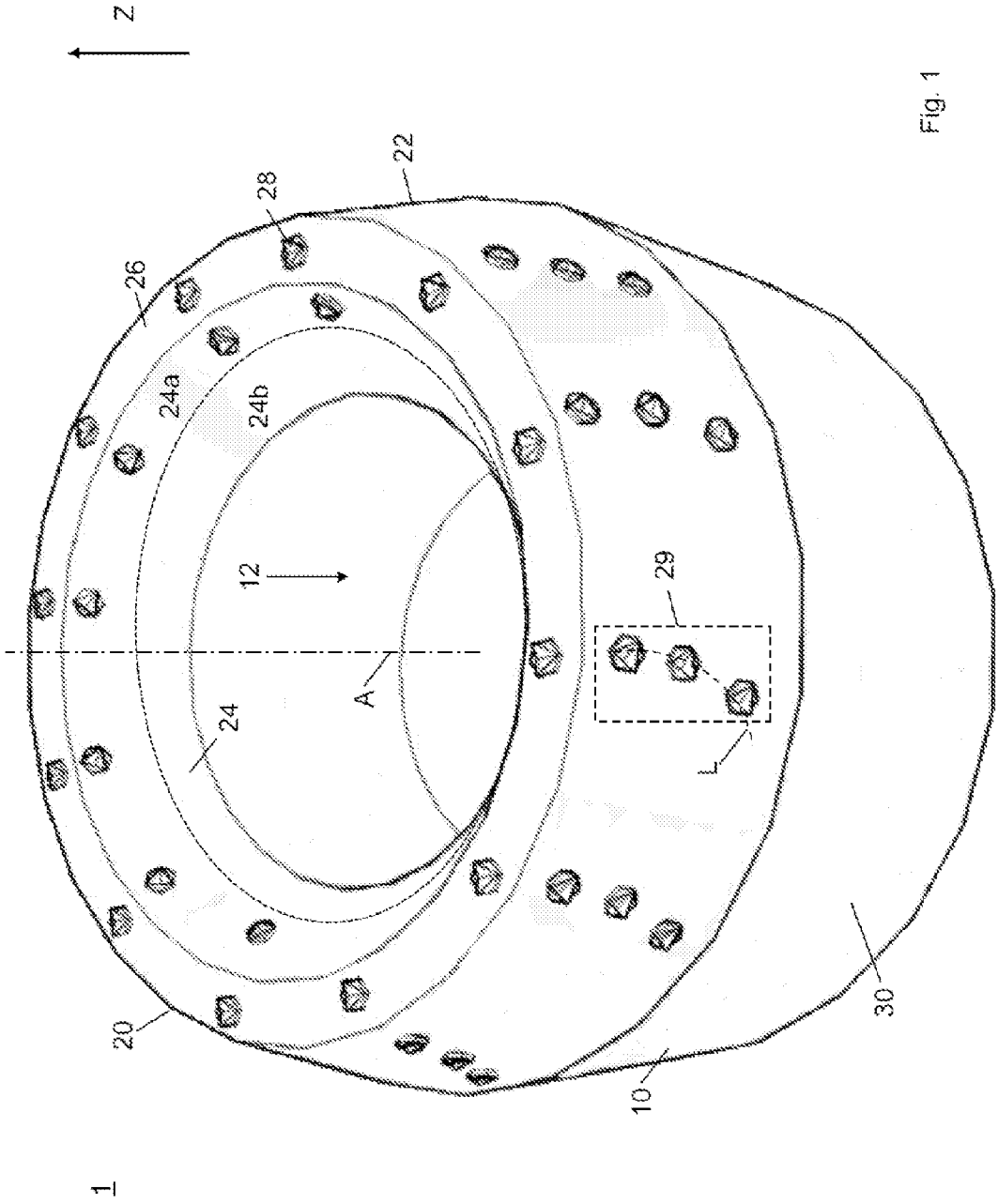
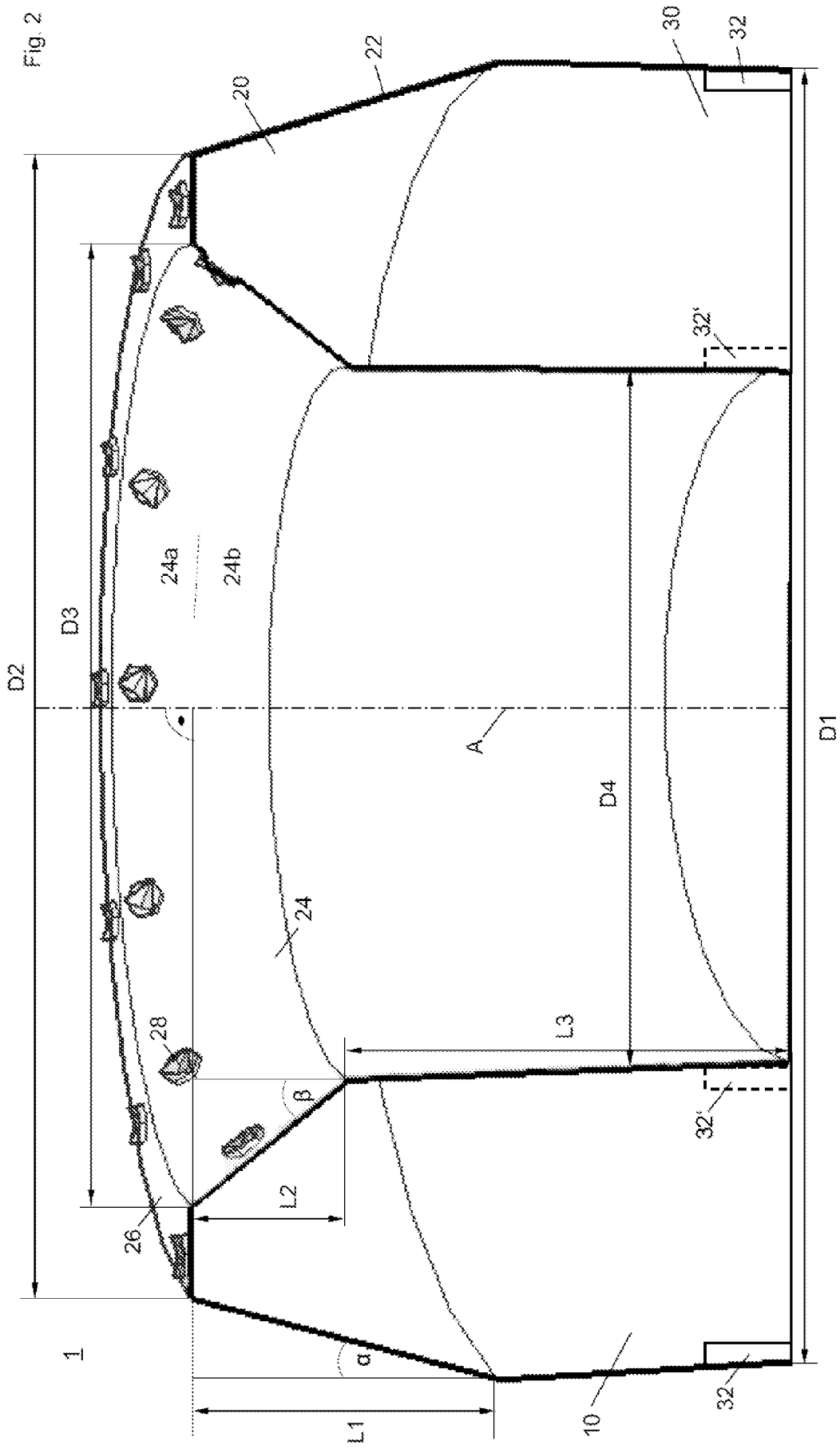


Fig. 1

Fig. 2



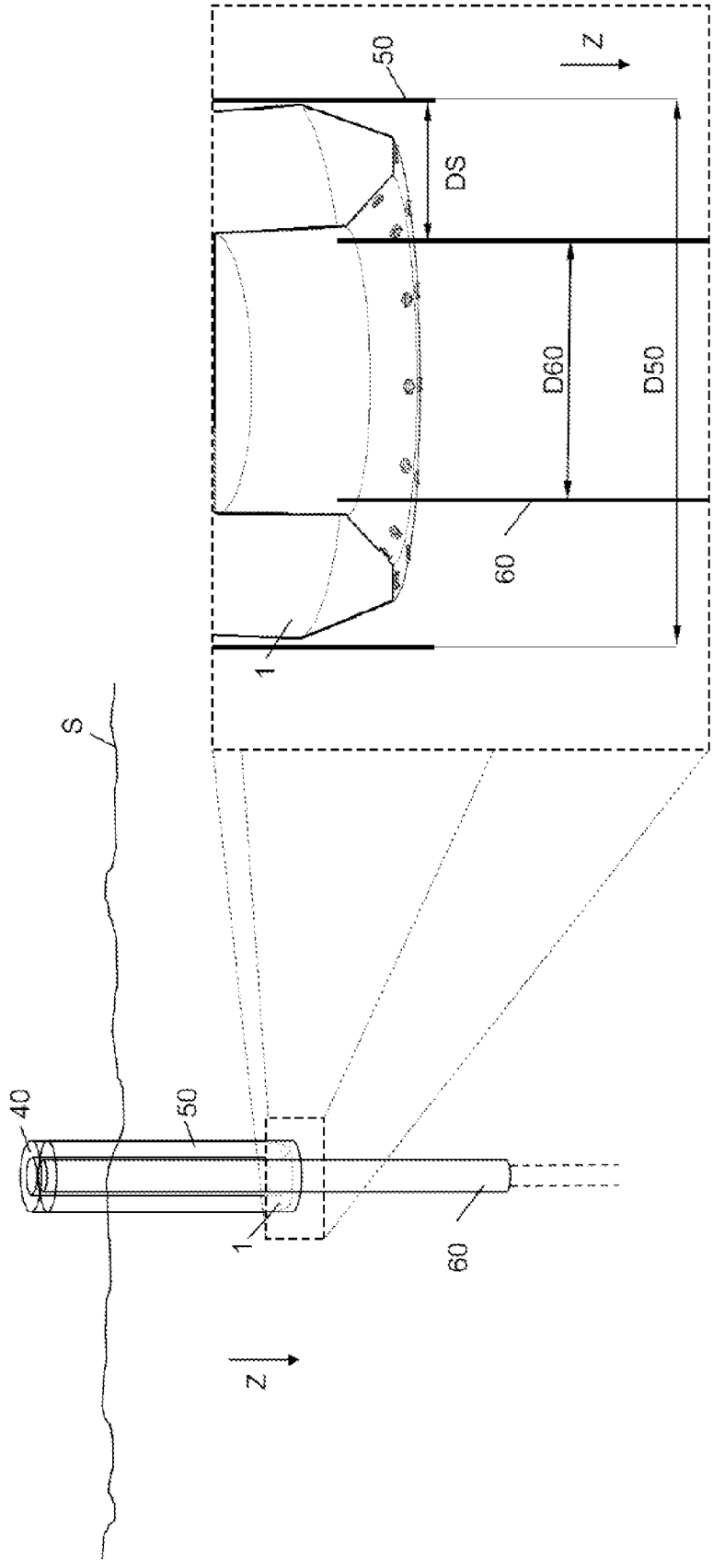


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT / IB 2018/052942

A. CLASSIFICATION OF SUBJECT MATTER

IPC: ***E21B 10/02***

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 practicable, search terms used)

EPODOC, WPI, TXT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2006076795 A1 (LAPOINTE, PAUL-PHILIPPE) 27 July 2006 (27.07.2006) figures	1-14
A	CN 203081305 U (BEIJING STS INSTRUMENT CO., LTD) 24 July 2013 (24.07.2013) abstract	1-14
A	SU 1020564 A1 (MO GEOLOGORAZVEDOCHNYJ I IM.S.ORDZHONIKIDZE) 30 May 1983 (30.05.1983) abstract	1-14
A	US 2326908 A (JR. EDWARD B. WILLIAMS) 17 August 1943 (17.08.1943) figures	1-14

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
07 August 2018 (07.08.2018)	10 August 2018 (10.08.2018)
Name and mailing address of the ISA/AT Austrian Patent Office Dresdner Straße 87, A-1200 Vienna Facsimile No. +43 / 1 / 534 24-535	Authorized officer WANKMÜLLER A. Telephone No. +43 / 1 / 534 24-415

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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