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

(11) EP 2 594 734 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
22.05.2013 Bulletin 2013/21

(51) Int Cl.:
E21B 47/01 *(2012.01)*

(21) Application number: **11290550.0**

(22) Date of filing: **21.11.2011**

(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

(71) Applicants:
- **Services Pétroliers Schlumberger**
  75007 Paris (FR)
  Designated Contracting States:
  FR
- **Schlumberger Technology B.V.**
  2514 JG The Hague (NL)
  Designated Contracting States:
  AL BG CZ DE DK GR HU IE IT LT MK NO PL RO RS SI SK SM TR
- **Schlumberger Holdings Limited**
  Tortola (VG)
  Designated Contracting States:
  GB NL
- **PRAD Research and Development Limited**
  Road Town, Tortola (VG)
  Designated Contracting States:
  AT BE CH CY EE ES FI HR IS LI LU LV MC MT PT SE

(72) Inventor: **Mouget, Pierre**
92310 Sèvres (FR)

(74) Representative: **Rzaniak, Martin**
Etudes & Productions Schlumberger
1, rue Henri Becquerel, BP 202
92142 Clamart Cedex (FR)

(54) Well data acquisition tool probe guard

(57) A probe assembly for use with a well data acquisition tool includes a probe and a probe guard. The probe includes a body and a tip extending from the body along a longitudinal axis of the tip to a terminal end. The tip defines a length and a surface area along the length and is configured for sensing one or more well characteristics. The probe guard extends about the tip of the probe and leaves a majority of the surface area of the tip exposed to a flow that is angularly offset from the longitudinal axis of the tip of the probe.

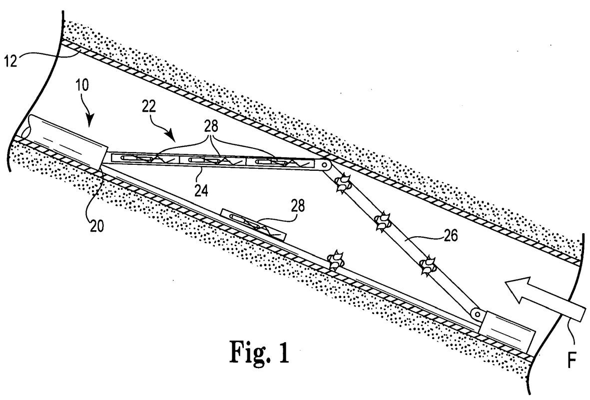

Fig. 1

EP 2 594 734 A1

Description

Background

[0001] Oil and gas explorations and/or productions rely on well logging, a process of taking well measurements in order to evaluate a well throughout its various life-cycle phases, including drilling (e.g., logging-while-drilling or measurement-while-drilling), wireline logging, testing, completion, production, and abandonment phases. Over the years, increasingly sophisticated tools and testing strategies have been developed to characterize well properties and performance. Measurements are often made of the fluid moving in the well, where the fluid may include mixtures of oil, water, gas, and particulate in various proportions. Measurements of local fluid properties in oil wells often include electrical resistivity and optical reflectivity, among others. Often times, the probes utilized for these measurements include relatively delicate tips with diameters tapering from about 1 millimeter to about 50 micrometers, for example. Due to the sensitivity of the tips, there is often an increased risk of tip damage, during conveyance within the well or from debris in the fluid flowing across the tip, for example.

Summary

[0002] Some embodiments relate to a probe guard to help decrease risk of probe damage during conveyance and data logging while promoting probe responsiveness. In some implementations, the probe guard is utilized in association with well data acquisition tools, such as well reservoir evaluation tools, or well drilling tools, such as logging- or measuring-while-drilling tools.

[0003] Some embodiments relate to a probe assembly for use with a well data acquisition tool, the probe assembly including a probe and a probe guard. The probe includes a body and a tip extending from the body along a longitudinal axis of the tip to a terminal end. The tip defines a length and a surface area along the length and is configured for sensing one or more well characteristics. The probe guard extends about the tip of the probe and leaves a majority of the surface area of the tip exposed to a flow that is angularly offset from the longitudinal axis of the tip of the probe.

[0004] Some embodiments relate to securing a probe guard about a tip of a probe. The probe extends from a probe body, along a longitudinal axis, and to a terminal end. The probe tip defines a length and a surface area along the length and is configured for sensing one or more well characteristics. The probe guard is extended about the tip of the probe such that a majority of the surface area of the tip is left exposed to a flow that is angularly offset from the longitudinal axis of the probe tip.

[0005] While multiple embodiments with multiple elements are disclosed, still other embodiments and elements will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative embodiments. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not restrictive.

Brief Description of the Figures

[0006] FIG. 1 is a schematic diagram of a well data acquisition tool, according to some embodiments.

[0007] FIG. 2 is a side view of a probe assembly that can be used with the well data acquisition tool of FIG. 1, according to some embodiments.

[0008] FIG. 3 is a top view of the probe assembly of FIG. 2, according to some embodiments.

[0009] FIG. 4 is an isometric view of the probe assembly of FIG. 2, according to some embodiments.

[0010] FIG. 5 is an end view of a probe guard that can be used with the probe assembly of FIG. 2, according to some embodiments.

[0011] FIG. 6 is an end view of another probe guard that can be used with the probe assembly of FIG. 2, according to some embodiments.

[0012] FIG. 7 is a side view of another probe assembly that can be used with the well data acquisition tool of FIG. 1, according to some embodiments.

[0013] Some embodiments are shown in the figures by way of example. Additional or alternate features are contemplated.

Detailed Description

[0014] Various embodiments of the present disclosure are described below including method, apparatus and system embodiments. These described embodiments and their various elements are examples of the presently disclosed techniques. It should be appreciated that in the development of any actual implementation, as in any engineering or design project, numerous implementation-specific decisions can be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which can vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit(s) of this disclosure.

[0015] When introducing elements of various embodiments of the present disclosure, the articles "a," "an," and "the" are intended to mean that there are one or more of the elements. The terms "comprising," "including," and "having" are intended to be inclusive and mean that there can be additional elements other than the listed elements. Additionally, it should be understood that references to "one embodiment" or "an embodiment" of the present disclosure are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the listed elements.

[0016] FIG. 1 shows an example of a well data acquisition tool 10 that can be deployed into a well 12 as part of a well production logging operation. In some embodiments, the well 12 can be inclined or horizontal with the tool 10 being lowered into the well 12 in a compact state and then expanded to engage the walls of the well 12. The tool 10 may be optionally connected to the surface (or other desired location) by a rod, a cable, or other coupling means (not shown). While the coupling means are optionally utilized for conveying data from the tool 10 to the desired location, in addition or as an alternative the tool 10 can optionally include telemetry means for conveying data to the desired location.

[0017] As shown, the tool 10 includes a body 20 and an expansion assembly 22 connected to the body 20. The expansion assembly 22 includes a first arm 24 and a second arm 26, the first and second arms 24, 26 being configured to articulate with each other and with the body 20. As shown, the body 20 is supported on the lower wall of the well 12. During deployment, the arms 24, 26 are in shape of a "V" located in a vertical plane passing through a longitudinal axis of the well 12. A plurality of probe assemblies 28, such as electrical resistivity probes/sensors or optical reflectivity probes/sensors, are located on the tool 10, such as on the first arm 24 and the body 20. In some embodiments, the tool 10 can be same as or similar to those made by Schlumberger Ltd. under the trade name "Flow Scanner". In other embodiments, the tool 10 can be same as or similar to those made by Schlumberger Ltd. under the trade name "FloView Holdup Measurement Tool".

[0018] In some embodiments, the probe assemblies 28 can be configured for sensing one or more well characteristics. For example, the probe assemblies 28 can optionally include one or more probes that are same as or similar to those made by Schlumberger Ltd. under the trade name "FloView," "GHOST," or others. In some embodiments, the plurality of probe assemblies 28 may include a probe assembly 28A, such as that shown schematically in Fig. 2.

[0019] Although the probe assemblies 28, 28A are described in association with well production logging tools, any of a variety of well data acquisition tools may employ the probe assemblies 28, 28A, such as any tools associated with one or more of drilling (e.g., logging-while-drilling or measurement-while-drilling), wireline logging, testing, completion, production, and abandonment phases.

[0020] FIG. 2 is a top view, FIG. 3 is a side view, and FIG. 4 is an isometric view of the probe assembly 28A, according to some embodiments. As shown, the probe assembly 28A includes a probe 50, a probe guard 52, and a support 54. In some embodiments, the probe 50 includes a body 60 and a tip 62. As previously described, the probe 50 can optionally be an electrical, resistivity probe or sensor, where the tip 62 senses electrical impedance of fluid touching the tip 62 in order to, for example, distinguish water, which is low-impedance, from high-impedance oil and gas. In other embodiments, the probe 50 can be an optical, reflectivity probe or sensor that is sensitive to a fluid's index of refraction.

[0021] The body 60 can optionally be elongate (e.g., about 2 to about 6 cm long overall, although other dimensions are contemplated) and cylindrical, defining one or more outer diameters (e.g., about 5 mm to about 20 mm in diameter, although other dimensions are contemplated). The body 60 may optionally house electrical, optical, or other components 66.

[0022] In some embodiments, the tip 62 can be relatively small and configured for measuring tiny droplets of fluid as the fluid flows past the tip 62. As indicated by FIG. 2, the tip 62 is elongate (e.g., about 1 cm to about 3 cm long overall, although other dimensions are contemplated) and is relatively thin. For example, the tip 62 is cylindrical, having a continuous diameter or tapering from a first diameter (e.g., about 0.1 mm to about 1 mm) to a second diameter (e.g., about 0.050 mm to about 0.005 mm), although other dimensions are contemplated). The tip 62 extends from the body 60 and defines a terminal end 68.

[0023] In some embodiments, the probe guard 52 can be secured about at least a portion of the probe 50. As shown in FIGS. 2-4, the probe guard 52 defines a first end 70, a second end 72, and an intermediate portion 74 and extends over the body 60 and the tip 62 of the probe 50 and then beyond the tip 62. The probe guard 52 can be formed by an elongate member that is helically-shaped, such as a piece of wire stock that has been suitably formed. The elongate member of the probe guard 52 may optionally have a substantially circular cross-section, although a variety of cross-sections (e.g., square, triangular, octagonal, diamond, or others) are contemplated. As shown in FIGS. 2-4, the probe guard 52 has a helical shape with a variable pitch - the angle at which the helix progresses longitudinally changes along a longitudinal axis Y of the helix, or in different terms, tangent lines at different points along the helix are at a variable angle to the longitudinal axis Y of the helix.

[0024] In some embodiments, the probe guard 52 can have a helical shape that is characterized by a minimum pitch (i.e., the tangent line that corresponds to an axial location corresponding to the terminal end 68 of the tip 62). In some embodiments, the probe guard 52 may have a helical shape with a constant radius (r), such that when viewed from the end, the probe guard 52 has a circular profile (FIG. 5). In other embodiments, the helical shape of the probe guard 52 may have a variable radius (r), such that when viewed from the end, the probe guard 52 has a non-circular profile, such as an elliptical (FIG. 6) or other profile. In still other embodiments, the probe guard 52 may have a discontinuously varying radius (r) such that when viewed from the end, the probe guard 52 has a rectangular, diamond, or other end profile (not shown).

[0025] In some embodiments, the support 54 can be formed as part of the tool 10, such as part of the first arm 24 as shown in FIG. 1. The support 54 can define an inner face 78 and include one or more mounting features 80 for maintaining the probe 50 and the probe guard 52 as desired. The mounting features 80 may optionally include hooks, clamps, welds, fasteners, or other means for securing the probe 50 and the probe guard 52 to the inner face 78 of the support 54.

[0026] In some embodiments, assembly of the probe 50, the probe guard 52, and the support 54 can include securing the probe 50 to the support 54 at a desired orientation with respect to flow F (illustrated, by way of example, as an arrow in FIG. 1 and as two arrows in FIG.2 with one at a first, slanted angle and the other at a second, perpendicular angle). The probe guard 52 can be secured about the probe 50, including the probe tip 62. In some embodiments, the first end 70 of the probe guard 52 can be secured to the probe 50 (e.g., the body 60) using one or more mounting features 80 (e.g., a spot weld), the intermediate portion 74 of the probe guard 52 can be secured to the support 54 using one or more of the mounting features 80 (e.g., a spot weld), and the second end 72 of the probe guard 52 can be secured to the support 54 using one or more of the mounting features 80 (e.g., a spot weld). As shown in FIGS. 2-4, in some embodiments, the second end 72 of the probe guard 52 can be secured at a location on the support 54 that is located beyond the terminal end 68 of the tip 62. Greater or fewer locations for fixing the probe guard 52 are contemplated.

[0027] In some embodiments, the probe guard 52 may be mounted such that the tip 62 of the probe 50 is spaced from the support 54 by a desired distance - e.g., to help allow flow to pass between the tip 62 and the support 54. In some embodiments, the probe guard 52 may define a longitudinal axis Y that is coaxial with the longitudinal axis X of the tip 62 such that the terminal end 68 of the tip 62 is located centrally within the probe guard 52. As shown in FIGS. 2-4, the probe guard 52 may extend about the probe 50 at a varying distance from the inner face 78 of the support 54. In some embodiments, the terminal end 68 of the tip 62 may be located adjacent a portion of the probe guard 52 that is at a maximum distance Dmax from the inner face 78 of the support 54 (FIG. 3).

[0028] In some embodiments, during use liquid flow F passes the probe 50 and measurements or other information regarding the flow F of liquid can be gathered using the probe tip 62. As shown in FIGS. 2-4, the probe guard 52 can leave a majority of the surface area of the tip 62 exposed to the flow F that is offset from the longitudinal axis X of the tip 62. For example, the probe guard 52 can be configured to leave over 50%, over 60%, over 70%, over 80%, over 90%, over 95%, over 98%, or over 99% of the surface area of the tip 62 exposed to the flow F that is offset from the longitudinal axis X of the tip 62. As another example, the probe guard 52 can be configured to leave from 50% to 99%, from 80% to 90%, almost 100%, or some other percentage of the surface area of the tip 62 exposed to the flow F that is offset from the longitudinal axis X of the tip 62.

[0029] Restriction of the flow F to the tip 62 can result in decreased responsiveness and measurement error. The probe guard 52 helps provide responsiveness while protecting the tip 62 by configuring the probe guard 52 with a minimum pitch and radius that promotes the flow F to the tip 62 while providing sufficient structure to help deflect debris, to help prevent the probe tip 62 from striking the well wall during conveyance or other positioning, or otherwise protect the tip 62 from physical contact with unwanted objects.

[0030] As shown in FIGS. 2-4, the helical shape can have a relatively larger pitch distal of the tip 62 (toward the second end 72) and a relatively larger pitch proximal of the tip 62 (toward the first end 70). In different terms, the probe guard 52 can include a plurality of interconnected turns with adjacent turns defining a pitch of the probe guard 52 where the pitch decreases around the probe tip 62 and increases proximally and distally of the probe tip 62. In some embodiments, the probe guard 52 may be configured such that the helical shape of the probe guard 52 distal to the terminal end 68 of the probe tip 62 extends through one half of a turn and in a coiling direction (e.g., right handed) which is selected to help avoid masking the probe tip 62 and is configured proximally to the probe tip 62 to help limit downstream flow restriction and facilitate flow evacuation, although a variety of other configurations and features are contemplated.

[0031] FIG. 7 shows a schematic, side view of another probe assembly 128A including a guard 152 extending about a probe tip 162 of a probe 150, according to some embodiments. As shown, the probe guard 152 can leave a majority of the surface area of the tip 162 exposed to flow F1 that is offset from the longitudinal axis X1 of the probe tip 162. The probe guard 152 can include a plurality of interconnected turns 200 with adjacent turns defining a pitch of the probe guard 152. As shown, the pitch decreases around a terminal end 168 of the probe tip 162 and increases proximally and distally of the probe tip 162. The probe guard 152 can optionally be secured to the probe 150 and a support 154 by mounting features (not shown) in a similar manner to that described in association with the probe assemblies 28, 28A. The probe guard 152 can optionally be formed of one or more elongate members (e.g., wire stock material). As shown, the probe guard 152 defines a maximum distance from an inner face 178 of the support 154 adjacent to the probe tip 162, and in particular the terminal end 168.

[0032] Various modifications, additions and combinations can be made to the described embodiments and their various features. For example, while the embodiments described above refer to particular features, the scope of disclosure also includes embodiments having different combinations of features and embodiments that do not include all of the above described features.

Claims

1. A probe assembly for use with a well data acquisition tool comprising:

   a probe including a body and a tip extending from the body along a longitudinal axis of the tip to a terminal end, the tip defining a length and a surface area along the length and being configured for sensing one or more well characteristics; and
   a probe guard extending about the tip of the probe, the probe guard leaving a majority of the surface area of the tip exposed to a flow that is angularly offset from the longitudinal axis of the tip of the probe.

2. The probe assembly of claim 1, wherein the probe guard includes a helically-shaped member.

3. The probe assembly of any of the preceding claims, wherein the probe guard is formed by a helically-shaped wire.

4. The probe assembly of any of the preceding claims, wherein the probe guard is formed by an elongate member having a substantially circular cross-section.

5. The probe assembly of any of the preceding claims, wherein the probe guard has a helical shape with a variable pitch.

6. The probe assembly of any of the preceding claims, wherein the probe guard has a helical shape with a constant radius.

7. The probe assembly of any of claims 1 to 5, wherein the probe guard has a helical shape with a variable radius.

8. The probe assembly of any of the preceding claims, wherein the probe guard has a helical shape defining a longitudinal axis that is coaxial with the longitudinal axis of the tip of the probe.

9. The probe assembly of any of the preceding claims, further comprising a support maintaining the probe and the probe guard such that the tip of the probe is spaced from the support.

10. The probe assembly of any of claims 1 to 8, further comprising a support maintaining the probe, the support defining a face that is positioned toward the probe, and the probe guard extending along the probe at a varying distance from the face of the support.

11. The probe assembly of claim 10, wherein the terminal end of the tip is located adjacent a portion of the probe guard that is at a maximum distance from the face of the support.

12. A method comprising securing a probe guard about a tip of a probe extending from a probe body, along a longitudinal axis, and to a terminal end, the probe tip defining a length and a surface area along the length and being configured for sensing one or more well characteristics, wherein the probe guard is extended about the tip of the probe such that a majority of the surface area of the tip is left exposed to a flow that is angularly offset from the longitudinal axis of the probe tip.

13. The method of claim 12, wherein the probe guard has a helical shape and the probe guard is secured about the tip of the probe such that a longitudinal axis of the helical shape is coaxial with the longitudinal axis of the probe tip.

14. The method of claim 12 or 13, further comprising securing the probe to a support defining a face that is positioned toward the probe such that the probe guard extends along the probe tip to define a varying distance from the face of the support.

15. The method of claim 14, further comprising securing a portion of the probe guard that is at a maximum distance from the face of the support adjacent to the terminal end of the tip.

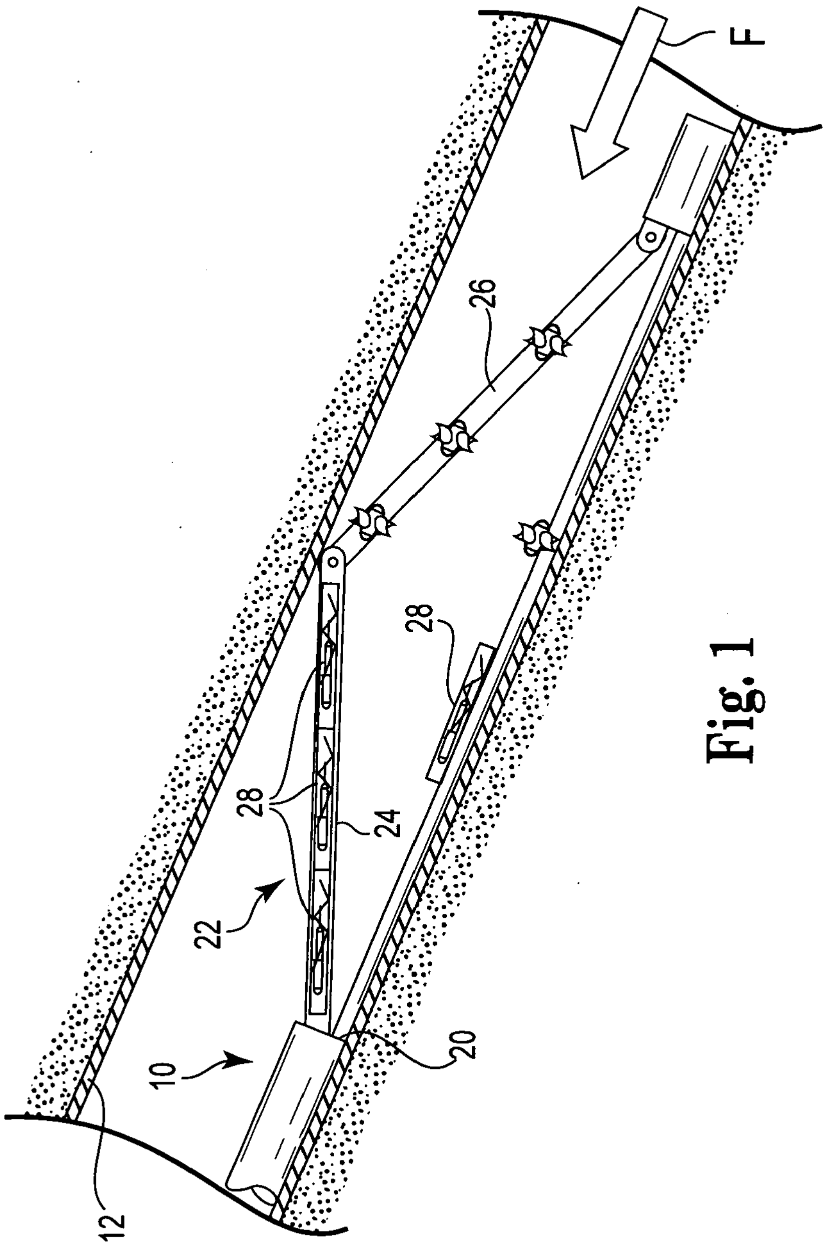

Fig. 1

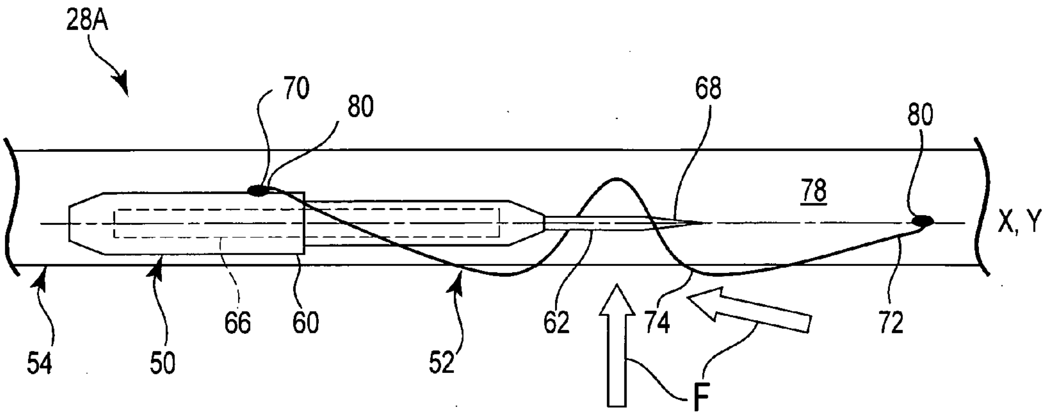

Fig. 2

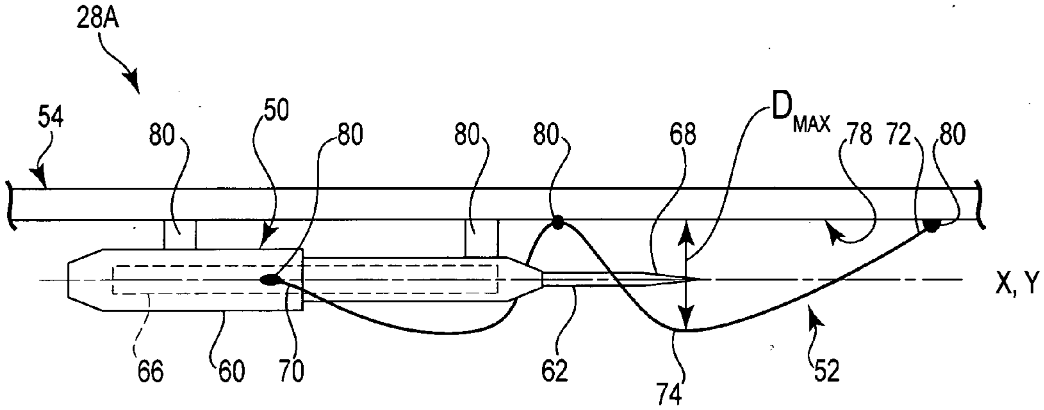

Fig. 3

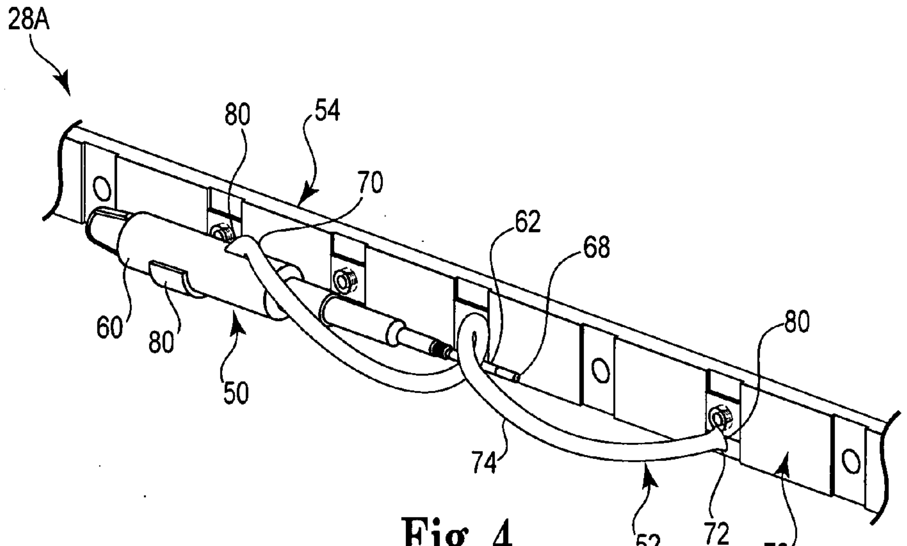

Fig. 4

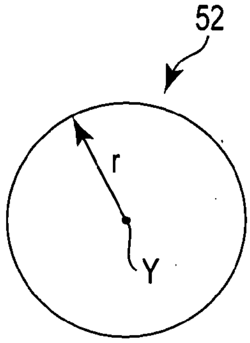

Fig. 5

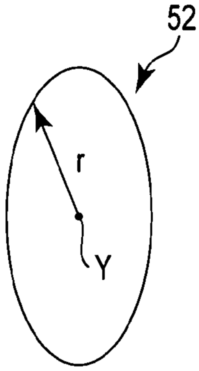

Fig. 6

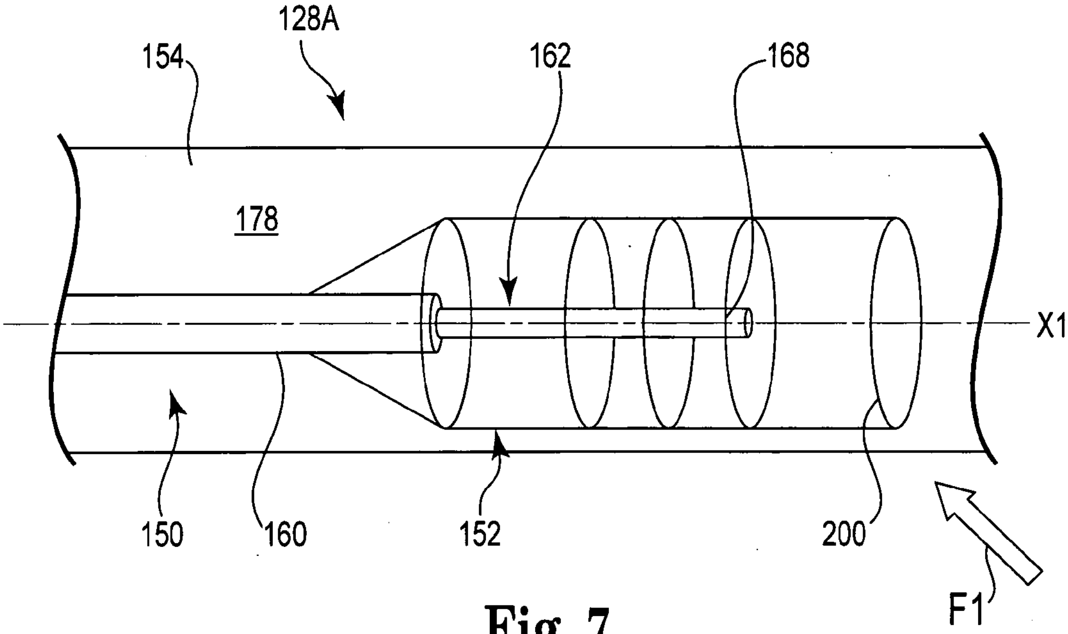

Fig. 7

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 11 29 0550

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 2003/084716 A1 (PATEY RONALD ERNEST RUSSELL [CA] ET AL) 8 May 2003 (2003-05-08) * paragraph [0034] - paragraph [0039]; figure 3 *	1-4, 9-12,14, 15	INV. E21B47/01
X	US 2011/061473 A1 (PAULSEN RONALD J [US] ET AL) 17 March 2011 (2011-03-17) * paragraph [0032]; figure 1 *	1,12	
A	US 5 351 532 A (HAGER ROBERT N [US]) 4 October 1994 (1994-10-04) * abstract; figure 1 *	1-15	
A	WO 00/43812 A1 (HALLIBURTON ENERGY SERV INC [US]) 27 July 2000 (2000-07-27) * abstract; figures 1,2 *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

E21B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	26 April 2012	Strømmen, Henrik

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 11 29 0550

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.

26-04-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2003084716 A1	08-05-2003	NONE	
US 2011061473 A1	17-03-2011	NONE	
US 5351532 A	04-10-1994	AU 5327394 A	01-05-1995
		US 5351532 A	04-10-1994
		WO 9509971 A1	13-04-1995
WO 0043812 A1	27-07-2000	DE 60026688 T2	12-10-2006
		EP 1153320 A1	14-11-2001
		NO 20013655 A	25-09-2001
		US 6301959 B1	16-10-2001
		WO 0043812 A1	27-07-2000

EPO FORM P0459

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