(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 179 028 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
14.06.2017 Bulletin 2017/24

(51) Int Cl.:
E21B 29/00 *(2006.01)*

(21) Application number: **15198341.8**

(22) Date of filing: **08.12.2015**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(71) Applicant: **Welltec A/S**
3450 Allerød (DK)

(72) Inventors:
- **KRÜGER, Christian**
  3450 Allerød (DK)
- **JENSEN, Sven Karsten**
  3450 Allerød (DK)

(74) Representative: **Hoffmann Dragsted A/S**
Rådhuspladsen 16
1550 Copenhagen V (DK)

(54) **DOWNHOLE WIRELINE MACHINING TOOL STRING**

(57) The present invention relates to a downhole wireline machining tool string 3 for increasing an inner diameter of a well tubular metal structure in a well. The downhole wireline machining tool string has a longitudinal axis 4 and comprises a rotatable tool part 5 comprising a machining tool 7 having a first end part 8, a second end part 9, a diameter and a circumference, and a stationary tool part 6 comprising a driving unit 10 configured to rotate the rotatable tool part 5 and powered through the wireline 11. The machining tool 7 comprises a body 12 having an outer face 14, and the machining tool 7 further comprising a plurality of inserts 15, each insert 15 having a length along the longitudinal axis 4, and the inserts 15 projecting from the outer face 14 of the body 12 and being distributed around the circumference.

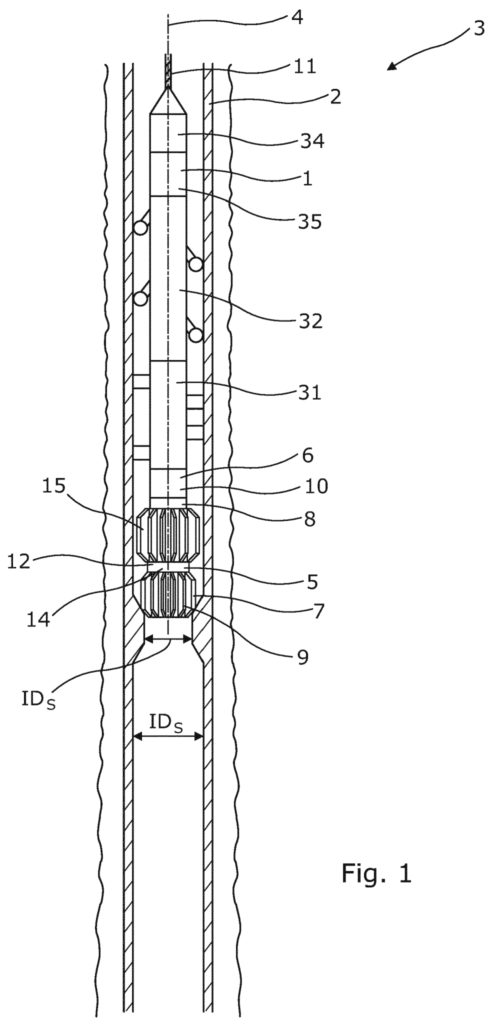

Fig. 1

EP 3 179 028 A1

Description

Field of the invention

[0001] The present invention relates to a downhole wireline machining tool string for increasing an inner diameter of a well tubular metal structure in a well, the downhole wireline machining tool string having a longitudinal axis and comprising a rotatable tool part comprising a machining tool having a first end part, a second end part, a diameter and a circumference, and a stationary tool part.

Background art

[0002] A casing or liner in a well often has restrictions such as nipples, no-goes or patches, or restrictions caused by scale or cement on the inner surface, and in order to optimise production e.g. by intervening the well by a tool, this restriction needs to be removed or at least decreased in order to increase the inner diameter of the casing. Another possible restriction may be a stuck valve, such as a ball valve or a flapper valve, at least partly closing the well.

[0003] Such restrictions may be removed by means of a wireline tool which is quickly run into the well, but the power available downhole to perform the operation is very limited, which reduces the operation methods available for removing or at least reducing the restriction.

Summary of the invention

[0004] It is an object of the present invention to wholly or partly overcome the above disadvantages and drawbacks of the prior art. More specifically, it is an object to provide an improved downhole wireline tool string which is able to remove a metal nipple in a well receiving less power than 8,000 watt.

[0005] The above objects, together with numerous other objects, advantages and features, which will become evident from the below description, are accomplished by a solution in accordance with the present invention by a downhole wireline machining tool string for increasing an inner diameter of a well tubular metal structure in a well, the downhole wireline machining tool string having a longitudinal axis and comprising:

- a rotatable tool part comprising a machining tool having a first end part, a second end part, a diameter and a circumference, and
- a stationary tool part comprising:
    - a driving unit configured to rotate the rotatable tool part and powered through the wireline,

wherein the machining tool comprises a body having an outer face, and the machining tool further comprising a plurality of inserts, each insert having a length along the longitudinal axis, and the inserts projecting from the outer face of the body and being distributed around the circumference.

[0006] The well tubular metal structure to be machined may be partly or fully restricted, meaning that the inner diameter of the well tubular metal structure may be zero at the restriction. By increasing the inner diameter of the well tubular metal structure, at least part of the restriction is removed. The restriction may be made of metal, ceramics, rubber, scale, cement or other materials in a well.

[0007] In an embodiment, the inserts may be plate-shaped and project radially from the body.

[0008] Furthermore, the body may have longitudinal grooves in which parts of the inserts extend.

[0009] In addition, the inserts may be made of tungsten carbide, cubic boron nitride (CBN) or diamonds embedded in a binder material.

[0010] In an embodiment, the tungsten carbide, cubic boron nitride (CBN) or diamonds may be in the form of particles having a particle size of 0.01-4 mm.

[0011] Also, the inserts may extend along the longitudinal axis.

[0012] Moreover, the inserts may be soldered, glued or welded to the outer face of the body.

[0013] In addition, each insert may have a width smaller than a length of the insert. Additionally, each insert may have a width which is less than 40% of the length. Further, the inserts may be distributed along the circumference with a mutual distance being at least the width of one insert.

[0014] By having a distance between the inserts, the shavings or cuttings from the machining process of increasing the inner diameter are able to pass the outer face of the insert abutting the restriction and leave the machining area. When the inserts comprise embedded particles which are made of tungsten carbide, cubic boron nitride (CBN) or diamonds, the particles released during the machining process are also able to leave the machining area. By machining area is meant the area of the insert having contact with the restriction.

[0015] In an embodiment, magnets may be arranged on the outer face of the body, closer to the first end part than the second end part.

[0016] Also, the inserts may incline towards at least one of the first and second end parts.

[0017] Furthermore, the second end part may have a decreasing outer diameter, and at least part of the inserts may extend at least partly along part of the second end part having the decreasing outer diameter.

[0018] By the second end part having a decreasing diameter is meant that the second end part is round, inclining or tapering.

[0019] The inserts may be arranged in succession along the longitudinal axis.

[0020] In an embodiment, the machining tool may have a bore extending into the second end part.

[0021] Moreover, the bore may be arranged coincident with a centre axis of the machining tool.

[0022] The downhole wireline machining tool string may further comprise an anchor section for anchoring the string in the well, or a self-propelling section, such as a downhole tractor, for propelling the string forward in the well.

[0023] Furthermore, the inserts may be arranged in at least a first and a second row extending along the circumference, and the first and second rows of inserts may be arranged in succession along the longitudinal axis.

[0024] In an embodiment, the first row of inserts arranged closest to the second end part may have a smaller outer diameter than the second row of inserts arranged closer to the first end part.

[0025] Hereby, the inner diameter of the well tubular metal structure can be increased from a first inner diameter to a second inner diameter by the first row of inserts and from the second inner diameter to a third inner diameter by the second row of inserts. By increasing the inner diameter by means of at least two rows of inserts, the resulting torque is substantially reduced, as the removal of the material is performed in at least two steps instead of one.

[0026] Furthermore, an outer diameter of the body may be larger opposite the inserts than closer to the first end part.

[0027] In addition, the rotatable tool part may rotate less than 300 revolutions per minute (RPM).

[0028] Also, the driving unit may be powered by less than 7,000 Watt.

[0029] Moreover, the rotatable tool part may rotate at a low torque.

[0030] Finally, the machining tool may increase the inner diameter by milling away part of a nipple, scale, a sliding sleeve, a whip stock or a valve.

Brief description of the drawings

[0031] The invention and its many advantages will be described in more detail below with reference to the accompanying schematic drawings, which for the purpose of illustration show some non-limiting embodiments and in which

Fig. 1 shows a downhole wireline machining tool string in a well,

Fig. 2 shows part of a downhole wireline machining tool string in perspective,

Fig. 3 shows a side view of the downhole wireline machining tool string of Fig. 2,

Fig. 4 shows a perspective view of part of another downhole wireline machining tool string having inserts at an end of the machining tool,

Fig. 5 shows a side view of another downhole wireline machining tool string of Fig. 4,

Fig. 6 shows a perspective view of part of yet another downhole wireline machining tool string having inserts at an end of the machining tool and a bore,

Fig. 7 shows a side view of yet another downhole wireline machining tool string having rows of inserts and thus machining in two steps in one run, and

Fig. 8 shows a perspective view of part of yet another downhole wireline machining tool string.

[0032] All the figures are highly schematic and not necessarily to scale, and they show only those parts which are necessary in order to elucidate the invention, other parts being omitted or merely suggested.

Detailed description of the invention

[0033] Fig. 1 shows a downhole wireline machining tool string 1 for increasing an inner diameter ID_s of a casing or well tubular metal structure 2 in a well 3. The downhole wireline machining tool string 1 has a longitudinal axis 4 along the extension of the well 3 and comprises a rotatable tool part 5 and a stationary tool part 6. The stationary tool part 6 is arranged closest to a top of the well 3. The rotatable tool part 5 comprises a machining tool 7 having a first end part 8 arranged closest to stationary tool part 6, and a second end part 9 which is arranged by the restriction to be at least partly removed. As shown in Fig. 2, the machining tool 7 has a diameter D_T and a circumference C_T. The machining tool 7 increases the inner diameter ID_s of the well tubular metal structure by machining, such as by milling away part of a nipple, scale, a sliding sleeve, a whip stock or a valve in order to at least partly remove the restriction.

[0034] The stationary tool part 6 of Fig. 1 comprises a driving unit 10, such as an electrical motor, which is configured to rotate the rotatable tool part 5 and is powered through a wireline 11. The machining tool 7 comprises a body 12 having an outer face 14 and a plurality of inserts 15. Each insert 15 has a length L (shown in Fig. 3) along the longitudinal axis 4, and the inserts 15 project from the outer face 14 of the body 12.

[0035] The inserts 15 are distributed around the circumference C_T with a mutual distance 16 between them, as shown in Figs. 2 and 3. By having a mutual distance between the inserts, fluid is allowed to flow past and along the inserts and thus flush and cool the inserts, thereby increasing the service life of the inserts. Furthermore, the shavings or cuttings released during the machining process are able to pass the outer face of the insert abutting the restriction and leave the machining area. When the inserts comprise embedded particles made of tungsten carbide, cubic boron nitride (CBN) or diamonds, the particles released during the machining process are also able to leave the machining area.

[0036] By machining area is meant the area of the insert having contact with the restriction, and along the longitudinal axis 4, the machining area or contact area is less than 60% of the total area of the restriction, preferably less than 50% of the total area of the restriction. In other words, if the tool had contact with the restriction along the whole circumference of the restriction when seen in cross-section perpendicular to the longitudinal axis, contact with the whole circumference is 100%.

[0037] As shown in Figs. 2 and 3, the inserts 15 are plate-shaped and project radially from the outer face of the body. Each insert 15 is arranged in a groove 18 in the outer face of the body 12 and is fastened to the body, e.g. by means of soldering. The heat may be applied from within the bore of the machining tool. The inserts 15 thus extend from the grooves 18 and project radially outwards away from the outer face 14 of the body 12. The inserts 15 extend along the longitudinal axis so that the length L of the inserts extends along the longitudinal axis 4. Each insert 15 has a width W_i which is less than 40% of the length L of the insert, preferably less than 30% of the length L of the insert, more preferably less than 20% of the length L of the insert, and even more preferably less than 15% of the length L of the insert. The inserts 15 are arranged distributed along the circumference C_T with a mutual distance of least the width W_i of one insert.

[0038] In Fig. 3, the inserts have a curvature and an even thickness along their length. When having a curvature, the inserts function as blades of a turbine and thus lead or shovel the shadings or cuttings away from the machining area.

[0039] In Fig. 2, the machining tool 7 has a bore 17 extending into the second end part 9. By having the bore 17, the area of the machining tool 7 engaging the restriction in order to perform the machining operation, such as by milling or grinding, is substantially reduced, which requires substantially less power than a machining tool 7 having inserts 15 all the way around the front of the tool, as shown in Fig. 4. The bore 17 has a centre axis arranged coincidently with the centre axis and thus the longitudinal axis 4 of the machining tool 7.

[0040] As shown in Fig. 3, the machining tool 7 has a first tool end 19 closest to the stationary tool part 6 and a second tool end 20 closest to the second end part 9, and the inserts 15 incline towards the second tool end 20, thereby enabling the inserts to engage the restriction and centralise the machining tool 7. As can be seen, the inserts 15 also incline towards the first tool end 19, which ensures that the inserts do not have any sharp edges which may easily be broken off. The body 12 of the machining tool 7 has magnets 33 arranged on the outer face 14 thereof so that shavings from the machining process adhere to the magnets 33 and are in this way collected and brought up to surface together with the tool string when the tool string is retracted from the well. The outer diameter OD_B of the body is larger opposite the inserts 15 than closer to the first end part 8, and the magnets 33 are arranged in the part of the body having the smaller outer diameter.

[0041] In Fig. 4, the second end part 9 of the machining tool 7 has a decreasing outer diameter due to the body tapering, and at least part of the inserts 15 extends partly along part of the second end part 9 having the decreasing outer diameter. By the second end part 9 having a decreasing diameter is meant that the second end part is round, inclining or tapering and some of the inserts 15 cover part of the round, tapering or inclining end part. The rotatable tool part 5 has inserts 15 arranged in succession along the longitudinal axis so that the second end part 9 is partly covered with inserts in prolongation of each other along the longitudinal extension. Inserts 15 are arranged at the centre of the second tool end 20 of the second end part 9, extending from an end face 21 of the second tool end 20, and further inserts are arranged abutting these centre inserts 15, 15a and as a prolongation of the centre inserts at the inclining face of the second end part 9. Other inserts 15, 15c are arranged in prolongation of the inclining inserts 15, 15b, projecting radially from the outer face 14 of the body 12.

[0042] In Fig. 6, the machining tool 7 has a bore 17 and first inserts 15, 15' projecting radially from the body 12, and also extending along the inclining surface of the second end part 9.

[0043] The inserts 15 of Fig. 4 are arranged in a first row 22 and a second row 23, each row extending along the circumference C_T, and the first 22 and second rows 23 of inserts are arranged in succession along the longitudinal axis 4. The second row 23 of inserts 15 acts as a back-up to the first row 22 of inserts, and the inserts of the first row 22 are arranged in recesses 24.

[0044] When seen from the side of the machining tool as shown in Fig. 5, the inserts may be arranged with different lengths and in an overlapping manner, and the inserts 15b arranged closest to the second part 9 have a smaller radial extension than the inserts 15c arranged closest to the first part 8. The inserts 15c are L-shaped so as to overlap the inserts 15b also in the radial direction so that when the inserts 15b have machined the restriction from its initial and first inner diameter to a second inner diameter, the inserts 15c can take over the machining process to machine increase the inner diameter of the restriction even further.

[0045] The inserts 15 may be made of tungsten carbide, cubic boron nitride (CBN) or diamonds embedded in a binder material, and the tungsten carbide, cubic boron nitride (CBN) or diamonds may be in the form of particles having a particle size of 0.01-2 mm. By having smaller bits of tungsten carbide, cubic boron nitride (CBN) or diamonds embedded in a binder material, new bits of tungsten carbide, cubic boron nitride (CBN) or diamonds are always ready to take over when the first part of the insert is worn down, and then, new bits of tungsten carbide, cubic boron nitride (CBN) or diamonds will appear. Thus, the inserts can be used over a longer period of time, as the inserts function over their entire extension, and machining tools having these inserts are therefore better able to decrease the thickness of the casing from one inner diameter to a second larger inner diameter than known tools.

[0046] In Fig. 7, the inserts 15 are arranged in at least a first 22 and a second row 23 extending along the circumference, and the first and second rows of inserts are arranged in succession along the longitudinal axis. The first row 22 of inserts 15 arranged closest to the second end part 9 has a smaller outer diameter OD_1 than the second row 23 of inserts arranged closer to the first end part 8. The inner diameter of the well tubular metal structure can thereby be increased from a first inner diameter to a second inner diameter by the first row 22 of inserts 15, and from the second inner diameter to a third inner diameter by the second row 23 of inserts. By increasing the inner diameter ID_s by means of at least two rows 23, 23 of inserts 15, the resulting torque and thus the power required are substantially reduced as the material to be removed is machined in at least two steps instead of one.

[0047] In Fig. 8, each insert has a varying radial extension so that a first part of the insert closest to the second part 9 of the machining tool has a smaller radial extension than a second part of the insert closest to the first part 8. The machining tool thus has a smaller outer diameter opposite the part of the inserts having a smaller radial extension, since each insert has an indentation so that the first part of the inserts contact the restriction and machine it from a first initial diameter to a second inner diameter and the second part of the inserts machine the restriction from the second inner diameter to its final inner diameter.

[0048] In another embodiment, the inserts may be plate-shaped, have a varying thickness and be cone-shaped. The inserts may have a varying thickness in the radial direction so that the thickness of the inserts are greater closer to the centre of the machining tool or the thickness may vary along the longitudinal extension.

[0049] As can be seen in Fig. 1, the downhole wireline machining tool string 1 further comprises an anchor section 31 for anchoring the string in the well 3, and a self-propelling section 32, such as a downhole tractor, for propelling the string forward in the well. By having either the anchor section 31 or the self-propelling section 32, the tool string 1 is anchored further up the well tubular metal structure 2, which means that all the force is transferred to the machining operation. The anchor section 31 or the self-propelling section 32 comprises a power unit 34, such as an electrical motor, which receives power from the wireline 11. The power unit 34 drives a pump unit 35 driving the anchor section 31 and/or the self-propelling section 32. The anchor section 31 and the self-propelling section 32 may have both a power unit 34 and a pump unit 35. The tool string 1 may furthermore comprise one or more pressure compensators.

[0050] The rotatable tool part rotates at a low torque and rotates less 300 revolutions per minute (RPM). The driving unit receives less than 1,000 Volts or 7,000 Watt due to a loss of power in the long wireline when performing an operation several kilometres down the well.

[0051] A stroking tool may be used to provide weigth on bit, i.e. weigth on the machining tool. The stroking tool is a tool providing an axial force along the longitudinal extension. The stroking tool comprises an electrical motor for driving a pump. The pump pumps fluid into a piston housing in order to move a piston acting therein. The piston is arranged on a stroker shaft. The pump may pump fluid into the piston housing on one side and simultaneously suck fluid out on the other side of the piston.

[0052] By fluid or well fluid is meant any kind of fluid that may be present in oil or gas wells downhole, such as natural gas, oil, oil mud, crude oil, water, etc. By gas is meant any kind of gas composition present in a well, completion, or open hole, and by oil is meant any kind of oil composition, such as crude oil, an oil-containing fluid, etc. Gas, oil, and water fluids may thus all comprise other elements or substances than gas, oil, and/or water, respectively.

[0053] If the well is filled with gas, the downhole wireline machining tool string may comprise a fluid delivery unit for delivering fluid to the machining area.

[0054] By a casing or well tubular metal structure 2 is meant any kind of pipe, tubing, tubular, liner, string etc. used downhole in relation to oil or natural gas production.

[0055] In the event that the tool is not submergible all the way into the well tubular metal structure, a downhole tractor can be used to push the tool all the way into position in the well. The downhole tractor may have projectable arms having wheels, wherein the wheels contact the inner surface of the well tubular metal structure for propelling the tractor and the tool forward in the well tubular metal structure. A downhole tractor is any kind of driving tool capable of pushing or pulling tools in a well downhole, such as a Well Tractor®.

[0056] Although the invention has been described in the above in connection with preferred embodiments of the invention, it will be evident for a person skilled in the art that several modifications are conceivable without departing from the invention as defined by the following claims.

Claims

1. A downhole wireline machining tool string (1) for increasing an inner diameter (ID_s) of a well tubular metal structure (2) in a well (3), the downhole wireline machining tool string having a longitudinal axis (4) and comprising:

- a rotatable tool part (5) comprising a machining tool (7) having a first end part (8), a second end part (9), a diameter (D_T) and a circumference (C_T), and
- a stationary tool part (6) comprising:
  - a driving unit (10) configured to rotate the rotatable tool part and powered through the wireline,

wherein the machining tool comprises a body (12) having an outer face (14), and a plurality of inserts (15), each insert having a length (L) along the longitudinal axis, and the inserts projecting from the outer face of the body and being distributed around the circumference.

2. A downhole wireline machining tool string according to claim 1, wherein the inserts are plate-shaped and project radially from the body.

3. A downhole wireline machining tool string according to claim 1 or 2, wherein the inserts are made of tungsten carbide, cubic boron nitride (CBN) or diamonds embedded in a binder material.

4. A downhole wireline machining tool string according to any of the proceeding claims, wherein each insert has a width (W_i) which is less than 40% of the length.

5. A downhole wireline machining tool string according to any of the proceeding claims, wherein the inserts are distributed along the circumference with a mutual distance (16) being at least the width of one insert.

6. A downhole wireline machining tool string according to any of the proceeding claims, wherein the inserts incline towards at least one of the first and second end parts.

7. A downhole wireline machining tool string according to any of the proceeding claims, wherein the second end part has a decreasing outer diameter, and at least part of the inserts extends at least partly along part of the second end part having the decreasing outer diameter.

8. A downhole wireline machining tool string according to any of the proceeding claims, wherein the machining tool has a bore (17) extending into the second end part.

9. A downhole wireline machining tool string according to any of the proceeding claims, further comprising an anchor section (31) for anchoring the string in the well, or a self-propelling section (32), such as a downhole tractor, for propelling the string forward in the well.

10. A downhole wireline machining tool string according to any of the proceeding claims, wherein the inserts are arranged in at least a first row (22) and a second row (23) extending along the circumference, and the first and second rows of inserts are arranged in succession along the longitudinal axis.

11. A downhole wireline machining tool string according to claim 10, wherein the first row of inserts arranged closest to the second end part has a smaller outer diameter than the second row of inserts arranged closer to the first end part.

12. A downhole wireline machining tool string according to any of the proceeding claims, wherein an outer diameter (OD_B) of the body is larger opposite the inserts than closer to the first end part.

13. A downhole wireline machining tool string according to any of the proceeding claims, wherein the rotatable tool part rotates less than 300 revolutions per minute (RPM).

14. A downhole wireline machining tool string according to any of the proceeding claims, wherein the driving unit is powered by less than 7,000 Watt.

15. A downhole wireline machining tool string according to any of the proceeding claims, wherein the machining tool increases the inner diameter by milling away part of a nipple, scale, a sliding sleeve, a whip stock or a valve.

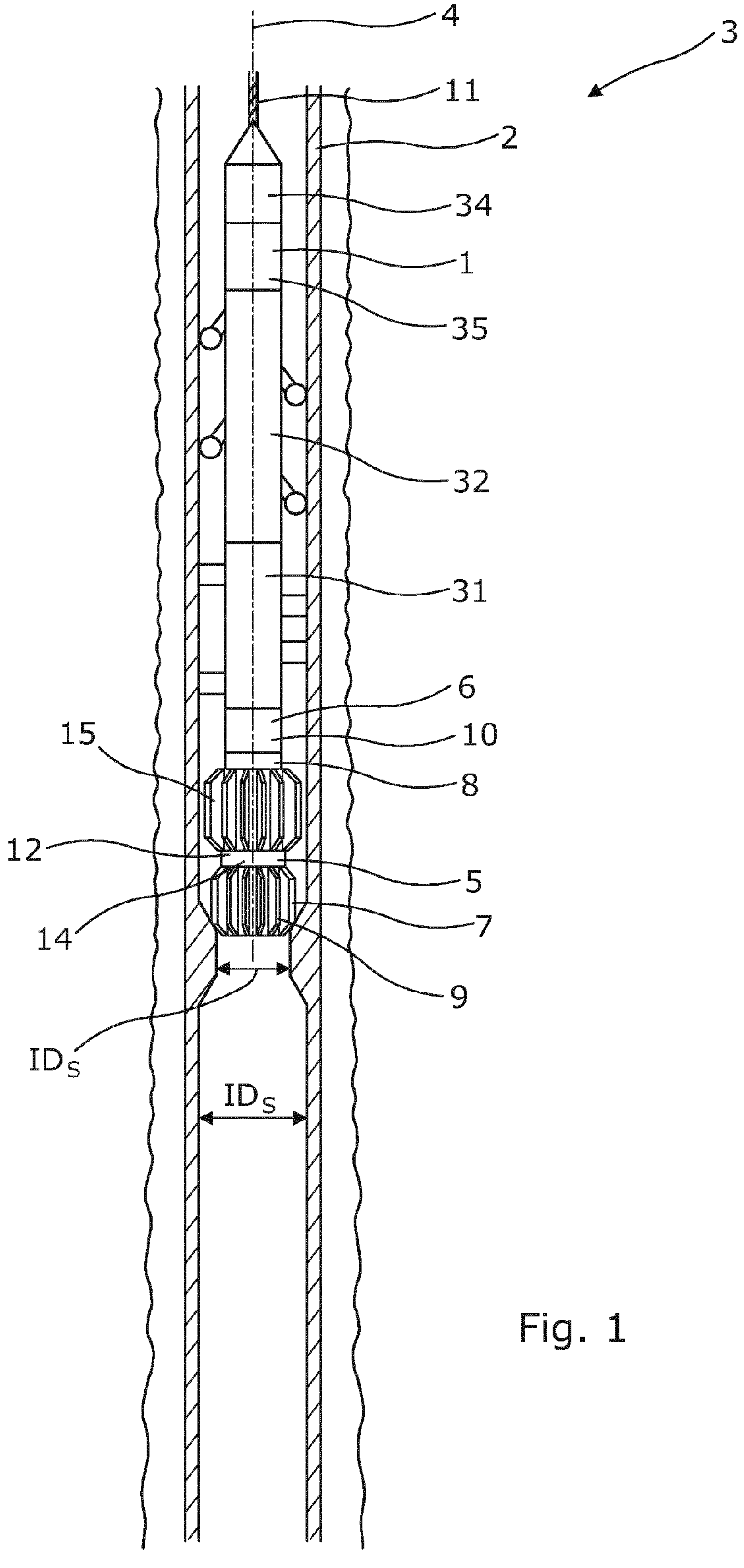

Fig. 1

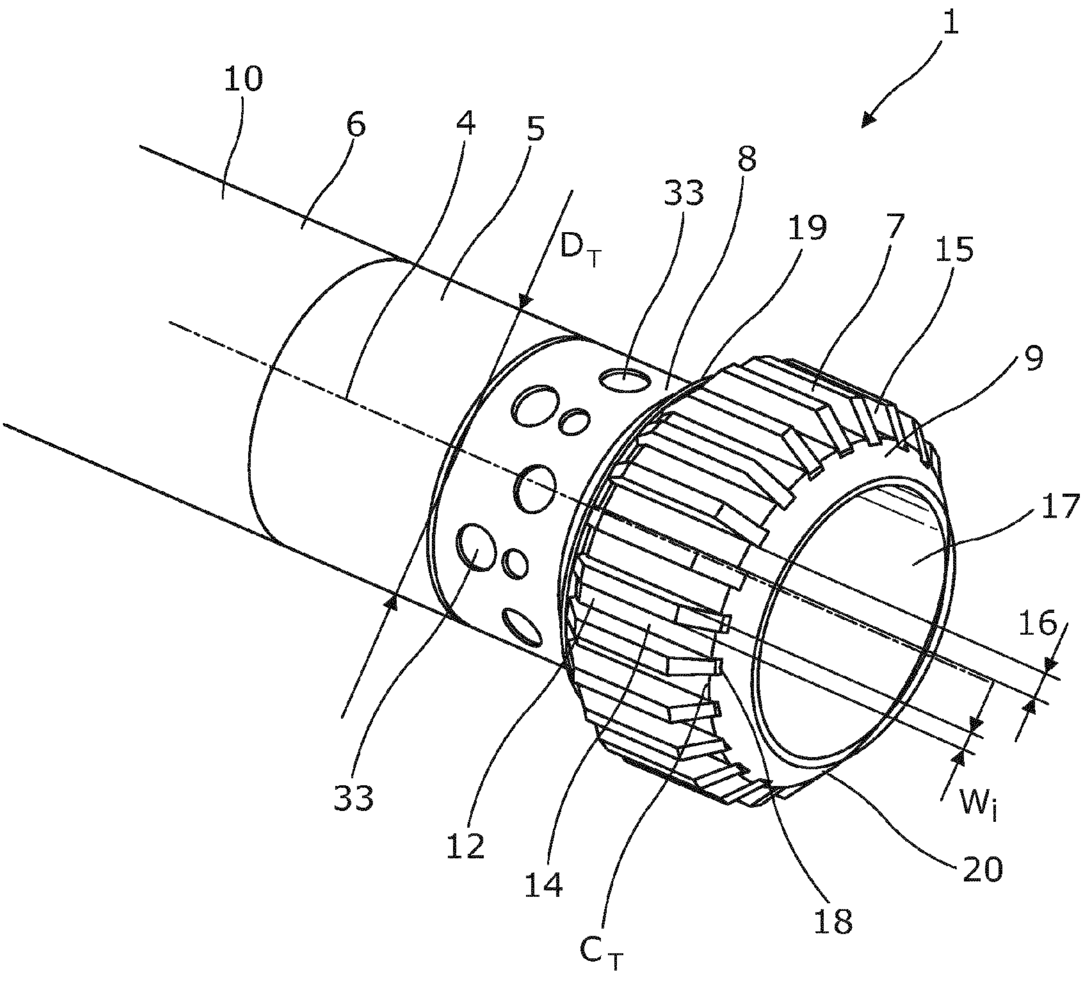

Fig. 2

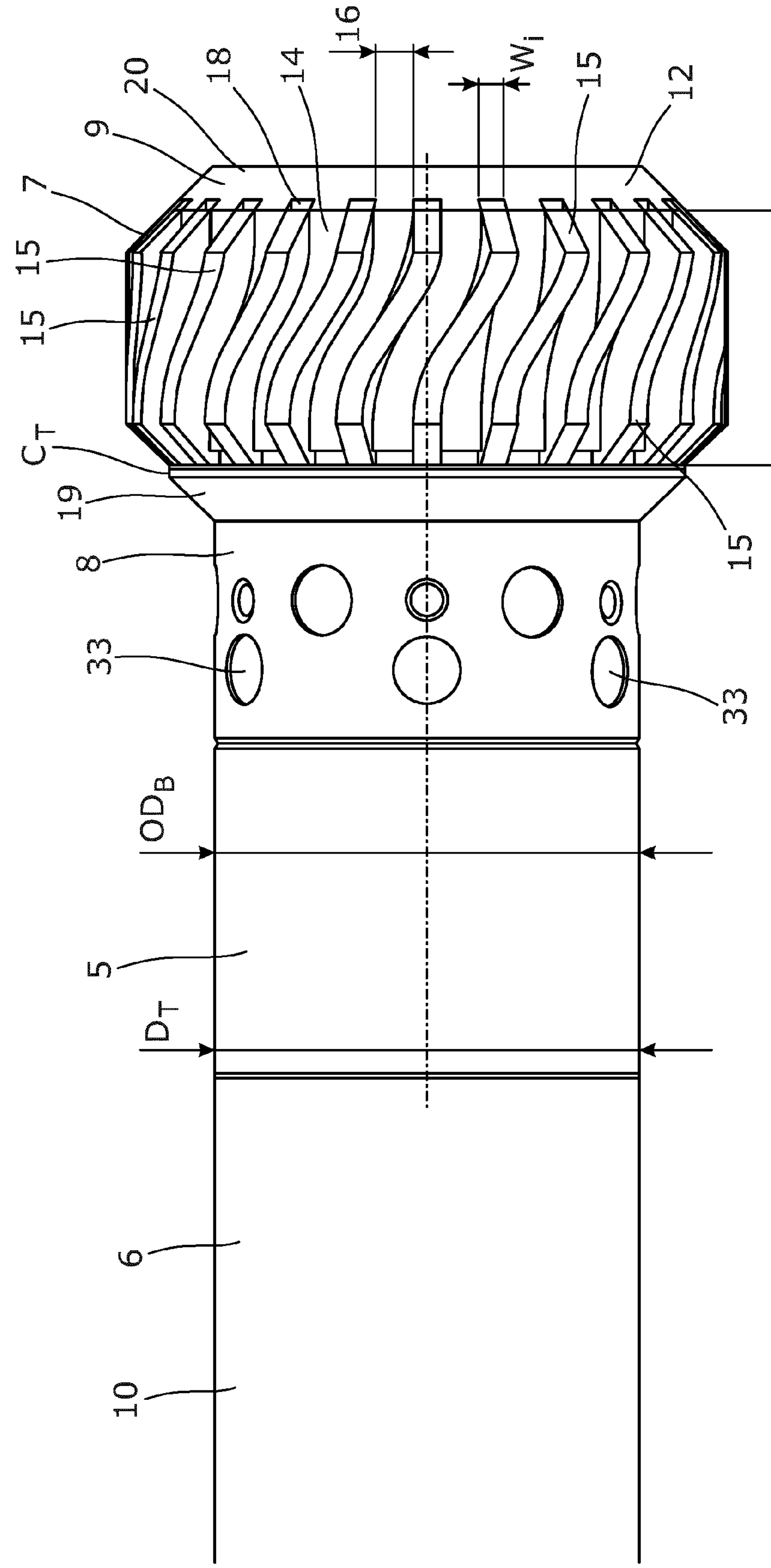

Fig. 3

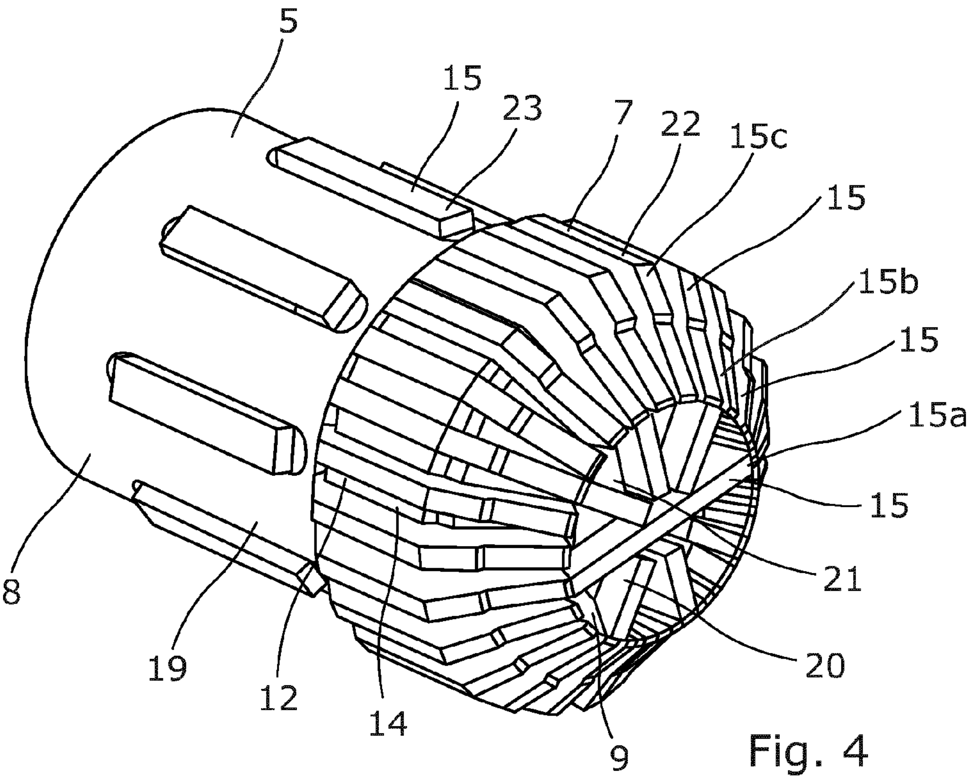
5
15
23
7
22
15c
15
15b
15
15a
15
21
20
9
14
12
19
8

Fig. 4

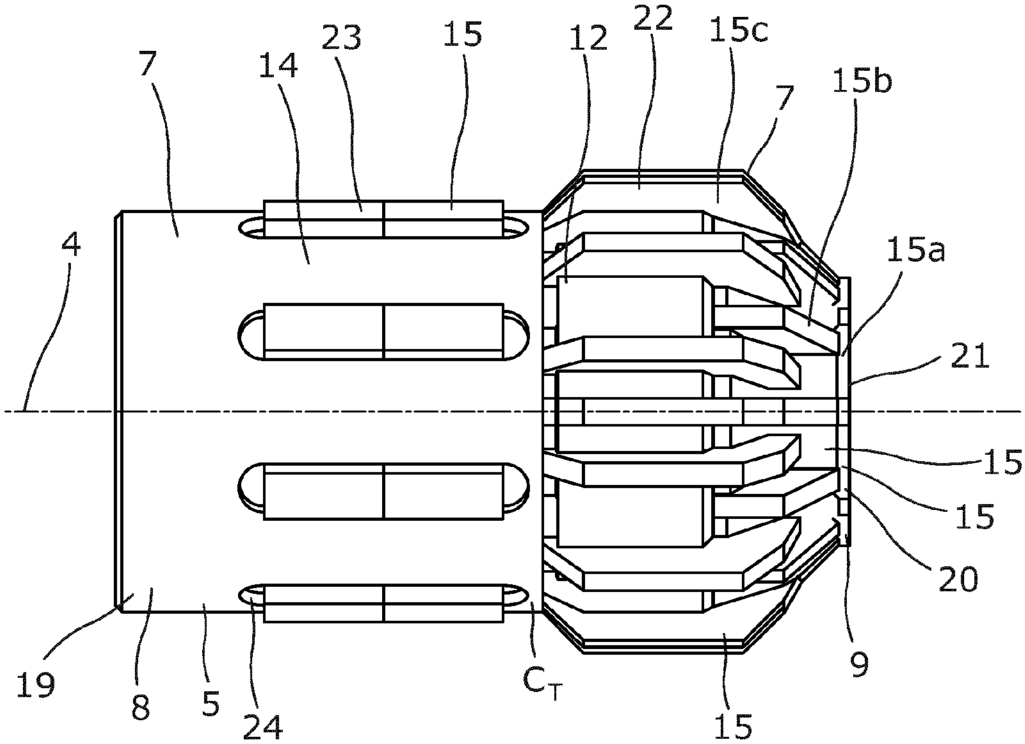
7
14
23
15
12
22
15c
7
15b
15a
4
21
15
15
20
9
15
C_T
24
5
8
19

Fig. 5

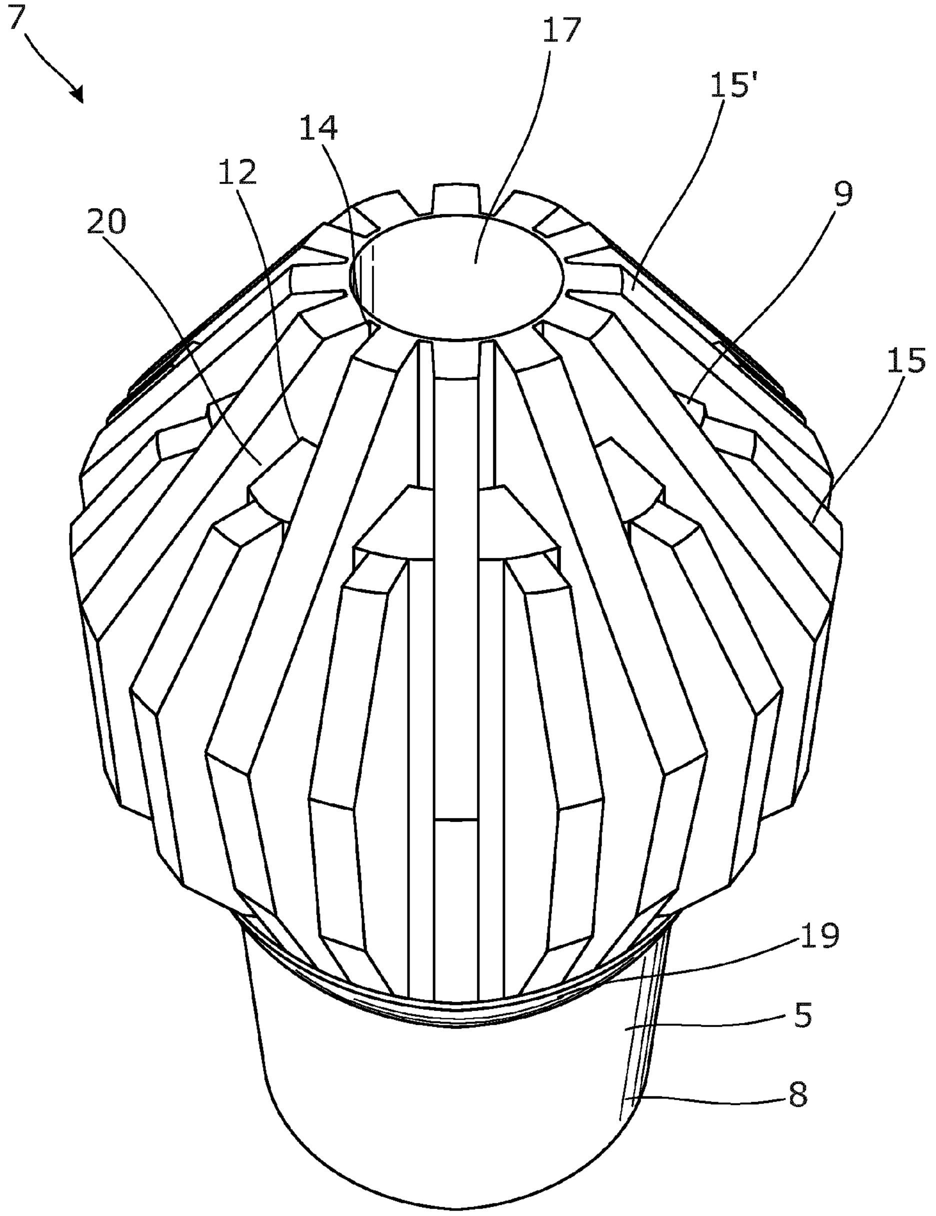

Fig. 6

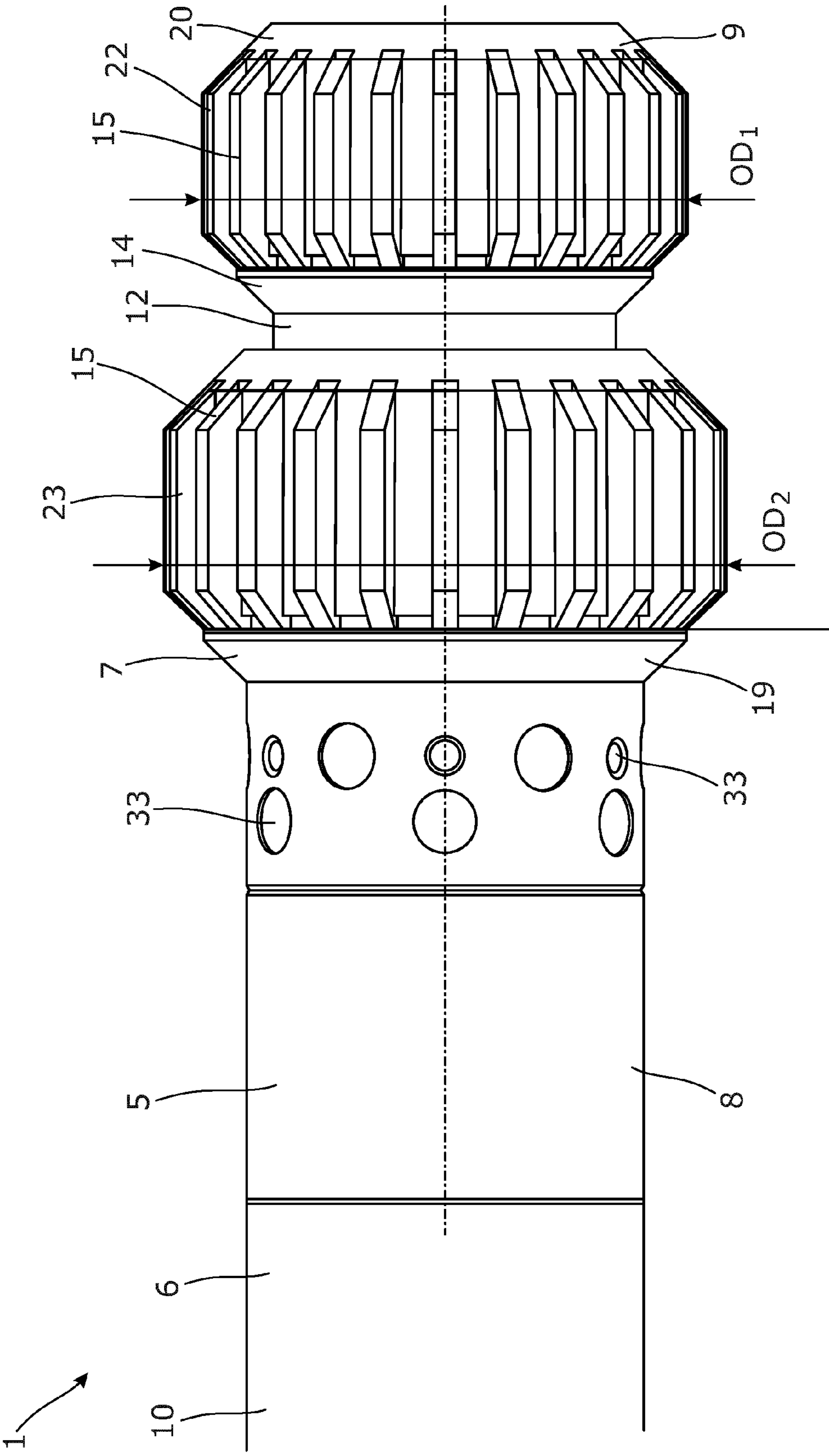

Fig. 7

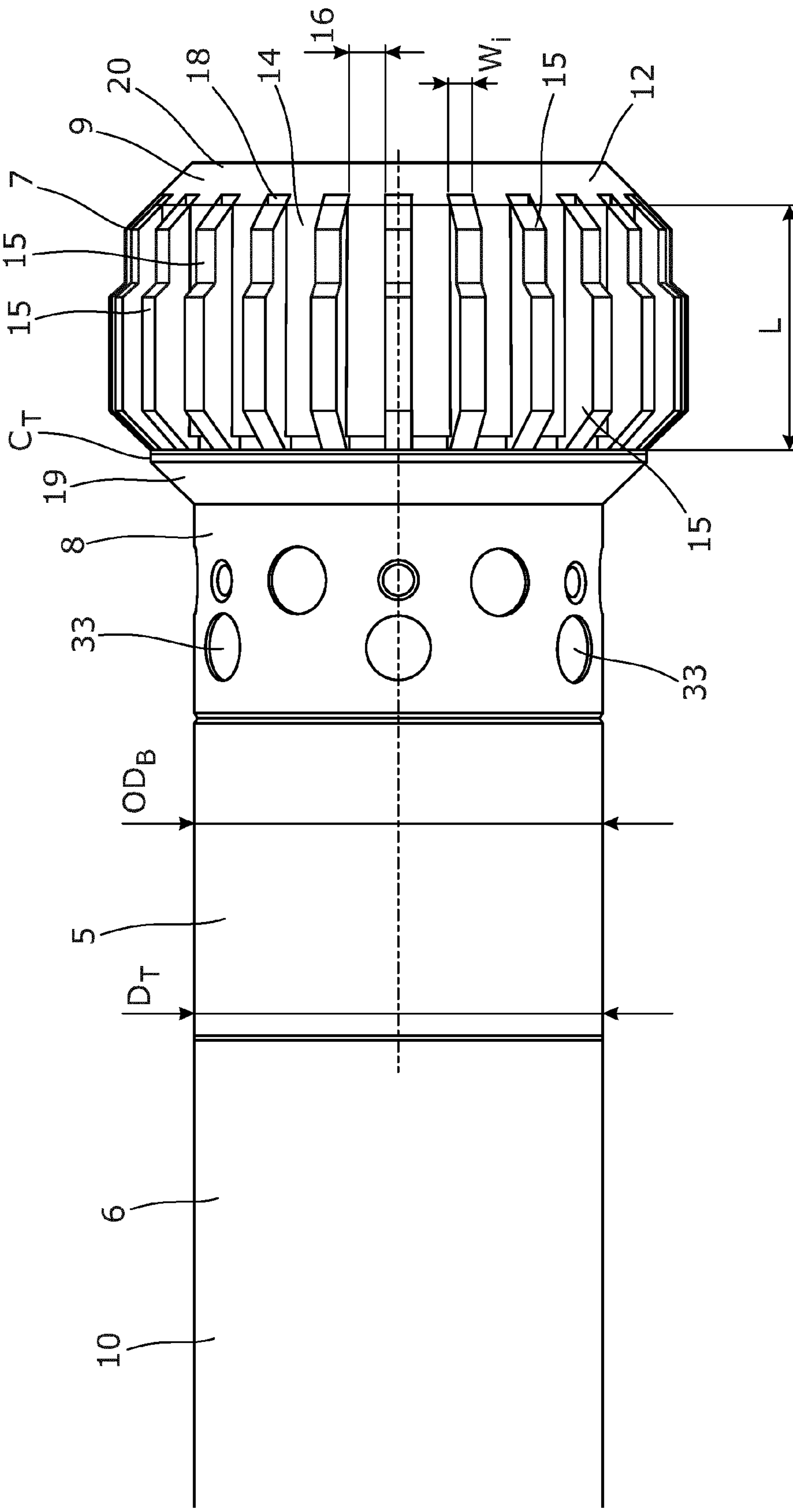

Fig. 8

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 15 19 8341

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	WO 2013/067263 A2 (SCHLUMBERGER CA LTD [CA]; SCHLUMBERGER SERVICES PETROL [FR]; SCHLUMBER) 10 May 2013 (2013-05-10) * paragraphs [0002], [0004], [0006], [0012], [0013], [0015], [0017], [0018] * -----	1-15	INV. E21B29/00
Y	US 4 717 290 A (REYNOLDS CARL D [US] ET AL) 5 January 1988 (1988-01-05) * column 2, line 14 - line 20 * * column 3, line 61 - column 4, line 5 * * figures 3-5 * -----	1-15	
A	US 2012/145394 A1 (JENSEN MICHAEL [US] ET AL) 14 June 2012 (2012-06-14) * paragraphs [0024], [0025] * -----	1-15	
A	US 2013/153227 A1 (LAIRD MARY L [US] ET AL) 20 June 2013 (2013-06-20) * paragraphs [0016], [0027] * -----	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
A	US 6 478 088 B1 (HANSEN HENNING [NO] ET AL) 12 November 2002 (2002-11-12) * column 2, line 53 - line 61 * * column 5, line 47 - line 60 * -----	1-15	E21B

1

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 May 2016	Schneiderbauer, K

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 15 19 8341

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

10-05-2016

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
WO 2013067263	A2	10-05-2013	CA	2853973	A1	10-05-2013
			CN	104040106	A	10-09-2014
			EP	2773837	A2	10-09-2014
			RU	2014122549	A	10-12-2015
			US	2014305653	A1	16-10-2014
			WO	2013067263	A2	10-05-2013
US 4717290	A	05-01-1988	AT	390644	B	11-06-1990
			BE	1000252	A4	27-09-1988
			BR	8703302	A	12-07-1988
			CA	1280633	C	26-02-1991
			DE	3722478	A1	07-07-1988
			FR	2608672	A1	24-06-1988
			GB	2198671	A	22-06-1988
			IT	1215582	B	14-02-1990
			JP	H0532165	B2	14-05-1993
			JP	S63156606	A	29-06-1988
			MX	165657	B	27-11-1992
			NL	8701067	A	18-07-1988
			NO	871353	A	20-06-1988
			US	4717290	A	05-01-1988
US 2012145394	A1	14-06-2012	EP	2466056	A2	20-06-2012
			US	2012145394	A1	14-06-2012
			US	2015354305	A1	10-12-2015
US 2013153227	A1	20-06-2013	NONE			
US 6478088	B1	12-11-2002	AU	754410	B2	14-11-2002
			BR	9910243	A	23-01-2001
			CA	2331381	A1	11-11-1999
			DE	69918297	D1	29-07-2004
			DE	69918297	T2	25-08-2005
			DK	1076758	T3	01-11-2004
			EP	1076758	A2	21-02-2001
			ID	28211	A	10-05-2001
			MX	PA00010853	A	08-05-2002
			NO	20005574	A	04-01-2001
			US	6478088	B1	12-11-2002
			WO	9957409	A2	11-11-1999

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82