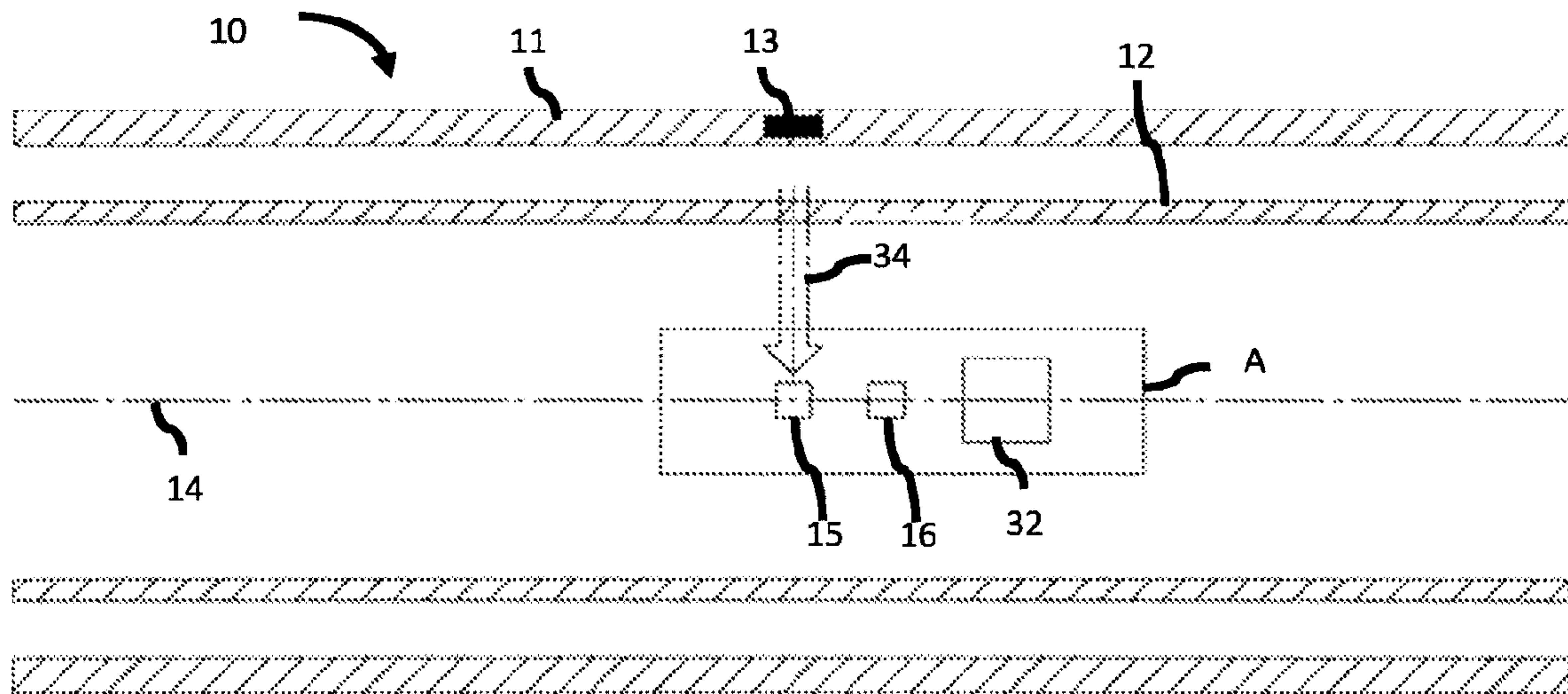




(86) Date de dépôt PCT/PCT Filing Date: 2015/08/14
(87) Date publication PCT/PCT Publication Date: 2016/02/18
(45) Date de délivrance/Issue Date: 2019/11/12
(85) Entrée phase nationale/National Entry: 2017/01/30
(86) N° demande PCT/PCT Application No.: NO 2015/050134
(87) N° publication PCT/PCT Publication No.: 2016/024867
(30) Priorité/Priority: 2014/08/14 (NO20140989)

(51) Cl.Int./Int.Cl. *E21B 47/024* (2006.01),
E21B 47/022 (2012.01), *G01C 21/16* (2006.01)
(72) Inventeur/Inventor:
BORG, EIRIK, NO
(73) Propriétaire/Owner:
HUYGENS AS, NO
(74) Agent: PARLEE MCLAWS LLP

(54) Titre : SYSTEME ET PROCEDE PERMETTANT LA DETECTION DE LA POSITION ET DE L'ORIENTATION D'UN
DISPOSITIF DE FOND DE PUITS
(54) Title: SYSTEM AND METHOD FOR POSITION AND ORIENTATION DETECTION OF A DOWNHOLE DEVICE



(57) Abrégé/Abstract:

This publication relates to a system and a method for identifying or monitoring the orientation and position of a device, such as a tool, intended to be moved through or be stationary arranged a medium, such as rock, the system comprises an orientation unit (10) including an outer element (11) and an inner element (12). The system comprises further: -a fixed reference point member (13) is arranged on one element of the orientation unit; -at least one detector (15) for at any time sensing and thus identifying the position of the fixed reference point member(13); -at least one second detector (16) for sensing earth gravity; -device(s) for connecting the at least one first detector (15) and the at least one second detector (16) with a processor or retrieving collected data from said at least one first detector (15) and said at least one second detector (16), using such data from said at least one first detector (15) and said at least one second detector (16) for calculating and determining the rotational orientation of the fixed reference point member (13) relative to earth gravity.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



WIPO | PCT



(10) International Publication Number

WO 2016/024867 A1

(43) International Publication Date
18 February 2016 (18.02.2016)

(51) International Patent Classification:

E21B 47/024 (2006.01) *G01C 21/16* (2006.01)
E21B 47/022 (2012.01)

(21) International Application Number:

PCT/NO2015/050134

(22) International Filing Date:

14 August 2015 (14.08.2015)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

20140989 14 August 2014 (14.08.2014) NO

(71) Applicant: AZIWELL AS [NO/NO]; Drammensveien 64,
N-7224 Melhus (NO).

(72) Inventor: BORG, Eirik; Bjørnsons gate 6, N-7015 Trond-
heim (NO).

(74) Agent: ACAPO AS; P.O. Box 1880 Nordnes, 5817 Ber-
gen (NO).

(81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG,
MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM,
PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,
SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ,
TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,
TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: SYSTEM AND METHOD FOR POSITION AND ORIENTATION DETECTION OF A DOWNHOLE DEVICE

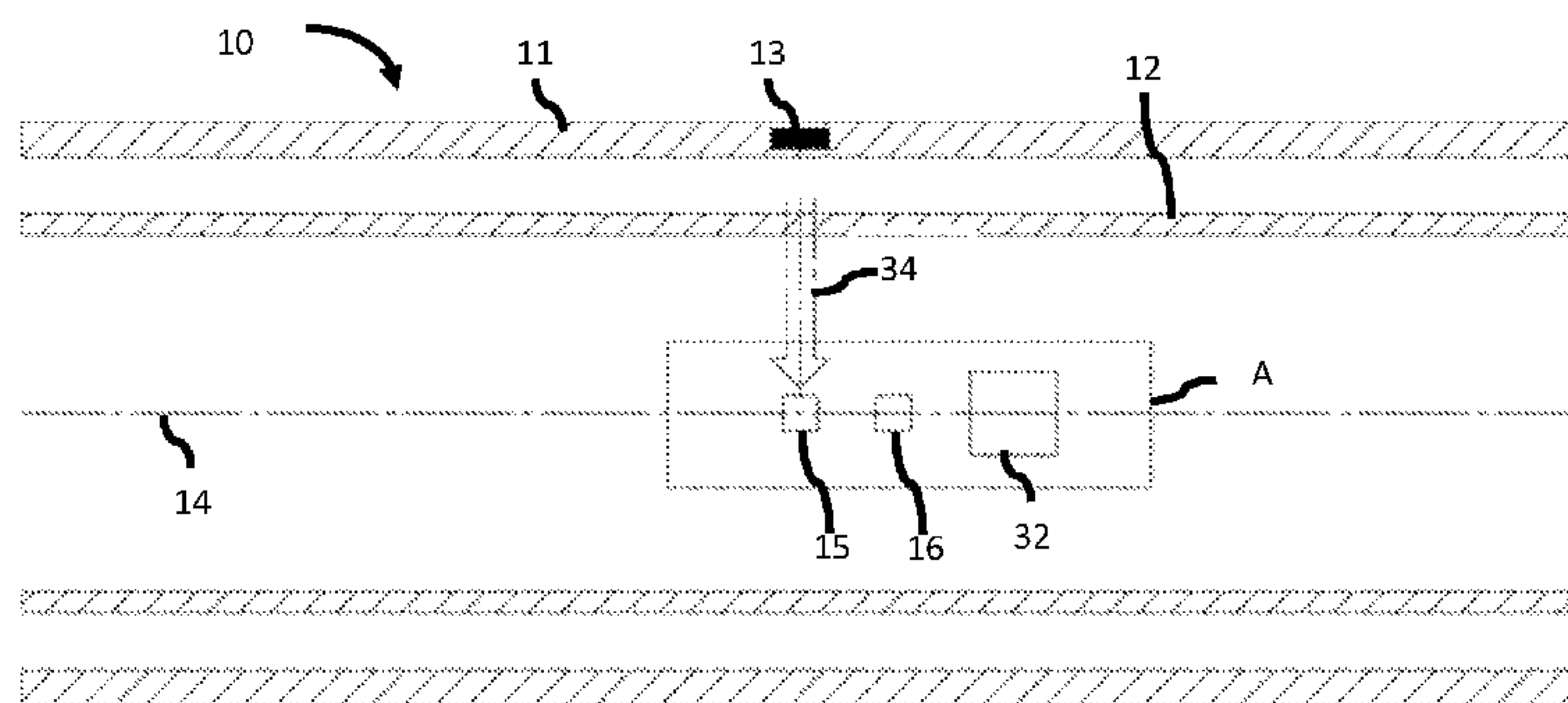


Fig. 1

(57) Abstract: This publication relates to a system and a method for identifying or monitoring the orientation and position of a device, such as a tool, intended to be moved through or be stationary arranged a medium, such as rock, the system comprises an orientation unit (10) including an outer element (11) and an inner element (12). The system comprises further: -a fixed reference point member (13) is arranged on one element of the orientation unit; -at least one detector (15) for at any time sensing and thus identifying the position of the fixed reference point member(13); -at least one second detector (16) for sensing earth gravity; -device(s) for connecting the at least one first detector (15) and the at least one second detector (16) with a processor or retrieving collected data from said at least one first detector (15) and said at least one second detector (16), using such data from said at least one first detect- or (15) and said at least one second detector (16) for calculating and determining the rotational orientation of the fixed reference point member (13) relative to earth gravity.



WO 2016/024867 A1

SYSTEM AND METHOD FOR POSITION AND ORIENTATION DETECTION OF A DOWNHOLE DEVICE

Technical Field of the Invention

5 The present invention relates to a system and a method for identifying or monitoring the orientation and position of a device, such as a tool, intended to be moved through a medium or to be stationary arranged in said medium, such as, but not limited to rock, soil or clay.

10 *Background for the Invention*

 Several ways of identifying and monitoring the orientation and position of a downhole body are known in the prior art. One example is to use a Universal Bottom Hole Orientation (UBHO) sub, sometimes referred to as a mule shoe sub, said sub being connected to a mechanical or electronic survey unit. The sub and the survey
15 unit are then usually pumped down the drill rods. When the sub is landing it should lock onto the body that need to be orientated, in known position, establishing a reference point for the survey unit and through that make it possible to log the "body's orientation in the well bore. Sometimes the sub can be downhole while a matching unit such as a pin is connected to the survey unit.

20 US 4,094,360 discloses using a mule shoe for locating a direction indicating instrument in axial alignment with a direction instrument assembly, a deflecting tool or deflecting drill bit where the axially lowermost constituent element of the direction instrument assembly is a mule shoe. Such a retrievable orientation unit can be used for many applications and contrary to stationary orientation systems, it has the
25 advantage that it can either be left stationary on the tool or retrieved from the hole. The retrievable option is essential for operating for example directional core barrels, wedges and other tools where the orientation unit may need to be taken to surface.

 Use of a mule shoe has, however, several inherent disadvantages, such as:

 - the mule shoe relies on that the shoe or shaped unit slide/rotate into a
30 matching shed connected to the body that are going to be oriented. To complete the connection can be difficult and some axial force is usually necessary to complete the operation and fulfil the required intention. As a result the sub often needs an additional force, by means of a hydraulic pressure, to ensure that it locks into position.

35 - the mule shoe can only be connected to the body in one specific position. If the shoe or the matching shape is worn or meet tip to tip, a jam may occur and the unit becomes stuck or may act falsely as connected to the body

- if using the mule shoe for orientation of directional drilling tools with an independently rotating internal drive shaft, a locking mechanism or coupling between the drive shaft and the outer body of the drill is needed in order to obtain a reference point. This locking coupling is sensitive to malfunctioning and will usually be very difficult to operate when the hole gets deep, due to high torque. Moreover, it is difficult to know if the locking device or coupling is in open or closed mode.

References should also be made to WO 2013/0028075 regarding an eccentric bushing assembly for a wireline-operated directional core barrel drill.

Finally references should also be made to US 2009/0056938 regarding estimating orientation of a liner conveyed in a wellbore and deploying the liner based on such orientation.

It is therefore a need for an orientation system that does not need the current mule shoe. Moreover it is a need for an orientation system that can sense the position of a point on the outer body of a device with respect to gravity, independent of the position of the point on the peripheral surface of the outer body at any time.

Moreover, it is also a need for a system that does not depend on a locking mechanism or coupling between the drive shaft and the outer body of a device being a drill or other tools with an independently running internal drive shaft. It is also a need for a orientation system comprising a survey unit that can be removed and brought to surface when orientating tools or bodies that do not require continuous orientation, such as stationary tools, like a wedges or a valves etc., and a orientation system where the survey unit can retracted to surface if malfunction occur or servicing is needed. Moreover, its also need for a system that can be brought to surface for downloading data, i.e. does not necessary relay on downhole cables or other systems for sending signals between the downhole orientation system and surface.

Summary of the Invention

The main principle of the present invention is to provide an alternative orientation system that does not need the UBHO (muleshoe), for determining the circumferential position of a reference point on an outer body of a device at any time or at certain periods in time, and to collect such information, so that the position of a device can be determined and/or calculated. Such determinations or calculations may be real-time activities or logged for later downloads, on surface or downhole, and if desired, used for adjustment of the position of the device. The adjustment may be automatic, semi-automatic or manual.

According to this principle, a reference point member may be arranged on an outer element for example an external body or part of a structure, the well bore, a tube, casing or the like, while detectors or devices sensing the position of the reference point member and gravity are positioned on the device whose position are being identified. The term "outer element" should be understood to also comprise the situation where the reference point member is arranged on an outer body of the device, and the detectors are arranged internally, for example associated with an inner element arranged inside the device. In both cases, the detectors sense outwards.

It should be appreciated, however, that the reference point member and the detectors may be configured in such way that the detectors sense inwards, i.e. that the reference point member is arranged on a centrally positioned extension of a tool body, for example arranged on a shaft or the like, with the detectors arranged on a separate cylinder, body or ring surrounding the reference point member.

Nevertheless a gravity detector will sense downwards.

In the drawings and the detailed description of an embodiment below, only the embodiment having the reference point member arranged on an outer body of the device and detectors arranged on or associated with an inner element, preferably retractable from the outer body, are shown and described, without thereby intending to limit the invention and scope of protection to such embodiment. Also the embodiments comprising a solution where the detectors are arranged on an outer element such as an outer ring surrounding a centrally arranged reference point member is intended to be encompassed by the scope of protection.

An object of the present invention is to provide a system that can provide the same degree of flexibility as the mule shoe, i.e. either be stationary or retrieved for determining the position of a movable device or a part of a tool with respect to or relative to the earth gravity, said movable device moving through a bore or a hole or being stationary, in any case without the use of a mule shoe.

An object of the invention is also to obtain a system that can be used for obtaining information of the orientation of a core sample.

Another object of the present invention is to provide an alternative way of determining the position of a device, moveably or stationary arranged in a well bore.

Yet another object of the present invention is to provide a solution where the sensing devices and electronics applied for determining the position of a device forms a part that can be a fixed part, an integral part, and/or a retrievable part of a device being stationary or moved through a medium, the device for example being a drill string or a tool.

In particular, but not exclusively, an object of the present invention is to provide a retrievable system and a method for identifying and/or monitoring the orientation of a tool face relative to gravity, in a well bore or a hole, based on the position of a reference point member on an outer element.

It should be appreciated that another object of the invention is to provide a system that may be used in connection with orientation of multiple types of downhole tools and systems, including but not limited to any type of drilling system, rod orientation, packers, wedges, valves, branches, monitoring and controlling systems.

Another object of the present invention is to provide a system and a method for improving the identification or monitoring of the position of a device moving through or stationary in a bore or hole, such as a drill string or a tool, by determining the position of a reference point member on the device relative to gravity.

It should be appreciated that the system does not depend on a locking mechanism or coupling between the drive shaft and the body of the device if used on for example a drill with an independently running internal drive shaft. Moreover the sensing devices and electronics can be removed and brought to surface, leaving only the relatively low cost reference point member downhole.

Yet another object of the invention is to provide an orientation system giving good readings close to vertical, something that is known to be a problem for existing systems based on moveable weights, balls and similar to determine the low side of the device.

It should also be appreciated that the orientation system according to the invention may in certain cases be seated permanently.

According to the present invention a system for identifying or monitoring the orientation and position of a device, such as a tool is provided. The system is intended to be moved through or be stationary arranged in a medium, such as rock, and comprises an orientation unit comprising an outer element and an inner element. The inner element may be retrievable. The system further comprises:

- a fixed reference point member arranged on one element of the orientation unit;
- at least one first detector for at any time sensing and thus identifying the position of the fixed reference point member, either directly or indirectly;
- at least one second detector for sensing earth gravity;

- device(s) for connecting the at least one first detector and the at least one second detector with a processor for retrieving collected data from said at least one first detector and said at least one second detector, using such data from said at least one first detector and said at least one second detector for calculating and/or determining the rotational orientation of the fixed reference point member relative to gravity. The data may also be used to calculate the inclination of the device or orientation of a core sample.

The first and second detectors are preferably arranged on another element of the orientation unit than the reference point member.

According to one embodiment of the system, the fixed reference point member may be mechanically or physically fixed on the outer element, while said at least one first and at least one second detector are arranged on the inner element. In a preferred embodiment, the outer element is the outer body of the device.

According to a second embodiment of the invention, the fixed reference point member may be fixed on a body centrally arranged on the device whose position should be identified, while said at least one first and at least one second detector is arranged on a ring or tube surrounding the centrally arranged fixed referenced point member arranged inside the device.

The reference point member may comprise at least one magnet, the first detector may comprise at least one magnetic field detector, preferably magnetometer or hall effect sensor and the second detector may comprise at least one gravitation detector, such as inclinometer and/or accelerometer, preferably tri-axes accelerometer.

By "magnet" it is in this application meant permanent magnets, electro magnets or magnetic fields made in any other way. In this application, whenever the word "magnet" is written it should be interpreted as a permanent magnet, electro magnet or a magnetic field made in any other way.

Moreover, the reference point member may be placed in fixed seat(s) on the outer body of the device, intended to create an artificial magnetic field that can be detected by the first detector.

Further, the first and second detectors may be arranged on the inner element, providing data for a rotational position of the outer body of the device, and thereby the rotational displacement during operation of the device; location of a body face; and/or position of the outer body by measuring location of the reference point member, preferably a permanent magnet, with respect to earth gravity.

The inner element may comprise a separate rotatable alignment shaft, and a magnet may be fixed to the rotatable shaft, said magnet will always align with the

reference point member on the outer element, as said reference point member comprises one or more magnets. Thus the alignment shaft will rotate due to the magnetic forces, and independently of the inner element. In another embodiment magnets are not fixed to the alignment shaft, but the alignment shaft itself is
 5 magnetic, and will rotate to align with the reference point magnets.

It should be appreciated that at least one magnet may be fixed to the end of the rotatable alignment shaft, providing a magnetic field that is sensed by a magnetic field detector such as a magnetometer or hall effect sensor, allowing the detector to sense the shaft orientation. Based on the position of the shaft, the position of the
 10 reference point member will be given.

Moreover, the reference point member may be chosen from one of a radioactive source, laser, permanent magnet, electromagnet and Radio Frequency Identification (RFID).

In one embodiment, the entire tool is made non-magnetic, allowing a
 15 magnetometer also to read directions relative to magnetic north. The magnetometer may be the first detector, or another separate detector.

The present invention also relates to a method for identifying or monitoring the orientation and position of a device, such as a tool. The method relates to a system, intended to be moved through or left stationary in a medium, such as rock, and
 20 comprises an orientation unit comprising an outer element and an inner element. The inner element is preferably retrievable. The method comprises the following steps:

- establishing a fixed reference point member mechanically or physically on one part of the orientation unit;
- 25 - arranging detectors or sensors on another part of the orientation unit;
- using at least one detector to sense signals emitted by the reference point member, thus at any time sensing and identifying the position of the fixed reference point member;
- using at least one second detector for sensing earth gravity;
- 30 - connecting the output from at least one first detector and the at least one second detector with a processor or retrieving collected data from said at least one first detector and said at least one second detector, using such data from said at least one first detector and said at least one second detector for calculating and/or determining the rotational orientation of the fixed reference point member relative to gravity. It may also be used to calculating and/or
 35 determining the inclination of the body or orientation of a core sample.

According to one embodiment of the invention, the method comprises fixing the reference point member mechanically or physically to the outer element, while arranging said at least one first and at least one second detector on the retrievable inner element.

- 5 According to another embodiment, the method comprises fixing the reference point member on a body centrally arranged on the device while arranging said at least one first and at least one second detector on a retrievable outer ring surrounding the centrally arranged fixed reference point member.

According to one specific embodiment the method comprises:

- 10 - establishing a fixed reference point member on an outer element;
 - arranging detectors on the inner element and/or associated elements thereon;
 - using the magnetic field from the reference point member, which is mechanically or physically fixed on the outer element, as a reference for detecting the position of the outer element;
 15 - detecting at least the magnetic field by a first detector associated with the inner element in order to sense and thus identify the position of the reference point member on the outer element,
 - using a second detector for detecting earth gravity; and
 - communicating the detected information from the first detector and the second
 20 detector to a processor for calculating and/or determining the orientation of the outer element.

The method may comprise arranging one or more magnets to a rotatable alignment shaft, in the inner element of the orientation unit, allowing at least one of
 25 said magnet to align with a magnet on the outer element acting as reference point member, by rotating the alignment shaft, and arranging a magnet on an end of said alignment shaft, and using the magnetic field from it as a source for monitoring and identifying the position and orientation of the alignment shaft. In another embodiment magnets are not fixed to the alignment shaft, but the alignment shaft itself is
 30 magnetic, and will rotate to align with the reference point magnets. By using the data from the magnetic field detector and a gravitation detector, such as an accelerometer or inclinometer the position of the reference point member may be determined relative to gravity.

Moreover, the method may also comprise determining or calculating real-time
 35 activities or data can be logged for later downloads, on surface or downhole.

Gravitation detectors, such as accelerometers or inclinometers are used together with any one of the detectors for sensing the rotational position of the outer element, and thus the position for the device may be identified.

Moreover, it should also be appreciated that the system according to the present invention is to provide an improved orientation system that can replace the current use of a mule shoe, and when operating a system with internal drive shaft that rotates independently of the tool body, it is not necessary nor required to include a locking device for aligning the mule shoe shed in a known position relative to the outer body.

According to the present invention, the detector for identifying the rotational position of the alignment shaft, when aligned with the reference point member, may in lieu of a magnet field detector, be provided at the circumference of the free end of the alignment shaft with a number of separated axially orientated sectors, co-functioning with brushes or shoes, similar to the system used on the commutator on an electric motor, the position of the various sectors with respect to the position of the corresponding magnet on the alignment shaft being known.

Short Description of the Drawings

In the following principles and an embodiment of the invention shall be described in further detail, referring to the drawings wherein:

Figure 1 discloses schematically one principle for a orientation unit according to the present invention, indicating a suitable position of an embodiment forming the reference point member and the configuration of the first and second detector;

Figure 2 discloses schematically and in principle for a orientation unit using a second embodiment of the invention, showing the device forming the reference point member, the detectors applied and a second one or more magnets fixed to a rotatable alignment shaft;

Figure 3 shows schematically a directional core drill with the orientation unit according to the present invention for identifying or monitoring the orientation and position of a the drill;

Figure 4 shows mud motor drill unit, with the orientation unit according to the present invention for identifying or monitoring the orientation and position of the unit

Figure 5 shows schematically a part of the interior of a drilling system, with the orientation unit according to the invention;

Figure 6 shows schematically a retrievable orientation unit in accordance to the invention.

Description of the Reference Signs

The following reference numbers and signs refer to the drawings:

10	Orientation unit
11	Outer element
12	Inner element
13	Magnet, reference point magnet
14	Centreline
15	Detector, Magnetic field detector
16	Detector, Accelerometer
17	Magnet, shaft alignment magnet
18	Magnet, shaft reference magnet
19	Rotatable alignment shaft
20, 20'	Bearings
21	Alignment shaft extension
22	Drill bit
23	Deflection mechanism
24	Packer
25	Rod coupling
32	CPU, memory
34	Magnetic force

Detailed Description of the Embodiments shown in the Figures

- 5 The following description of the exemplary embodiments refers to the accompanying drawings. The same reference numbers in different drawings identify the same or similar elements. The following detailed description is not meant or intended to limit the invention. Moreover, the embodiments to be discussed next are not limited to these configurations, but may be extended to
- 10 other arrangements as discussed later.

Reference throughout the specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with an embodiment is included in at least one embodiment of the subject matter disclosed. Thus, the appearance of the

15 phrases "in one embodiment" or "in an embodiment" in various places throughout the specification is not necessarily referring to the same embodiment. Further, the particular features, structures or

characteristics may be combined in any suitable manner in one or more embodiments.

Figure 1 discloses schematically a orientation unit showing the principle used according to one embodiment of the present invention, indicating a suitable position of the magnet forming the reference point member 13 and the configuration of the first and second detector 15, 16. The Figure indicates schematically a orientation unit 10 provided with an outer element 11 and a inner element 12 arranged inside the outer element 11. The orientation unit 10 constitutes as a separate but yet integral part of the drilling tool and is arranged downhole together with the tool. According to the element shown, a reference point member in form of a magnet 13 is arranged in a fixed position on the outer element 11, providing a magnetic field. The outer element 11 may have a cylindrical cross sectional shape, having a centreline 14. A magnetic field detector such as a magnetometer or a halleffect sensor 15 may be incorporated in the inner element 12 and is preferably centrically positioned with respect to the inner element 12. The magnetic field detector 15 may be of any known type measuring the magnetic field of the magnet 13 arranged on the outer element 11, and hence the circumferential position of the magnet 13. Moreover, the orientation unit 10 also comprises a three-axis accelerometer 16 arranged on the inner element 12, the purpose of which is to sense the earth gravity.

The system according to the embodiment shown in Figure 1, functions in the following way:

- The position of the magnet 13 fixed to the outer element 11 is known, with respect to, for example the eccentric mechanism or other features or elements of the tool, since the position of the magnet 13 is physically and mechanically fixed on the outer element 11, which in turn is fixed relative to the tool.
- The position of the accelerometer 16 senses earth gravity and both detectors are connected to a processor 32, calculating the location of the magnet 13 relative to the earth gravity. The information from the detectors may either be processed and used in real time downhole or communicated to the surface, or may be saved and processed when the inner element 12 is retrieved to the surface. Knowing the magnet's 13 position relative to the earth gravity, it is possible by means of processing to identify the position of e.g. the eccentric mechanism relative to earth gravity, i.e. the tool face.

Figure 2 discloses schematically and in principle a further embodiment of the invention, showing a second principle for a orientation unit 10, comprising the

magnet forming the reference point member 13, the two detectors 15, 16 being fixed to an inner element 12. It should be appreciated that the magnet 13 is mechanically fixed to an outer element 11, and that the inner element 12 comprises a rotatable alignment shaft 19. The magnetic field detector 15 and the accelerometer 16 are
 5 fixed to the inner element 12, the magnetic field detector 15 sensing the orientation position of the rotatable shaft 19, while the accelerometer 16 sensing the earth gravity. The orientation of the rotatable alignment shaft 19 has a relevance to the position of the reference point member 13.

The inner element 12 comprises a alignment shaft 19, rotatable suspended in
 10 the inner element 12, allowing free rotation of the alignment shaft 19 with respect to the inner element 12. The bearings 20, 20' may for example be roller bearings. According to the embodiment shown in Figure 2 the rotatable arranged shaft 19 is provided with a alignment magnet 17. The alignment magnet 17 is arranged in such manner that the alignment magnet 17 always will align itself with the reference point
 15 magnet 13 fixed to the outer element 11 of the device due to the magnetic field forces 34 between the reference magnet 13 and alignment magnet 17.

According to the embodiment shown in Figure 2 the alignment shaft 19 is provided with an extension 21, extending through the ball bearing 20'. At the end face of the end of the extension 21, a shaft reference magnet 18 is arranged. Since
 20 the shaft alignment magnet 17 always will align with the reference point magnet 13 fixed to the outer element 11, the magnetic field of the shaft reference magnet 18 will rotate correspondingly, thus enabling the magnetic field detector 15 to sense the orientation of the alignment shaft 19, giving the orientation or placement of reference point magnet 13, which together with gravity, gives the orientation of the device 10.

25 Compared to the embodiment shown in Figure 1, the embodiment shown in Figure 2 will function in the following way:

- The reference point magnet 13 creates a magnetic field 34, and since the shaft alignment magnet 17 is fixed to the alignment shaft 19, the said alignment shaft 19 will be rotated so that the magnets 13 and 17 will align at
 30 all time. As a consequence of the alignment, the shaft reference magnet 18 located at the end of the alignment shaft extension 21 will rotate correspondingly, and any change in the magnetic field of the shaft reference magnet 18 will be sensed by the magnetic field detector 15. In such way the position of the reference point magnet 13 on the outer element 11 of the
 35 device will be sensed.
- The accelerometer 16 will sense the orientation of the inner element 12 relative to the earth gravity and by means of a processor the orientation unit

10 will be able to identify and monitor the orientation of the device, for example the position of a deflection mechanism 23 relative to earth gravity.

- As for the embodiment disclosed in both Figure 1 and 2, the information from the detectors may either be processed and used real time downhole or
5 communicated to the surface, or may be saved and read after the inner element 12 is retrieved to the surface.

Figure 3 shows schematically a directional core barrel drill tool with an orientation unit 10 according to the present invention incorporated, for identifying or
10 monitoring the orientation and position of the drilling tool. The tool is provided with a drill bit 22 connected to the internally arranged drive shaft (not shown). At its opposite end the tool is provided with a rod coupling 25 for connecting the drive shaft to a drill string (not shown), transferring rotation to the drive shaft and the drill bit 22. As shown the tool is also provided with a packer 24 for holding the orientation unit 10
15 of the device fixed during drilling operation.

Figure 4 shows schematically a view of the exterior of mud motor drill assembly and the orientation unit 10 according to the invention is shown in a partly section of the tool. As indicated, the tool comprises a deflection mechanism 23 for changing the direction of drilling.

20 Figure 5 shows schematically in enlarged scale an orientation unit 10, showing the retrievable inner element 12 according to the invention. As indicated the outer element 11 of the device is in the form of a tube and is provided with a fixed reference point member 13, which in the embodiment shown is a magnet, fixed to the wall of the outer element 11. The detectors may be of a type and a configuration
25 as disclosed above in Figures 1 and 2, i.e. magnetic field detector(s) 15 and accelerometer 16, or of other types of detectors as discussed above in the summary of the invention.

In the figures, the box denoted A represents the electronics, processors and sensing devices for sensing the position of the reference point member 13 on the
30 outer element and gravity, for example in the form of a magnetic field detector and an accelerometer as disclosed either in Figure 1 or in Figure 2, or as further defined in the description above. The sensing devices may be arranged on a same configuration as disclosed in Figure 1 or Figure 2.

35 Figure 6 shows schematically a retractable assembly for e.g. a mud motor, directional core drill, wedge or similar device. The assembly comprises at the least an inner part of an orientation unit according to the present invention, the inner part will be retrieved together with the assembly. The inner part can either be fastened to

the assembly in a fixed position, or in a freely rotating position relative to the assembly. At one end the assembly is provided with a seating device 25, being configured to make it possible to lock and release the assembly to the mud motor, directional core drill, wedge or similar device. Depending on the type of device the retractable assembly should be mounted to, the assembly may also comprise other detectors, sensors and equipment, samples or seating devices. This will be obvious to a person skilled in the art, based on knowledge to the device the assembly is mounted to.

If the fixed reference point member is in the form of one or more permanent magnets, it may preferably, but not necessarily, be placed in fixed seats in the tube wall of the outer body of the device or element, creating an artificial magnetic field that can be sensed and read by a magnetic field detector.

It should be appreciated that the reference point member may either be arranged as part of the surface of the outer element or device. Alternatively, the reference point member may be incorporated as an integral part of the wall of outer element. As a variant the entire or a portion of the outer element may be of a magnetized material.

While the reference point members in one embodiment are magnets, reference point member may be chosen from one of a radioactive source, laser, permanent magnet, electromagnet and Radio Frequency Identification (RFID). Systems such as electromagnets and RDIF are beneficial in that they can be turned off and thus one can avoid potential interference issues. The magnets, typically reference magnets, alignment magnets and shaft reference magnets can freely be replaced with the above alternatives and still provide the same technical effect. In a sensor pair one can be an emitter such as a laser and the other be a sensed part such as a reflector. The parts can also be swapped in the above disclosure and still provide the same technical effect.

It should also be appreciated that the outer element and the inner elements do not necessarily have to be coaxial, nor does the outer element have to fully surround the inner element, for instance as if it were a pipe. In fact reference units such as magnets can be inserted in the well outside the orientation unit, for instance into the cement during completion.

It should be appreciated that the algorithms applied for detecting a position and an orientation of the downhole tool face and for creating an image of said position and/or orientation, are based standard mathematics.

Claims

1. A system for identifying or monitoring the orientation and position of a downhole drilling device, the system comprising an orientation unit (10) including a reference point member (13) connected to an outer body element (11) and an inner body element (12) arranged inside the outer body element (11), characterized in that
 - the inner body element is fully or partially enclosing at least a first detector (15) and a second detector (16), the first detector (15) at any time sensing, directly or indirectly, the rotational position of the reference point member (13), the second detector (16) sensing earth gravity,
 - the system further including:
 - a processor (32) adapted to retrieve collected data from the first detector (15) and the second detector (16), using the data for calculating and determining the rotational orientation of the reference point member (13) relative to earth gravity,
 - wherein the inner body element (12) is retrievable independent of the outer body element (11), and
 - a device(s) for using data provided by the processor as input to identify, control and/or adjust the position of the downhole drilling device or deflection mechanism of the downhole drilling device.
2. The system according to claim 1, wherein the downhole drilling device comprises a directional core barrel drill or wedge.
3. The system according to claim 1 or 2, wherein the reference point member (13) is mounted on a body centrally arranged in the downhole drilling device, the body being connected to the outer body element (11), while the first detector (15) and the second detector (16) are arranged on a retrievable ring or tube surrounding the reference point member (13).
4. The system according to any one of claims 1 to 3, wherein the reference point member (13) comprises at least one magnet, the first detector (15) comprises at least one magnetic field detector, and the second detector (16) comprises at least one gravitation detector.
5. The system according to claim 4, wherein the at least one magnetic field detector is selected from a magnetometer or a Hall-effect sensor.

6. The system according to claim 4, wherein the at least one gravitation detector is selected from an inclinometer or an accelerometer.
7. The system according to any one of claims 1 to 6, wherein for indirectly measuring the rotational position of the reference point member (13), the inner body element (12) comprises a rotatable alignment shaft (19), configured to rotate independently of the inner body element (12), and one or more shaft alignment magnets (17) being fixed to the alignment shaft (19), or the shaft itself being magnetic, wherein the alignment shaft aligns with one or more reference point magnets (13) on the outer body element (11), and at least one shaft reference magnet (18) which is fixed to an end of the alignment shaft (19), or the shaft itself being magnetic, providing a magnet field that is sensed by the magnetic field detector (15), allowing the detector (15) to sense the orientation of the alignment shaft (19).
8. The system according to claim 1 or 2, wherein the reference point member (13) is selected from a radioactive source, laser, electromagnet, or Radio Frequency Identification.
9. A method for identifying or monitoring the orientation and position of a device intended to be moved through or left stationary in a medium, the method using an orientation unit (10) comprising an outer body element (11) and an inner body element (12), characterized by comprising the following steps:
 - establishing a reference point member (13) on a first part of the unit (10);
 - arranging at least one first detector (15), and at least one second detector (16) on a second part of the unit (10);
 - using the at least one first detector (15) to at any time sense the position of the reference point member (13);
 - using the at least one second detector (16) for sensing earth gravity;
 - connecting the output from the at least one first detector (15) and the at least one second detector (16) with a processor or retrieving collected data from the at least one first detector (15) and the at least one second detector (16), using the data from the at least one first detector (15) and the at least one second detector (16) for calculating and determining the rotational orientation of the reference point member (13) and
 - using data provided by the processor to identify, control and/or adjust the position of the device or deflection mechanism of the device.
10. The method according to claim 9, wherein the device comprises a tool.
11. The method according to claim 9, wherein the medium comprises rock.

12. The method according to any one of claims 9 to 11, wherein the reference point member (13) is mechanically or physically fixed to the outer body element (11), and the at least one first detector (15) and the at least one second detector (16) are arranged on the inner body element (12), the inner body element (12) being retrievable.

13. The method according to any one of claims 9 to 12, wherein the reference point member (13) is mounted on a body centrally arranged in the device, the body being connected to the outer body element (11), while the at least one first detector (15) and the at least one second detector (16) are arranged on a retrievable outer ring surrounding the reference point member (13).

14. The method according to any one of claims 9 to 13, wherein

- the reference point member (13) is established on the outer body element (11);
- the first detector (15) and the second detector (16) are arranged on the inner body element (12);
- the magnetic field from the reference point member (13), which is mechanically or physically fixed on the outer body element (11), is used as a reference for detecting the position of the outer body element (11);
- at least the magnetic field is detected by the first detector (15) associated with the inner body element (12) in order to sense and thus identify the position of the reference point member (13) on the outer body element (11);
- the second detector (16) is used for detecting earth gravity; and
- the detected information from the first detector (15) and the second detector (16) is communicated to the processor for calculating and determining the orientation of the outer body element (11), also the rotational displacement.

15. The method according to any one of claims 9 to 14, by arranging one or more magnets (17, 18) on a free rolling alignment shaft (19) on the inner body element (12), aligning one of the magnets (17) with a reference point member (13) on the outer body element (11), and arranging one of the magnets (18) on an end of the alignment shaft (19), and using the magnetic field from the magnet (18) as a source for monitoring and identifying the position and orientation of the reference point member (13), using a magnetic field detector and a gravitation detector.

16. The method according to claim 15, wherein the gravitation detector is selected from an accelerometer or inclinometer.

17. The method according to any one of claims 9 to 16, wherein calculations and determinations may be real-time activities or logged for later downloads, on surface or downhole.

1/2

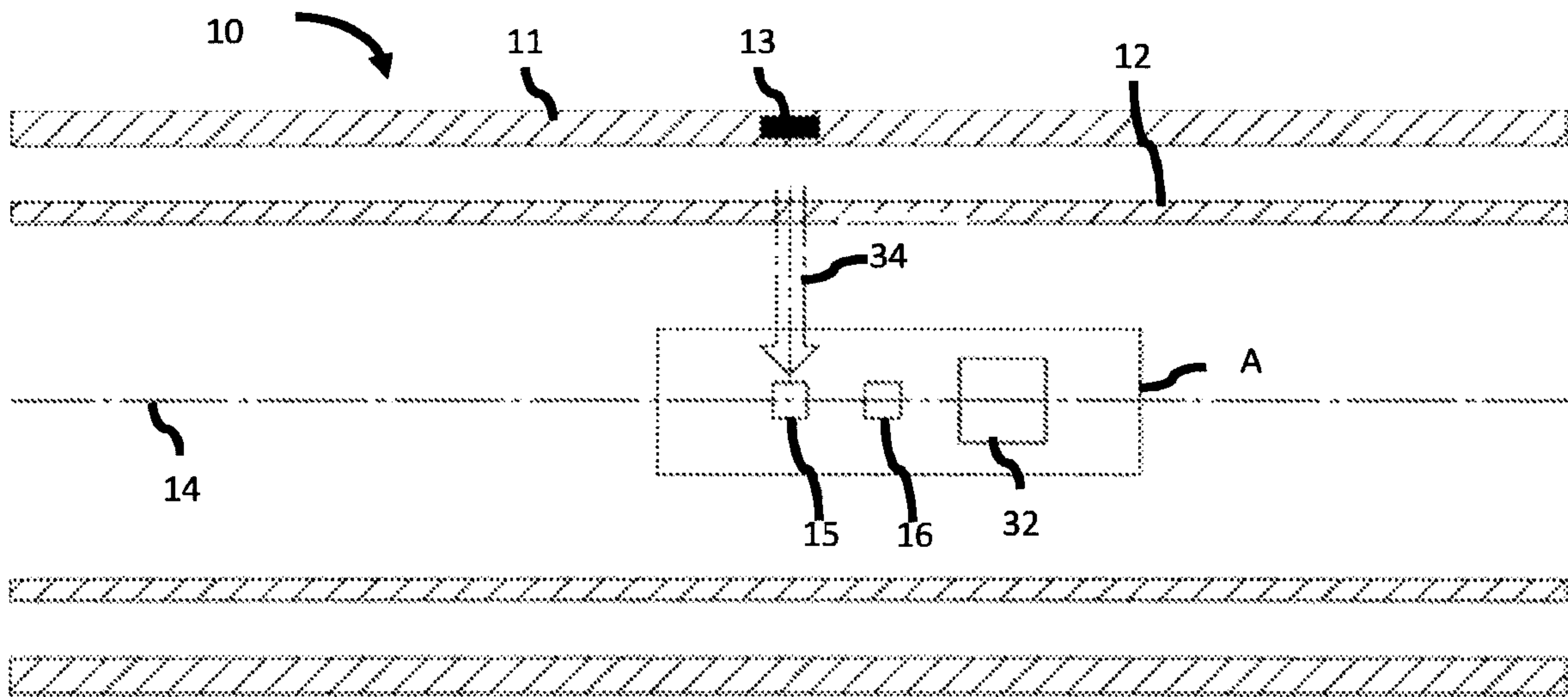


Fig. 1

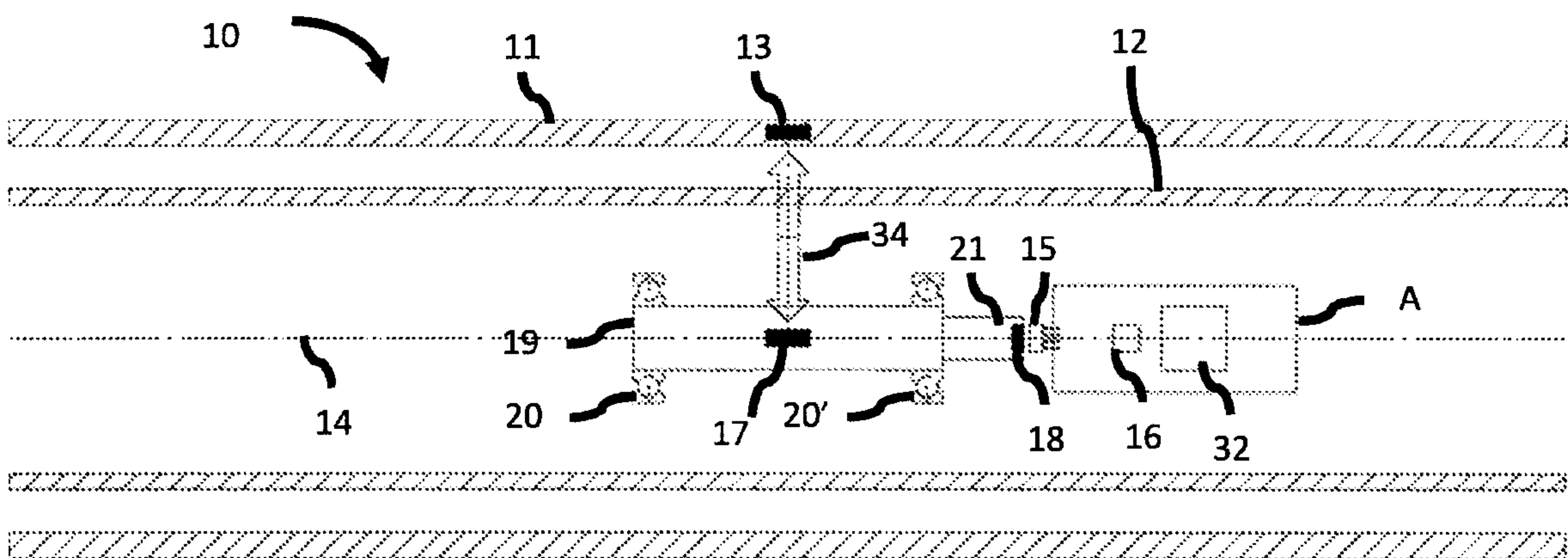


Fig. 2

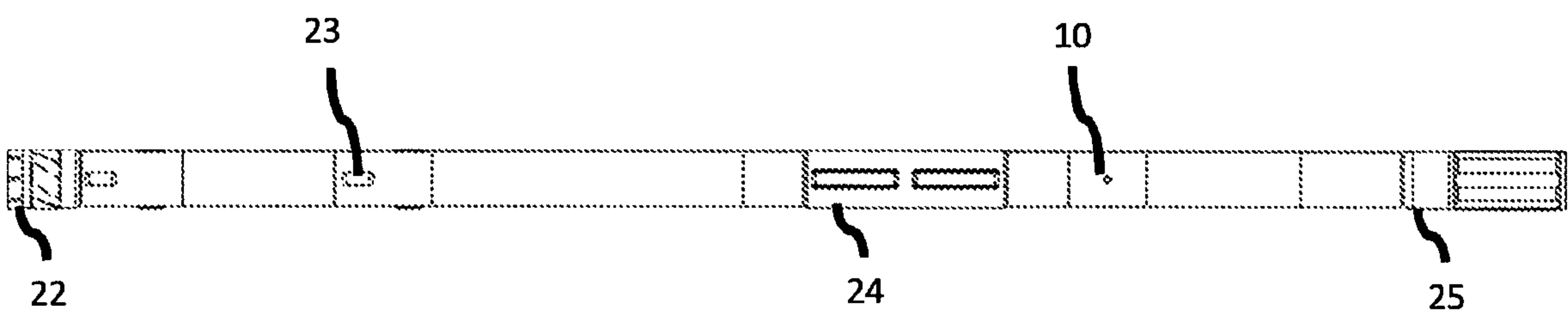


Fig. 3

2/2

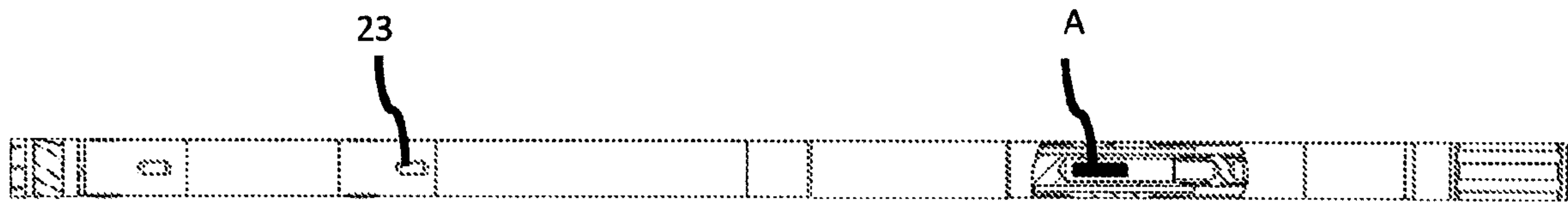


Fig. 4

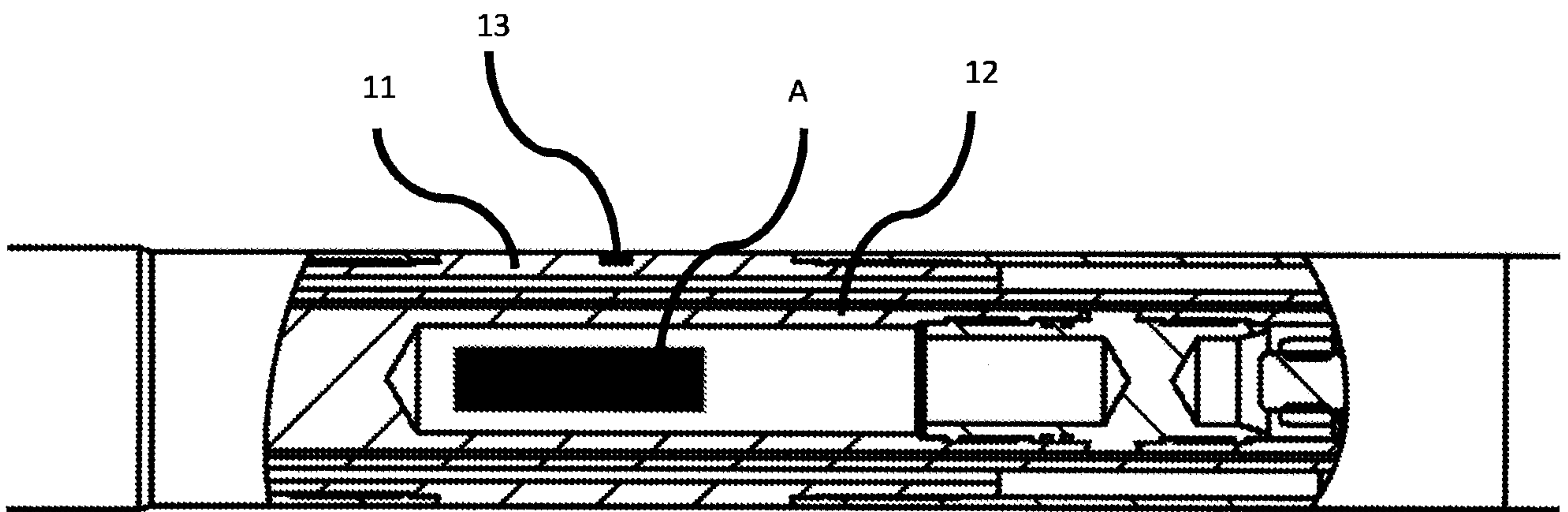


Fig. 5

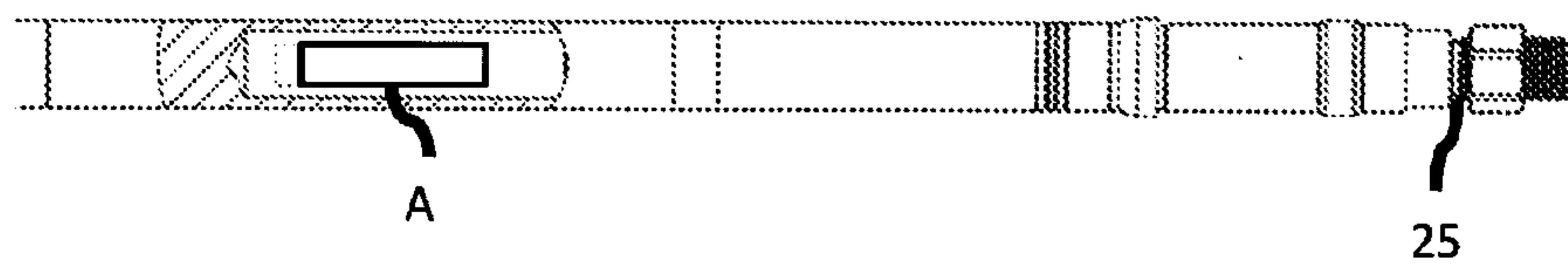


Fig. 6

