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(72) Inventor: **AADNÖY, Bernt Sigve**
4313 SANDNES (NO)

(74) Representative: **Brann AB**
P.O. Box 12246
102 26 Stockholm (SE)

(71) Applicant: **University Of Stavanger**
4036 Stavanger (NO)

(54) **Method and tool for removal of casings in wells**

(57) A method for removing a casing section (14) from a casing (12) that lines a subsurface borehole (16) is presented. The casing section has a wall constituting an elongated hollow cylinder. The method involves: separating the casing section from the rest of the casing, and cutting the complete casing section in a lengthwise direction of the borehole into at least three elongated casing portions (20). The method further involves: removing the elongated casing portions from the original location of the casing section. A tool (10) for performing the method is also presented

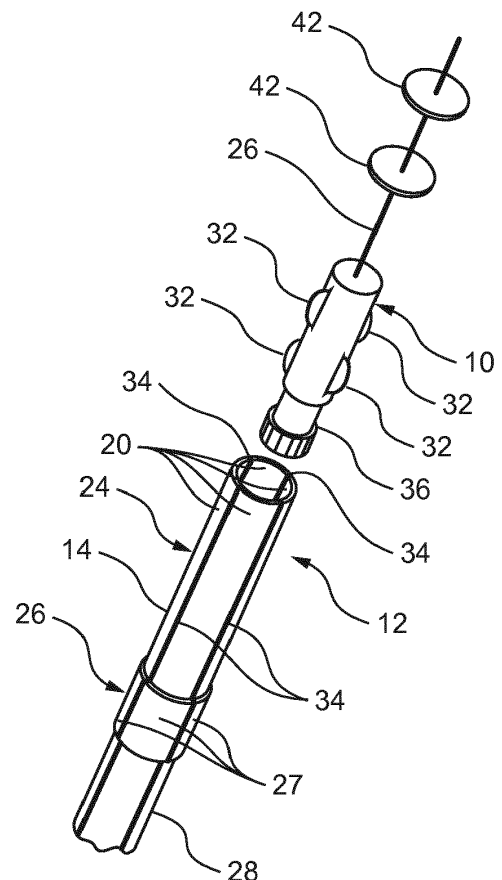


Fig. 1

Description

TECHNICAL FIELD

[0001] The present invention relates to plugging and abandonment operations of old and new wells, in particular in oil and gas fields. The present invention further relates to the removal of a section of a casing lining a borehole.

BACKGROUND

[0002] When a borehole is to be closed or abandoned, the solution for sealing the borehole must be safe and reliable. It is generally required that hydrocarbon emissions from a gas or oil well are prevented from leaking from an abandoned borehole.

[0003] A well in a gas or oil field typically has a casing that lines the inside of a borehole. The casing is typically composed of large diameter pipe sections that are coupled together and inserted into a recently drilled section of a borehole. The casing may be held into place inside the borehole with cement material injected between the casing and the wall of the borehole.

[0004] The casing material typically deteriorates over time, and should therefore not form an integral part of a plug. Furthermore, if cement material is holding the casing in place inside the borehole, it may be permeable to the fluids. It is sometimes difficult to obtain a sufficient good cement barrier. If only the casing is plugged, fluids may leak from the casing, through the cement material, and into the surrounding ground. Thus, the cement material should be sealed with additional material. In order to provide a good cement barrier, the casing is therefore removed and the wellbore opened up exposing a fresh formation or a surrounding cement barrier. A cement plug is then typically set in the newly opened hole.

[0005] There exist several methods to remove a casing inside a well. The most commonly used are milling from the top of the exposed casing and section milling inside a casing interval. These conventional milling operations are time consuming since the entire steel material of casing section has to be milled into small fragments. For longer casing strings or intervals, such operations may take several weeks.

SUMMARY

[0006] It is an object of the present invention to reduce the time needed for plug and abandonment operations in old wells. It is also an object of the present invention to reduce time in removing the casing or a portion of the casing inside a well. Additionally, it is an object of the invention to reduce the time needed for a complete removal of casing section.

[0007] The above objects, and further objects that are conceivable from the specifications, are achieved by a first aspect of the present invention involving a method

for removing a casing section from a casing that lines a subsurface borehole. The casing section comprises a wall constituting an elongated hollow cylinder. The method comprises: separating the casing section from the rest of the casing, cutting the complete casing section in a lengthwise direction of the borehole into at least three elongated casing portions, and removing the elongated casing portions from the original location of the casing section.

[0008] The cutting into elongated casing portions has the effect that the casing section can be removed in large pieces, which means that the required amount of energy and time is reduced. Furthermore, cutting requires only a small amount of the material, such as 1 %, of the casing section to be removed by machining, while in existing techniques, such as milling, 100 % of the material is removed through machining. This also reduces the required amount of energy and time of the operation.

[0009] The casing section may be a pipe segment in a long series of pipe segments constituting a casing string. Additionally or alternatively, the number of elongated casing portions may be 3, 4, 5, 6. Preferably, the number of elongated casing portions is 4. With this number of elongated casing portions, they can readily be transported together inside the casing, even if the cutting as such removes little material.

[0010] The step of separating the casing section may be performed prior, simultaneous, and/or subsequent to cutting the casing in a lengthwise direction. For example, if a casing section is a pipe segment joined to the rest of the casing by a coupling, the coupling may be broken before or after cutting the casing section. If couplings are not used, for example if the casing section is a pipe segment with a male threaded end coupled to a female threaded end of another pipe segment, the separating is then simultaneous to cutting the casing.

[0011] The step of removing the elongated casing portions may comprise: pulling an elongated casing portion of the at least three elongated casing portions back through the borehole. Alternatively, the step of removing the elongated casing portions may comprise: pulling all elongated casing portions back through the borehole. The pulling back through the borehole may be inside the casing. The inclination of the borehole at the original location of the casing section may have a vertical component and the step of removing the elongated casing portions may comprise: allowing an elongated casing portion of the at least three elongated casing portions to fall downward into the borehole.

[0012] The step of removing the elongated casing portions may comprise: guiding an elongated casing portion of the at least three elongated casing portions deeper into the borehole. Alternatively or additionally, the step of removing the elongated casing portions may comprise: transporting an elongated casing portion of the at least three elongated casing portions deeper into than the original location of the casing section and subsequently releasing the elongated casing portion.

[0013] The casing section may be connected to the casing by an annular connector and the step of separating the casing section may comprise: cutting the annular connector in a lengthwise direction of the borehole into connector portions corresponding in number to the at least three elongated casing portions. The pipe section may be a male threaded pipe and the annular connector may be shorter double-female threaded pipe. The remaining of the casing may be composed of a series of male threaded pipes coupled by shorter double-female threaded pipes. The whole casing may be a casing string of composed of pipe sections having the same diameter. The casing string may line the complete borehole. Alternatively, the casing string may line a portion of the borehole and be connected in series with another casing string.

[0014] The casing section may be integral with the rest of the casing at an end of the casing section and the step of separating the casing section may comprise: cutting the casing at the end of the casing section for separating the casing section from the casing at that end. The cutting of the casing at the end of the casing section may be in a radial direction with respect to the wall of the casing section.

[0015] One or more of the above objects are achieved by a second aspect of the invention involving a method for sealing a subsurface borehole at least in part lined with a casing. The method comprises: removing a casing section from the casing that lines the subsurface borehole according to the method described in relation to the first aspect of the present invention. The casing section comprises a wall constituting an elongated hollow cylinder, and the method further comprises: introducing a curable medium at the original location of the casing section filling at least a portion of the borehole at the original location of the casing. An example of a curable medium is a cement mixture, such as concrete. The curable medium may contact the naked walls of borehole. This aspect has the additional effect that a safe and secure plugging of the borehole is achieved without the risk of the casing deteriorating and starting to leak. Furthermore, with the reduced time for removing a casing section, more locations or longer sections of the borehole can be plugged. After the step of removing the casing, the borehole may be reamed at the original location of the casing section to provide a fresh rock. This has the effect that the seal is improved. As an alternative to introducing a curable medium at the original location, the open borehole may be plugged with a mechanical plug.

[0016] All the additional or alternative features described above in relation to the first aspect of the present invention may be implemented in the second aspect of the present invention.

[0017] One or more of the above aspects are achieved by a third aspect of the invention. The third aspect is constituted by a cutting tool for cutting a casing section of a casing that lines a subsurface borehole into elongated casing portions, and the casing section comprises a

wall constituting an elongated hollow cylinder. The cutting tool comprises: a support structure for being introduced into and moved along the casing, and a cutter arranged on the support structure for cutting the complete casing section in a lengthwise direction of the borehole into a three or more elongated casing portions when moving the cutting tool along the casing section.

[0018] The arrangement of the cutter enables a quick removal of a casing section in that it can be removed in a few large pieces. The cutter may be adapted to cut the casing section into the elongated casing portion in one passage of the cutter through the casing section. This further reduced the time required for a removal of the casing. The wall of the casing may have a circular cross section and the cutter may be adapted for cutting the casing section into elongated casing portions of equal shape and/or size.

[0019] The cutter may comprise a plurality of circular cutting or abrasion disc for cutting the casing section into the elongated casing portions. For example, the circular cutting or abrasion discs may be a diamond saw blades. Alternatively or additionally, the cutter may comprise a laser cutter or water jet. Each circular cutting or abrasion disc may be retractable with respect to the support structure for allowing the cutting tool to be inserted into the casing, and each circular cutting or abrasion disc may be extendable with respect to the support structure for allowing the circular cutting or abrasion discs to contact and cut the wall of the casing section. For example, this may be achieved by expanding the circular cutting or abrasion disc so the outer diameter exceeds that of the casing section and any couplings connected to the casing section. With this arrangement, the cutting tool can be positioned at any location along the casing before commencing the cutting. Furthermore, the cutting tool can be moved in any direction while cutting. This gives great flexibility in performing a plugging operation, and the required time of operation can typically be reduced.

[0020] The cutting tool may further comprise: a casing portion support for carrying the elongated casing portions with the cutting tool in a movement of the cutting tool inside the borehole. The casing portion support may be further adapted for carrying the elongated casing portions in a movement of the cutting tool inside and along the casing. This allows for the elongated casing portions to be pulled back through the borehole or to guide or transport them deeper into the borehole.

[0021] The casing section may be of a ferromagnetic material and the casing portion support may comprise one or more electromagnets for carrying the elongated casing portions. This allows for a swift handling of the elongated casing portions, for example when pulling them back through the borehole. Alternatively or additionally, the casing portion support may comprise a mechanical clamping device for carrying the elongated casing portions. The casing portion support may be arranged on the support structure at a location that is deeper in the borehole than the cutter. This is particularly advan-

tageous if cutting tool is operated to pull elongated casing portions back through the borehole.

[0022] The cutting tool may further comprise: a centralizer for preventing the elongated casing portions from collapsing inwards subsequent to a cutting of the casing section into the elongated casing portions. Additionally or alternatively the cutting tool may further comprise: a centralizer for supporting the elongated casing portions at the original location of the casing section subsequent to a cutting of the casing section into the elongated casing portions. This has the effect that the elongated casing portions are prevented from collapsing inward and trapping the cutting tool or falling into the borehole.

[0023] The centralizers may be arranged on the support structure. Additionally or alternatively, the centralizer may comprise a wheel supported by the support structure, and the wheel may be rotatable in the lengthwise direction of the casing section. The wheel may be biased to press against the elongated casing portions.

[0024] The centralizer may be located at a shallower depth in the borehole than the cutter. This is particularly advantageous when cutting in a direction downward, since then cuts longer than the support structure can be made without the elongated casing portion collapsing inward and preventing the cutting tool to be pulled backward. This allows for longer cutting operations without removal of a previously cut casing section, which may reduce the operation time of removing several casing sections. The cutting tool may further comprise a connector support for connecting the support structure to equipment above the borehole and supporting the support structure inside the borehole. The centralizer may be attached to the connector support. The centralizer may be a disc like structure centered on and oriented at a right angle to the connector support. This solution allows for particularly long cutting operations with several pipe sections cut in one continuous movement downward.

[0025] The connector support may be wireline. Alternatively, the connector support may be tubing, which is particularly advantageous for bore holes with high well-bore inclination.

[0026] All the additional or alternative features described above in relation to the first aspect of the present invention may be implemented in the second aspect of the present invention.

[0027] In all aspects, the borehole may form part of an oil and/or gas well. Alternatively, the borehole may form part of a water well.

[0028] The above defined aspects of the invention are not limited to be used in plug and abandonment operations only, but can also be employed also in other applications, such as when removing a part of a casing or liner to recomplete a production well or to create a flow window in an injection well.

[0029] Other objects, advantages and features of embodiments of the invention will be explained in the following detailed description when considered in conjunction

with the accompanying drawings and claims.

BRIEF DESCRIPTION OF DRAWINGS

5 [0030]

Fig. 1 is a perspective view of a casing and an embodiment of a cutting tool illustrating the operation of the cutting tool,

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Fig. 2 is a cross-sectional side view of a borehole illustrating an embodiment of the cutting tool in operation,

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Fig. 3a-c are cross-sectional views of boreholes illustrating the cutting of a casing section according to different embodiments,

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Fig. 4a-c are cross-sectional views of boreholes illustrating the removal elongated casing portions according to different embodiments, and

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Fig. 5a-b are side view of an embodiment of the cutting tool.

DETAILED DESCRIPTION

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[0031] Figs. 1 and 2 illustrate the use of a cutting tool 10 for removing a casing section 14 from a casing 12 that lines a subsurface borehole 16 in the ground 22. The casing section 14 comprises a wall 18 constituting an elongated hollow cylinder having a circular cross-section. The casing section 14 is a pipe segment or section 24 in a long series of pipe segments constituting a casing string. The pipe segment or section 24 is joined to the rest of the casing 12 by a coupling or connector 26. The pipe segment or section 24 is a male threaded pipe and the annular coupling or connector 26 is a shorter double-female threaded pipe connecting to another male threaded pipe segment or section 28.

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[0032] The cutting tool has a support structure 30 in the form of a hollow steel cylinder of a sufficiently small diameter for being introduced into and moved along the casing 12. A cutter in the form of four circular cutting diamond saw blades 32 are arranged on and supported by the support structure 30. The diamond saw blades 32 are driven by electrical motors located inside the support structure 30. The electric motor is supplied with electricity by way of an electric wire 38 connecting the cutting tool 10 to a power supply at the surface.

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[0033] The diamond saw blades 32 are arranged on the support structure 30 and extend from the support structure 30 so that they cut the casing section 14 lengthwise into four elongated casing portions of equal size and shape. This is achieved by a first pair of the diamond saw blades 32 being parallel to one another and the remaining second pair of diamond saw blades 32 being parallel to one another, and the diamond saw blades 32 of the first

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pair being perpendicular to the diamond saw blades 32 of the second pair. The diamond saw blades 32 of the first pair are located on the same elevation, and the diamond saw blades 32 of the second pair are located on the same elevation, but below the first pair. In an alternative embodiment, the diamond saw blades 32 may be stacked lengthwise with respect to the support structure 30.

[0034] The lengthwise cutting is illustrated in Fig. 1, showing the cuts 34 that the diamond saw blades 32 will make when the cutting tool is moved downward inside the casing 12. The locations of the cuts 34 are also illustrated in Fig. 3b. In other embodiments, the number of diamond saw blades 32 is three or five, and the corresponding locations of the cuts dividing the casing section 14 into elongated casing portions 20 of equal size and shape are illustrated in Fig. 3a and 3b, respectively.

[0035] The diamond saw blades 32 are retractable with respect to the support structure 30 into the support structure 30 via apertures 31, thus allowing the cutting tool 10 to be inserted into the casing 12. Each diamond saw blades 32 is further extendable with respect to the support structure 30 so that it can contact and cut the wall of the casing section 14. The retraction and extension of the diamond saw blades 32 is controlled by electrical actuators attached to and supported within the support structure 30. The diamond saw blades 32 are shown in extended state in Fig. 5a and retracted state in Fig. 5b. The electric actuator is supplied with electricity by way of the electric wire 38 connecting the cutting tool 10 to a power supply at the surface.

[0036] In the extended state, the outer diameter or maximum extent of the diamond saw blades 32 defines an effective diameter of the cutting tool 10 that exceeds the diameter of the casing section 14 and the coupling 26 connected to the casing section 14. Thus, in the extended state, the four diamond saw blades 32 will cut the complete casing section 14 in a lengthwise direction of the borehole 16 into four elongated casing portions when the cutting tool 10 is moved along the casing section 14. The effective diameter also exceed the outer diameter of the annular connector 26, thus cutting it in a lengthwise direction of the borehole 16 into four connector portions 27 of equal size and shape when the cutting tool is moved through the connector 26. Two of the cuts of the connector 26 are shown in Fig. 1.

[0037] In the cutting illustrated in Fig. 1, the cutting tool 10 is moved downward, which means that the coupling 26 is cut after the casing section 14. Thus the casing section 14 is separated from the rest of the casing 12 subsequent to the cutting of the casing section 14, provided that the casing section is already separated at its upper end. In the cutting illustrated in Fig. 2, the cutting tool 10 is moved downward, which means that the coupling 26 is cut before the casing section 14. Thus the casing section 14 is separated from the rest of the casing 12 prior to the cutting of the casing section 14, provided that the casing section is already separated at its lower

end.

[0038] After the casing section 14 has been cut into four elongated casing portions 20, the elongated casing portions 20 are removed from the original location of the casing section 14. The cutting tool 10 has a casing portion support 36 for carrying the elongated casing portions with the cutting tool in a movement of the cutting tool inside the borehole. The casing section 14 is of ferromagnetic steel and the casing portion support 36 has electromagnets that can carry the elongated casing portions 20 by way of generating a magnetic field. The electromagnet 36 is supplied with electricity by way of an electric wire 38 connecting the cutting tool 10 to a power supply at the surface.

[0039] The cutting tool 10 has a connector support 40 in the form of a steel wire which supports the support structure 30 inside the borehole 16. The elongated casing portions 20 are pulled back through the casing 12 and borehole 16 together with the support structure 30 by pulling the connector support 40. This is illustrated in Fig. 4b, showing how the elongated casing portions 20 are attracted to the electro magnet 36 and arranged so that they so can be pulled through the casing 12. The casing portion support 36 is located a location that is deeper in the borehole than the diamond saw blades 32, which means that the elongated casing portions 20 can easily be pulled back through the borehole 16.

[0040] The casing portion support 34 can carry the elongated casing portions 20 in a movement of the cutting tool inside and along the casing, both up and down. Thus, an operator of the cutting tool can choose to remove the elongated casing portions 20 from the original location of the casing section 14 by pulling them back through the borehole or to guide or transport them deeper into the borehole. This can be done inside the remaining casing 12. The elongated casing portions can be released deeper in the borehole 14 without a casing, as is illustrated in Fig. 4c, or within a casing, as is illustrated in Fig. 4a.

[0041] In an alternative embodiment, the four elongated casing portions 20 are allowed to fall downward into the borehole subsequent to the cutting.

[0042] The cutting tool 10 has centralizers in the form of a disc like structures 42 attached to the connector support 40. This way, the centralizer is located at a shallower depth in the borehole 16 than the diamond saw blades 32. The disc like structures 42 are centered on and oriented at a right angle so that the connector support 40 extends in a direction that is normal to the disc like structures 42. In Fig. 2 the cutting tool 10 is moved downward and the disc like structures 42 prevents the previously cut casing section 44 or pipe segments from collapsing inward. When the cutting tool 10 moves further downward, the disc like structures 42 will supporting the elongated casing portions 20 at the original location of the casing section 14 subsequent to the cutting of the casing section 14

[0043] Centralizers are also arranged on the support structure 30 in the form of wheels 46 supported by the

support structure 30. The wheels 46 are rotatable in the lengthwise direction of the casing section 14 and are biased to press against the elongated casing portions. This prevents the elongated casing portions 20 from collapsing on the cutting tool 10 while cutting and also centers the cutting tool 10 and the diamond saw blades 32 in the casing section 14 so that it can be cut into elongated casing portions 20 of equal size and shape.

[0044] In an embodiment not shown in the figures, after the elongated casing portions 20 have been removed from the original location of the casing section 14 and the cutting tool 10 has been removed from the borehole, a curable medium in the form of a cement mixture is introduced at the original location of the casing section 14 with a known technique. After the curable medium has cured, a plug has been formed at the original location of the casing section 14. In alternative embodiments, the borehole 16 may be reamed at the original location of the casing section 14 and mechanical plug may be used instead of a curable medium.

ITEM LIST

[0045]

10 cutting tool
12 casing
14 casing section
16 borehole
18 wall
20 elongated casing portions
22 ground
24 pipe segment
26 coupling or connector
27 connector portion
28 pipe section
30 support structure
31 apertures
32 diamond saw blades
34 cuts
36 electro magnet
38 electric wire
40 connector support
42 disc like structures
44 previously cut casing section
46 wheels

Claims

1. A method for removing a casing section from a casing that lines a subsurface borehole, the casing section comprises a wall constituting an elongated hollow cylinder, and the method comprises:

separating the casing section from the rest of the casing,
cutting the complete casing section in a length-

wise direction of the borehole into at least three elongated casing portions, and
removing the elongated casing portions from the original location of the casing section.

2. The method according to claim 1, wherein the step of removing the elongated casing portions comprises: pulling an elongated casing portion of the at least three elongated casing portions back through the borehole.
3. The method according to claim 1, wherein the inclination of the borehole at the original location of the casing section has a vertical component and the step of removing the elongated casing portions comprises: allowing an elongated casing portion of the at least three elongated casing portions to fall downward into the borehole.
4. The method according to claim 1, wherein the step of removing the elongated casing portions comprises: transporting an elongated casing portion of the at least three elongated casing portions deeper into than the original location of the casing section and subsequently releasing the elongated casing portion.
5. The method according to any of the claims 1-4, wherein the casing section is connected to the casing by an annular connector and the step of separating the casing section comprises: cutting the annular connector in a lengthwise direction of the borehole into connector portions corresponding in number to the at least three elongated casing portions.
6. The method according to any of the claims 1-5, wherein the casing section is integral with the rest of the casing at an end casing section and the step of separating the casing section comprises: cutting the casing at the end of the casing section for separating the casing section from the casing at that end.
7. A method for sealing a subsurface borehole at least in part lined with a casing, the method comprises:

removing a casing section from the casing that lines the subsurface borehole according to the method described in any of the claims 1-6, the casing section comprises a wall constituting an elongated hollow cylinder, and
introducing a curable medium at the original location of the casing section filling at least a portion of the borehole at the original location of the casing.

8. A cutting tool for cutting a casing section of a casing that lines a subsurface borehole into elongated casing portions, the casing section comprises a wall con-

stituting an elongated hollow cylinder, the cutting tool comprises:

a support structure for being introduced into and moved along the casing, and 5
a cutter arranged on the support structure for cutting the complete casing section in a length-wise direction of the borehole into a three or more elongated casing portions when moving the cutting tool along the casing section. 10

9. The cutting tool according to claim 8, wherein the cutter is adapted to cut the casing section into the elongated casing portion in one passage of the cutter through the casing section. 15
10. The cutting tool according to any of the claims 8-9, wherein the wall of the casing has a circular cross section and the cutter is adapted for cutting the casing section into elongated casing portions of equal shape and/or size. 20
11. The cutting tool according to any of the claims 8-10, wherein the cutter comprises a plurality of circular cutting or abrasion disc for cutting the casing section into the elongated casing portions. 25
12. The cutting tool according to claim 11, wherein each circular cutting or abrasion disc is retractable with respect to the support structure for allowing the cutting tool to be inserted into the casing, and each circular cutting or abrasion disc is extendable with respect to the support structure for allowing the circular cutting or abrasion discs to contact and cut the wall of the casing section. 30
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13. The cutting tool according to any of the claims 8-12, wherein the cutting tool further comprises:
a casing portion support for carrying the elongated casing portions with the cutting tool in a movement of the cutting tool inside the borehole. 40
14. The cutting tool according to claim 13, wherein the casing section is of a ferromagnetic material and the casing portion support comprises one or more electromagnets for carrying the elongated casing portions. 45
15. The cutting tool according to any of the claims 8-14, wherein the cutting tool further comprises:
a centralizer for preventing the elongated casing portions from collapsing inwards subsequent to a cutting of the casing section into the elongated casing portions. 50
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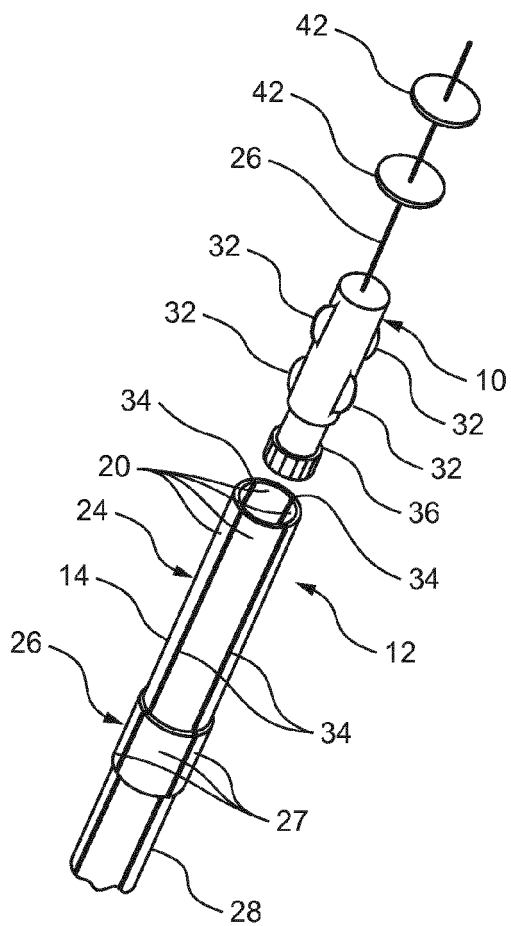


Fig. 1

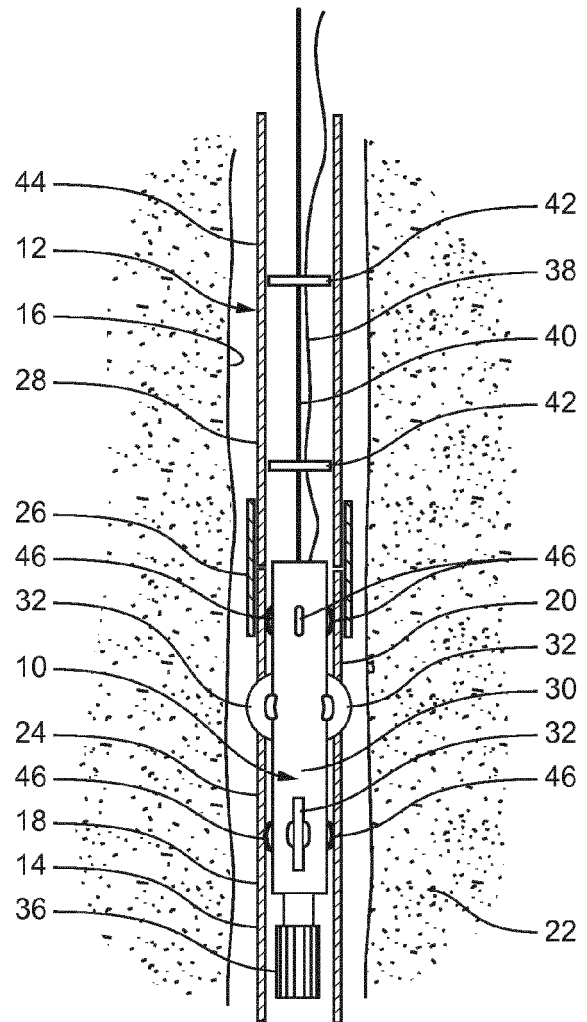


Fig. 2

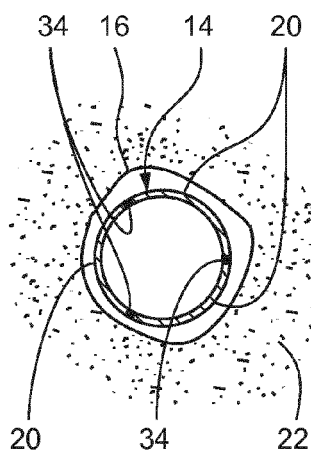


Fig. 3a

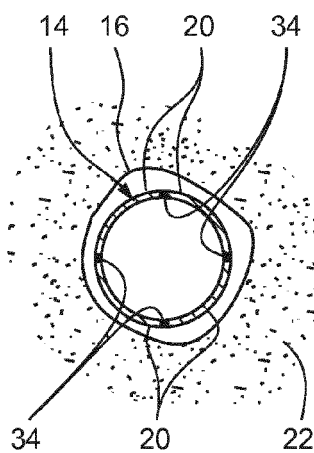


Fig. 3b

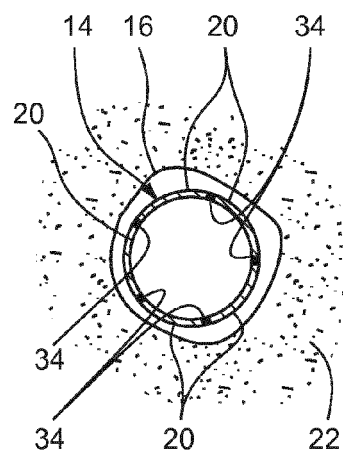


Fig. 3c

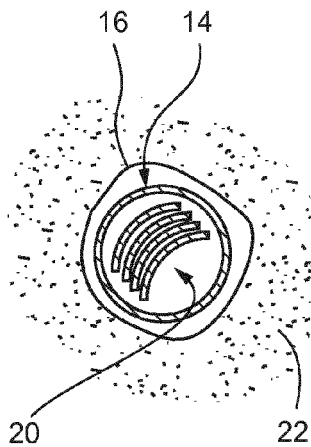


Fig. 4a

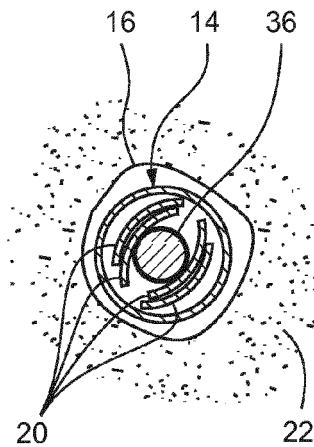


Fig. 4b

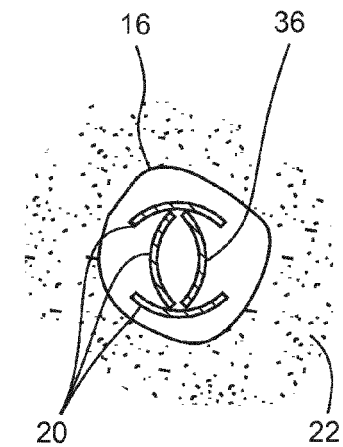


Fig. 4c

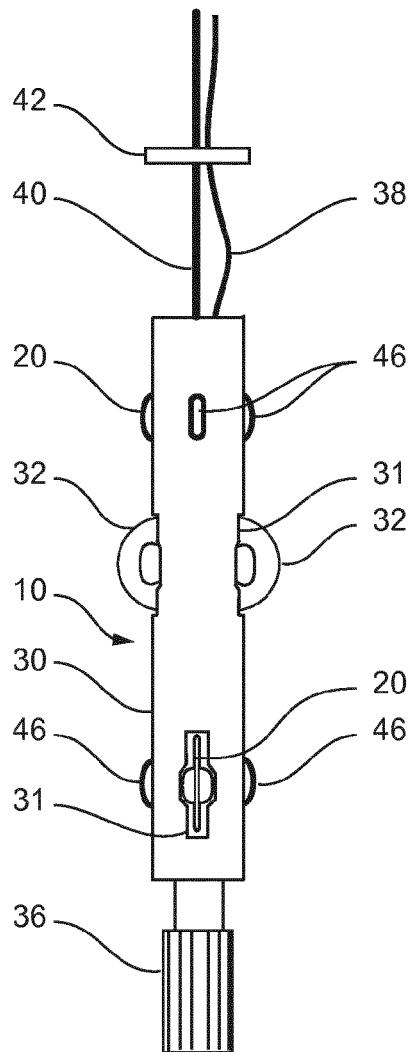


Fig. 5a

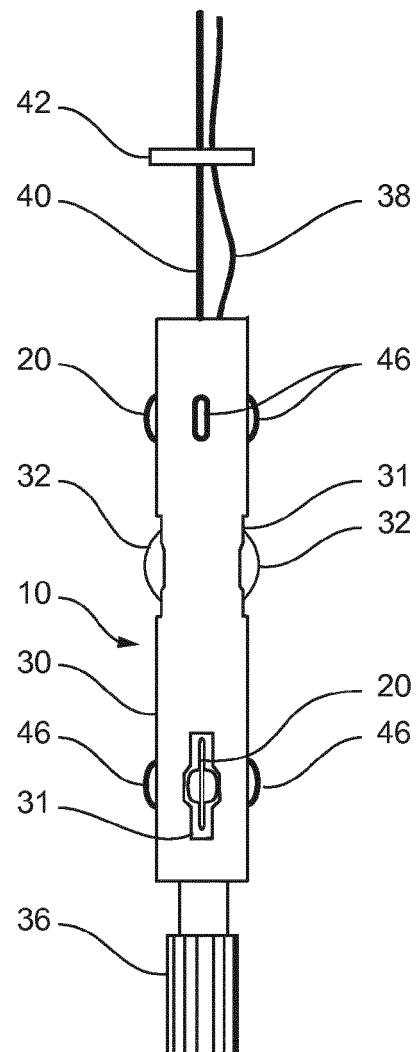


Fig. 5b



EUROPEAN SEARCH REPORT

Application Number
EP 14 18 2748

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2014/231087 A1 (ORSTAD LEIF [NO]) 21 August 2014 (2014-08-21) * paragraphs [0001], [0002], [0039] - [0053], [0057], [0071] - [0079], [0121] - [0133]; figures 13-20 *	1-15	INV. E21B29/00
A	US 2009/071640 A1 (IVANOV ANATOLIY NIKOLAYEVICH [RU] ET AL) 19 March 2009 (2009-03-19) * paragraph [0036] - paragraph [0055]; figures *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			E21B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 9 February 2015	Examiner Dekker, Derk
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			

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EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 14 18 2748

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2014231087 A1	21-08-2014	AU 2012337455 A1	17-04-2014
		CA 2850915 A1	23-05-2013
		CN 103930643 A	16-07-2014
		EA 201490934 A1	30-10-2014
		EP 2780537 A1	24-09-2014
		NO 333912 B1	21-10-2013
		US 2014231087 A1	21-08-2014
		WO 2013073949 A1	23-05-2013

US 2009071640 A1	19-03-2009	NONE	

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