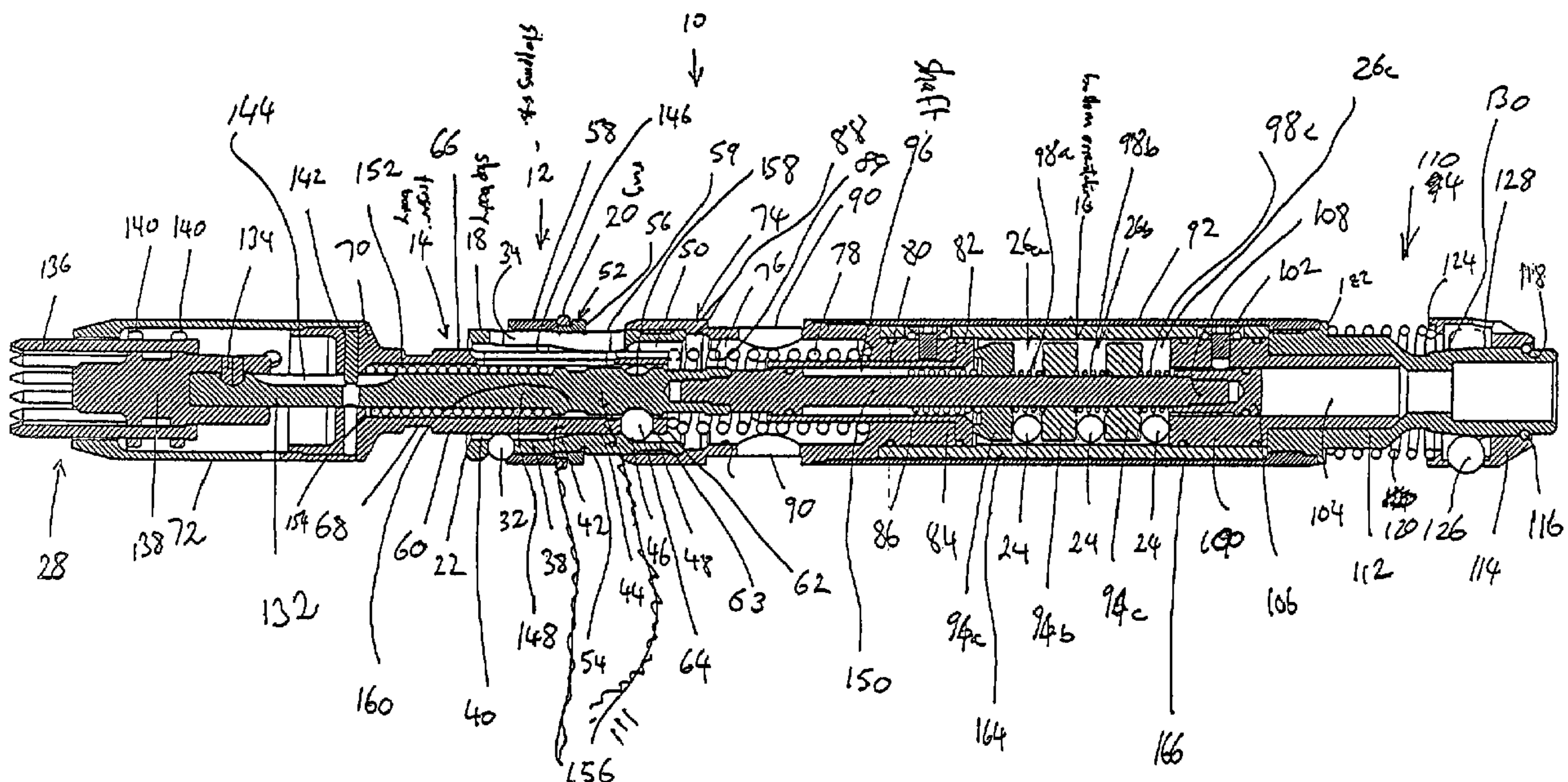




(86) Date de dépôt PCT/PCT Filing Date: 2005/03/10
(87) Date publication PCT/PCT Publication Date: 2005/09/15
(45) Date de délivrance/Issue Date: 2013/09/03
(85) Entrée phase nationale/National Entry: 2006/09/08
(86) N° demande PCT/PCT Application No.: AU 2005/000339
(87) N° publication PCT/PCT Publication No.: 2005/085584
(30) Priorité/Priority: 2004/03/10 (AU2004901241)

(51) Cl.Int./Int.Cl. *E21B 25/16* (2006.01),
E21B 23/00 (2006.01)
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(54) Titre : OUTIL DE FOND D'ORIENTATION DE CAROTTE
(54) Title: DOWNHOLE CORE ORIENTATION TOOL



(57) Abrégé/Abstract:

A core orientation tool for a core drill having a core bit at a downhole end and a retrievable core tube for receiving a core cut by said drill said orientation tool comprising: a stopping system comprising a tubular stop body and a ring extending about an outer circumferential surface of said stop body, said ring having an expanded state where said ring stops said stop body from passing through said core tube and relaxed state where said stop body can pass through said core tube; a trigger body extending from a down hole end of said stop body and slidable relative to said stop body, said trigger body extending beyond said core bit prior to commencement of drilling; and, a bottom orientator providing an indication of the location of a bottom of said core, said bottom orientator provided with one or more orientation balls, each orientation ball having a first state where said orientation ball is free to move and a second state where said orientation ball is held in position; said bottom orientation and stopping system operatively associated with said trigger body whereby when said trigger body is moved from a first position to a second position by lowering of said drill so that said orientation tool contacts a face of said core to be cut, the state of said orientation balls is changed from said first to said second state and the state of said ring is changed from said expanded state to said relaxed state so that as a core is cut by said drill, said core pushes said orientation tool in an uphole direction through said core tube.

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

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
15 September 2005 (15.09.2005)

PCT

(10) International Publication Number
WO 2005/085584 A1

(51) International Patent Classification⁷: **E21B 25/16**,
23/00

(21) International Application Number:
PCT/AU2005/000339

(22) International Filing Date: 10 March 2005 (10.03.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2004901241 10 March 2004 (10.03.2004) AU

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

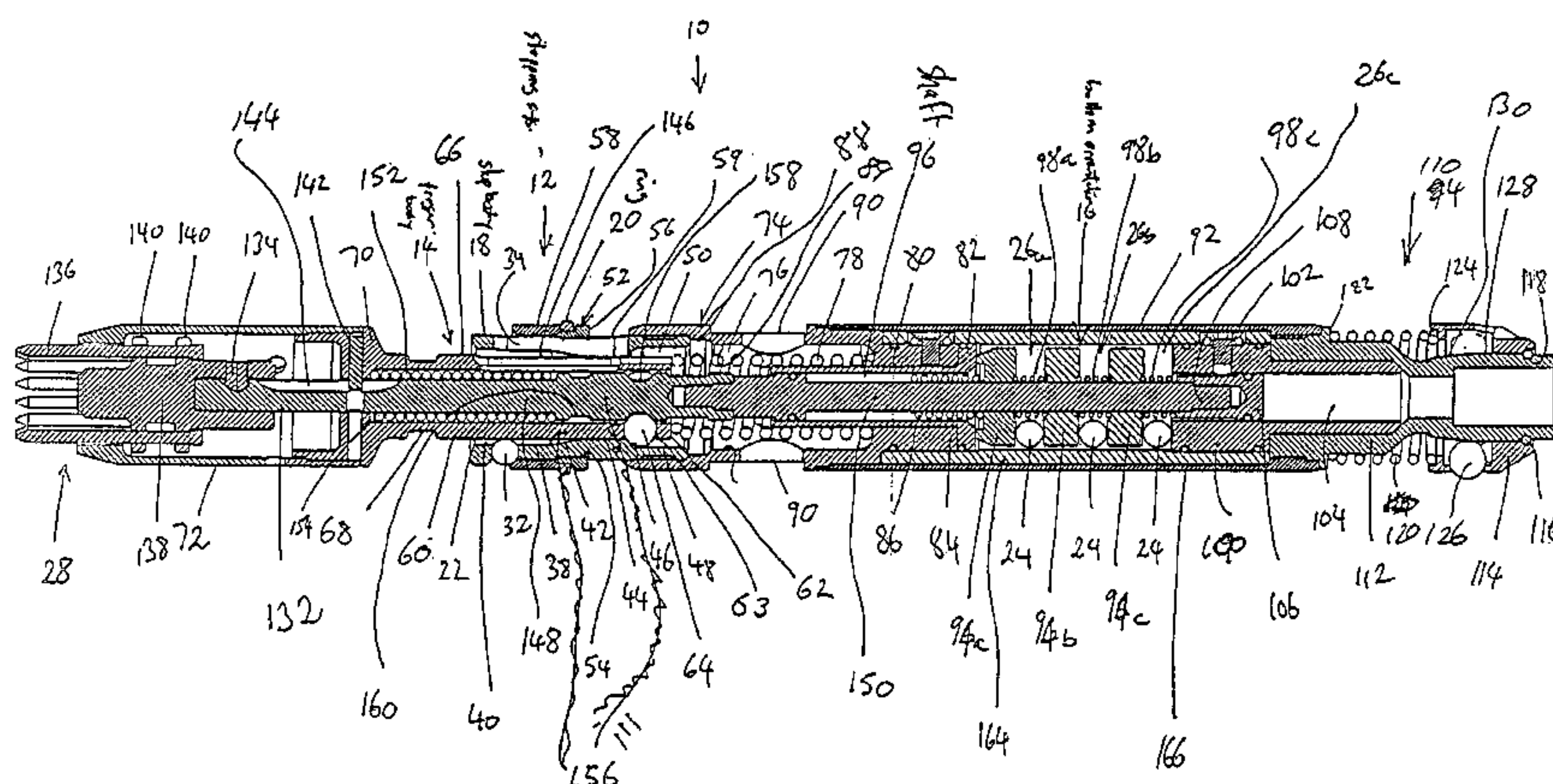
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

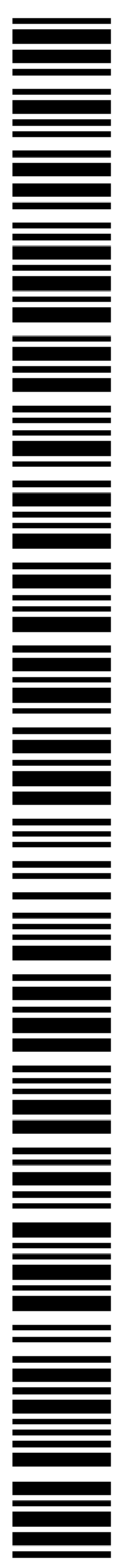
— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: DOWNHOLE CORE ORIENTATION TOOL



(57) **Abstract:** A core orientation tool for a core drill having a core bit at a downhole end and a retrievable core tube for receiving a core cut by said drill said orientation tool comprising: a stopping system comprising a tubular stop body and a ring extending about an outer circumferential surface of said stop body, said ring having an expanded state where said ring stops said stop body from passing through said core tube and relaxed state where said stop body can pass through said core tube; a trigger body extending from a down hole end of said stop body and slidable relative to said stop body, said trigger body extending beyond said core bit prior to commencement of drilling; and, a bottom orientator providing an indication of the location of a bottom of said core, said bottom orientator provided with one or more orientation balls, each orientation ball having a first state where said orientation ball is free to move and a second state where said orientation ball is held in position; said bottom orientation and stopping system operatively associated with said trigger body whereby when said trigger body is moved from a first position to a second position by lowering of said drill so that said orientation tool contacts a face of said core to be cut, the state of said orientation balls is changed from said first to said second state and the state of said ring is changed from said expanded state to said relaxed state so that as a core is cut by said drill, said core pushes said orientation tool in an uphole direction through said core tube.



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Downhole Core Orientation Tool**Field of the Invention**

5 The present invention relates to a downhole tool and more particularly to a downhole core orientation tool for providing an indication of the orientation of a ground core sample cut by a core drill.

10 **Background of the Invention**

Core sampling is used to enable geological surveying of the ground for various purposes including exploration, mine development and civil construction. Analysis of the
15 material within the core sample provides information of the composition of the ground. Visual inspection of the core also enables a geologist to map ore veins and boundaries between different types of minerals. However to do so it is necessary to precisely know the orientation
20 of the core relative to the ground from which it was cut.

The present inventor has developed core orientation devices and systems which enable a geologist to precisely determine the orientation of a core relative to the ground
25 sample. Such devices are disclosed in International publication No. WO 03/038232 and International Publication No. WO 05/078232. The orientation devices in the aforementioned documents comprise in broad terms, a face orientator and a bottom orientator. The face orientator
30 enables rotational matching of the core sample to the orientation device. The bottom orientator provides an indication of the lowest position in the hole from which the core is cut. With this information a geologist is able to rotate the core once extracted from the ground to
35 a position commensurate with its position prior to being cut.

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The present invention has been developed as an enhancement of the aforementioned devices.

5 It is to be understood that, if any prior art publication is referred to herein, such reference does not constitute an admission that the publication forms a part of the common general knowledge in the art, in Australia or any other country.

10 In the claims of this application and in the description of the invention, except where the context requires otherwise due to express language or necessary implication, the words "comprise" or variations such as "comprises" or "comprising" are used in an inclusive
15 sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

Summary of the Invention

20

According to one aspect of the present invention there is provided a core orientation tool for a core drill having a core bit at a downhole end and a retrievable core tube for receiving a core cut by said drill, said orientation tool
25 comprising:

a stopping system comprising a tubular stop body and a ring extending about an outer circumferential surface of said stop body, said ring having an expanded state where
30 said ring stops said stop body from passing through said core tube and a relaxed state where said stop body can pass through said core tube;

a trigger body extending from a downhole end of said stop
35 body and slidable relative to said stop body, said trigger body extending beyond said core bit prior to commencement of drilling; and,

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a bottom orientator providing an indication of the location of a bottom of said core, said bottom orientator provided with one or more orientation balls, each
5 orientation ball having a first state where said orientation ball is free to move and a second state where said orientation ball is held in position;

10 said bottom orientation and stopping system operatively associated with said trigger body whereby when said trigger body is moved from a first position to a second position by lowering of said drill so that said orientation tool contacts a face of said core to be cut, the state of said orientation balls is changed from said
15 first state to said second state and the state of said ring is changed from said expanded state to said relaxed state so that as a core is cut by said drill, said core pushes said orientation tool in an uphole direction through said core tube.

20

Preferably said core orientation tool further comprises a face orientator coupled to said trigger body, said face orientator initially disposed forward of said trigger body when said trigger body is in said first position, to
25 provide, by contact with said face, an indication of the rotational position of the core relative to the tool.

Preferably said stop system further comprises:

30 a seat supported on said stop body and on which said stop ring is seated when in said expanded state and, a mechanism which holds said stop ring on said seat prior to said trigger body reaching said second position, and allows said stop ring to separate from said seat and
35 change to said relaxed state when said trigger body reaches said second position.

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Preferably said mechanism comprises:

one or more stop balls retained in said stop body, and an
outer circumferential surface of said trigger body against
5 which each stop ball bears; said outer circumferential
surface of said trigger body having a first length of
constant outer diameter and a circumferential groove of
reduced outer diameter, wherein each stop ball bears
against said first length prior to said trigger body
10 reaching said second position, whereby each stop ball
extends radially of said trigger body preventing said stop
ring from separating from said seat, and after the trigger
body reaches said second position, each stop ball retracts
radially inward into said groove allowing said stop ring
15 to separate from said seat and change from said expanded
state to said relaxed state.

Preferably said mechanism further comprises a stop locking
sleeve disposed about said stop body, said stop locking
20 sleeve held against said stop ring and said seat by each
stop ball thereby holding said stop ring in said expanded
state prior to said trigger body reaching said second
position, and wherein after said trigger body reaches said
second position each stop ball retracts into said groove
25 and said stop locking sleeve slides away from said ring
and said seat over each of said stop balls allowing said
core tube to push said ring off said seat and said stop
locking sleeve over each of said stop balls, locking said
trigger body to said stop body.

30

Preferably said core orientation tool further comprises: a
shaft retained in said trigger body, and coupled at one
end to said face orientator; a trigger spring acting
between said shaft and said trigger body to bias said
35 shaft in an uphole direction relative to said trigger
body; and, one or more trigger balls locking said trigger
body to said shaft when said trigger body is in said first

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- position for an initial distance of travel of said trigger body relative to said stop body until said trigger body reaches an intermediate position, at which said trigger balls release said shaft from said trigger body allowing
- 5 said spring to advance said shaft in said uphole direction relative to said trigger body, thereby retracting said face orientator into said trigger body so that said trigger body can contact said face of said core.
- 10 Preferably said trigger balls relock said shaft to said trigger body when said trigger body reaches said second position.

- Preferably said bottom orientator comprises a ball race
- 15 for each of said orientation balls, each race comprising a pair of opposing surfaces mounted on said shaft and between which a respective orientation ball resides, said opposing surfaces moveable relative to each other along said shaft between a free position where said orientation
- 20 ball is in first state and a clamped position where said orientation ball is in said second state, said shaft acting to move said opposing surfaces to said clamped position after said trigger body reaches said second position.

25

According to another aspect of the invention there is provided a downhole tool comprising:

- a stopping system comprising a tubular stop body and a
- 30 ring extending about the stop body, the ring moveable between an expanded position where the ring has a first outer diameter and a relaxed position where the ring has a second outer diameter less than the first outer diameter;
- 35 a trigger body extending from a downhole end of the stop body and slidably retained in the stop body, the trigger

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body having a first length of a first outer diameter and a groove of a reduced outer diameter; and,

one or more stop devices retained by the stop body and
5 disposed about the trigger body, each stop device
extending through the stop body to stop the ring from
moving from the expanded position to the relaxed position
when the one or more stop devices are in radial alignment
with the first length of the trigger body, and wherein the
10 one or more stop devices retract inwardly when in radial
alignment with the groove to allow the ring to move to the
relaxed position.

Optionally the downhole tool comprises a seat supported on
15 the stop body and on which the stop body is seated when in
the expanded state.

Optionally the downhole tool further comprises a stop
locking sleeve disposed about the stop body, the stop
20 locking sleeve held against the seat by the one or more
stop devices when the one or more stop devices are in
radial alignment with the first length of the tubular body
thereby holding the ring in the expanded position; the one
or more stop devices being free to retract from the stop
25 locking sleeve when in radial alignment with the groove
whereby the stop locking sleeve can slide away from the
stop body to allow the ring to move off the stop body and
into the relaxed position.

30 Optionally each of the one or more stop devices comprises
a ball.

Optionally the downhole tool further comprises a bottom
orientator providing an indication the location of a
35 vertically lowest point in a vertical plane intersecting
the downhole tool, the bottom orientator provided with one
or more orientation balls, each orientation ball having a

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first state where the orientation ball is free to move and a second state where the orientation ball is held in position.

- 5 Optionally the downhole tool further comprises a face orientator coupled to the trigger body, the face orientator initially disposed forward of the trigger body, the face orientator providing, by contact with a toe of the hole in which the downhole tool is placed, an
10 indication of the rotational position of the toe of the hole relative to the downhole tool.

Optionally the downhole tool further comprises a shaft retained in the trigger body;

15

a trigger spring acting between the shaft and the trigger body to bias the shaft in an uphole direction relative to the trigger body; and,

- 20 one or more trigger balls locking the trigger body to the shaft in a first relative juxtaposition when the trigger body is in a first position for an initial distance of travel of the trigger body relative to the stop body until the trigger body reaches an intermediate position, at
25 which the trigger balls release the shaft from the trigger body allowing the trigger spring to advance the shaft in the uphole direction relative to the trigger body.

- In one embodiment the shaft comprises first and second
30 axially spaced recesses, the first recess being disposed nearer an uphole end of the tool and the one or more trigger balls are retained in the trigger body, the one or more trigger balls partially sealed in the first recess when the trigger body is in the first position, partially
35 sealed in the second recess when the trigger body is in a second position and between the first and second recesses when the trigger body is in the intermediate position.

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Optionally the bottom orientator is operatively associated with the trigger body whereby when the trigger body slides inwardly of the stop body from the first position to the
5 intermediate position, the state of the orientation balls is changed from the first state to the second state.

Optionally the face orientator is coupled at a downhole end of the shaft, the face orientator being retracted into
10 the trigger body when the trigger balls are in the intermediate position.

In one embodiment the bottom orientator comprises a ball race for each orientation ball, each race comprising a
15 pair of opposing surfaces mounted on the shaft and between which a respective orientation ball resides, the opposing surfaces moveable relative to each other along the shaft between a free position where each orientation ball is in the first state and a clamped position where each
20 orientation ball is in the second state, the shaft acting to move the opposing surfaces to the clamped position after the trigger body has reached a second position.

Optionally the downhole tool further comprises a race
25 spring disposed about the shaft between a shoulder on the shaft and the ball races, the shoulder contacting the race spring when the shaft is in the second position, the race spring biasing the opposing surfaces of the ball springs to the clamped position.

30

Brief Description of the Drawings

An embodiment of the present invention will now be described by way of example only with reference to the
35 accompanying drawings in which:

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Figure 1 is a section view of an embodiment of the tool in a first stage of operation;

Figure 2 is a section view of the tool in a second stage
5 of operation;

Figure 3 is a section view of the tool in a third stage of operation;

10 Figure 4 is a partial cut-away view of the tool in the first stage of operation.

Detailed Description of Preferred Embodiment

15 Figure 1 illustrates an embodiment of a downhole tool and more particularly a core orientation tool 10 for a core drill (not shown) having a core bit of conventional construction at a downhole end and a retrievable core tube for receiving a core cut by the drill. Typically the core
20 tube includes an internal core lifter case which is used to grip the core after drilling has ceased to allow the application of a tensile force by lifting of the drill thereby breaking the core from the ground from which it is cut.

25

The orientation tool 10 comprises a stopping system 12, a trigger body 14 and a bottom orientator 16. The stopping system 12 comprises a tubular stop body 18 and a ring 20 extending about an outer circumferential surface of the stop body 18. The ring 20 has an expanded state (shown in
30 Figures 1 and 2) where the ring 20 prevents or otherwise stops the tool 10 from passing through the core tube of the drill in which the tool 10 is loaded, and a relaxed state, shown in Figure 3, where the stop body 12 and
35 indeed the tool 10 can pass through the core tube. That is, when the ring 20 is in the expanded state shown in Figure 1, the outer diameter of the ring 20 is greater

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than the inner diameter of the core tube (incorporating a core lifter case) thereby preventing the tool 10 from being pushed upwardly in the uphole direction. Whereas, when the ring 20 is in the relaxed state shown in Figure 3, it has a reduced outer diameter enabling the ring 20 and the associated stop body 18 and tool 10 to pass through the core tube.

The trigger body 14 extends from a downhole end 22 of the stop body 18 and is slidable relative to the stop body 18. The trigger body 14 also extends beyond the core bit of the core drill prior to the commencement of drilling. The bottom orientator 16 provides an indication of the location of the bottom of the core cut by the drill. The "bottom of the core" is in reality an axial line corresponding with the lowest point along the length of the hole from which the core is cut. The bottom orientator 16 is provided with one or more (in this case three) orientation balls 24. Each orientation ball 24 has a free state (shown in Figure 1) where it is able to freely roll within a corresponding race 26 under the influence of gravity, and a second state (shown in Figure 3) where each ball is held or fixed in position. The bottom orientator 16 and the stopping system 12 are operatively associated with the trigger body 14 so that when the trigger body 14 is moved from a first position (shown in Figure 1) to a second position (shown in Figure 3) by lowering of the drill in which the tool 10 is loaded, so that the tool 10 contacts the face of the core to be cut, the state of the orientation balls 24 is changed from the first state to the second state, and the state of the ring 20 is changed from the expanded state to the relaxed state. Thus, by simply lowering the drill so that the tool 10 contacts the face of the core to be cut, the motion of the trigger body 14 places the orientation balls in the second state thereby providing an indication of the lowest axial line in the hole from which the core

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is to be cut, and changes the state of the ring 20 to the relaxed state shown in Figure 3 so that upon cutting of the core, the advancing core can push the entire tool 10 in an uphole direction through the core tube.

5

In order to match the position of the lowest line in the hole from which the core is cut, indicated by the position of the clamped orientation balls 24, it is necessary to rotationally align the tool 10 with the core which has been cut. This is achieved by use of a face orientator 28 which is coupled to the trigger body 14 via a shaft 96. The face orientator provides an indication of the rotational position of the core relative to the tool 10 by physical contact with the face of the core prior to the commencement of drilling.

15

Looking at the components of the tool 10 in more detail, the stop body 18 is in the form of a short tube provided with a number of holes 30 near, but in board of its downhole end 22, each hole 30 retaining a corresponding stop ball 32. Typically three holes 30 and corresponding stop balls 32 are provided in the stop body 18 at evenly spaced locations about the circumference of the body 18. A longitudinal slot 34 (shown in Figure 1) is also formed in the stop body 18 in which is partially seated a lock ball 36 (shown in Figure 4). An inner circumferential surface of the stop body 18 has: a first portion 38 of a first diameter, which is dimensioned to provide an annular space 40 between portion 38 and an outer diameter of the trigger body 14; a second portion 42 of progressively decreasing diameter; a third portion 44 of a constant diameter marginally less than the outer diameter of the trigger body 14; an arcuate portion 46; and, a portion 48 again of constant outer diameter dimensioned to define with the outer diameter of the trigger body 14 an annular space 50. Waterways 51 are also formed in the body 18 to allow for the passages of liquids

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The stop system 12 further comprises a seat 52 which is held within a circumferential groove 54 formed about the outer diameter of the body 18. The seat 52 is provided at its uphole end with a radially extending lip 56 which prevents the ring 20 from passing in the uphole direction over the seat 52. A stop locking sleeve 58 is also seated about the outer circumference of the body 18 between the seat 52 and the downhole end 22 of the body 18. The sleeve 58 and stop balls 32 together form a mechanism that holds the ring 20 in the expanded state on the seat 52 prior to the trigger body 14 reaching its second position. However, as shown in Figure 3 when the trigger body 14 reaches the second position, the sleeve 58 is able to separate from the seat 52 allowing the ring 20 to be pushed off the seat 52 by action of abutment with the core tube or more particularly, a core lifter case within the tube.

The trigger body 14 includes a tubular portion 60 which is able to slide axially relative to the stop body 18. Inboard of an uphole end 62 of the tubular portion 60 is a plurality of holes 63 each of which retains a corresponding trigger ball 64. The outer circumference of the tubular portion 60 has a first (and major) length 66 of constant outer diameter and, on the downhole side thereof, a circumferential groove 68 of reduced diameter. The groove 68 leads to a head 70 on which is attached a shroud 72.

An uphole end of the stop body 18 is coupled internally of a main body 74 of the tool 10. The body 74 is provided with an internal cavity 76 which houses a coil spring 78. A guide tube 80 is also held within the main body 74 and is provided with a flange 82 that sits on an uphole end 84 of the main body 74. The tube 82 houses a coil spring 86. A portion 88 of the main body 74 adjacent the uphole end

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of the body 18 has an inner diameter that is greater than the inner diameter of the portion 48 of the body 18. Waterways 90 are cut in the main body 74 and communicate with the waterways 51 of the stop body 18 to provide a
5 flow path for fluids such as water through the tool 10.

An orientation body 92 is attached to an end of the main body 74 distant the stop body 18. The orientation body 92 houses the bottom orientator 16 which comprises three
10 spaced apart and axially aligned washers 94a, 94b and 94c (hereinafter referred to in general as "washers 94"). The washers 94 are slidably supported on the shaft 96. With the trigger body 14 in the first position shown in Figure 1, the washers 94 are spaced apart by respective springs
15 98a, 98b and 98c (hereinafter referred to in general as "springs 98") which are disposed about the shaft 96. The ball race 26a is formed between opposing faces of washers 94a and 94b respectively; the race 26b is formed between the opposing surfaces of washers 94b and 94c respectively;
20 and, the ball race 26c is formed between the opposing surface of washer 94c and a plug member 100 which is fixed to an uphole end of the orientation body 92 by a screw 102.

25 The plug member 100 is formed with an axial passage 104 in which slides an end cap 106 screwed to an uphole end 108 of the shaft 96.

An anchor system 110 is attached to the plug member 100
30 and acts to anchor the tool 10 on an internal surface of the core tube, preventing the tool 10 from falling out of the core tube by the action of gravity.

The anchor system 110 comprises an anchor body 112 which receives a portion of the end plug 100 and, seats about
35 its outer diameter an anchor sleeve 114 which is able to move axially relative to the anchor body 112 to a position limited in the uphole direction by a stop ring 116 seated

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in a groove 118 formed near an uphole end of the body 112. Anchor spring 120 is seated on the outer diameter of the anchor body 112 and resides between a shoulder 122 formed in the anchor body and an internal seat 124 formed in the anchor sleeve 114. The spring 120 biases the anchor sleeve 114 in an uphole direction to abut the stop ring 116. A plurality of anchor balls 126 are retained in the anchor sleeve 114 but have respective portions that extend radially from the anchor sleeve 114 when the anchor sleeve is abutted against the stop ring 116. In this position the anchor balls 126 are in contact with a constant outer diameter portion 128 of the anchor body 112. However moving in a downhole direction from the constant diameter portion 128 the anchor body 122 is formed with a further portion 130 of progressively reducing outer diameter.

The shaft 96 extends through the trigger body 14, guide tube 80, washers 94 and into the passage 104 of the plug member 100. A downhole end 132 of the shaft 96 is attached by a grub screw 134 to the face orientator 28. In this particular embodiment, the face orientator 28 is in the style of a VAN RUTH orientator comprising a plurality of elongate circumferentially arranged pins 136 which are retained in, and can slide axially of, a core block 138. The core block 138 is formed with a pair of parallel spaced apart radial flanges 140 through which each pin 136 extends. A plurality of rubber bands or O-rings (not shown) extend about the pins 136 between the flanges 140 to act as a brake holding the pins 136 in position in the absence of a force applied along the length of the pins 136.

A pin 142 is held within the head 70 of the trigger body 14 and extends transversely into a longitudinal slot or keyway 144 formed near the downhole end 132 of the shaft 96. The engagement of the pin 142 in a slot 144 prevents relative rotational motion between the shaft 96 (and thus the face orientator 28) and the trigger body 14. Relative

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rotational motion between the trigger body 14 and the stop body 18 (and thus also the main body 74) is prevented by the lock ball 36 which resides within the slot 34 formed in the stop body 18, and a parallel underlying slot 146
5 formed in the tubular portion 60 of the trigger body 14.

The shaft 96 comprises to separate rods 148 and 150 which are screw-coupled together. Trigger spring 152 is disposed about the rod 148 inside the trigger body 14. A
10 downhole end of the spring 152 abuts an internal shoulder 154 formed in the tubular portion 60 adjacent the head 70. An uphole end of the spring 152 abuts an increased diameter portion 156 of the rod 148. The increased diameter portion 156 is formed with a first
15 circumferential recess 158 at an end near the rod 150, and a second axially spaced recess 160 formed nearer the downhole end of the shaft 96.

A plurality of rubber O-rings or seals 162 (see Figure 2) are provided in the rod 150, main body 74, flange 82, plug member 100 and end cap 106. These O-rings or seals 162 prevent the escape of a light oil (not shown) held within the orientation body 92 and which envelopes the
20 orientation balls 24.

25 The orientation body 92 comprises an inner clear polycarbonate sleeve 164 which extends between the main body 74 and the plug member 100; and, an overlying outer stainless steel sleeve 166. The sleeve 166 provides
30 protection to the polycarbonate sleeve 164. After the tool 10 has been used, the outer stainless steel sleeve 166 is removed so that the position of the balls 24 can be viewed through the clear polycarbonate sleeve 164. Neither of the sleeves 164 or 166 is designed to bear any
35 substantial axial load.

The operation of the tool 10 will now be described.

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The orientation tool 10 when initially inserted into a core tube is in the configuration shown in Figure 1, with the pins 136 of the face orientator 28 extending from a downhole end of the shroud 72, the shaft 96 locked to the trigger body 14 by virtue of the trigger balls 64 being seated in the first circumferential recess 158 and bearing against the portions 46 and 48 of the inner surface of stop body 18, the ring 20 in the expanded state seated on the seat 52 and held in that state by the combination of the sleeve 58 and stop balls 32; the spring 152 in a relatively compressed state and the springs 78, 86, 98 and 120 in a relatively expanded state. The spring 120, being in a relatively expanded state, urges the anchor sleeve 114 against the ring 116 so that the anchor balls 126 ride on the constant diameter portion 128 of the anchor body 112.

The tool 10 is loaded into a downhole end of the core tube by first inserting the anchor body 112. The anchor system 110 is arranged so that when the anchor sleeve 114 abuts against the ring 116, the balls 126 extend radially at a distance greater than the internal diameter of the core tube. Therefore initially the anchor sleeve 114 slides axially away from the ring 116 so that the anchor balls 126 ride along the portion 130 having a progressively reduced outer diameter. This causes the balls 126 to effectively move radially inward reducing the radial extent of the balls 126 so that they can now enter the core tube, thereby allowing the orientation tool 10 to be inserted into the core tube. The tool 10 is inserted into the core tube until the ring 20 abuts a downhole end of the core tube (and more particularly the core lifter case within the core tube). The anchor spring 120 is continually biasing the anchor sleeve 114 in an uphole direction urging the balls 126 to ride up the tapered portion 130 to a position where they bear against the

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inner diameter of the core tube. This effectively anchors the orientation tool 10 to the core tube thus preventing it from falling out. It should be appreciated that any force applied to the orientation tool 10 in a downhole direction further wedges the balls 126 against the inner diameter of the core tube. Further, by appropriate selection of the spring 120, the anchor system 110 also provides a braking effect against motion of the tool in an opposite direction. The degree of braking effect is dependent on the spring constant of the spring 120. This braking effect is particularly useful when the tool 10, or another tool to which a similar braking system is applied is used in an uphole configuration to reduce the speed of the tool 10 or other tool when travelling back under the influence of gravity.

The core tube is then lowered into a core drill via a conventional wire line, with the core drill being suspended above a toe of the hole to be drilled. With the core tube seated within the core drill, the pins 136 of the face orientation 128, and the shroud 72 of the trigger body 14 extend axially beyond and through a core bit attached to the core drill. Prior to imparting torque to the drill, the drill is lowered onto the toe of the hole. This results in the pins 136 contacting the toe of the hole which will form a face of the core to be drilled. Accordingly the pins 136 slide axially in an uphole direction to positions which correspond with the profile of the core face. This continues until the toe of the hole (ie face of the core to be cut) contacts a downhole end of the shroud 72. Now the load (ie the weight) of the core drill is transferred onto the trigger body 14 causing the trigger body 14 to slide axially in an uphole direction relative to the stop body 18. Since the shaft 96 is locked to the trigger body 14 by virtue of the trigger balls 64 sitting in the groove 158, the shaft 96 moves axially in an uphole direction in unison with the

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trigger body 14. As this occurs, the trigger balls 64 roll along the portion 48 of the internal diameter of the stop body 18. Eventually the balls 64 roll out of the stop body 18 and into the portion 88 of the main body 74. The portion 88 has an increased outer diameter in comparison with the portion 48. Thus, the balls 64 are able to move in a radially outward direction and disengage from the circumferential recess 158. The shaft 96 is now released from the trigger body 14. When this occurs, the spring 152 is able to expand thereby causing the shaft 96 to slide axially in an uphole direction relative to the trigger body 14. This in turn acts to retract the face orientator 28 to a position wholly within the shroud 72 as indicated in Figure 2.

The action of the spring 152 causes the shaft 96 to slide axially to a position where the second circumferential recess 160 is located adjacent the trigger balls 64. Additionally, the shaft 96, and in particular the rod 150 is positioned so that the race spring 86 now applies a light pressure or bias to the washers 94, causing them to concertina in the uphole direction against the bias of springs 98. This in turn leads to a reduction in the width of the races 26 within which the orientation balls 24 ride. However it may not be sufficient to place the orientation balls 24 in the second state where they are clamped from rotation within their respective races 26.

With reference to Figure 3 lowering of the core drill forces the trigger body 14, shaft 96 and trigger balls 64 to move in an uphole direction relative to the stop body 18. As a consequence, the trigger balls 64 commence to ride up the inner diameter of the main body 74 onto the reduced inner diameter portion 89. This causes the trigger balls 64 to move radially inward and seat in the circumferential groove 160, effectively relocking the trigger body 14 to the shaft 96. This motion further

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causes the shaft 96 to travel in an uphole direction relative to the orientation body 92 so that the pressure applied by the spring 86 to the washers 94 increases to the extent that the orientation balls 24 are now

5 effectively clamped and placed in a second position where they are no longer able to rotate within their respective races 26. Shortly thereafter, the continued lowering of the drill onto the toe of the hole causes the trigger body 14 to slide relative to the anchor body 18 to a position

10 where the grooves 68 underlies the stop balls 32. The stop balls 32 are now free to move radially inward to a position where they no longer hold the stop lock sleeve 58. As a result, the core tube, which abuts the ring 20 is now able to slide the ring 20 off the seat 52 in a

15 downhole direction. The ring 20, being in the form of a snap ring relaxes or contracts about the outer diameter of the body 18 thereby reducing its outer diameter, and the sleeve 58 slides over the stop balls 32 as shown in Figure 3. The stop balls 32, being retained by the stop body 18

20 and seated in the groove 68, lock the trigger body 14 to the stop body 18. Due to the contraction of the ring 20, continued lowering of the core drill 20 now results in the tool 10 being effectively pushed in an uphole direction within the core tube.

25

The core drill is further lowered onto the toe of the hole until the core bit contacts the toe of the hole. The occurrence of this event is indicated in a conventional manner.

30

Torque may now be applied to the drill causing a core to be cut. As the core is cut it advances into the core tube pushing the entire orientation tool 10 inwardly of the core tube.

35

Once drilling has ceased, and the core has been broken by the lifting of the core drill, the core tube with the

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orientation tool 10 and core sample is retrieved by a conventional wire line. The orientation tool 10 together with the core sample are removed from the core tube and the shroud 72 detached from the head 70 of the trigger
5 body 14. The sleeve 166 is also removed from the orientation body 92.

The tool 10 and the core sample are rotationally aligned by matching the profile of the pins 136 to the face of the
10 core. The outer circumference of the core is now marked with a line collinear with the position of the clamped orientation balls 24, which can be viewed through the transparent sleeve 164. The line marked on the outer diameter of the core denotes the bottom of the core.

15

The core block 138 can be removed from the tool 10 by unscrewing of the grub screw 134 and kept with the core sample as a permanent record of the core orientation. To this end, the core block 138 should also be marked with a
20 line in alignment with the balls 24. It is further advantageous for the core block 138 to be made from a relatively cheap material such as a plastics material.

Now that an embodiment of the present invention has been
25 described in detail it will be apparent to those skilled in the relevant arts that numerous modifications and variations may be made without departing from the basic inventive concepts. Most notably, if desired, the face orientator 28 may also be provided with a marker such as a pencil for
30 producing a mark on the face of the core to be drilled. This produces a degree of redundancy in the face marker 28 whereby the mark produced by the pencil together with the profile of the pins 136 may be used to match the rotational position of the tool 10 to the core. In the event that the
35 mark produced by the pencil and the profile of the pins 136 do not coincide, a geologist will be given an indication that the orientation of the core is unreliable and therefore

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should not be used. Alternately, all of the pins 136 may simply be replaced by a single pencil or other marker to produce mark on the face of the core.

- 5 It is further possible to modify the face orientator 28 in a manner similar to that described in relation to co-pending International Publication No. WO 05/078232 so as to include a demountable disc and face marker, such as a pencil. The demountable disc would be seated on the shaft 132 within the
- 10 shroud 72 and marked simultaneously with the core by the marker. The disc can subsequently be marked after retrieval of the core with a mark in alignment with the orientation balls 24. Thus the demountable disc will bear both a mark in alignment with the mark produced on the core face by the
- 15 marker, and a second mark in alignment with the orientation balls 24 providing an indication of the location of the bottom of the core. The demountable disc may then be held as a permanent record of the core sample.
- 20 All such modifications and variations together with others that would be obvious to a person of ordinary skill in the art are deemed to be within the scope of the present invention the nature of which is to be determined from the above description.

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CLAIMS:

1. A core orientation tool for a core drill having a core bit at a downhole end and a retrievable core tube for receiving a core cut by said drill, said orientation tool comprising:
- 5
- a stopping system comprising a tubular stop body and a ring extending about an outer circumferential surface of said stop body, said ring having an expanded state where said ring stops said stop body from passing through said core tube and a relaxed state where said stop body can pass through said core tube;
- 10
- a trigger body extending from a downhole end of said stop body and slidable relative to said stop body, said trigger body extending beyond said core bit prior to commencement of drilling; and,
- 15
- a bottom orientator providing an indication of the location of a bottom of said core, said bottom orientator provided with one or more orientation balls, each orientation ball having a first state where said orientation ball is free to move and a second state where said orientation ball is held in position;
- 20
- 25
- said bottom orientation and stopping system operatively associated with said trigger body whereby when said trigger body is moved from a first position to a second position by lowering of said drill so that said orientation tool contacts a face of said core to be cut, the state of said orientation balls is changed from said first state to said second state and the state of said ring is changed from said expanded state to said relaxed state so that as a core is cut by said drill, said core pushes said orientation tool in an uphole direction through said core tube.
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- 35

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2. The core orientation tool according to claim 1 further comprising a face orientator coupled to said trigger body, said face orientator initially disposed forward of said trigger body when said trigger body is in
5 said first position, to provide, by contact with said face, an indication of the rotational position of the core relative to the tool.

3. The core orientation tool according to claim 1 or 2
10 wherein said stop system further comprises:

a seat supported on said stop body and on which said stop ring is seated when in said expanded state and, a mechanism which holds said stop ring on said seat prior to
15 said trigger body reaching said second position, and allows said stop ring to separate from said seat and change to said relaxed state when said trigger body reaches said second position.

20 4. The core orientation tool according to claim 3 wherein said mechanism comprises:

one or more stop balls retained in said stop body, and an outer circumferential surface of said trigger body against
25 which each stop ball bears; said outer circumferential surface of said trigger body having a first length of constant outer diameter and a circumferential groove of reduced outer diameter, wherein each stop ball bears against said first length prior to said trigger body
30 reaching said second position, whereby each stop ball extends radially of said trigger body preventing said stop ring from separating from said seat, and after the trigger body reaches said second position, each stop ball retracts radially inward into said groove allowing said stop ring
35 to separate from said seat and change from said expanded state to said relaxed state.

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5. The core orientation tool according to claim 4 wherein said mechanism further comprises a stop locking sleeve disposed about said stop body, said stop locking sleeve held against said stop ring and said seat by each
5 stop ball thereby holding said stop ring in said expanded state prior to said trigger body reaching said second position, and wherein after said trigger body reaches said second position each stop ball retracts into said groove and said stop locking sleeve slides away from said ring
10 and said seat over each of said stop balls allowing said core tube to push said ring off said seat and said stop locking sleeve over each of said stop balls, locking said trigger body to said stop body.
- 15 6. The core orientation tool according to any one of claims 2-5 further comprising a shaft retained in said trigger body, and coupled at one end to said face orientator; a trigger spring acting between said shaft and said trigger body to bias said shaft in an uphole
20 direction relative to said trigger body; and, one or more trigger balls locking said trigger body to said shaft when said trigger body is in said first position for an initial distance of travel of said trigger body relative to said stop body until said trigger body reaches an intermediate
25 position, at which said trigger balls release said shaft from said trigger body allowing said spring to advance said shaft in said uphole direction relative to said trigger body, thereby retracting said face orientator into said trigger body so that said trigger body can contact
30 said face of said core.
7. The core orientation tool according to claim 6 wherein said trigger balls relock said shaft to said trigger body when said trigger body reaches said second
35 position.

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8. The core orientation tool according to claim 6 or 7 wherein said bottom orientator comprises a ball race for each of said orientation balls, each race comprising a pair of opposing surfaces mounted on said shaft and
5 between which a respective orientation ball resides, said opposing surfaces moveable relative to each other along said shaft between a free position where said orientation ball is in said first state and a clamped position where said orientation ball is in said second state, said shaft
10 acting to move said opposing surfaces to said clamped position after said trigger body reaches said second position.

9. A downhole tool comprising:
15 a stopping system comprising a tubular stop body and a ring extending about the stop body, the ring moveable between an expanded position where the ring has a first outer diameter and a relaxed position where the ring has a
20 second outer diameter less than the first outer diameter;

a trigger body extending from a downhole end of the stop body and slidably retained in the stop body, the trigger body having a first length of a first outer diameter and a
25 groove of a reduced outer diameter; and,

one or more stop devices retained by the stop body and disposed about the trigger body, each stop device extending through the stop body to stop the ring from
30 moving from the expanded position to the relaxed position when the one or more stop devices are in radial alignment with the first length of the trigger body, and wherein the one or more stop devices retract inwardly when in radial alignment with the groove to allow the ring to move to the
35 relaxed position.

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10. The downhole tool according to claim 9 comprising a seat supported on the stop body and on which the stop body is seated when in the expanded state.

5 11. The downhole tool according to claim 10 further comprises a stop locking sleeve disposed about the stop body, the stop locking sleeve held against the seat by the one or more stop devices when the one or more stop devices are in radial alignment with the first length of the
10 tubular body thereby holding the ring in the expanded position; the one or more stop devices being free to retract from the stop locking sleeve when in radial alignment with the groove whereby the stop locking sleeve can slide away from the stop body to allow the ring to
15 move off the stop body and into the relaxed position.

12. The downhole tool according to any one of claims 9-11 further comprising a bottom orientator providing an indication the location of a vertically lowest point in a
20 vertical plane intersecting the downhole tool, the bottom orientator provided with one or more orientation balls, each orientation ball having a first state where the orientation ball is free to move and a second state where the orientation ball is held in position.

25 13. The downhole tool according to any one of claims 9-12 further comprising a face orientator coupled to the trigger body, the face orientator initially disposed forward of the trigger body, the face orientator
30 providing, by contact with a toe of the hole in which the downhole tool is placed, an indication of the rotational position of the toe of the hole relative to the downhole tool.

35 14. The downhole tool according to claim 13 further comprising a shaft retained in the trigger body;

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a trigger spring acting between the shaft and the trigger body to bias the shaft in an uphole direction relative to the trigger body; and,

5 one or more trigger balls locking the trigger body to the shaft in a first relative juxtaposition when the trigger body is in a first position for an initial distance of travel of the trigger body relative to the stop body until the trigger body reaches an intermediate position, at
10 which the trigger balls release the shaft from the trigger body allowing the trigger spring to advance the shaft in the uphole direction relative to the trigger body.

15 15. The downhole tool according to claim 14 wherein the shaft comprises first and second axially spaced recesses, the first recess being disposed nearer an uphole end of the tool and the one or more trigger balls are retained in the trigger body, the one or more trigger balls partially sealed in the first recess when the trigger body is in the
20 first position, partially sealed in the second recess when the trigger body is in a second position and between the first and second recesses when the trigger body is in the intermediate position.

25 16. The downhole tool according to any one of claims 12-15 wherein the bottom orientator is operatively associated with the trigger body whereby when the trigger body slides inwardly of the stop body from the first position to the intermediate position, the state of the orientation balls
30 is changed from the first state to the second state.

17. The downhole tool according to any one of claims 14-16 wherein the face orientator is coupled at a downhole end of the shaft, the face orientator being retracted into
35 the trigger body when the trigger balls are in the intermediate position.

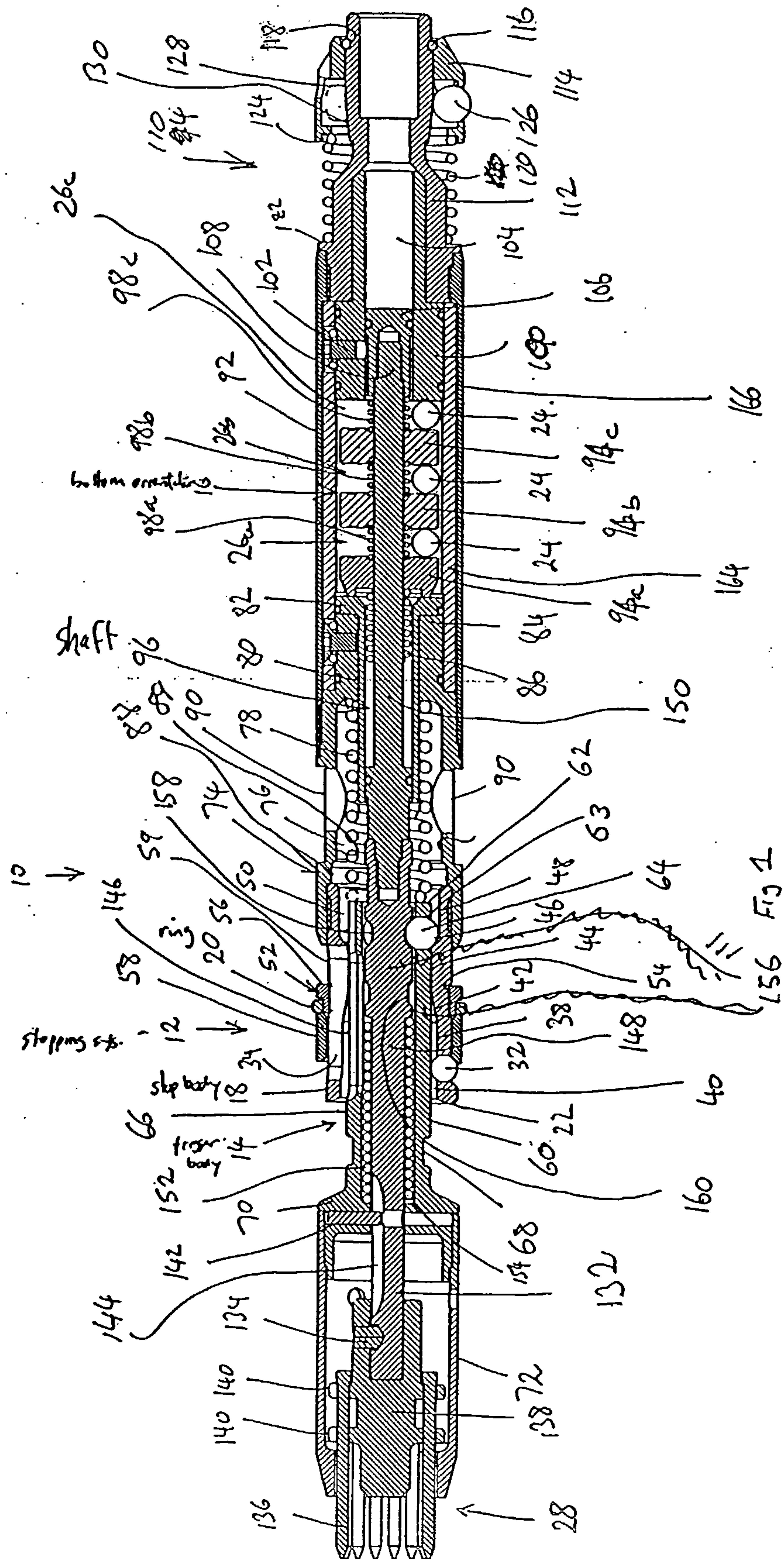
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18. The downhole tool according to claim 17 wherein the bottom orientator comprises a ball race for each orientation ball, each race comprising a pair of opposing surfaces mounted on the shaft and between which a
5 respective orientation ball resides, the opposing surfaces moveable relative to each other along the shaft between a free position where each orientation ball is in the first state and a clamped position where each orientation ball is in the second state, the shaft acting to move the
10 opposing surfaces to the clamped position after the trigger body has reached a second position.

19. The downhole tool according to claim 18 further comprising a race spring disposed about the shaft between
15 a shoulder on the shaft and the ball races, the shoulder contacting the race spring when the shaft is in the second position, the race spring biasing the opposing surfaces of the ball springs to the clamped position.

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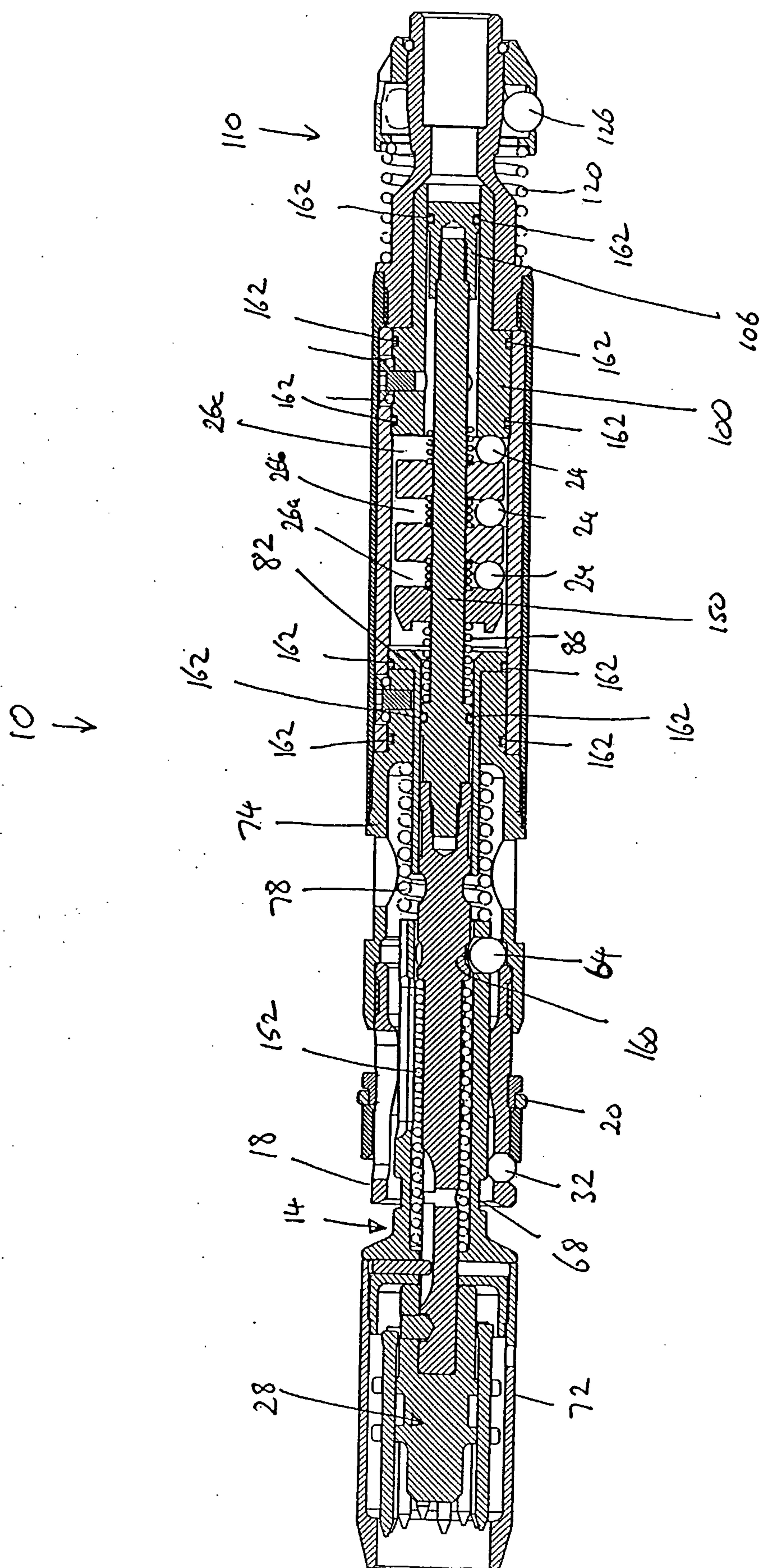


Fig 2

