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(54) **Title:** WELLBORE TOOL WITH DEBRIS PLUG

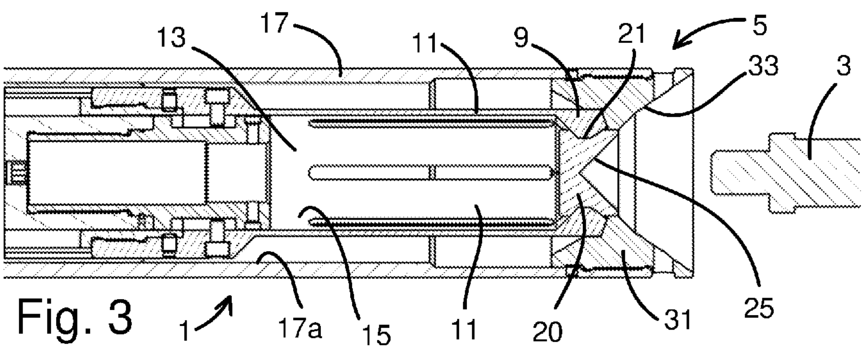

Fig. 3

(57) **Abstract:** A wellbore tool (1) comprising an inner bore (17a), an axially forward-facing aperture (32) constituting an access between the exterior of the wellbore tool (1) and at least a part of the inner bore (17a). The wellbore tool (1) further comprises a debris plug (20, 120) in the forward-facing aperture (32) when in a barrier state, and a plug retaining means (9) configured to retain the debris plug (20, 120) in the forward-facing aperture (32) and to release the debris plug.

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WELLBORE TOOL WITH DEBRIS PLUG

Technical Field

The present invention relates to a wellbore tool of the kind that is used for work inside a drilled subterranean well.

Background Art

There are known several types of wellbore tools that are applied for various operations inside a drilled well. Inside such wells, there may be residual debris present. For some tools, entry of debris into the tool may hamper its operation.

One type of wellbore tool is referred to as a fishing tool. A fishing tool is designed for connecting to an object inside the wellbore so that the object can be pulled out of the well together with the fishing tool. Such objects are commonly referred to as a fish.

The applicant's own patent application publication WO2019035726 relates to such a fishing tool.

Publication WO2019207280A1 discloses a latch tool configured to latch onto an item inside a wellbore. The latch tool has a plurality of latch elements configured to move radially for engaging with an object. The latch elements are distributed along a circle that defines a forward-facing aperture.

Thus, an object of the present invention may be to provide a wellbore tool that avoids entry of wellbore debris into the tool before the tool is used as intended.

Summary of invention

According to the present invention, there is provided a wellbore tool comprising an inner bore, an axially forward-facing aperture constituting an access between the exterior of the wellbore tool and at least a part of the inner bore. According to the present invention, the wellbore tool further comprises a debris plug arranged in the forward-facing aperture when in a barrier state. The wellbore tool also comprises a plug retaining means configured to retain the debris plug in the forward-facing aperture and to release the debris plug.

With the term axially forward-facing aperture is meant that the aperture faces in an axial direction, into the well and towards the bottom or end of the well when the tool is arranged in the well.

With the term barrier state is meant a state wherein the debris plug is arranged in the wellbore tool in such a way that it prevents debris, that may be present in a well, to enter into the wellbore tool through the forward-facing aperture.

With the term well is herein meant a well that has been drilled in a subterranean formation, either subsea or onshore. Typically, such a well is drilled for hydrocarbon production, water injection or water production.

With such a wellbore tool, the operator reduces the risk of malfunction when the tool reaches its location of operation. Such malfunction could result from debris entering the tool and hampering tool functions, typically mechanical movement of tool elements.

In some embodiments, the debris plug can comprise threads and the plug retaining means can comprise opposite threads. The threads of the debris plug can then engage the opposite threads of the plug retaining means. With such embodiments, the operator can position the debris plug in the barrier state by screwing the debris plug into position.

In some embodiments of the present invention, the debris plug can comprise a plug engagement profile. Moreover, the plug retaining means may comprise locking dogs engaging the plug engagement profile when the debris plug is arranged in the forward-facing aperture (i.e. when the debris plug is in the barrier state).

In such embodiments, the forward-facing aperture can advantageously be defined by an inwardly facing aperture wall, and the debris plug may comprise a sealing face that abuts the aperture wall when in the barrier state. By having a sealing face of the debris plug sealing against the aperture wall, one prevents not only larger pieces of debris to enter the tool, but also small pieces or even fluid.

Preferably, the wellbore tool comprises a debris plug reception space configured to accommodate the debris plug when it is not in the barrier state.

The forward-facing aperture can be configured to receive a fish engagement profile of a fish inside the well. The plug retaining means can advantageously be configured to engage with the fish engagement profile when the debris plug is accommodated inside the debris plug reception space.

In this manner, the plug retaining means, typically in the form of locking dogs, can be used both for retaining the debris plug in the barrier state, and to engage with the fish inside the well for retrieval of the fish.

The wellbore tool can in some embodiments further comprise a retainment face that is configured to retain the plug retaining means from outward radial movement when engaging the plug retaining means.

Advantageously, when the plug retaining means is used for engaging the fish, the same retainment face can be used to maintain the engagement between the fish and the plug retaining means.

Advantageously, the debris plug comprises a plug guide face, that, when in the barrier state, tapers towards an axial centerline of the wellbore tool. Furthermore, in such or other embodiments, the wellbore tool can have a frustoconical front guide face that encircles the forward-facing aperture.

Advantageously, the plug guide face and the front guide face are flush when the barrier plug is arranged in the barrier state.

Preferably, the wellbore tool will comprise a housing, and the plug retaining means can have locking dogs arranged on flexible locking arms that extend axially out from a common locking cylinder. The common locking cylinder can then be axially movable with respect to the housing. In that manner, the locking dogs will be axially movable into and out of alignment with the retainment face.

In some embodiments, the wellbore tool has a front body that comprises said forward-facing aperture and a frustoconical front guide face. With such a solution, the operator will be able adapt the wellbore tool to the dimensions of the fish that shall be retrieved, by installing a suitable front body to the wellbore tool. For instance, if the fish has a small diameter engagement profile, then a front body having a small aperture and low-diameter retainment face can be mounted to the wellbore tool. Naturally, the dimension of the debris plug would have to be adapted to the front body.

The debris plug can preferably have a plug disengagement face, and the locking dogs can have locking dog disengagement faces. Upon movement of the debris plug in an axial rearward direction, the plug disengagement face is configured to move the locking dogs radially outwards when sliding against said locking dog disengagement faces.

For embodiments involving a debris plug having threads, the plug retaining means can abut a conical inner face of a front body of the wellbore tool, when in the barrier state.

For embodiments involving a debris plug having threads and opposite threads of the plug retaining means, such threads can comprise a first thread angle and a second thread angle, wherein the first thread angle is less steep than the second thread angle. This will facilitate removal of the debris plug out of engagement with the plug retaining means, since less axial force on the debris plug will be needed to force the plug retaining means radially outwards. Simultaneously, such threads will have an increased engagement with a possible fish, for embodiments using the plug retaining means for locking onto a fish in the wellbore.

The debris plug may in some embodiments not only prevent entrance of debris or particles into the wellbore tool, but even fluid. In such embodiments one may provide the wellbore tool with a pressure balancing means to avoid significant pressure drop over the debris plug.

For embodiments of the present invention where the wellbore tool is designed as a fishing tool, an advantage is that the plug retaining means is used for connecting to the fish, hence fulfilling two purposes.

Detailed description of the invention

While various features of the invention have been discussed in general terms above, a more detailed example of embodiment is discussed in the following with reference to the drawings, in which

Fig. 1 is a perspective view of a wellbore tool according to an embodiment of the invention;

Fig. 2 is a cross section side view of the wellbore tool shown in Fig. 1, depicted adjacent a fish to be retrieved from a wellbore;

Fig. 3 to Fig. 9 depict a portion of the wellbore tool that is moved into engagement with a fish for retrieval of the fish;

Fig. 10 is a portion of an alternative embodiment of a wellbore tool according to the invention;

Fig. 11 is an enlarged cross section view of a portion of the wellbore tool shown in Fig. 10;

Fig. 12 is a perspective view of a debris plug configured for use with the wellbore tool shown in Fig. 10 and Fig. 11;

Fig. 13 is a perspective view of a gripping end of the wellbore tool shown in Fig. 10 to Fig. 12; and

Fig. 14 is a schematic view illustrating different thread angles of the threads of the debris plug and plug retaining means.

Fig. 1 shows a wellbore tool 1 with a perspective view. In this embodiment, the wellbore tool 1 is a fishing tool, configured for retrieval of items inside a well bore. Such items are commonly referred as a fish. When used, the wellbore tool 1 is run into the well, such as on a wireline or other deployment methods, such as drill pipes, coiled tubing etc. When at the position of the fish (not shown in Fig. 1), the wellbore tool 1 connects to the fish such that both the wellbore tool 1 and the fish can be pulled back up to the well surface.

Fig. 2 illustrates the same wellbore tool 1 as in Fig. 1 with a cross section view. Moreover, a fish 3 is shown at a gripping end 5 of the wellbore tool 1. Opposite of the gripping end 5, the wellbore tool 1 has a suspension end 7. The suspension end 7 is configured to connect to a suspension element (not shown), such as a wireline.

Fig. 3 to Fig. 9 illustrate the process of connecting the wellbore tool 1 to the fish 3. Reference is first made to Fig. 3, illustrating the gripping end 5 of the wellbore tool 1 and the fish 3 that shall be connected to the tool.

The wellbore tool 1 comprises a plurality of locking dogs 9, which are configured to engage the fish 3. The locking dogs 9 are arranged on flexible locking arms 11, that extends in an axial direction from a common locking cylinder 13. The flexible arms 11 enable the locking dogs 9 to move radially. The locking cylinder 13 and the flexible arms 11 together form a first bore 15.

The locking cylinder 13 and the flexible arms 11 are arranged inside a housing 17. The housing 17 has a housing bore 17a.

Fig. 3 depicts the wellbore tool 1 in a running state, i.e. wherein the wellbore tool 1 is being run from surface into the well (not shown). To avoid that debris enters the wellbore tool 1, the wellbore tool 1 comprises a debris plug 20. When in the shown running state, the debris plug 20 is held in place by the locking dogs 9. Hence, in this embodiment, the same locking dogs that are configured for engagement with the fish 3, are engaging the debris plug 20.

When the debris plug 20 is in its position shown in Fig. 3, held in place with the locking dogs 9, the debris plug 20 is in a barrier state, as it forms a barrier against debris entering the housing bore 17a.

The debris plug 20 has a plug engagement profile 21 that engages the locking dogs 9.

As appears from Fig. 3, the debris plug 20 is arranged inside the housing bore 17a.

At the gripping end 5 of the wellbore tool 1, the wellbore tool 1 comprises a front body 31.

Fig. 4 depicts the same items as in Fig. 3. However, in the situation shown in Fig. 4, the wellbore tool 1 has moved closer towards the fish 3. Reference is also made to Fig. 4a, which shows an enlarged portion of Fig. 4.

The front body 31 comprises a frustoconical, funnel-shaped front guide face 33. The front guide face 33 tapers towards the center, i.e. towards the axial center line (not shown) of the wellbore tool 1. Furthermore, the wellbore tool 1 comprises an axially forward-facing aperture 32. By forward-facing is meant that the aperture faces toward the bottom of the well when the tool is inside the well.

In the present embodiment, where the wellbore tool 1 is a fishing tool, the aperture 32 will thus face towards the fish 3 inside the well.

In this embodiment, the front body 31 comprises the aperture 32. Moreover, in this embodiment, the aperture 32 of the front body 31 is defined by a cylindrical, inwardly facing aperture wall 35.

The debris plug 20 has an external sealing face 23 that abuts the aperture wall 35 of the front body 31. Thus, during running of the wellbore tool 1 into the well, debris is prevented from entering the wellbore tool 1. The debris plug 20 further comprises a plug guide face 25. The plug guide face 25 is conical, tapering towards the axial center line of the wellbore tool 1 and thus also the plug 20. As appears from Fig. 4a, the plug guide face 25 is substantially flush with the front guide face 33 of the front body 31.

Thus, when the wellbore tool 1 approaches and engages the fish 3 inside the wellbore, the fish 1 will slide against the front guide face 33 and/or the plug guide face 25. This will align the wellbore tool 1 with respect to the fish 3, such that the wellbore tool 1 and the fish 3 are aligned with a common center axis.

In the shown embodiment, the fish 3 comprises a coned abutment face 3a, that abuts the said front guide face 33 and/or the plug guide face 25.

Also shown in Fig. 4a, the front body 31 comprises a retainment face 37. In this embodiment, the retainment face can be termed a locking dog retainment face 37. A radially outer portion of the locking dogs 9 abuts the retainment face 37 when in the said running state. In this manner, the debris plug 20 is retained in its sealing state while running the wellbore tool 1 into the well.

Reference is now made to Fig. 5. In the situation shown in Fig. 5, the housing 17 has moved further into the well, i.e. towards the fish 3. The locking dogs 9 and the debris plug 20, however, have not moved, since the debris plug 20 abuts the fish 3. As a result, the debris plug 20 has been pushed away from from the barrier state, i.e. from its engagement with the inwardly facing aperture wall 35. Also, a portion of the fish 3 has moved into the wellbore tool 1, through the aperture 32 defined by the aperture wall 35 of the front body 31.

Reference is now made to Fig. 6 and to Fig. 6a, which shows an enlarged portion of Fig. 6. In this situation, the housing 17 of the wellbore tool 1 has moved even further towards the fish 3. Furthermore, the locking dogs 9 has reached an inner end position, in which they cannot be moved further into the housing 17 (i.e. they cannot be moved further towards the left in Fig. 6 and Fig. 6a). As a result, the locking dogs 9 have been forced out of engagement with the locking dog retainment face 37 of the front body 31.

Furthermore, the plug engagement profile 21 comprises an inclined plug disengagement face 21a. The respective locking dogs 9 comprise a locking dog disengagement face 9a. When the locking dogs 9 retain the debris plug 20, such as in the running state shown in Fig. 3, the locking dog disengagement face 9a abuts the inclined plug disengagement face 21a. When the debris plug 20 is forced further into the wellbore tool 1 by the fish 3, as depicted in Fig. 6 and Fig. 6a, these faces will slide against each other and move the locking dogs 9 radially outwards. Eventually, the locking dogs 9 will no longer engage the debris plug 20. This situation is shown in Fig. 7.

Within the housing bore 17a there is a debris plug reception space 39. When the debris plug 20 is being pushed further into the wellbore tool 1, it will be received in the debris plug reception space 39.

As shown in Fig. 7, the fish 3 comprises a stem portion 3b that typically may be a cylindrical part of the fish 3. Radially extending out from the stem portion 3b there is a fish engagement profile 3c. In the situation shown in Fig. 7, the locking dogs 9 have moved in an axial direction beyond the fish engagement profile 3c and are now axially arranged at the position of the stem portion 3b. The wellbore tool 1 is now ready to securely connect to the fish 3.

In the situation shown in Fig. 8, the housing 17 of the wellbore tool 1, along with the front body 31, has moved backwards (i.e. towards the well surface) with respect to the locking dogs 9. As a result, the locking dogs 9 are again axially arranged at the position of the locking dog retainment face 37 of the front body 31. In this position, the locking dogs 9 are prevented from moving radially outwards.

In the situation shown in Fig. 9, the entire wellbore tool 1 is pulled backwards, i.e. towards the well surface. Consequently, the fish engagement profile 3c moves towards and engages the locking dogs 9. The wellbore tool 1 is now fixed to the fish 3, and the operator can pull the wellbore tool 1 and the fish 3 out of the well. The debris plug 20 remains inside the wellbore tool 1, i.e. inside the debris plug reception space 39, and can be removed from the wellbore tool 1 by the operator when at the surface.

Fig. 10 to Fig. 13 illustrate an alternative embodiment of the present invention. In this embodiment, the wellbore tool 1 comprises a debris plug 120 that is provided with threads 121. Several parts and features of the wellbore tool 1 shown in these figures correspond to the previously discussed embodiment and will not be repeated.

Fig. 11 illustrates this alternative embodiment in detail. The debris plug 120 comprises threads 121 that engage opposite threads 91 arranged on the inner faces of the plug retaining means 9, which in the shown embodiment are in the form of locking dogs. When the locking dogs 9 are in the shown position, i.e. in their debris plug retaining position, the debris plug 120 can be rotated (i.e. screwed) into and out of engagement with the opposite threads 91 of the locking dogs 9. To facilitate such rotation, the debris plug 120 comprises a rotation interface 123 for engagement with a rotation tool (not shown).

Corresponding to the embodiment discussed with reference to Fig. 1 to Fig. 9 above, when the debris plug 120 abuts a fish (not shown) inside the well, the debris plug 120 and the locking dogs 9 will move axially into the wellbore tool 1. As shown in Fig. 11, the front body 31 of this embodiment comprises an conical inner face 137, against which the locking dogs 9 abut when in the shown plug-retaining position (i.e. when the debris plug is in the barrier state). As the skilled person will appreciate, when the debris plug 120 and the locking dogs 9 move axially into the wellbore tool 1 (i.e. towards the left in Fig. 11), the debris plug 120 will no longer be locked to the opposite threads 91 of the locking dogs 9. Since the locking dogs 9, when moved out of engagement with the conical inner face 137, can move radially outwards, the debris plug 120 can move axially rearwards beyond and thus out of engagement with the locking dogs 9.

The opposite threads 91 of the locking dogs 9 are configured to engage with a fish inside the wellbore. When a fish (not shown) is axially aligned with the opposite threads 91, a sliding against the conical inner face 137 will force the locking dogs 9 into a gripping engagement with the fish. Hence, the shown embodiment is suitable for retrieving a fish that is without the fish engagement profile 3c shown with the previously discussed embodiment. The opposite threads 91 may grip onto even a smooth cylindrical outer surface of the fish with sufficient force for retrieval of the fish.

Fig. 12 depicts the threaded debris plug 120 with a perspective view. Fig. 13 is a perspective view of the gripping end 5 of the wellbore tool 1 shown in Fig. 10 and Fig. 11.

Advantageously, the plug retaining means 9, which in the shown embodiments are shown as locking dogs, are configured such that they abut each other to form a complete circle that encircles the debris plug 120. In the shown embodiment, the circle formed by the locking dogs 9 comprises a plurality of, for instance six, locking dogs 9. When the locking dogs 9 are forced in the forward direction, i.e. towards the right in the image of Fig. 11, the abutting faces between the opposite locking dogs 9 can be sufficiently pressed together to constitute a fluid barrier. Such abutting faces are indicated in Fig. 13, where compressed slits 93 are formed between the locking dogs 9.

Although not shown, the threaded debris plug 120 may comprise a plug guide face 25, corresponding to the plug 20 of the embodiment discussed above (see e.g. Fig. 4a).

Fig. 14 is a schematic view illustrating the threads 121 of the debris plug 120 when engaging the opposite threads 91 of the locking dogs 9. As appears from this image, the angles of the threads are different for the two axial directions.

By having one angle less steep, less axial force is needed to move the debris plug 120 of the engagement with the locking dogs 9. In the shown embodiment, a first thread angle $\alpha 1$ is less steep than a second thread angle $\alpha 2$. As the skilled person will understand, the thread faces having the less steep first angle $\alpha 1$ will slide against each other when moving the debris plug 120 of the engagement.

Moreover, the other pitch angle will be steeper, such that a better retaining function is obtained when the opposite threads 91 of the locking dogs 9 engages a fish (not shown) in the wellbore.

While the embodiments discussed above involves an axial force from a fish for disengaging the debris plug 20, 120 from the plug retaining means 9, other embodiments may not. In such other embodiments, one may provide a plug disengaging means (not shown) for pulling the debris plug 20, 120 axially rearwards and out of engagement.

Wellbore tools according to the invention, which are not designed as fishing tools, can typically be a wellbore measuring tool for measuring flow rates, pressure, temperature or chemical compositions.

Since the wellbore tool in some circumstances will need to travel significant distances through the wellbore, e.g. several kilometers, it is advantageous to prevent fluids and/or debris to enter the front end (or gipping end 5) of the wellbore tool 1 before it arrives at the location of operation.

The debris plug 20, 120 can be made of different types of materials, including for instance PEEK, PTFE (*Teflon*), elastomeric materials such as HNBR or NBR, or metals.

Claims

1. A wellbore tool (1) comprising

- an inner bore (17a);
- an axially forward-facing aperture (32) constituting an access between the exterior of the wellbore tool (1) and at least a part of the inner bore (17a);

characterized in that the wellbore tool (1) further comprises

- a debris plug (20, 120) arranged in the forward-facing aperture (32) when in a barrier state;
- a plug retaining means (9) configured to retain the debris plug (20, 120) in the forward-facing aperture (32) and to release the debris plug.

2. A wellbore tool (1) according to claim 1, **characterized in** that the debris plug (120) comprises threads (121), that the plug retaining means (9) comprises opposite threads (91), and that the threads (121) of the debris plug (120) engages the opposite threads (91) of the plug retaining means (9).

3. A wellbore tool (1) according to claim 1, **characterized in** that the debris plug (20) comprises a plug engagement profile (21), and that the plug retaining means (9) comprises locking dogs engaging the plug engagement profile (21) when the debris plug (20) is arranged in the forward-facing aperture (32).

4. A wellbore tool (1) according to one of the preceding claims, **characterized in** that the forward facing aperture (32) is defined by an inwardly facing aperture wall (35), and that the debris plug (20) comprises a sealing face (23) that abuts the aperture wall (35) when in the barrier state.

5. A wellbore tool (1) according to one of the preceding claims, **characterized in** that it comprises a debris plug reception space (39) configured to accommodate the debris plug (20) when not in the barrier state.

6. A wellbore tool (1) according to claim 5, **characterized in** that the forward-facing aperture (32) is configured to receive a fish engagement profile (3c) of a fish (3), and that the plug retaining means (9) is configured to engage with the fish engagement profile (3c) when the debris plug (20) is accommodated inside the debris plug reception space (39).

7. A wellbore tool (1) according to one of the preceding claims, **characterized in** that it further comprises a retainment face (37) configured to retain the plug retaining means (9) from outward radial movement when engaging the plug retaining means.

8. A wellbore tool (1) according to one of the preceding claims, **characterized in** that

- the debris plug (20) comprises a plug guide face (25), that, when in the barrier state, tapers towards an axial centerline of the wellbore tool (1);
- the wellbore tool (1) comprises a frustoconical front guide face (33) that encircles the forward-facing aperture (32).

9. A wellbore tool (1) according to claim 7, or according to claim 7 and any other preceding claims, **characterized in** that it comprises a housing (17), and that the plug retaining means (9) comprises locking dogs arranged on flexible locking arms (11) that extend axially out from a common locking cylinder (13), wherein the common locking cylinder (13) is axially movable with respect to the housing (17), such that the locking dogs are axially movable into and out of alignment with the retainment face (37).

10. A wellbore tool (1) according to one of the preceding claims, **characterized in** that it comprises a front body (31) that comprises said forward-facing aperture (32) and a frustoconical front guide face (33).

11. A wellbore tool (1) according to claim 3, or claim 3 and any other preceding claims, **characterized in** that the debris plug (20) comprises a plug disengagement face (21a), that the locking dogs comprise locking dog disengagement faces (9a), and wherein upon movement of the debris plug (20) in an axial rearward direction, the plug disengagement face (21a) is configured to move the locking dogs radially outwards when sliding against said locking dog disengagement faces (9a).

12. A wellbore tool (1) according to claim 2 or according to claim 2 and any other preceding claim, **characterized in** that when in the barrier state, the plug retaining means (9) abuts a conical inner face (137) of a front body (31) of the wellbore tool (1).

13. A wellbore tool (1) according to claim 2 or according to claim 2 or any other preceding claim, **characterized in** that the threads (121) of the debris plug (120) and the opposite threads (91) of the plug retaining means (9) comprises a first thread angle ($\alpha 1$) and a second thread angle ($\alpha 2$), wherein the first thread angle ($\alpha 1$) is less steep than the second thread angle ($\alpha 2$).

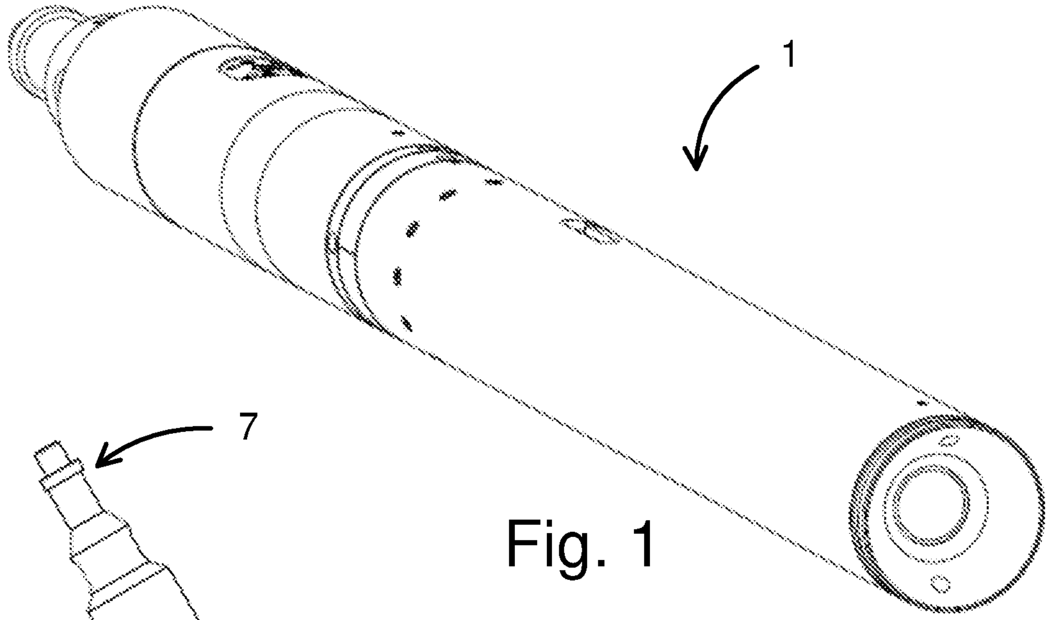

Fig. 1

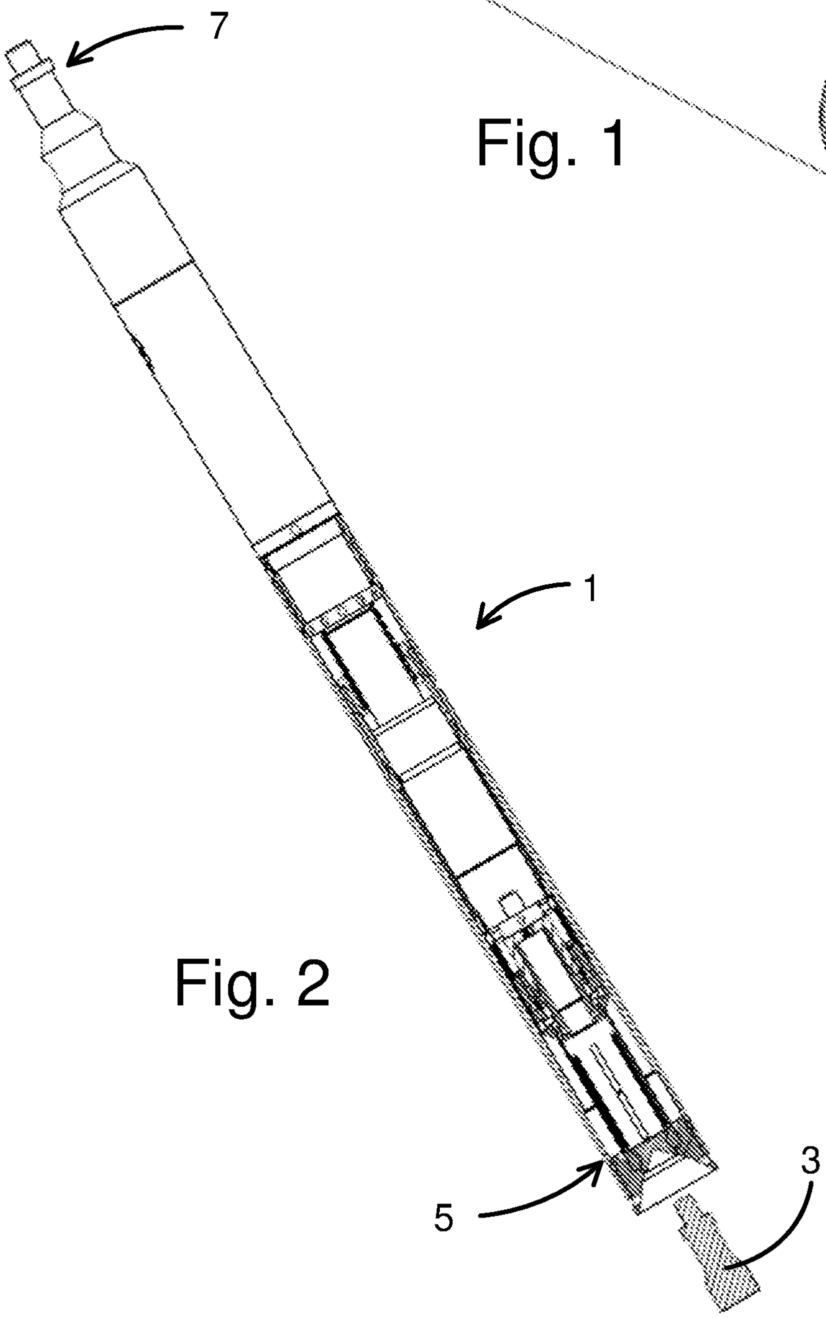

Fig. 2

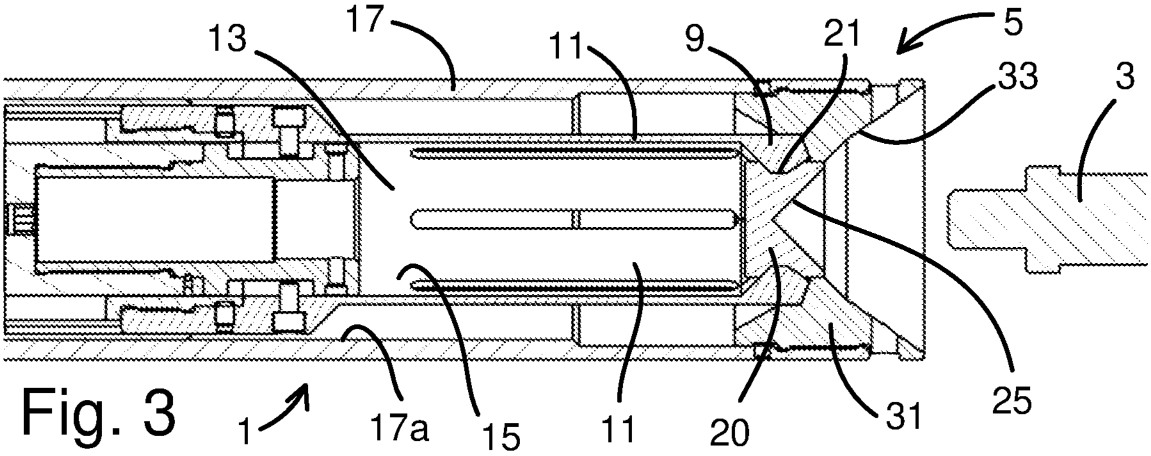

Fig. 3

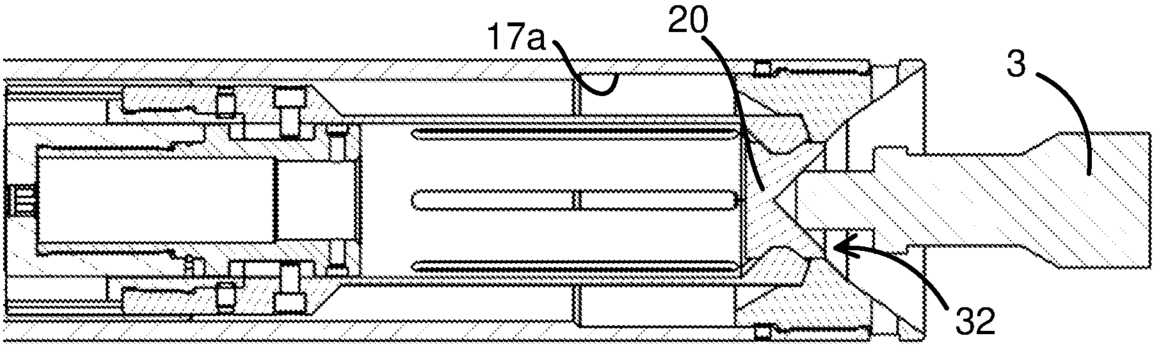

Fig. 4

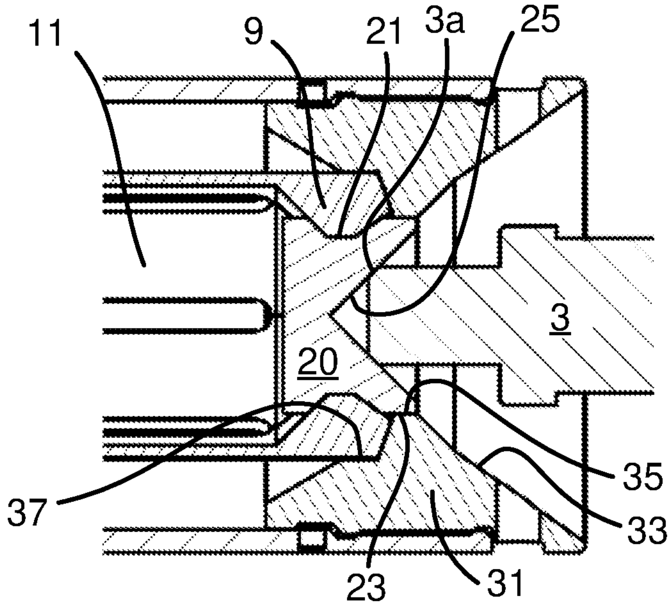

Fig. 4a

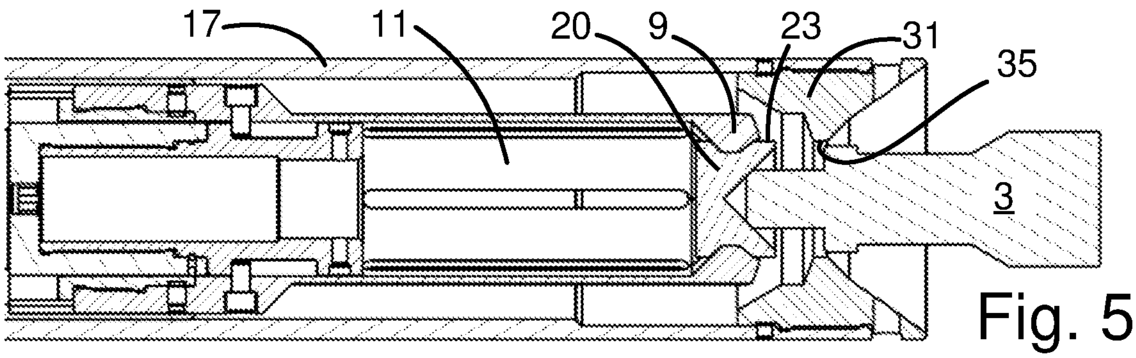

Fig. 5

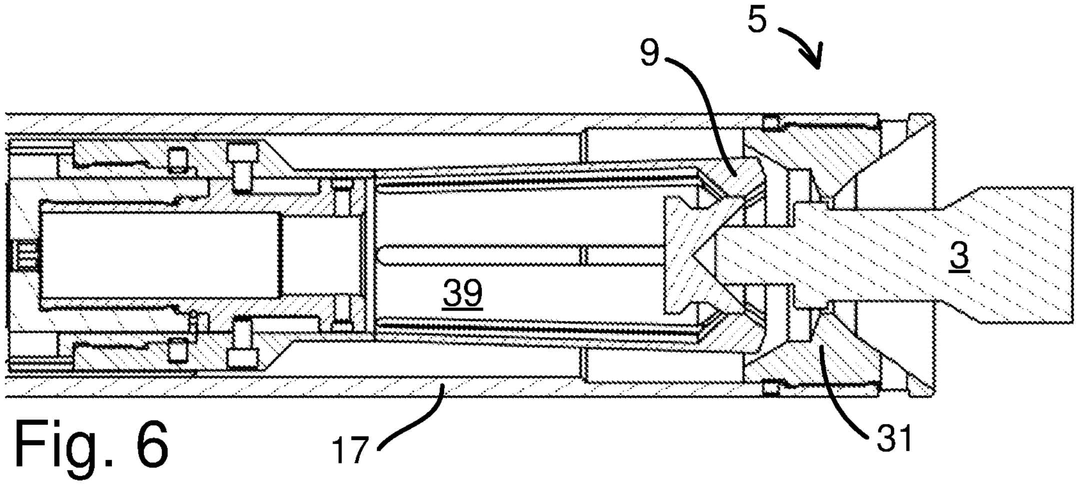

Fig. 6

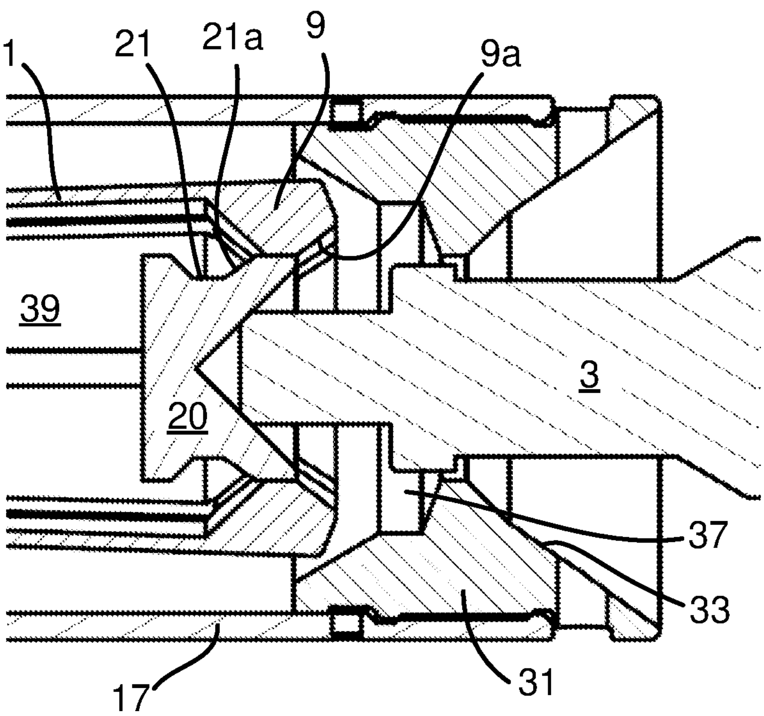

Fig. 6a

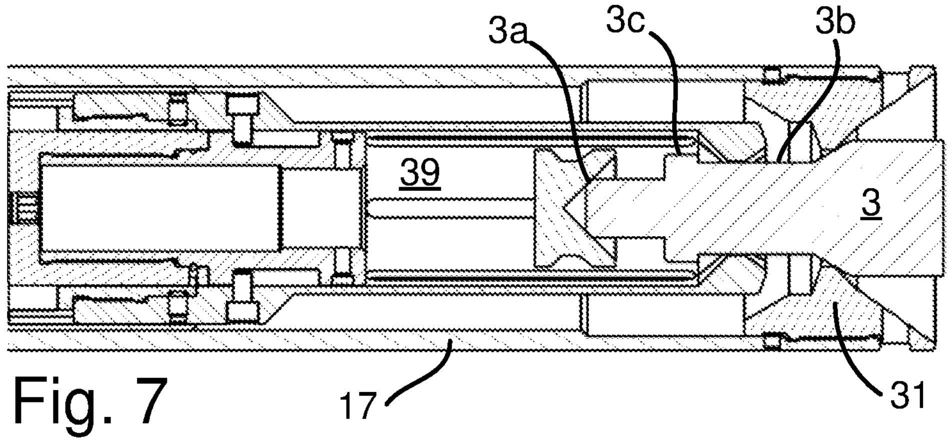

Fig. 7

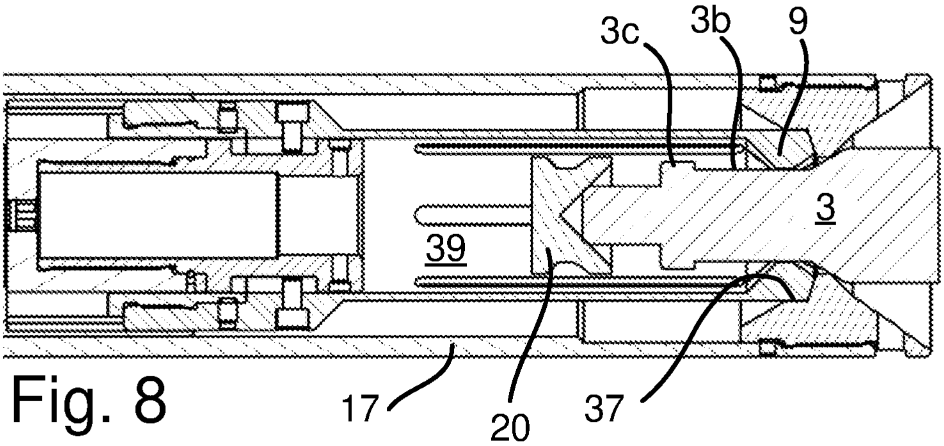

Fig. 8

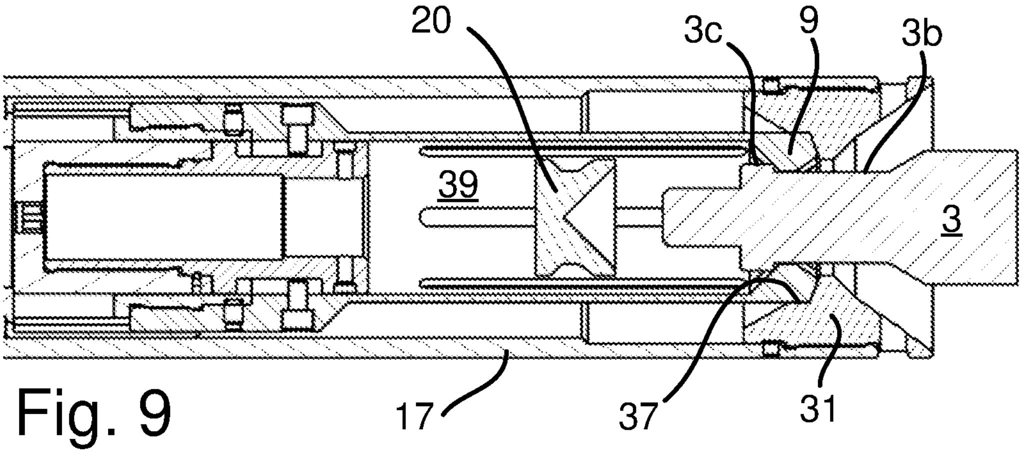

Fig. 9

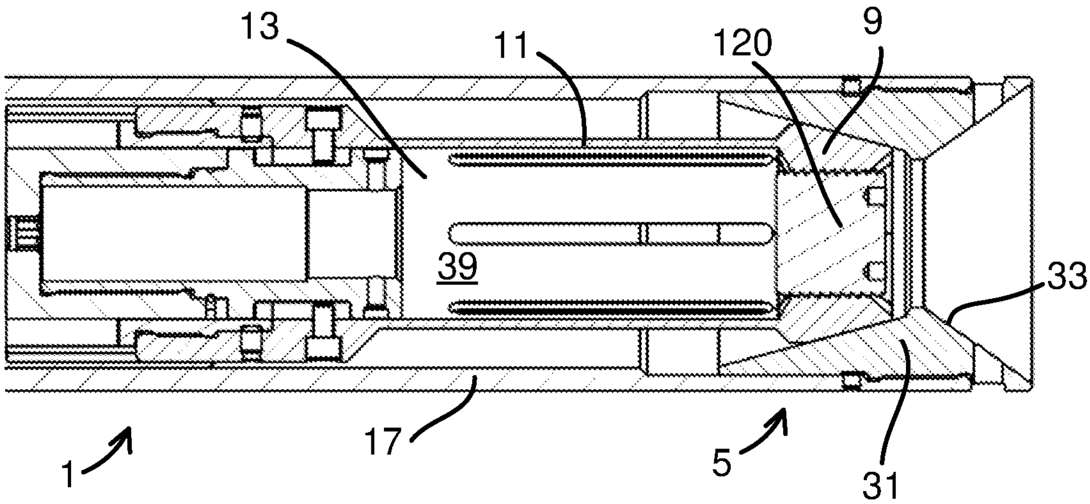

Fig. 10

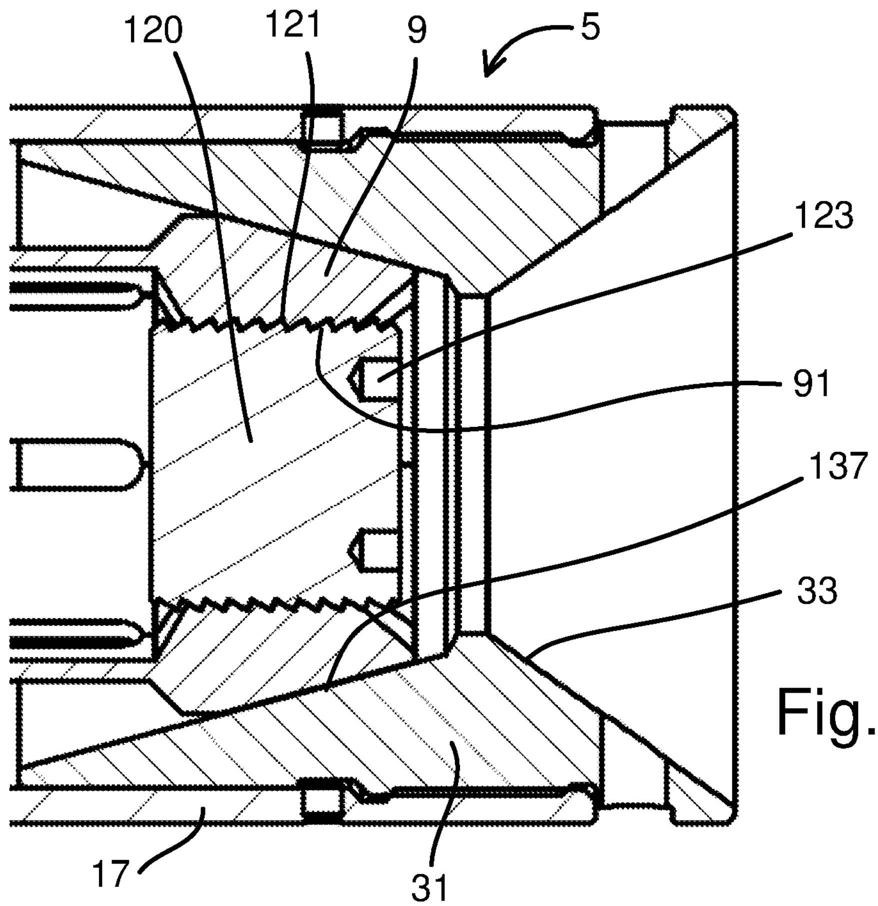

Fig. 11

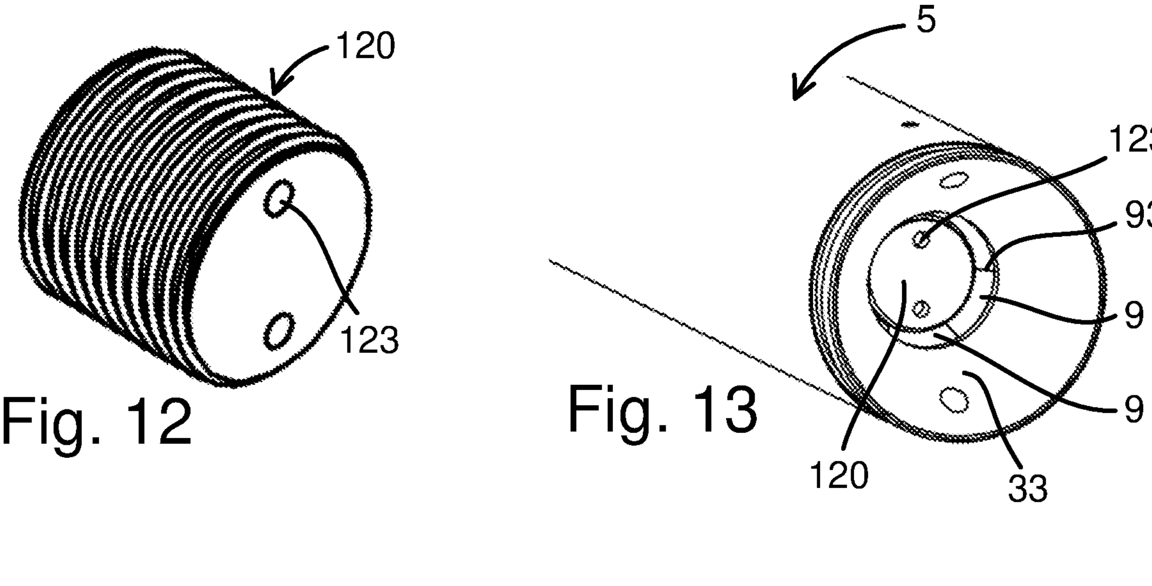

Fig. 12

Fig. 13

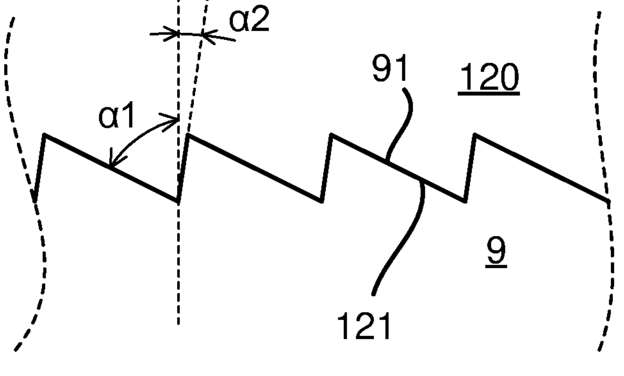

Fig. 14

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO2022/050005

A. CLASSIFICATION OF SUBJECT MATTER

E21B 31/18 (2006.01)i; E21B 31/12 (2006.01)i; E21B 23/04 (2006.01)i

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 31/18; E21B 31/12; E21B 23/04

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

E21B

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

EPODOC, WPI, FULL TEXT: ENGLISH, GERMAN, FRENCH

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2295410 A (BAKER HUGHES INC [US]) 29 May 1996 (1996-05-29) Abstract; figures 5-8; page 5, line 22 – page 6, line 10.	1-13
A	US 2009145604 A1 (RAGAB EMAD H) 11 June 2009 (2009-06-11) Abstract; paragraph [0014]- [0017].	1-13
A	WO 2010140896 A1 (2K TOOLS AS [NO]; MIKALSEN KJELL [NO]; BOTNMARK KETIL [NO]) 09 December 2010 (2010-12-09) Abstract; figures 1-5; page 2, lines 15-20; page 4, lines 11-22.	1-13

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

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"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
28 March 2022	**28 March 2022**

Name and mailing address of the ISA/XN	Authorized officer
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/NO2022/050005

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
GB	2295410	A	29 May 1996	CA	2162942	A	26 May 1996
				US	5580114	A	03 December 1996
US	2009145604	A1	11 June 2009	NONE			
WO	2010140896	A1	09 December 2010	NO	20092139	A	03 December 2010
				GB	2482847	A	15 February 2012
				US	2012118560	A1	17 May 2012