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(54) ROTATION ACTIVATED DOWNHOLE ORIENTATION SYSTEM AND METHOD

DURCH DREHUNG AKTIVIERTES BOHRLOCHAUSRICHTSYSTEM UND -VERFAHREN

PROCÉDÉ ET SYSTÈME D'ORIENTATION EN FOND DE TROU ACTIVÉ PAR ROTATION

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Description

Technical Field

[0001] A rotation activated downhole orientation system is disclosed. The system may be used to determine the orientation of a core sample extracted from the ground by a core or diamond drill.

Background of the Disclosure

[0002] Core sampling is used to enable geological surveying of the ground for various purposes including exploration, mine development and civil construction. Analysis of the 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 materials. However, to do so it is necessary to know the orientation of the core relative to the ground from which it was cut.

[0003] Many types of core orientation systems are currently available. Some of these systems comprise a bottom orientator that provides an indication of the bottom of the hole from which the core is extracted and an associated trigger mechanism. One type of trigger mechanism operates when the core drill contacts a toe of the hole to freeze or capture the bottom orientation of the hole indicated by the bottom orientator. An alternate type of trigger mechanism operates by the act of breaking the core from the ground.

[0004] The above reference to the background art does not constitute an admission that the art forms a part of the common general knowledge of a person of ordinary skill in the art. The above reference is also not intended to limit the application of the system and method as disclosed herein.

[0005] WO 2012/116393 A1 describes a rotation actuated core orientation system for a ground drill comprising an orientator and a rotation sensitive actuator.

Summary of the Disclosure

[0006] Aspects of the invention are set out in independent system claim 1 and preferred features are set out in the dependent claims.

[0007] Various aspects are disclosed of a system that enables the actuation or triggering of an orientator for a ground drill on the basis of rotational speed of the ground drill. The orientator provides an indication of the position of a reference bearing or location in or of a hole being drilled by the core drill. The orientation of the core extracted from the hole is the same as the orientation of the section of the hole from which the core is extracted.

[0008] Embodiments of the system rely on magnetic fields to switch the orientator between a free state in which the orientator is operable to provide an instantaneous indication of the orientation of the hole in which it

resides; and a locked state which locks or freezes the instantaneous indication. In general terms, two embodiments of the system are disclosed for providing the magnetic field to actuate the orientator. In one embodiment, that is not part of the current invention, a pump is operated by action of the rotation of the drill to apply a pressurised fluid that in turn moves a magnet to a position where its magnetic field is effective to switch the orientator from its locked state to its free state. When the speed of rotation of the drill drops below a threshold level, a bias mechanism operates to move the magnet in an opposite direction away from the orientator so that its magnetic field is no longer effective on the orientator thereby enabling the orientator to revert to its locked state. In an alternate embodiment, that is part of the current invention, an electric motor is provided that is operated by rotation of the drill. The electric motor produces a current that in turn drives an electromagnet. When the speed of the drill is greater than a threshold speed the electric current causes the generation of a magnetic field of sufficient strength to switch the orientator from its locked state to its free state. When the speed of the drill falls below the threshold speed the resultant current flow is insufficient to generate a magnetic field of a strength effective to hold the orientator in the free state. In that event the orientator reverts to the locked state.

[0009] Those of ordinary skill in the art of core or diamond drilling will recognise that a rotational speed of the drill string is 0 rpm immediately prior to a core break. Thus in one embodiment the threshold rotational speed of the drill may be set as 0 rpm. When the drill is being operated to drill a core the drill speed is greater than 0 rpm and the magnetic actuator acts to urge or hold the orientator in the free state. When the drill has stopped prior to a core break the drill speed is at the threshold speed of 0 rpm. The magnetic actuator no longer provides an effective magnetic field and allows the orientator to revert to the locked state to freeze the indication of orientation immediately prior to core breaking. However in alternate embodiments the threshold speed may be greater than 0 rpm. In one example the threshold speed could be up to 5 rpm. In this regard in embodiments of the system the orientator is biased in the absence of an external force to the locked state. Thus the magnetic actuator must overcome this bias to switch the orientator to the free state. According the threshold speed is just below the speed at which the magnetic field of the actuator becomes effective to overcome this bias of the orientator.

[0010] In one aspect there is disclosed a rotation activated orientation system for a ground drill comprising:

a magnetically operated orientator having a free state where the orientator provides a substantially instantaneous indication of a position of a reference bearing or location in or of a hole being drilled by the ground drill, and a locked state where the orientator maintains the indication; and,

a magnetic actuator operatively associated with the magnetically operated orientator wherein when the rotational speed of the ground drill is greater than a threshold speed the magnetic actuator supplies a magnetic field effective to place the orientator in the free state, and when the rotational speed of the drill is less than the threshold speed the magnetic actuator does not supply a magnetic field effective to operate the orientator so that the orientator reverts to or remains in the locked state; characterised in that the magnetic actuator comprises an electric generator and an electro-magnet which are together configured to produce a magnetic field, wherein when the rotational speed of the ground drill is greater than the threshold speed, the electric generator generates a current sufficient for the electromagnet to produce a magnetic field effective to place the orientator in the free state, and when the rotational speed of the ground drill is less than the threshold speed, the electric generator does not generate a current sufficient for the electromagnet to produce a magnetic field effective to operate the orientator so that the orientator reverts to or remains in the locked state.

[0011] In one embodiment the rotation activated orientation system comprises a time delay system arranged to delay the orientator in reverting from the free state to the locked state when the drill is rotating at a speed below the threshold speed.

[0012] In one embodiment the time delay system comprises a bleed path acting to restrict a flow rate of a fluid draining from a region which enables the orientator to move from a location corresponding to the free state to a location corresponding to the lock state.

[0013] In one embodiment the fluid is oil and the time delay system is a hydraulic time delay system which provides the time delay by restricting flow of oil through the bleed path.

[0014] In one embodiment the oil is transparent or translucent such that the indication provided by the orientator is visible through the oil.

[0015] In one embodiment the magnetic actuator comprises an electric machine or a fluid pump; and a coupling connected between the machine or the pump and the drill to impart torque to the machine or the pump when the drill rotates.

[0016] In one embodiment when the magnetic actuator is the pump, the magnetic actuator further comprises a magnet producing a magnetic field and a cavity in which the magnet is able to move between a first position where the magnet is spaced a distance from the orientator so that the magnetic field is not effective to place the orientator in the free state; and a second position where the magnet is sufficiently close to the orientator so that its magnetic field places the orientator in the free state, and wherein the pump is operable to pressurise the fluid to move the magnet from the first position to the second

position.

[0017] In one embodiment the magnetic actuator comprises a bypass flow path enabling fluid between the magnet and the orientator to flow from the cavity in response to the magnet moving from the first position toward the second position.

[0018] In one embodiment wherein the magnetic actuator comprises a high pressure path providing fluid communication between an outlet of the pump and the cavity on a side of the magnet distant the orientator wherein when the drill is rotating with a speed greater than the threshold speed the pump provides pressurised fluid through the high pressure flow path to move the magnet toward the second position.

[0019] In one embodiment the magnetic actuator comprises a fluid return path providing fluid communication between the cavity and an inlet of the pump.

[0020] In one embodiment the bleed path is arranged to enable a continuous circulating flow of fluid when the magnet is in the second position and while the drill is rotating at a speed greater than the threshold speed, wherein fluid flowing through the high pressure flow path and exerting pressure on the magnet holding the magnet in the second position is returned to the pump via the bleed path.

[0021] In one embodiment the rotation activated orientation system comprises a sump block disposed between the pump and the magnet, the sump block defining a fluid sump and being in direct fluid communication with the bleed path, the bypass path and the fluid return path.

[0022] In one embodiment the bleed path is formed in the sump block and provides fluid communication between the fluid sump and the side of the cavity distant the orientator.

[0023] In one embodiment the sump block comprises a bore that forms a part of the high pressure flow path.

[0024] In one embodiment the rotation activated orientation system comprises a bias mechanism acting to bias the magnet away from the second position and toward the first position, the bias mechanism arranged so that when the drill is rotated at a speed greater than the threshold speed fluid pressure produced by the pump overcomes the bias mechanism and moves the magnet from the first position toward the second position; and when the drill is operated at a speed less than the threshold speed the bias mechanism is operable to move the magnet in a direction from the second position toward the first position.

[0025] In one embodiment when the magnetic actuator is an electric machine the electric machine comprises an electric generator arranged to generate an electric current when the drill is being rotated at a speed greater than the threshold speed.

[0026] In one embodiment the electric machine comprises an electro-magnet connected to the electric generator, the electro-magnet arranged to produce a magnetic field effective to place the orientator in the free state when the drill is being rotated at a speed greater than

the threshold speed.

[0027] In one embodiment the orientator comprises a bias mechanism which accumulates potential energy when the orientator is being moved toward the free state by action of the magnetic actuator and converts the accumulated potential energy to kinetic energy when the drill is being rotated at a speed less than the threshold speed to return the orientator to the locked state.

[0028] In embodiments of the rotation activated orientation system the bleed path may operate as a fluid brake against action of the bias mechanism to restrict a rate of action of the bias mechanism in moving the orientator towards the locked position.

[0029] In a further aspect there is disclosed an orientation device comprising at least one orientation element and an associated closed loop race having a central axis in which the orientation element is confined, the race comprising first and second clamp members between which the orientation element is located the first and second clamp members being movable relative to each other between a free position where the clamp members are spaced sufficiently to enable the orientation element to roll about the axis within the closed loop race, and a locked position where the clamping members are moved toward each other to contact the orientation element, and wherein at least one of the clamping members is resiliently deformable wherein when the orientator is in the locked state, the resiliently deformable clamping members deforms about the orientation element.

[0030] In one embodiment clamping members comprises a resilient washer.

Brief Description of the Drawings

[0031] Notwithstanding any other forms which may fall within the scope of the system as set forth in the Summary, specific embodiments will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 is a longitudinal section view of a first embodiment of the system;

Figure 2 is an enlarged view of a portion of the system shown in Figure 1;

Figure 3 is an enlarged view of a portion of the system shown in Figure 1 and indicating an initial flow of fluid for switching an associated magnetically operated orientator from a locked to free state;

Figure 4 is a further view of the section of the system shown in Figure 3 of fluid now flowing in a steady state condition and holding the magnetically operated orientator in the free state;

Figure 5 is a view of the portion of the system shown in Figure 2 when the drill is stationary and the magnetically operated orientator is switching from the free state to the locked state;

Figure 6a is an isometric view from one angle of a sump block incorporated in the embodiment of the

system shown in Figures 1 - 5;

Figure 6b is an isometric view of the sump block of Figure 6a but from an opposite angle;

Figure 7 is an isometric view of a magnetic coupling incorporated in the embodiment of the system shown in Figure 1;

Figure 8 is an isometric view of a spindle incorporated in the system shown in Figure 1;

Figure 9 is a representation of a core marking system that may be used in conjunction with the orientation system shown in Figure 1 for the purposes of providing an orientation mark on a core sample extracted by a core drill in relation to which the orientation system is used;

Figure 10 illustrates the core marking system coupled with a portion of the orientation system shown in Figure 1;

Figure 11a is an isometric view from the bottom of a magnetic cradle incorporated in the core marking system shown in Figures 9 and 10;

Figure 11b is an isometric view of the magnetic cradle shown in Figure 11a;

Figure 11c is an end view of the magnetic cradle shown in Figures 11a and 11b;

Figure 12 is a section view of a core tube assembly incorporating a second embodiment of the orientation system;

Figure 13 is an enlarged view of a magnetically operated orientator incorporated in the embodiment of the system shown in Figure 12 when in a locked state;

Figure 14 is a representation of the magnetically operated orientator of Figure 13 in a free state;

Figure 15 is a representation of the orientator of Figure 14 illustrating a final possible position when in the free state; and,

Figure 16 is a representation of the orientator of Figures 13 - 15 when transitioning from the free state back to the locked state.

Detailed Description of the Preferred Embodiments

[0032] Figure 1 illustrates a pump embodiment of a rotation activated orientation system 10 (herein after "system 10") for a ground drill (not shown). The system 10 has a magnetically operated orientator 12 and an operatively associated magnetic actuator 14. The orientator 12 is disposed in a lower housing 16. A down hole end 17 of the housing 16 is coupled to an inner core tube 18 (which is only partly shown). The magnetic actuator 14 is coupled intermediate of the lower housing 16 and an upper housing 20. The upper housing 20 is connected at an up hole end to a back end assembly (not shown). The back end assembly enables the system 10 to be lowered and latched to a core barrel of the core drill and subsequently released and retrieved from the core barrel together with the inner core tube 18 and a core sample captured therein.

[0033] With particular reference to Figure 2, the orientator 12 has casing 22 with a cylindrical wall 24 and integrated radial wall 26 at one end, and a plug 28 that screws into an opposite end of the cylindrical wall 24. The casing is made of a transparent material so that its internal moving parts can be seen when lower housing 16 is separated from the screw coupling 64. An inside surface of the cylindrical wall 24 is formed with three axially spaced apart races 30a, 30b and 30c (hereinafter referred to in general as "races 30"). The races 30 are in the form of grooves which have a concave profile. Interleaved with the races 30 is a set of grooves 32a - 32c (hereinafter referred to in general as "grooves 32"). The races 30 are configured to partially seat and receive respective orientation elements in the form of balls 34a - 34c respectively (hereinafter referred to in general as "balls 34"). Each of the grooves 32 seat respective O-rings 36a - 36c (hereinafter referred to in general as "O-rings 36").

[0034] A "T" shaped plunger 38 extends coaxially within the casing 22. The plunger 38 is formed with a stem 46 having an increased diameter cap 40 at an end nearest the radial wall 26. The cap 40 has an outer diameter marginally smaller than an inner diameter the cylindrical wall 24. This provides a small clearance and fluid flow path to enable pressure equalisation on opposite sides of the disc as the plunger 38 slides axially within the casing 22. A permanent magnet 44 is disposed between the cap 40 and the radial wall 26. The magnet 44 is able to move or slide axially within the up hole portion 42. Optionally the magnet 44 can be attached to the cap 40.

[0035] The stem 46 has a constant outer diameter. A transverse through hole 48 is formed near a down hole end 50 of the stem 46. Additionally, a hole 52 is formed from the end 50 and extends axially along the stem 46 to the transverse hole 48.

[0036] Four spacer rings 54a-54d (hereinafter referred to in general as "spacer 54" or "spacers 54") are co-axially arranged on the plunger 38 about stem 46. The spacers 54 are separated by respective elastically deformable washers 56a - 56c (hereinafter referred to in general as "washers 56"). Specifically, washer 56a separates or is otherwise disposed between spacers 54a and 54b; washer 56b separates or is otherwise located between spacers 54b and 54c; and washer 56c separates or is otherwise disposed between the spacers 54c and 54d.

[0037] A bias mechanism in the form of a metal coil spring 58 is located about the stem 46 between the spacer 54d and the end 50. Further, the spring 58 is retained in a circumferential rebate 60 formed in the plug 28. The spring 58 is arranged to apply bias to the spacers 54 and consequently to the plunger 38 in a direction pushing the plunger 38 toward the radial wall 26. Thus the spring acts to bias the orientator toward the locked state. The plug 28 is formed with an axially cavity 62. The plunger 38 and cavity 62 are relatively dimensioned so that the plunger 38 can slide axially further into the cavity 62.

[0038] In the configuration shown in Figure 2, the ori-

entator 12 is in its locked state with the spring 58 biasing the plunger 38 toward the radial wall 26 so that there balls 34 are clamped between the washers 56 and O-rings 36. It will also be seen that a space or gap exists between the end 50 and the bottom wall of the cavity 62. When the orientator 12 is in the free state (as shown in Figure 4) the plunger 38 is moved axially in a down hole direction so that the balls 34 are free to roll in their races. Additionally the end 50 is closer to or indeed contacts the bottom wall of the cavity 62.

[0039] The orientator 12 threadingly engages an inner circumferential wall of a screw coupling 64. The screw coupling 64 is integrally formed at the uphole end of the inner core tube 18. The lower housing 16 screws onto the screw coupling 64.

[0040] The interior of the outer casing 22 may be filled with a light transparent oil or at least translucent liquid. The balls 34 are made of a specific gravity greater than that of the oil. Therefore provided the orientator is in its free state and assuming that the system 10 is inclined from the vertical, the balls 34 will sink in the oil to a lowest point of their respective races 30. This results in the orientator 12 being a bottom of a hole orientator.

[0041] The depth of the races 30 and the outer diameter of the spacers 54 are arranged so that the balls 34 are confined in axial direction. That is, while the balls 34 many roll or otherwise move about their respective races 30 they are unable to roll out in an axial direction from their respective races 30.

[0042] The washers 56 and O-rings 32 co-operate to form respective clamps that either hold the balls 34 in place or release the balls 34 enabling them to roll in their respective races 30 about the stem 46. Thus the O-rings 32 and the washers 56 constitute first and second clamping members of the clamp. One or both of the claiming members can be resiliently deformable. In one embodiment at least the washers are resiliently deformable.

[0043] The orientator 12 is in the free state when a washer 56 and its corresponding O ring 32 are sufficiently spaced apart to not simultaneously contact the corresponding ball 34 to the extent to impede rolling of a ball 34 with a corresponding race 30. This configuration is depicted in Figure 4. However, when the orientator 12 is in the locked state for example is shown in Figure 2, the balls 34 are contacted on opposite sides by its respective washer 56 and O-ring 36. This achieved by action of the spring 58 pushing the spacer rings and plunger 42 hard up against the end wall 26.

[0044] The washers 56 of each clamp are configured so that when the orientator is in the locked state parts of the washers in contact with the ball resiliently deform about the ball by action of the spring. This forms a depression in the washers that cradle the balls. This provides greater contact area between a ball 34 and washer 56 than that in the event where the washer is not resilient deformable under the action of the spring.

[0045] With particular reference to Figures 1, 2 and 3, the magnetic actuator 14 in this embodiment comprises

a magnetic drive gear pump 70 and magnets 72. The magnets 72 are axially moveable within a cavity 74. Magnetic drive gear pumps are readily available. One example of current use of such pumps is in the metering of liquid medicaments. The pump 70 is provided with a high pressure outlet 76 and lower pressure inlet port 78. The gears of the pump 70 are rotated by way of a magnetic coupling 80 which in turn is coupled to a spindle 82 (Fig 1). The spindle 82 is coupled to the back end assembly and rotates about its longitudinal axis when a corresponding drill rotates. The upper housing 20, the lower housing 16 and orientator 12 are rotationally decoupled from the spindle 82 by way of a swivel arrangement 84. The magnets 44 and 72 are arranged to have like poles facing each other. That is the magnets 44 and 72 produce magnetic fields that mutually repel.

[0046] The pump 70 is provided with a body 86 which houses the pump gears. The magnetic actuator 14 further includes a sump block 88 and an optional oil reservoir 90. The magnets 72 are retained within a piston 92 that is able to slide in axially direction within the cavity 74. The cavity 74 is defined between a dividing wall 94 formed in the lower housing 16 and the sump block 88. The sump block 88 is clamped onto the opposite end of the cavity 74 when the magnetic actuator 14 is attached to the lower housing 16. A return spring 96 acts between the dividing wall 94 and the piston 92/magnets 72 biasing the magnets 72 away from the magnet 44 of the orientator 12.

[0047] A high pressure flow path 98 extends from the pump outlet 76 and through the sump block 88 to provide high pressure fluid to a side of the magnets 72/piston 92 distant the orientator 12. The path 98 comprises a bore 100 formed in a body of the magnetic actuator 14 and a bore 102 formed in the sump block 88. The pump block 88 is further provided with an oil sump 104 and bleed path 106. The bleed path 106 extends through a plug 108 of the sump block 88 which fits in to the cavity 74. Further, the bleed path 106 provides fluid communication between sump 104 and a side of the magnets 72/piston 92 distant the orientator 12.

[0048] A bypass flow path 110 provides fluid communication between the cavity 74 and sump 104. The flow path 110 comprises in combination a bore 112 formed in the body of the lower housing 16 and which extends in an axially direction, and circumferential feed groove 114 formed on the inside wall of the cavity 74. A hole 116 formed in the sump block 88 provides fluid communication between the bypass flow path 110 and the sump 104. Oil is returned from the sump 104 to the inlet port 78 via return path 118 which is formed as an axially extending bore in the body of the actuator 14.

[0049] The piston 92 is formed with a head 120 of an outer diameter marginally smaller than the inner diameter of the cavity 74. The head 120 is formed with a circumferential groove which seats a sealing ring 122. At an end of the piston 92 opposite the head 120 a cavity 124 is provided for seating and retaining the magnets 72. The

return spring 96 is arranged to bias the piston 92 away from the orientator 12.

[0050] With particular reference to Figures 1, 7 and 8, the magnetic coupling 18 comprises a cup like structure 126 which is configured to fit over an end portion of the pump 70. The cup like structure 126 is formed with a plurality of recesses 128 which seat drive magnets 130. A connection post 132 extends axially from the cup like structure 126 in a direction away from the orientator 12. A hexagonal shaped hole 134 is formed axially in the post 132 and receives a hex key 136 formed at an end of the spindle 82. A circumferential groove 138 is formed in the post 132 near but inboard of its free end. The groove 138 seats a circlip 140 which holds the post 132 within bearings 142 seated in the upper end of the body of the actuator 14.

[0051] The spindle 82 extends through and is able to rotate axially within a spindle bearing 144 which threadingly engages upper end of the upper housing 20. The spindle 82 also extends through upper and lower thrust bearings 146 and 148 respectively. The thrust bearing 146 and 148 are located adjacent opposite side of the spindle bearing 144. The thrust bearing 146 is also located adjacent a shut off valve 150. The shut off valve 150 is seated about the spindle 82 between the thrust bearing 146 and a stop 152 of the spindle 82.

[0052] A spring 154 acts between the thrust bearing 148 and a nut 156 threaded onto the spindle 82. The spring 154 acts to bias the spindle 82 in a direction toward the orientator 12 to maintain engagement of the hex key 136 in the hex hole 134. To this end, the spindle 82 is able to slide in an axial direction to operate the shut off valve 150.

[0053] The operation of the system 10 will now be described in detail.

[0054] As previously explained the system 10 is attached to a back end assembly and lowered by a wire line into a core drill. An inner core tube 18 is attached to an opposite end of the system 10. Figures 1 and 2 depict the locked state of the system 10 which occurs when the rotational speed of the drill is at or below a threshold speed. In this example the threshold speed is 0 rpm. When the drill is at this speed (i.e. is not rotating) the pump 70 is not operating to pump oil from its outlet 76. Thus no fluid pressure is exerted on the magnets 72/piston 92. Rather the return spring 96 biases the magnets 72/piston 92 away from the orientator 12. Also the spring 60 is biasing the plunger 38 toward the wall 26 of the casing 22. This pushes the spacer rings 54 hard up against the cap 40 of plunger 38. This in turn brings the washers 56 in their closest proximity to the O-rings 36 clamping the balls 34 there between and preventing them from rotating in their races 30. The orientator 12 is accordingly in the locked state with the position of the balls 34 being locked or fixed by clamping action of the washers 56 and O-rings 36 on opposite sides of the balls 34. Due to the distance between the magnets 44 and 72 the magnetic field of the magnets 72 has no effect or at least

has no effective interaction with the magnetic field of the magnet 44 for the purposes of pushing the plunger 38 in a down hole direction to release the balls 34 and the orientator 12 from the locked state.

[0055] When the drill rotates for example when operating to drill a core sample, torque is transferred via the spindle 82 to the magnetic coupling 80. The upper body 20, lower body 16 and the orientator 12 are rotationally decoupled from the drill by virtue of the swivel 84. The rotation of the magnetic coupling 80 operates the pump 70 causing fluid to be pumped from the high pressure port 76 through the high pressure path 98 to a region in the cavity 74 between the piston head 120 and the plug 108. Provided the flow rate is greater than the return flow rate through the bleed path 106 and the pressure of the fluid on the piston 92 is greater than that applied in a reverse direction by the spring 96, then the piston 92/magnets 72 will slide in an axial direction toward the orientator 12 compressing the spring 96. This flow rate may be considered to be the operational flow rate. The operational flow rate will occur when the drill rotates at a speed greater than the threshold speed. As previously exemplified this may be 0 rpm. However the threshold speed may be greater than 0 rpm. For example this may be 1-5 rpm. The threshold speed is set by design and is influenced by several factors including but not limited to the diameter of the bleed path 106 and spring constant of the spring 96.

[0056] As the magnets 72 move toward the orientator 12, oil within the cavity 74 between the piston head 120 and the wall 94 flows through the bypass flow path 110 and hole 116 into the sump 104 to be subsequently circulated through the pump 70 via the return flow path 118. This circulation and movement of oil is depicted in Figure 3. Eventually the magnets 72 will move to within a distance where its magnetic field will be effective in repelling the field the magnet 44. Now the magnetic field from the magnets 72 is able to interact with the field of the magnet 44 repelling the magnet 44 and causing the magnet 44 together with the plunger 38 to move in a down hole direction away from the magnets 72. This releases the balls 34 enabling them to rotate in their respective races.

[0057] Eventually, the pumping of oil by the pump 70 through the high pressure path 98 forces the magnets 72/piston 92 to the bottom of the cavity 74 and abutting the wall 96. During continued rotation of the drill a small amount of oil is recirculated through the bleed path 106 to the sump 104 and return flow path 118. Thus the continued rotation of the drill maintains the operation of the pump 70 and fluid pressure on the magnets 72 holding the orientator 12 in the free state.

[0058] When the inner core tube 18 is full and it is necessary to break the core sample from the ground, the rotation of the drill is stopped. This results in the ceasing of rotation of the magnetic coupling 80 and consequently the pump 70 ceases pumping oil and applying pressure to the magnets 72/piston 92. As a consequence, the return spring 96 is now able to move or slide the magnets

72 axially away from the orientator 12 and toward the plug 108. This is achieved by way of a slow flow of oil through the bleed path 106. The bleed path 106 is of a relatively small diameter so that the flow of oil is relatively slow and thus the motion of the magnets 72 is slow. Oil which passes through the bleed path 106 to the sump 104 is then caused to flow back into the cavity 74 through the bypass flow path 110 as shown in Figure 5.

[0059] Due to the slow return motion of the magnets 72 the effect on the magnet 44 diminishes slowly resulting in the slow up hole motion of the plunger 38. This produces a time delay for the orientator 12 to switched back to its locked state from the time the drill speed is at or below its threshold speed. The time delay provides the balls 34 with time to settle to the lowest point within their respective races 30 and thereby provide an accurate indication of the bottom of the hole. The delay may mitigate effects of vibrations and linear movement of the drill after rotation has ceased and in preparation for a core breaking operation. In one example, the time delay for the orientator 12 to switch back to its lock position may be for example a time in the range of thirty seconds to one minute from the time the drill speed drops to or below the threshold speed. In this way the bleed path 106 may be seen as forming at least in part a time delay system 160.

[0060] The pump 70 acts as a flow restriction and indeed a shut off valve in relation to fluid flowing from the inlet 78 to the outlet 76 when pump 70 is not rotating. This assists in restricting oil flow when the drill is not rotating. As such the pump when not rotating may also be considered as forming part of the time delay system.

[0061] The time delay system 160 in this embodiment is a hydraulic time delay system as it operates by restricting flow of a fluid through the bleed path 106. More particularly the time delay system 160 restricts the flow of fluid draining from a region 77. In this embodiment fluid may be in the form of a liquid. The liquid may have a viscosity greater than water. Further the liquid may have lubricating properties and/or provide protection against corrosion. The liquid may take the form of oil. Examples of oils that may be used include but are not limited to paraffin oil; engine oil and hydraulic oil. The region 77 in this embodiment is between the piston 92 and the sump block 88. Draining of the fluid from the region 77 enables the orientator 12 to move from a down hole location corresponding to the free state (Fig 4) to an up hole location corresponding to the locked state (Fig 2). The orientator 12 is enabled to move between these locations to effect the change from free state to locked state by virtue of the piston 92 and magnets 72 moving axially away from the magnet 44 of the orientator 12.

[0062] As will be understood if the drill speed where to increase to be above the threshold speed then the orientator 12 will revert to or at least tend towards the free state. This provides a self- setting or re-setting feature where for example the drill speed fell below the threshold speed prior to a core breaking operation and subsequently speed up back to the normal drilling speed.

[0063] The system 10 can then be returned to the surface with the inner core tube 18.

[0064] Once returned to the surface, the bottom of hole indication provided by the orientator 12 can be transferred to a core sample 170 held in the inner core tube 18 by use of a core marking system 180 depicted in Figures 9-11c. The core marking system 180 comprises a magnetic cradle 182, an orientation guide 184, and a core marking guide 186.

[0065] The magnetic cradle 182 comprises a block 188 having a planar base 190 of a rectangular shape and two opposed upright planar surfaces 192a and 192b. Two further side walls 194a and 194b are convexly curved and extend between the side walls 192a and 192b. A portion of the block 188 opposite the base 190 is formed with a channel 196 having a planar bottom 198 and opposite outwardly diverging planar walls 200a and 200b. One or more magnets 202 are embedded in each of the side walls 200a, 200b and the base 190.

[0066] The orientation guide 184 comprises a tube 204 having an inner diameter which is able to fit with light to moderate interference onto the outer casing 22 of the orientator 12. A longitudinal window or slot 206 is formed in the tube 204 and is dimensioned so that when the orientation guide 184 is fitted onto the orientator 12 each of the three orientation balls 34 can be viewed through the window 206 assuming that the balls 34 are substantially aligned. One end of the tube 204 is provided with a knob 208 in which is fitted a spirit level 210.

[0067] The core marking guide 186 comprises a tube 212 which is opened at one end 214. The tube 212 has an inner diameter which is dimensioned to engage and fit over the inner core tube 18 with light to moderate interference. The light to moderate interference fitting of the orientation guide 184 and core marking guide 186 is to enable the respective guides to be fitted on and removed by hand but maintain sufficient grip so as to maintain their position in the absence of being manipulated by hand.

[0068] A longitudinal slot 216 is formed in the tube 212 from an intermediate location 218 inboard of the opening 214 and extending to a radial semicircular face 220 at an opposite end of the tube 212. A marking hole 222 is formed in the face 220 in alignment with the slot 216. A semi cylindrical extension 224 projects axially of the tube 212 and is fitted with a spirit level 226.

[0069] The manner of use of the core marking system 180 will now be described. Once the core breaking operation has been completed and the system 10 has been retrieved the lower housing 16 together with the actuator 14 and upper housing 20 is unscrewed or otherwise decoupled from the inner core tube 18 and the orientator 12. This is achieved by unscrewing the thread about the screw coupling 64 at an uphole end of the inner core tube 18. Thus the orientator 12 remains with the inner core tube 18 and the casing 22 and orientation balls 34 are now exposed and visible.

[0070] The magnetic cradle 182 is placed on a ferro-

magnetic (for example steel) bench. Due to the magnets 202 in the bottom wall 190 the cradle 182 is magnetically held on the bench. Next the inner core tube 18 is seated in the valley 196 with the orientator 12 extending from one side of the cradle 182 and the core sample 170 extending from an opposite side. The magnets 202 in the inclined walls 200a and 200b hold the rotational and translational position of the core tube 18 until changed by manually rotating or translating the tube 18 against the magnetic attraction force applied by the magnets 202.

[0071] The position of the balls 34 is fixed or locked by action of the orientator 12. When placing the inner core tube 18 on the cradle 182 the balls 34 should be visible and in particular approximately in a vertical plane. The orientation guide 184 is now fitted over the outer casing 22 and manipulated so that the orientation balls 34 are visible through the slot 206. The position of the spirit level 208 is now viewed. If the spirit level 208 does not indicate a horizontal plane then the inner core tube 18 is manually rotated within the valley 196 so that the spirit level 210 indicates that it is now lying in a horizontal plane. The core marking guide 186 is now fitted on an opposite end over a portion of the core sample 170 and onto the inner core tube 18. The core marking guide 186 is rotated about the inner core tube 18 until the spirit level 226 indicates that it is lying in a horizontal plane. Thus now the two spirit levels 226 and 210 indicate that the slots 216 and 206 are aligned.

[0072] In the present embodiment, the balls 34 are locked by the system 10 when in use to indicate the location of the bottom of a hole from which the core sample 170 is extracted. By using a marker pencil or a scribe, a mark is placed through the slot 216 on the circumferential portion of the core sample 170 extending from a core lifter case 228 of the inner core tube 18. This mark will be in the form of a line if the pencil or scribe is moved along the slot 216. Additionally, if desired or required a further bottom of the hole mark can be placed on a radial face of the core sample 170 by inserting a pencil or marking scribe through the hole 222.

[0073] Now that an indication of the bottom of the hole has been transferred onto the core sample 170 the orientation guide 184 and core marking guide 186 can be removed and the core sample 170 extracted from the inner core tube 18. The inner core tube 18 and orientator 12 can then be reconnected to the remaining parts of the system 10 and reused to orientate a subsequent core sample.

[0074] Figure 12 illustrates a further embodiment of the system designated as system 10'. The features of the system 10' that are identical to those of the system 10 are denoted with the same reference numbers. The features however which differ but function in a similar manner are indicated with the same reference number as for the system 10 but with the addition of the prime symbol (').

[0075] The substantive differences between the systems 10 and 10' lie in the: form of the actuator 14'; and,

various components of the orientator 12' to provide the return time delay when the rotational speed of the drill drops below the threshold speed. The magnetic actuator 14' in this embodiment comprises an electric generator 230 and an electromagnet 232 which together produce a magnetic field to repel the magnet 44 when the rotational speed of the drill is greater than the threshold speed. The generator 230 has a drive shaft 234 at an uphole end which may be formed with a hexagonal hole (not shown) of the same configuration as the hole 134 of the coupling 80 in the first embodiment. This hole receives the hex key 136 of the spindle 82. Engagement of the hexagonal hole 134 and the key 34 enables axial motion of the spindle 82 when the shut off valve 150 is activated and subsequently released. This action is exactly the same as in the first embodiment.

[0076] The electromagnet 232 comprises an outer magnetic coil 236 and an electro-magnet core 238. When the drill is rotated the electric generator 230 generates a current that is fed to the coil 236 to induce a magnetic field in the core 238. The current circulates in a direction so that lines of magnetic flux of the electro magnet 232 at a down hole end produce a pole of the same polarity as the facing end of the magnet 44. An electronic control chip 240 of the magnetic actuator 14' regulates the current/voltage to the coil 236. In particular, the electronic control chip 240 limits the maximum current delivered to the coil 236. This is provided as a safety mechanism to minimise the risk of burning out the coil 236 in the event that the rotational speed of the drill for some reason substantially exceeds the expected normal drilling speed.

[0077] The orientator 12' in the system 10' comprises an outer casing 22' made of a transparent plastics material and of generally the same shape and configuration as that of the orientator 12. However an additional race 242 is formed in the inner circumferential surface of the casing 22' for seating a floating ball 244. The ball 244 has a specific gravity greater than that of the oil in which it is immersed and will float to a highest position in a hole containing the system 10' when the system 10' is inclined from the vertical. The ball 244 however is not clamped and is always able to freely move within the race 242.

[0078] The plunger 38' comprises a stem 46' having an axially extending blind hole 246 which terminates at an intermediate location 248 along the length of the stem 46'. The purpose of the hole 246 is simply to reduce the weight of the stem 46'. The open end of the hole 246 is closed by a cap 40' which is provided with a seat for holding the magnet 44. Axially extending holes 247 are formed in the cap 40'. The stem 46' is also formed with a transverse through hole 48 and a hole 52 extending axially from the end 50 to the hole 48 as in the plunger 38. However in this embodiment a one way or non-return valve 250 is seated in the hole 52. The valve 250 enables a flow of oil in a direction from the end 50 up through the hole 52 and into the transverse hole 48. However the valve 250 prevents a flow of oil in a direction from the hole 48 into the hole 52. A lower end of the cavity 62' is

formed with a circumferential shoulder 257 that acts as a stop to limit for the travel of the plunger 38' when being stoked down by the magnetic field of the actuator 14'. The shoulder is created by tapering the bottom portion of the interior surface of the cavity 62' to form a conical surface 259.

[0079] The time delay in the return stroke of the plunger 38', which changes the state of the orientator from the free state to the locked state, is achieved by the provision of a time delay system 160' that is housed within the plug 28' of the orientator 12' and interact with the plunger 38' in its return stroke to the locked position.

[0080] The plug 28' is of a different configuration to that of the orientator 12 and has an up hole portion 256 that progressively reduces in outer diameter in an up hole direction. This forms an annular flow path 258 between the inner surface of the casing 22' and the outer circumferential surface of the up hole portion 256. A transversely extending through hole 260 is formed in the up hole portion 256. A bleed path 106' extends in an axial direction from the hole 260 to axial cavity 62' formed in the plug 28'. An adjustable needle valve 264 is housed in a cavity 266 in the plug 28' and is provided with a tapered needle point 268 that extends into the bleed path 106'. The position of the needle point 268 in the bleed paths 106' can be controlled by a screw disc 270 that threadingly engages the cavity 266. A spring 272 is retained about the needle valve 264 and maintains the position of the needle point 268 in the bleed path 106' in accordance with the position of the screw disc 270. By turning the screw disc 270 either clockwise or anticlockwise the position of the needle point 268 in the bleed path 106' can be controlled thereby controlling the amount of oil that can flow through the bleed path 106'.

[0081] The operation of the system 10' will now be described in detail. When the rotational speed of the drill is at or below the threshold rotational speed the generator 230 produces current but not sufficient to generate a magnetic field of a strength that is effective to interact with the magnet 44 of the orientator 12' for the purpose of changing its state from its rest or initial locked state where the balls 34 are clamped between washers 56 and O-rings 36. Again, this threshold speed can be 0 rpm or a higher speed. However when the drill is in operation drilling a core sample, the rotational speed of the drill is above the threshold speed. In this event the electric generator 230 generates a voltage and current sufficient such that the electromagnet 232 produces a magnetic field of an intensity effective to interact with the magnetic field of the magnet 44 to push the plunger 38' in a down hole direction against the bias of spring 58.

[0082] Figure 14 depicts the axial motion of the plunger 38' in the downhole direction caused by the magnetic field applied by the electromagnet 232. As the plunger 38' moves in this direction the washers 56 are moved away from the balls 34 thereby allowing them to freely roll in their respective races 30 under the influence of gravity. The non-return valve 250 allows oil within the

cavity 62' to flow through the hole 52 and hole 48 thereby preventing a hydraulic lock which may otherwise resist the downward motion of the plunger 38'. Additionally, a flow of oil occurs through the holes 247 formed in the cap 40'. This allows an equalisation of oil pressure on opposite sides of the cap 40'.

[0083] The non-return valve 250 is of a conventional construction having a valve ball/head that is lightly biased by a spring (not shown) onto a valve seat (not shown). When the plunger 38' is moved in a downhole direction as indicated in Figure 14, the oil is able to push the ball against the light spring opening the non-return valve. However once the flow of oil ceases, the valve spring is able to return the valve ball/head back on its seat thereby closing the valve.

[0084] Figure 15 depicts the configuration of the orientator 12' after the drill has been rotating at a speed greater than the threshold speed for a relatively short period of time such as but not limited to 20 - 30 seconds. The plunger 38' is moved to its maximum extent in the down hole direction with the down hole end 50 of the stem 46 abutting the circumferential shoulder 257 formed in the cavity 62' by the tapered side walls 259.

[0085] As drilling continues, the plunger 38' is maintained in the position shown in Figure 15. However there is now no flow of oil within the housing 22'. The bias mechanism, i.e. spring 58 is now in its most compressed state and has accumulated potential energy from the kinetic energy of the previously moving plunger 38'.

[0086] When the speed of the drill drops to or below the threshold speed, for example when the drill stops rotating prior to performing a core breaking operation, the magnetic field provided by the electromagnet 232 no longer exists. Thus the plunger 38' is now urged to return to the locked position by action of the spring 58. The spring 58 releases its accumulated potential energy which is converted to kinetic energy in moving the plunger 38' toward locked state. The spring 58 pushes the spacer rings 54a - 54d hard up against the cap 40' and consequently biases the plunger 38' and the washers 56 in an up hole direction. This action returns the orientator 12' back to the locked state. During this return action the time delay system 160' operates to enable a flow of oil back into the cavity 62' with a time delay. Without this oil flow the plunger 38' may be hydraulically held in the free state due to the non-return valve 250 preventing a flow of oil in a direction from the hole 48 through the hole 52 back into the cavity 62'.

[0087] The flow of oil into the cavity 62' via the time delay system 160' is shown by arrows 275 in Figure 16. The time delay system 160' acts to allow oil to flow back into the cavity 62' via the annular flow path 258, hole 260 and bleed path 106'. The amount of oil admitted through the bleed path 106' is controlled to provide a time delay for switching of the orientator 12' back to the locked state. The flow of fluid back to the cavity 62' acts as a fluid brake against the release of the potential energy of the spring 58 thus providing the time delay. This time delay may for

example be in the order of thirty seconds to one minute. As with the previous embodiment, the time delay provides time for the balls 34 to fall to the lowest position in their races 30 prior to the core breaking action. As with the embodiment of Figures 1 - 5 the time delay system 160' also acts to restrict the flow of fluid draining from a region 77'. Here the region 77' is the volume of the casing 22' bar the cavity 62'. The bleed path 106' provides restricted flow of fluid from the region 77' into the cavity 62' thereby enabling the orientator 12' to move from a down hole location corresponding to the free state (Fig 15) to an up hole location corresponding to the locked state (Fig 13).

[0088] The floating ball 244 is always free to rotate or roll within its race 242 and thus will always position itself at the highest location within the race 242 commensurate with the inclination of the system 10'.

[0089] Once the system 10 has been retrieved the location of the bottom of the hole from which the core sample was extracted can be marked in exactly the same way as described herein before above using the core marking system 180. The provision of the floating ball 244 provides an additional level of confidence or accuracy in provision of the marking. Specifically, when the inner core tube 18 has been rotated within the magnetic cradle 182 so that the balls 34 are in alignment and both the spirit levels 220 and 226 are indicative of respective horizontal planes, the floating ball 244 should also be in alignment with the balls 34 and the slots 206 and 216.

[0090] However the provision of the floating ball 244 provides an alternate and slightly simpler way of marking the location of the bottom of the hole. This still utilises the cradle 182 but does not require the orientation guide 184. In effect the floating ball 244 within the race 242 acts in a manner identical to the spirit level 210. Thus all that is required is that once the inner core tube 18 is placed within the cradle 182, inner core tube 18 needs to be rotated so that the ball 244 is in alignment with the balls 34. When this occurs, a line that passes through the balls 34 and 244 is representative of the bottom of the hole and thus marking or transferring such a line onto the core sample 170 via the core marking slot 216 and/or hole 222 provides a record on the core 170 itself of the position of the bottom of the hole.

[0091] Now that embodiments of the invention have been described in detail it will be apparent to those skilled in the art that numerous modifications and variations can be made without departing from the basic inventive concepts. For example the orientators 12 and 12' are described as comprising three rolling balls, however the number of rolling balls greater than one is not critical to the operation of the embodiment, only to the degree of confidence of the bottom of hole indication. Also in the embodiment comprising the pump 70, the fluid is described as oil, however the fluid can be other liquids or indeed could be a gas. Further while the embodiments are described in the context of core drilling and core orientation their application extends to at least hole orien-

tation irrespective of whether or not a core sample is being extracted. All such modifications and variations together with others that would be obvious to those of ordinary skill in the art are deemed to be within the scope of the disclosed orientation system the nature of which is to be determined from the above description and the appended claims.

Claims

1. A rotation activated orientation system (10') for a ground drill comprising:

a magnetically operated orientator (12') having a free state where the orientator provides a substantially instantaneous indication of a position of a reference bearing or location in or of a hole being drilled by the ground drill, and a locked state where the orientator maintains the indication; and

a magnetic actuator (14') operatively associated with the magnetically operated orientator (12') wherein when the rotational speed of the ground drill is greater than a threshold speed the magnetic actuator supplies a magnetic field effective to place the orientator in the free state, and when the rotational speed of the drill is less than the threshold speed the magnetic actuator does not supply a magnetic field effective to operate the orientator so that the orientator reverts to or remains in the locked state;

characterised in that the magnetic actuator (14') comprises an electric generator (230) and an electro-magnet (232) which are together configured to produce a magnetic field, wherein when the rotational speed of the ground drill is greater than the threshold speed, the electric generator (230) generates a current sufficient for the electromagnet (232) to produce a magnetic field effective to place the orientator (12') in the free state, and when the rotational speed of the ground drill is less than the threshold speed, the electric generator (230) does not generate a current sufficient for the electromagnet (232) to produce a magnetic field effective to operate the orientator (12') so that the orientator (12') reverts to or remains in the locked state.

2. The rotation activated orientation system (10') according to claim 1 comprising a time delay system (160') arranged to delay the orientator (12') in reverting from the free state to the locked state when the drill is rotating at a speed below the threshold speed.
3. The rotation activated orientation system (10') according to claim 2 wherein the time delay system

(160') comprises a bleed path (106') acting to restrict a flow rate of a fluid draining from a region (77') which enables the orientator (12') to move from a location corresponding to the free state to a location corresponding to the lock state.

4. The rotation activated orientation system (10') according to claim 3 wherein the fluid is oil and the time delay system (160') is a hydraulic time delay system which provides the time delay by restricting flow of oil through the bleed path (106').
5. The rotation activated orientation system (10') according to claim 4 wherein the oil is transparent or translucent such that the indication provided by the orientator (12') is visible through the oil.
6. The rotation activated orientation system (10') according to any one of claims 1 to 5 wherein the electric generator has a drive shaft (234) connectable to a spindle (82) of the ground drill to impart torque to the electric generator when the drill rotates.
7. The rotation activated orientation system (10') according to any one of claims 1 to 6 wherein the orientator (12') comprises a bias mechanism (58) which accumulates potential energy when the orientator (12') is being moved toward the free state by action of the magnetic actuator (14') and converts the accumulated potential energy to kinetic energy when the ground drill is being rotated at a speed less than the threshold speed to return the orientator (12') to the locked state.
8. The rotation activated orientation system (10') according to claim 7 wherein the bleed path (106') operates as a fluid brake against action of the bias mechanism (58) to restrict a rate of action of the bias mechanism (58) in moving the orientator (12') towards the locked position.
9. The rotation activated orientation system (10') according to any one of claims 1 to 8 wherein the orientator (12') comprises at least one orientation element (34) and an associated closed loop race (30) having a central axis in which the orientation element (34) is confined, the race (30) comprising first and second clamping members (32, 56) between which the orientation element (34) is located, the first and second clamping members (32, 56) being movable relative to each other between a free position when the orientator (12') is in the free state where the clamping members (32, 56) are spaced sufficiently to enable the orientation element (34) to roll about the central axis within the closed loop race (30), and a locked position when the orientator (12') is in the locked state where the clamping members (32, 56) are moved toward each other to contact the orienta-

tion element (34), and wherein at least one of the clamping members (56) is resiliently deformable wherein when the orientator (12') is in the locked state, the resiliently deformable clamping members (56) deforms about the orientation element (34).

10. The rotation activated orientation system (10') according to claim 9 wherein the orientator (12') comprises a plunger (38') and a magnet (44), and wherein when the rotational speed of the ground drill is greater than the threshold speed the magnetic field of the electromagnet (232) interacts with a magnetic field of the magnet (44) to cause the plunger (38') to move to place the orientator (12') in the free state, and when the rotational speed of the ground drill is less than the threshold speed the electromagnet (232) does not produce a magnetic field capable of moving or holding the orientator (12') in the free state and wherein the orientator (12') reverts to or remains in the locked state.
11. The rotation activated orientation system (10') according to claim 10 wherein the plunger (38') is formed with a stem (46) about which the bias mechanism (58) and the second clamping member (56) are located, the bias mechanism (58) being arranged to bias the plunger (38') and the second clamping member (56) in an up hole direction.
12. The rotation activated orientation system (10') according to claim 11 wherein the orientator (12') comprises a plurality of first and second clamping elements (32, 56) and one or more spacers (54) arranged on the stem (46), wherein the second clamping members (56) are spaced apart by respective spacers (54).
13. The rotation activated orientation system (10') according to any one of claims 9 to 12 wherein the orientator (12') includes an additional race (242) and a floating ball (244) able to freely rotate within the race irrespective of the state of the orientator (12').

Patentansprüche

1. Rotationsaktiviertes Ausrichtsystem (10') für einen Erdbohrer, das Folgendes umfasst:

einen magnetisch betriebenen Ausrichter (12'), der einen freien Zustand aufweist, wobei der Ausrichter eine im Wesentlichen momentane Anzeige einer Position eines Referenzlagers oder einer Referenzstelle in oder aus einem Loch, das von dem Erdbohrer gebohrt wird, und eines gesperrten Zustands bereitstellt, wobei der Ausrichter die Anzeige beibehält; und einen magnetischen Aktuator (14'), der dem ma-

gnetisch betriebenen Ausrichter (12') betriebsfähig zugeordnet ist, wobei, wenn die Drehzahl des Erdbohrers größer ist als eine Schwellengeschwindigkeit, der magnetische Aktuator ein Magnetfeld liefert, das wirksam ist, um den Ausrichter in den freien Zustand zu versetzen, und wenn die Drehzahl des Bohrers kleiner als die Schwellengeschwindigkeit ist, der magnetische Aktuator kein Magnetfeld liefert, das zum Betreiben des Ausrichters wirksam ist, so dass der Ausrichter in den gesperrten Zustand zurückkehrt oder dort bleibt;

dadurch gekennzeichnet, dass der magnetische Aktuator (14') einen elektrischen Generator (230) und einen Elektromagneten (232) umfasst, die zusammen dafür konfiguriert sind, ein magnetisches Feld zu erzeugen, wobei der elektrische Generator (230), wenn die Drehzahl des Erdbohrers größer ist als die Schwellengeschwindigkeit, einen Strom erzeugt, der ausreicht, dass der Elektromagnet (232) ein Magnetfeld erzeugt, das den Ausrichter (12') in den freien Zustand versetzt, und wenn der elektrische Generator (230), wenn die Drehzahl des Erdbohrers geringer ist als die Schwellengeschwindigkeit, keinen Strom erzeugt, der ausreicht, dass der Elektromagnet (232) ein Magnetfeld erzeugt, das den Ausrichter (12') so betreibt, dass der Ausrichter (12') in den gesperrten Zustand zurückkehrt oder dort bleibt.

2. Rotationsaktiviertes Ausrichtsystem (10') nach Anspruch 1, das ein Zeitverzögerungssystem (160') umfasst, das dafür ausgelegt ist, den Ausrichter (12') beim Zurückkehren von dem freien Zustand in den gesperrten Zustand zu verzögern, wenn sich der Bohrer mit einer Geschwindigkeit unterhalb der Schwellengeschwindigkeit dreht.
3. Rotationsaktiviertes Ausrichtsystem (10') nach Anspruch 2, wobei das Zeitverzögerungssystem (160') einen Ablasspfad (106') umfasst, der bewirkt, dass er eine Durchflussrate eines Fluids begrenzt, das aus einem Bereich (77') abfließt, wodurch sich der Ausrichter (12') von einem Ort, der dem freien Zustand entspricht, zu einem Ort, der dem Sperrzustand entspricht, bewegen kann.
4. Rotationsaktiviertes Ausrichtsystem (10') nach Anspruch 3, wobei das Fluid Öl ist und das Zeitverzögerungssystem (160') ein hydraulisches Zeitverzögerungssystem ist, das die Zeitverzögerung durch Beschränken des Ölstroms durch den Ablasspfad (106') bereitstellt.
5. Rotationsaktiviertes Ausrichtsystem (10') nach Anspruch 4, wobei das Öl transparent oder durchscheinend ist, so dass die Anzeige, die durch den Aus-

richter (12') bereitgestellt wird, durch das Öl sichtbar ist.

6. Rotationsaktiviertes Ausrichtsystem (10') nach einem der Ansprüche 1 bis 5, wobei der elektrische Generator eine Antriebswelle (234) aufweist, die mit einer Spindel (82) des Erdbohrers verbunden werden kann, um dem elektrischen Generator ein Drehmoment zu verleihen, wenn sich der Bohrer dreht.
7. Rotationsaktiviertes Ausrichtsystem (10') nach einem der Ansprüche 1 bis 6, wobei der Ausrichter (12') einen Vorspannmechanismus (58) umfasst, der potentielle Energie akkumuliert, wenn der Ausrichter (12') durch die Wirkung des magnetischen Aktuators (14') in den freien Zustand bewegt wird, und die akkumulierte potentielle Energie in kinetische Energie umwandelt, wenn der Erdbohrer mit einer Drehzahl gedreht wird, die geringer als die Schwellendrehzahl ist, um den Ausrichter (12') in den gesperrten Zustand zurückzuführen.
8. Rotationsaktiviertes Ausrichtsystem (10') nach Anspruch 7, wobei der Ablasspfad (106') als eine Fluidbremse gegen die Wirkung des Vorspannmechanismus (58) wirkt, um eine Bewegungsrate des Vorspannmechanismus (58) beim Bewegen des Ausrichters (12') in die gesperrte Position einzuschränken.
9. Rotationsaktiviertes Ausrichtsystem (10') nach einem der Ansprüche 1 bis 8, wobei der Ausrichter (12') mindestens ein Ausrichtelement (34) und eine zugehörige geschlossene Schleifenbahn (30) umfasst, die eine zentrale Achse aufweist, in der das Ausrichtelement (34) eingeschlossen ist, wobei die Schleifenbahn (30) erste und zweite Klemmelemente (32, 56) umfasst, zwischen denen sich das Ausrichtelement (34) befindet, wobei das erste und das zweite Klemmelement (32, 56) relativ zueinander zwischen folgenden Positionen beweglich sind: einer freien Position, wenn sich der Ausrichter (12') im freien Zustand befindet, wenn die Klemmelemente (32, 56) ausreichend beabstandet sind, um das Ausrichtelement (34) um die zentrale Achse innerhalb der geschlossenen Schleifenbahn (30) rollen zu lassen, und einer gesperrten Position, wenn sich der Ausrichter (12') im gesperrten Zustand befindet, wenn die Klemmelemente (32, 56) aufeinander zu bewegt werden, um das Ausrichtelement (34) zu berühren, und wobei mindestens eines der Klemmelemente (56) elastisch verformbar ist, wobei, wenn sich der Ausrichter (12') in dem gesperrten Zustand befindet, die elastisch verformbaren Klemmelemente (56) sich um das Ausrichtungselement (34) verformen.
10. Rotationsaktiviertes Ausrichtsystem (10') nach An-

spruch 9, wobei der Ausrichter (12') einen Stößel (38') und einen Magneten (44) aufweist und wobei, wenn die Drehzahl des Erdbohrers größer ist als die Schwellengeschwindigkeit, das Magnetfeld des Elektromagneten (232) mit einem Magnetfeld des Magneten (44) zusammenwirkt, um den Kolben (38') zu bewegen, um den Ausrichter (12') in dem freien Zustand anzuordnen, und wenn die Drehzahl des Erdbohrers kleiner als die Schwellengeschwindigkeit ist, der Elektromagnet (232) kein Magnetfeld erzeugt, das den Ausrichter (12') in den freien Zustand bewegen oder darin halten kann, wobei der Ausrichter (12') in den gesperrten Zustand zurückkehrt oder verbleibt.

11. Rotationsaktiviertes Ausrichtsystem (10') nach Anspruch 10, wobei der Kolben (38') mit einem Schaft (46) gebildet ist, um den der Vorspannmechanismus (58) und das zweite Klemmelement (56) angeordnet sind, wobei der Vorspannmechanismus (58) so angeordnet ist, dass er den Kolben (38') und das zweite Klemmelement (56) in einer Aufwärtslochrichtung vorspannt.
12. Rotationsaktiviertes Ausrichtsystem (10') nach Anspruch 11, wobei der Ausrichter (12') mehrere erste und zweite Klemmelemente (32, 56) und einen oder mehrere am Schaft (46) angeordnete Abstandshalter (54) aufweist, wobei die zweiten Klemmelemente (56) durch jeweilige Abstandshalter (54) voneinander beabstandet sind.
13. Rotationsaktiviertes Ausrichtsystem (10') nach einem der Ansprüche 9 bis 12, wobei der Ausrichter (12') eine zusätzliche Bahn (242) und eine schwimmende Kugel (244) umfasst, die in der Lage ist, sich unabhängig von dem Zustand des Ausrichters (12') innerhalb der Bahn frei zu drehen.

Revendications

1. Système d'orientation activé par rotation (10') pour un trépan de forage comportant :

un dispositif d'orientation à fonctionnement magnétique (12') ayant un état libre dans lequel le dispositif d'orientation fournit une indication sensiblement instantanée d'une position d'un point ou d'un emplacement de référence dans un ou d'un trou en cours de forage par le trépan de forage, et un état verrouillé dans lequel le dispositif d'orientation maintient l'indication ; et un actionneur magnétique (14') associé fonctionnellement au dispositif d'orientation à fonctionnement magnétique (12') dans lequel, quand la vitesse de rotation du trépan de forage est supérieure à une vitesse de seuil, l'action-

- neur magnétique fournit un champ magnétique ayant pour effet de placer le dispositif d'orientation dans l'état libre, et quand la vitesse de rotation du trépan est inférieure à la vitesse de seuil, l'actionneur magnétique ne fournit pas un champ magnétique ayant pour effet de faire fonctionner le dispositif d'orientation de telle sorte que le dispositif d'orientation repasse à ou reste dans l'état verrouillé ;
- caractérisé en ce que** l'actionneur magnétique (14') comporte un générateur électrique (230) et un électroaimant (232) qui sont configurés ensemble pour produire un champ magnétique, dans lequel, quand la vitesse de rotation du trépan de forage est supérieure à la vitesse de seuil, le générateur électrique (230) génère un courant suffisant permettant à l'électroaimant (232) de produire un champ magnétique ayant pour effet de placer le dispositif d'orientation (12') dans l'état libre, et quand la vitesse de rotation du trépan de forage est inférieure à la vitesse de seuil, le générateur électrique (230) ne génère pas un courant suffisant permettant à l'électroaimant (232) de produire un champ magnétique ayant pour effet de faire fonctionner le dispositif d'orientation (12') de telle sorte que le dispositif d'orientation (12') repasse à ou reste dans l'état verrouillé.
2. Système d'orientation activé par rotation (10') selon la revendication 1, comportant un système à action temporisée (160') agencé pour retarder le dispositif d'orientation (12') quand il repasse de l'état libre à l'état verrouillé quand le trépan tourne à une vitesse inférieure à la vitesse de seuil.
 3. Système d'orientation activé par rotation (10') selon la revendication 2, dans lequel le système à action temporisée (160') comporte un trajet de purge (106') agissant pour restreindre un débit d'écoulement d'un fluide s'évacuant en provenance d'une région (77') ce qui permet au dispositif d'orientation (12') de se déplacer d'un emplacement correspondant à l'état libre à un emplacement correspondant à l'état verrouillé.
 4. Système d'orientation activé par rotation (10') selon la revendication 3, dans lequel le fluide est de l'huile et le système à action temporisée (160') est un système à action temporisée hydraulique qui permet de temporiser l'action par la restriction de l'écoulement de l'huile au travers du trajet de purge (106').
 5. Système d'orientation activé par rotation (10') selon la revendication 4, dans lequel l'huile est transparente ou translucide de telle sorte que l'indication fournie par le dispositif d'orientation (12') est visible au travers de l'huile.
 6. Système d'orientation activé par rotation (10') selon l'une quelconque des revendications 1 à 5, dans lequel le générateur électrique a un arbre d'entraînement (234) en mesure d'être raccordé à un foret (82) du trépan de forage à des fins de communication de couple au générateur électrique quand le trépan tourne.
 7. Système d'orientation activé par rotation (10') selon l'une quelconque des revendications 1 à 6, dans lequel le dispositif d'orientation (12') comporte un mécanisme de sollicitation (58) qui accumule de l'énergie potentielle quand le dispositif d'orientation (12') est déplacé en direction de l'état libre par l'action de l'actionneur magnétique (14') et convertit l'énergie potentielle accumulée en énergie cinétique quand le trépan de forage tourne à une vitesse inférieure à la vitesse de seuil pour ramener le dispositif d'orientation (12') à l'état verrouillé.
 8. Système d'orientation activé par rotation (10') selon la revendication 7, dans lequel le trajet de purge (106') fonctionne sous la forme d'un frein à fluide contre l'action du mécanisme de sollicitation (58) pour restreindre une vitesse d'action du mécanisme de sollicitation (58) lors du déplacement du dispositif d'orientation (12') en direction de la position verrouillée.
 9. Système d'orientation activé par rotation (10') selon l'une quelconque des revendications 1 à 8, dans lequel le dispositif d'orientation (12') comporte au moins un élément d'orientation (34) et un chemin de roulement à boucle fermée associé (30) ayant un axe central dans lequel l'élément d'orientation (34) est confiné, le chemin de roulement (30) comportant des premier et deuxième éléments de serrage (32, 56) entre lesquels l'élément d'orientation (34) est situé, les premier et deuxième éléments de serrage (32, 56) étant mobiles l'un par rapport à l'autre entre une position libre quand le dispositif d'orientation (12') est dans l'état libre dans lequel les éléments de serrage (32, 56) sont suffisamment espacés pour permettre à l'élément d'orientation (34) de rouler autour de l'axe central à l'intérieur du chemin de roulement à boucle fermée (30), et une position verrouillée quand le dispositif d'orientation (12') est dans l'état verrouillé dans lequel les éléments de serrage (32, 56) sont déplacés l'un vers l'autre à des fins de mise en contact avec l'élément d'orientation (34), et dans lequel au moins l'un des éléments de serrage (56) est déformable de manière élastique dans lequel, quand le dispositif d'orientation (12') est dans l'état verrouillé, les éléments de serrage déformables de manière élastique (56) se déforment autour de l'élément d'orientation (34).
 10. Système d'orientation activé par rotation (10') selon

la revendication 9, dans lequel le dispositif d'orientation (12') comporte un plongeur (38') et un aimant (44), et dans lequel, quand la vitesse de rotation du trépan de forage est supérieure à la vitesse de seuil, le champ magnétique de l'électroaimant (232) interagit avec un champ magnétique de l'aimant (44) pour amener le plongeur (38') à se déplacer pour placer le dispositif d'orientation (12') dans l'état libre, et quand la vitesse de rotation du trépan de forage est inférieure à la vitesse de seuil, l'électroaimant (232) ne produit pas un champ magnétique en mesure de déplacer ou de retenir le dispositif d'orientation (12') dans l'état libre et dans lequel le dispositif d'orientation (12') repasse à ou reste dans l'état verrouillé.

11. Système d'orientation activé par rotation (10') selon la revendication 10, dans lequel le plongeur (38') est formé avec une tige (46) autour de laquelle le mécanisme de sollicitation (58) et le deuxième élément de serrage (56) sont situés, le mécanisme de sollicitation (58) étant agencé pour solliciter le plongeur (38') et le deuxième élément de serrage (56) dans une direction allant vers le haut du trou.
12. Système d'orientation activé par rotation (10') selon la revendication 11, dans lequel le dispositif d'orientation (12') comporte une pluralité de premiers et deuxièmes éléments de serrage (32, 56) et un ou plusieurs éléments d'écartement (54) agencés sur la tige (46), dans lequel les deuxièmes éléments de serrage (56) sont espacés les uns par rapport aux autres par des éléments d'écartement respectifs (54).
13. Système d'orientation activé par rotation (10') selon l'une quelconque des revendications 9 à 12, dans lequel le dispositif d'orientation (12') comprend un chemin de roulement supplémentaire (242) et une sphère flottante (244) en mesure de tourner librement à l'intérieur du chemin de roulement quel que soit l'état du dispositif d'orientation (12').

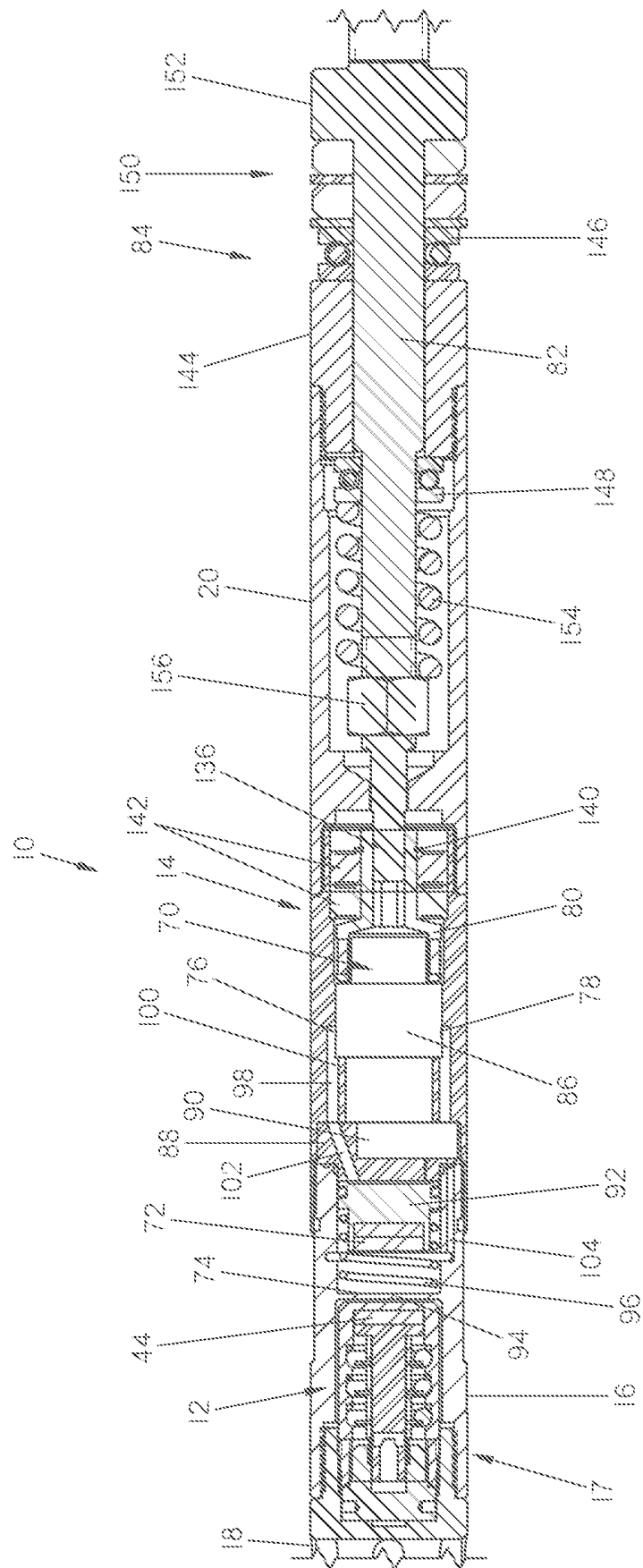


FIGURE 1

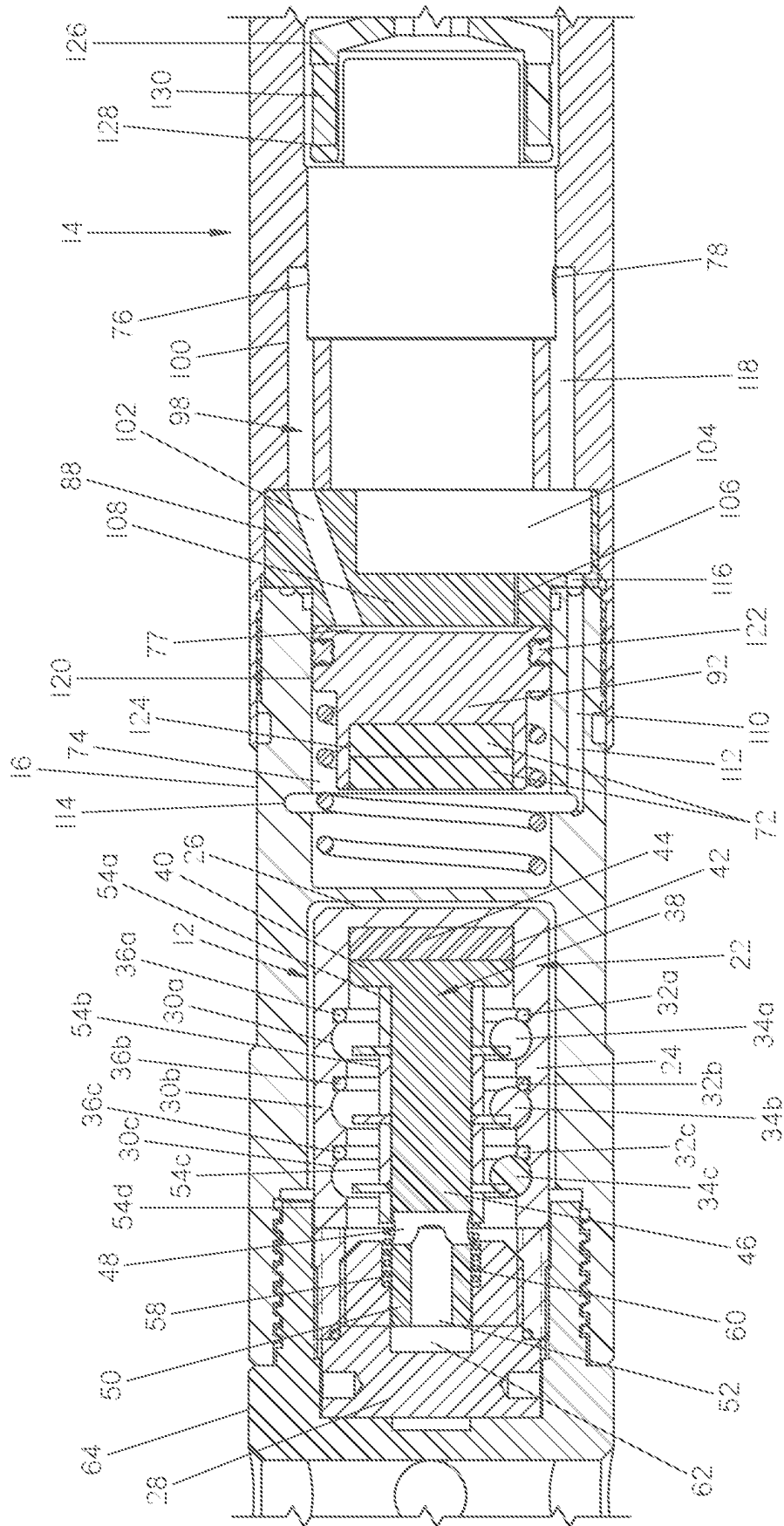


FIGURE 2

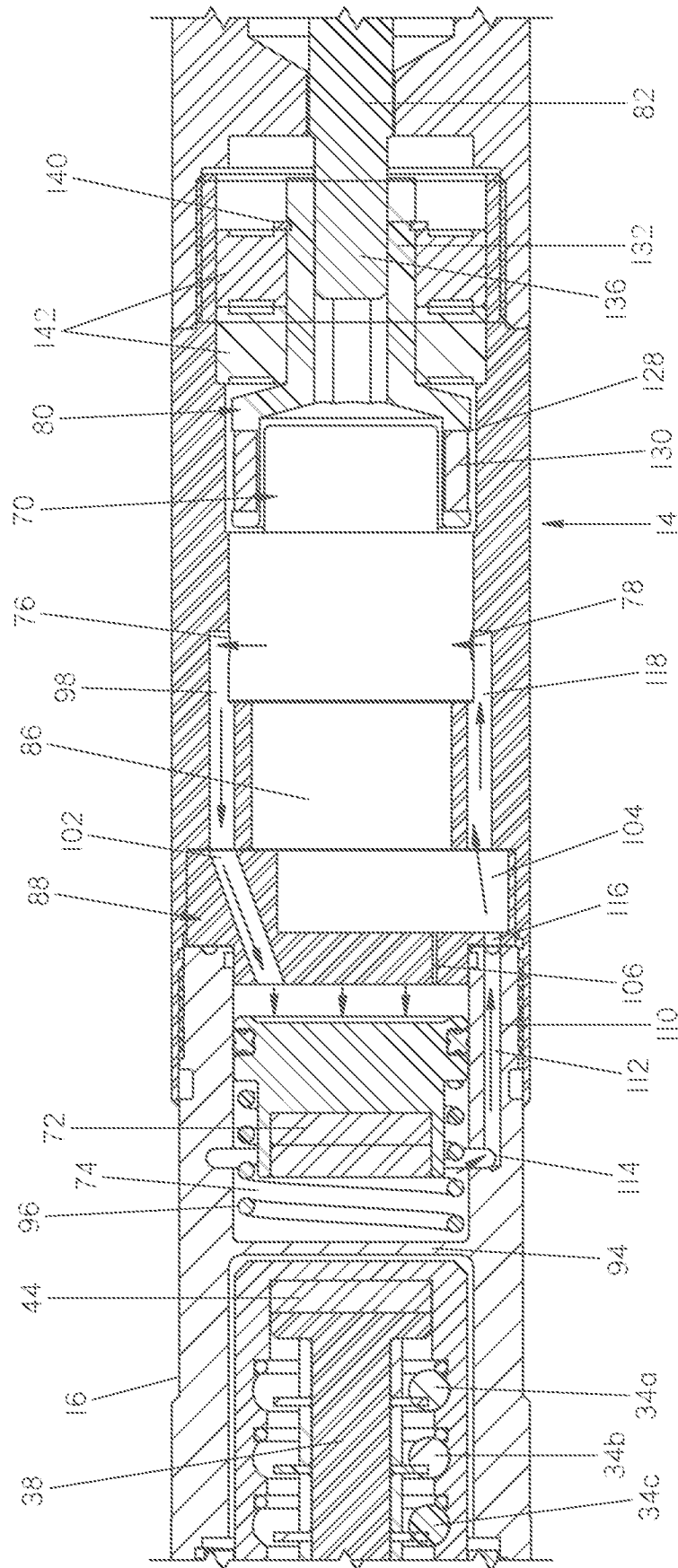


FIGURE 3

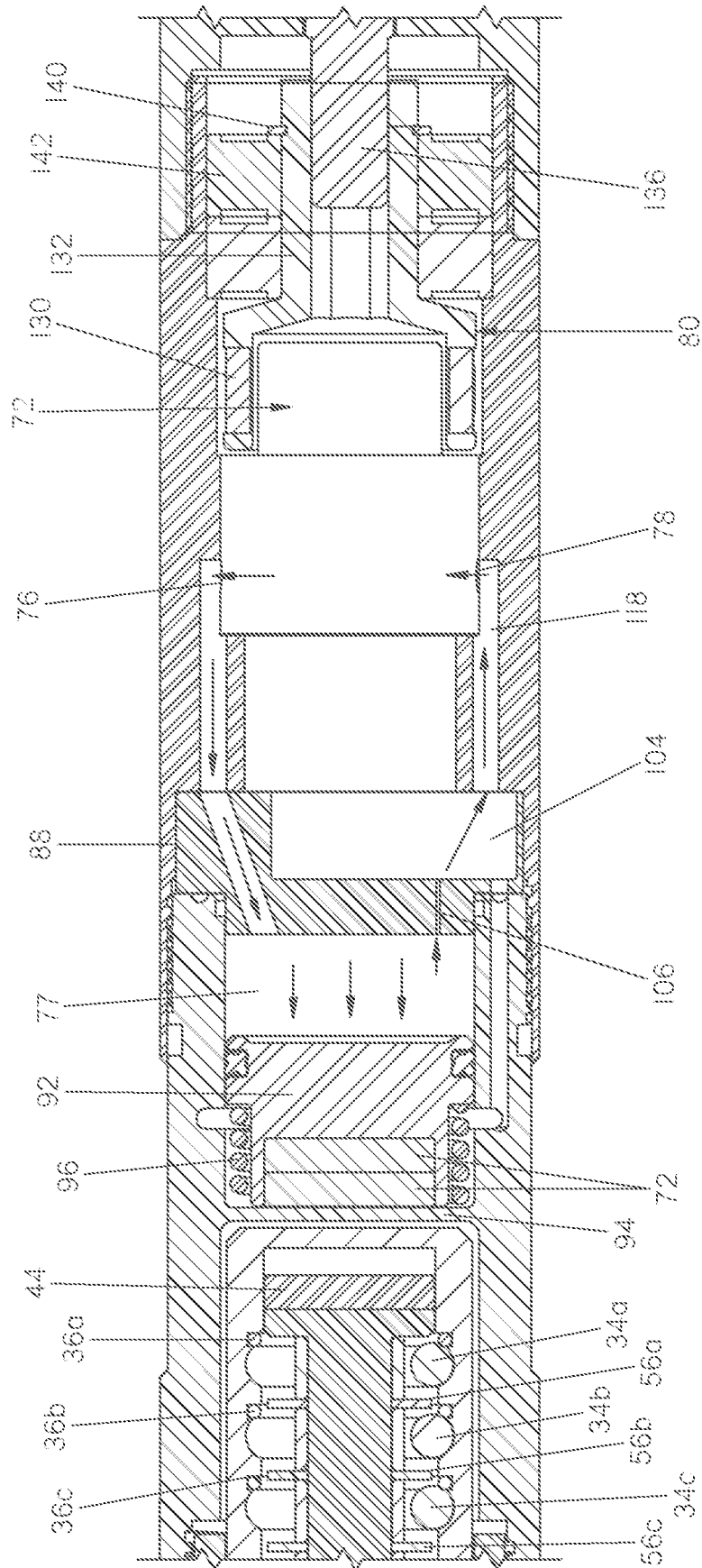


FIGURE 4

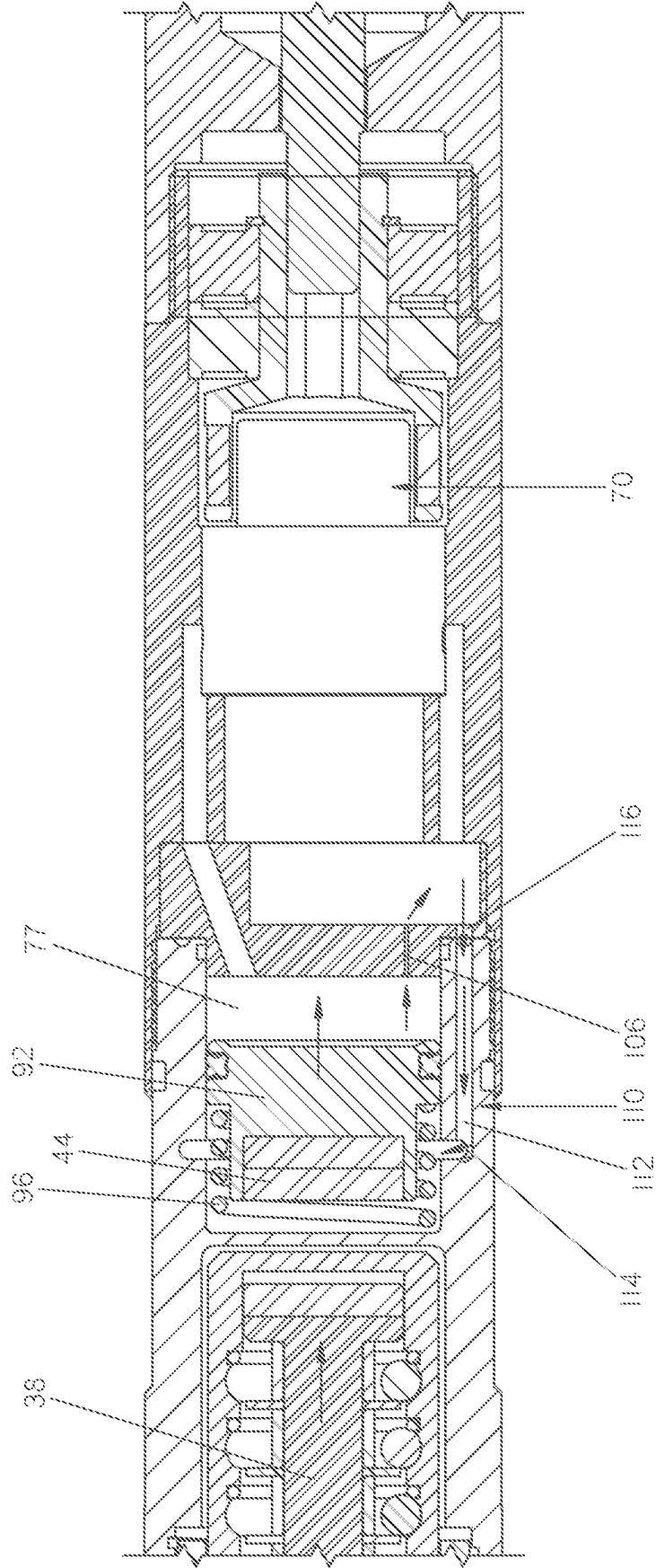
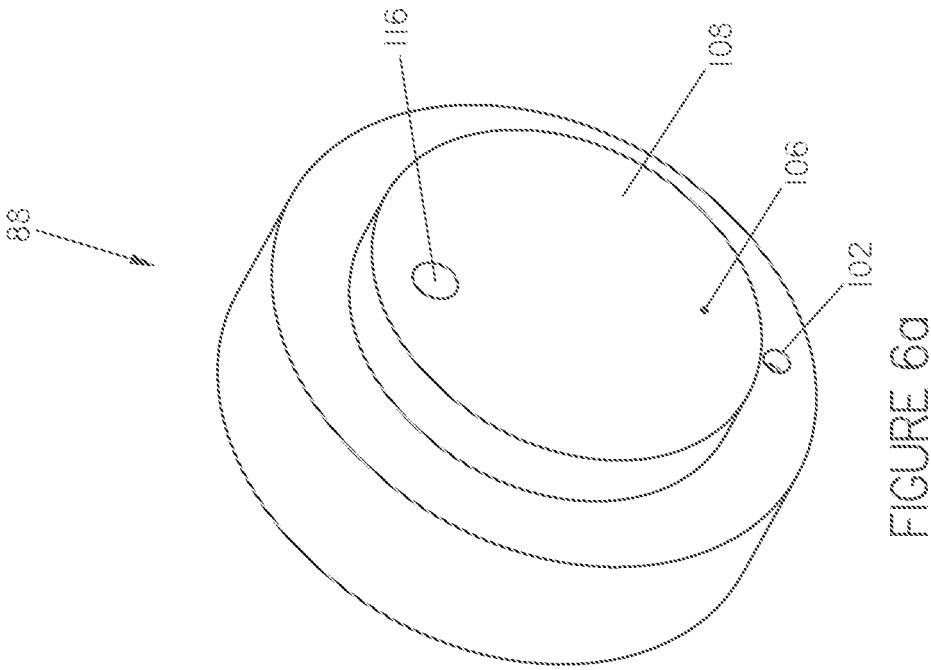
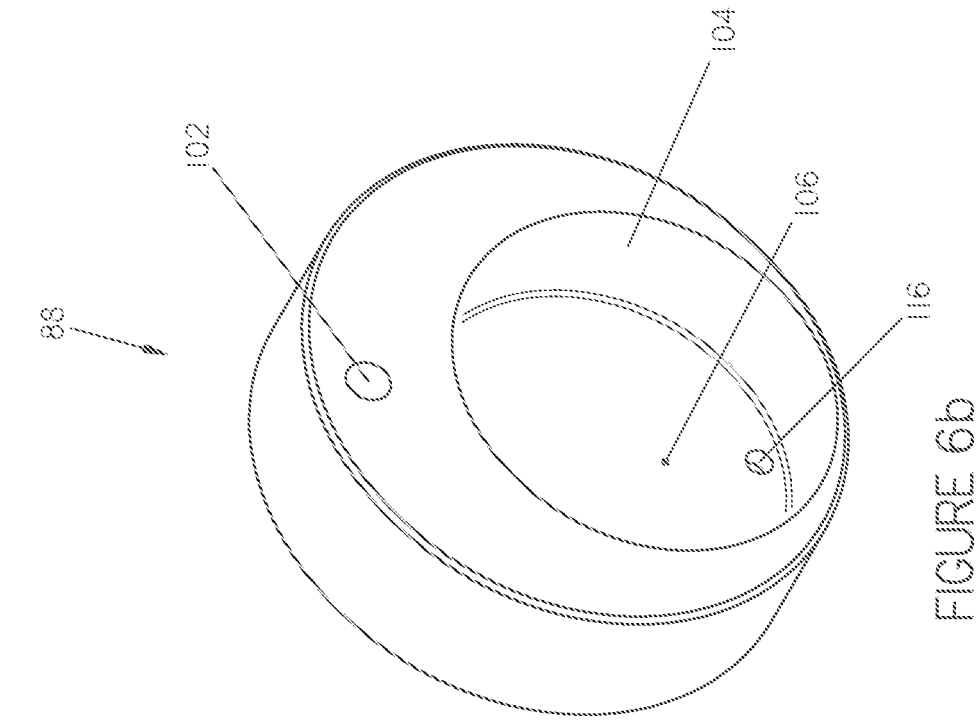
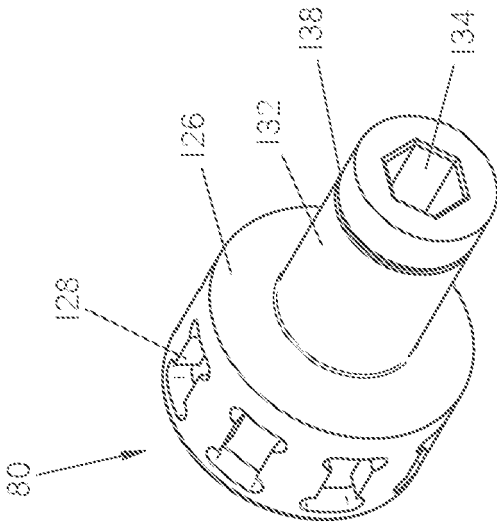
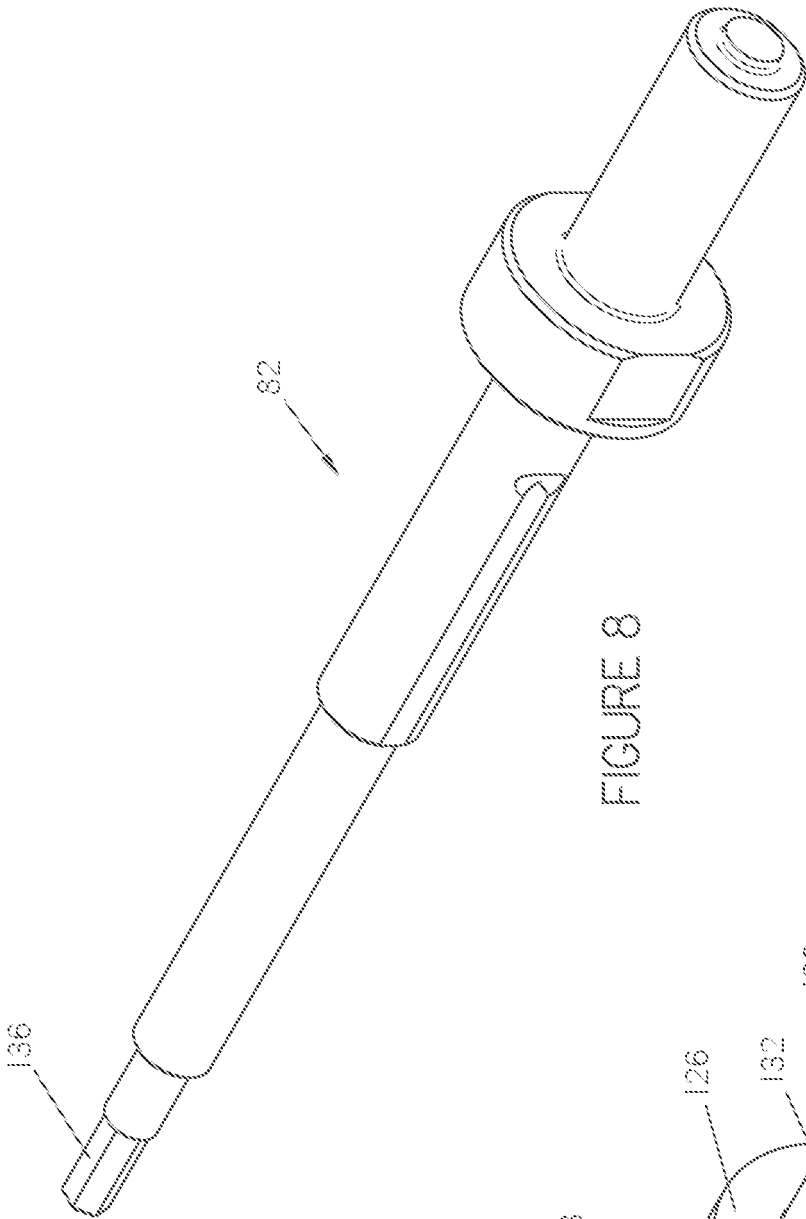
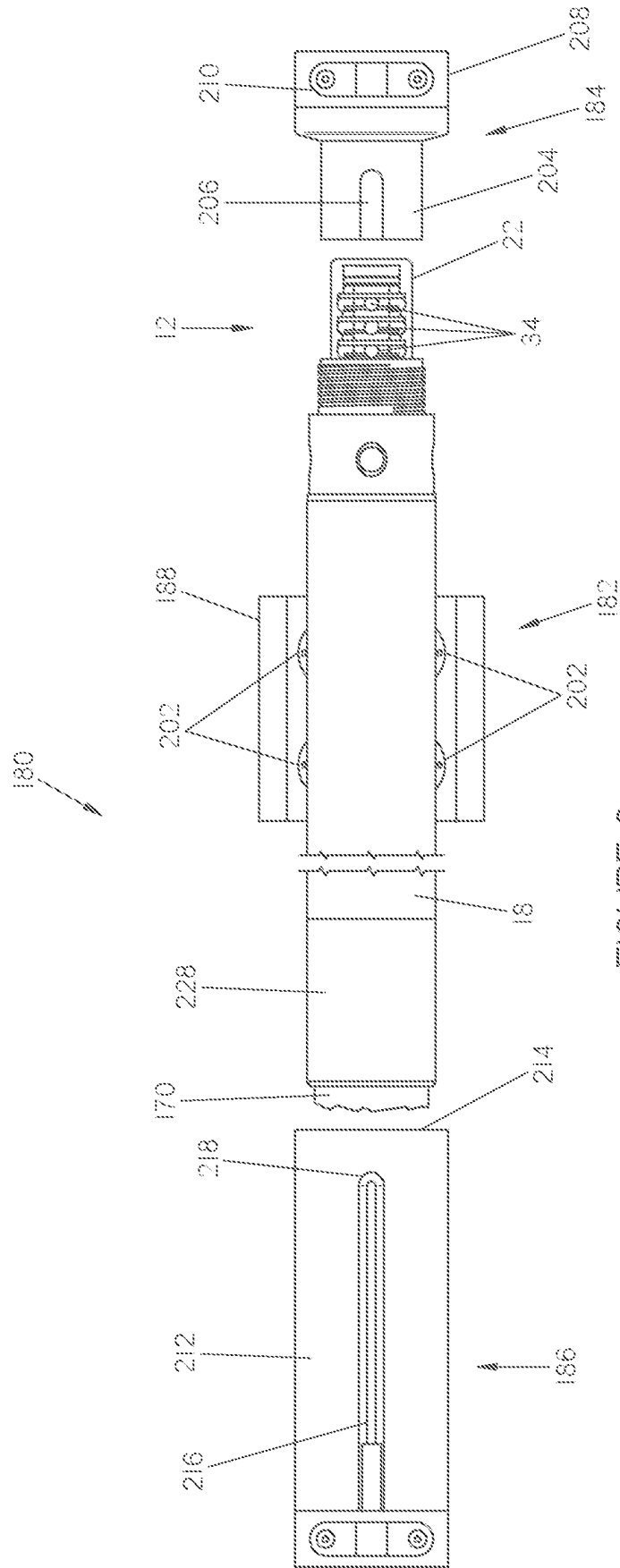


FIGURE 5







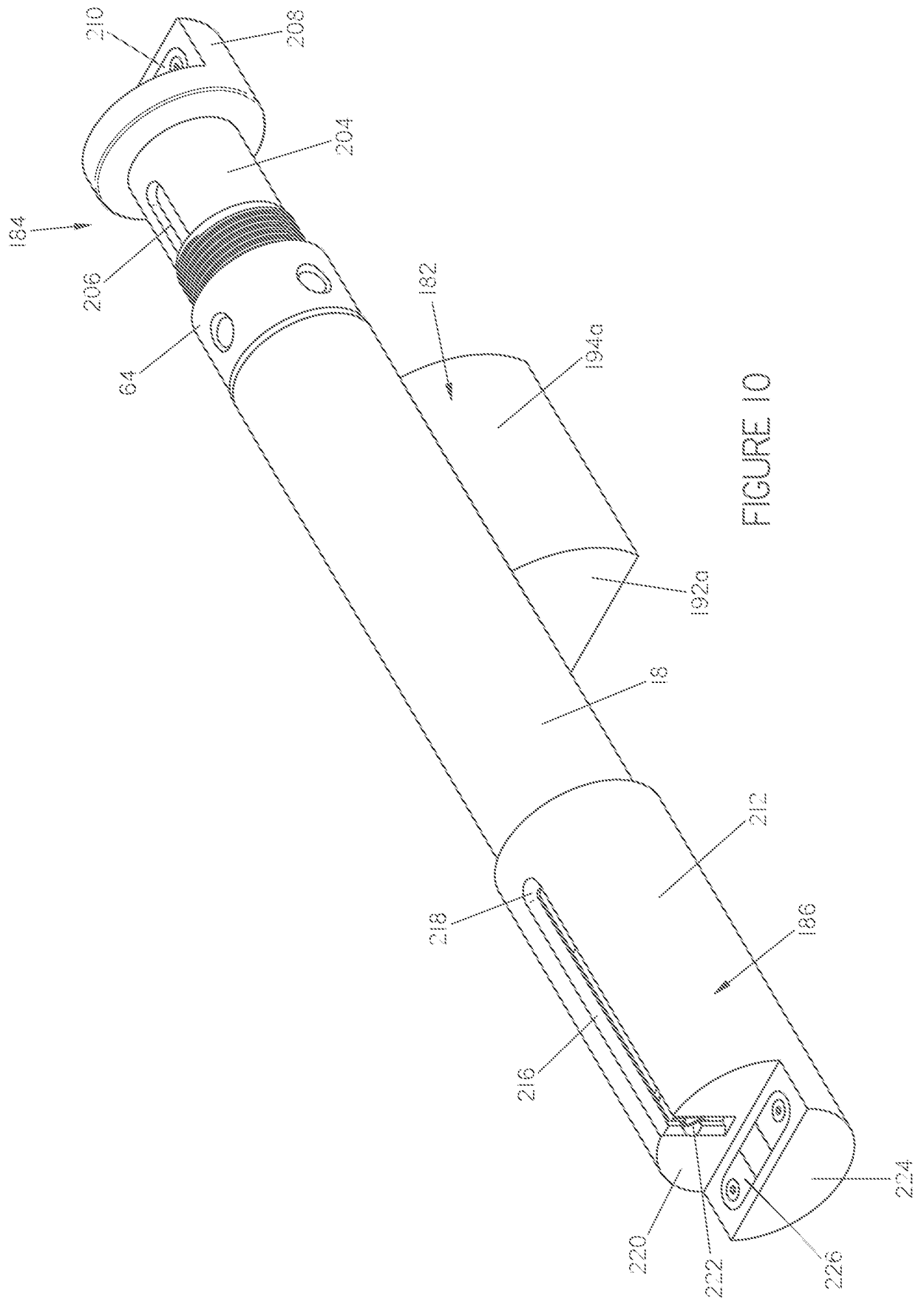
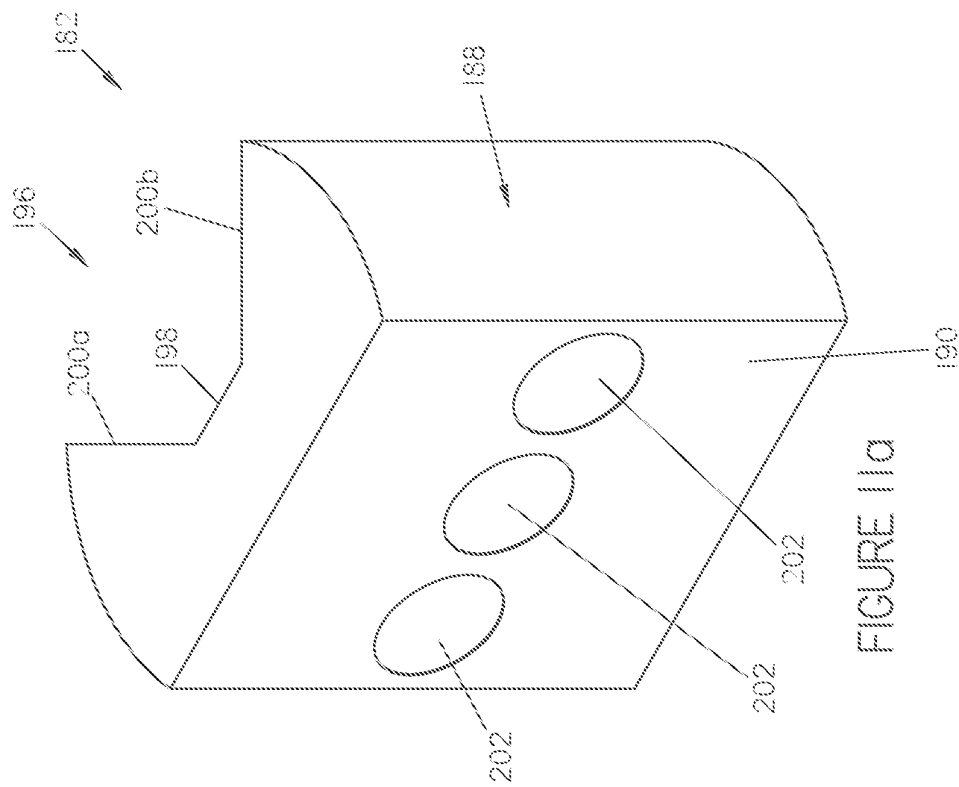
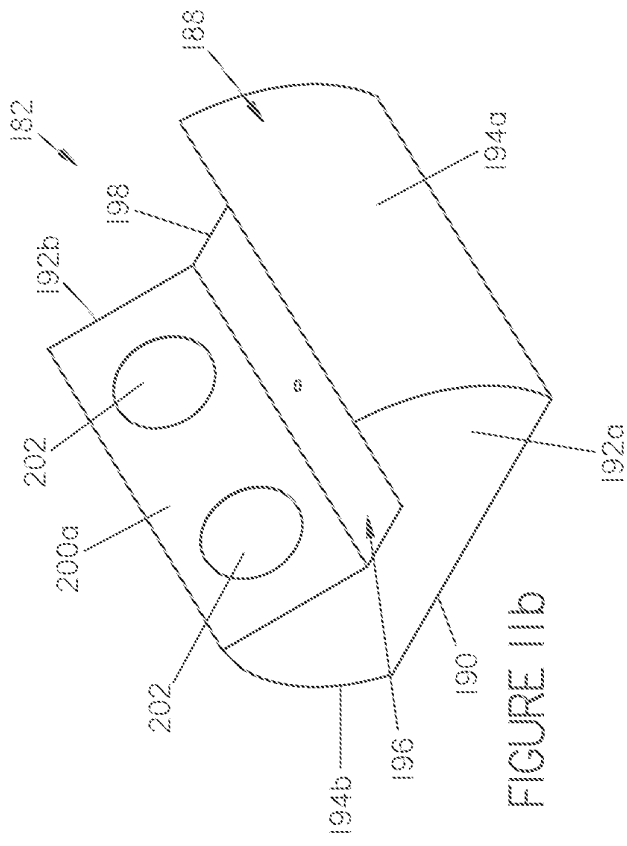
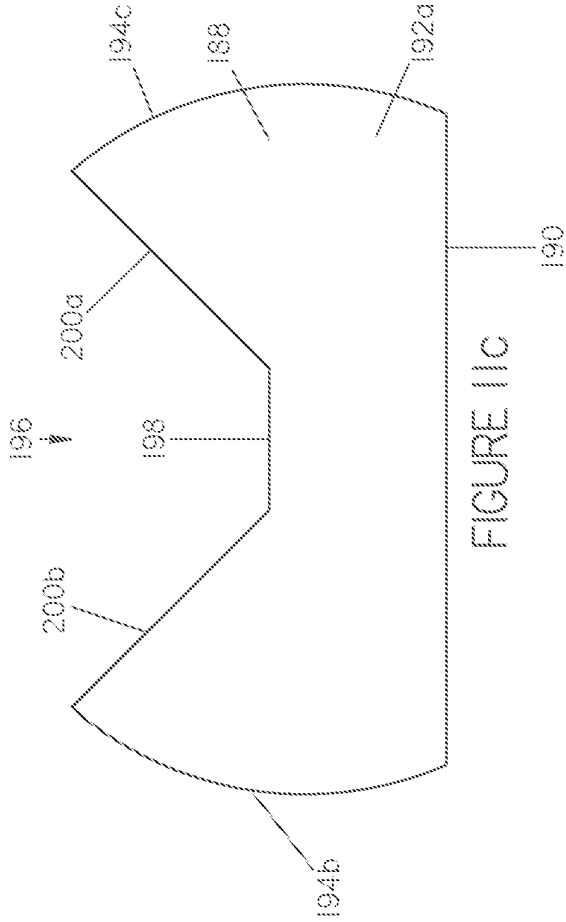


FIGURE 10



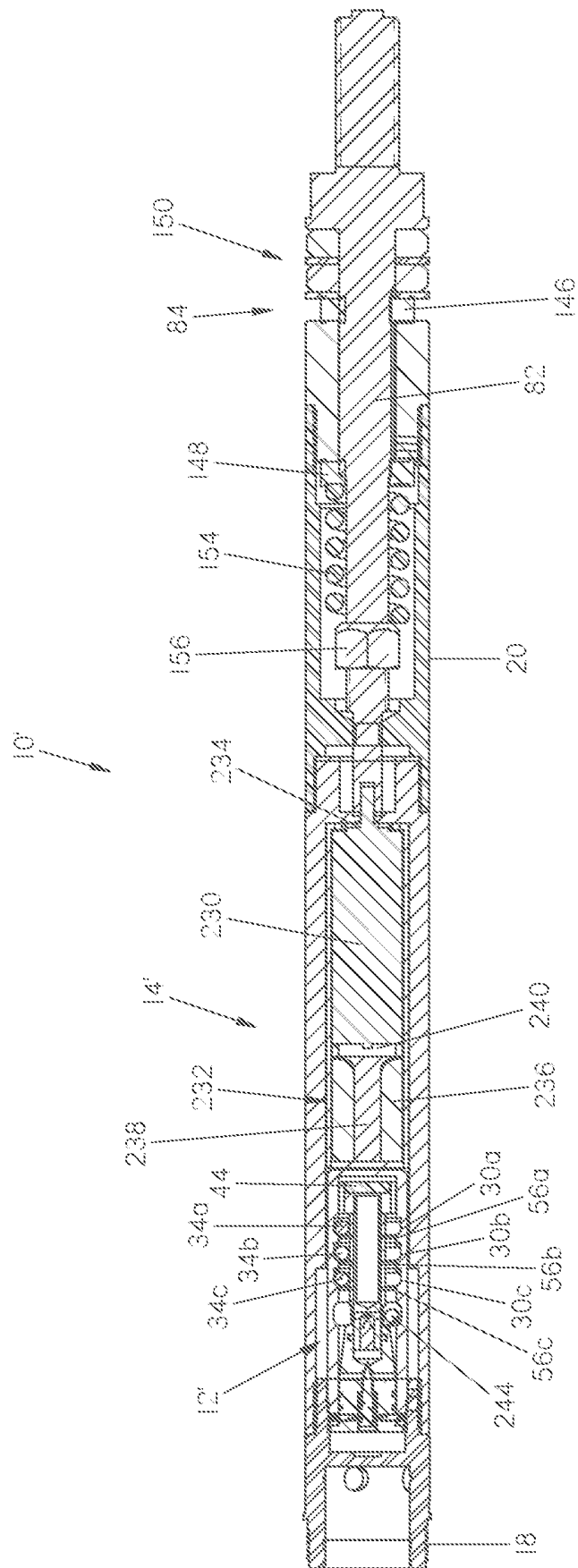


FIGURE 12

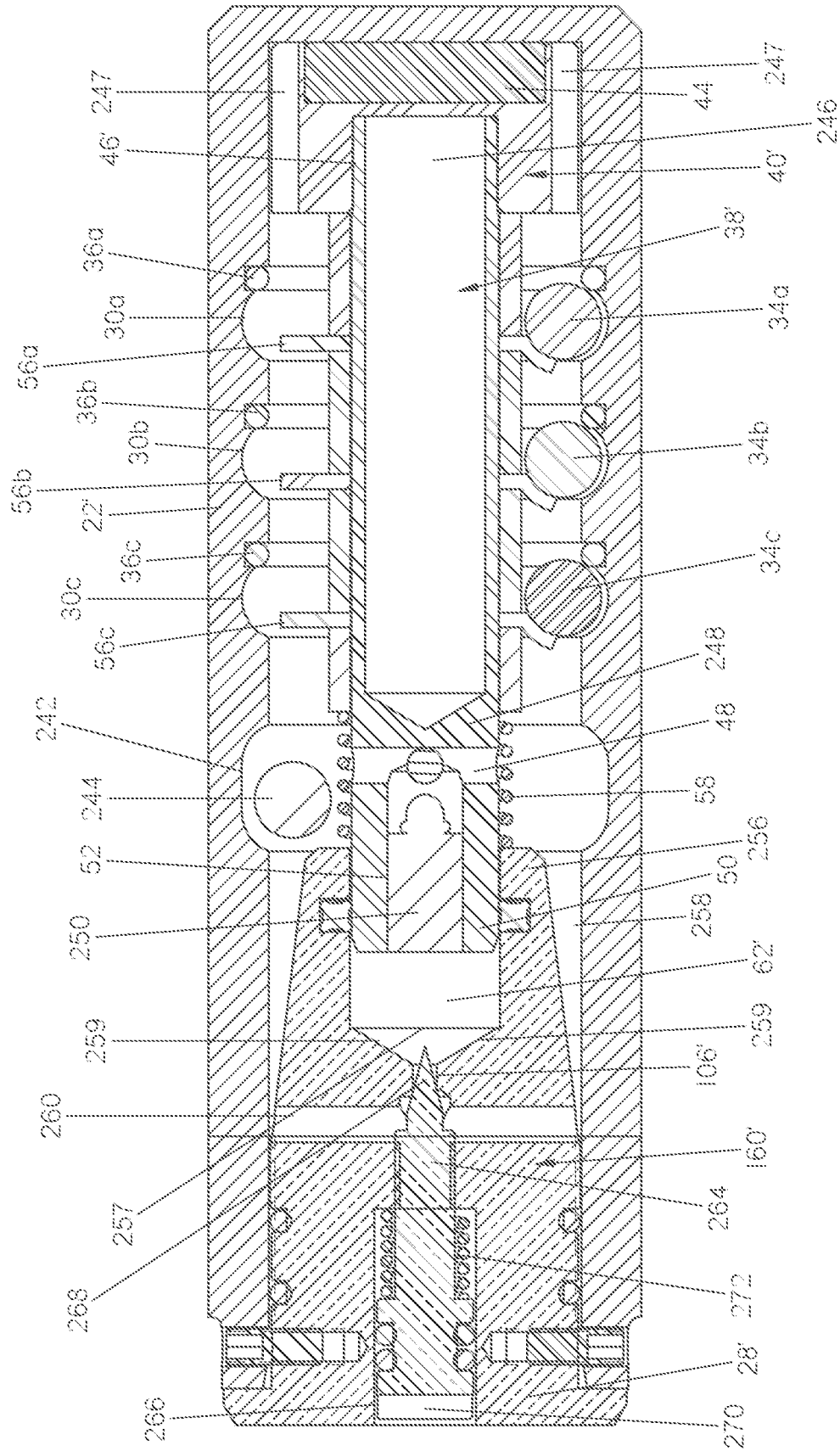


FIGURE 13

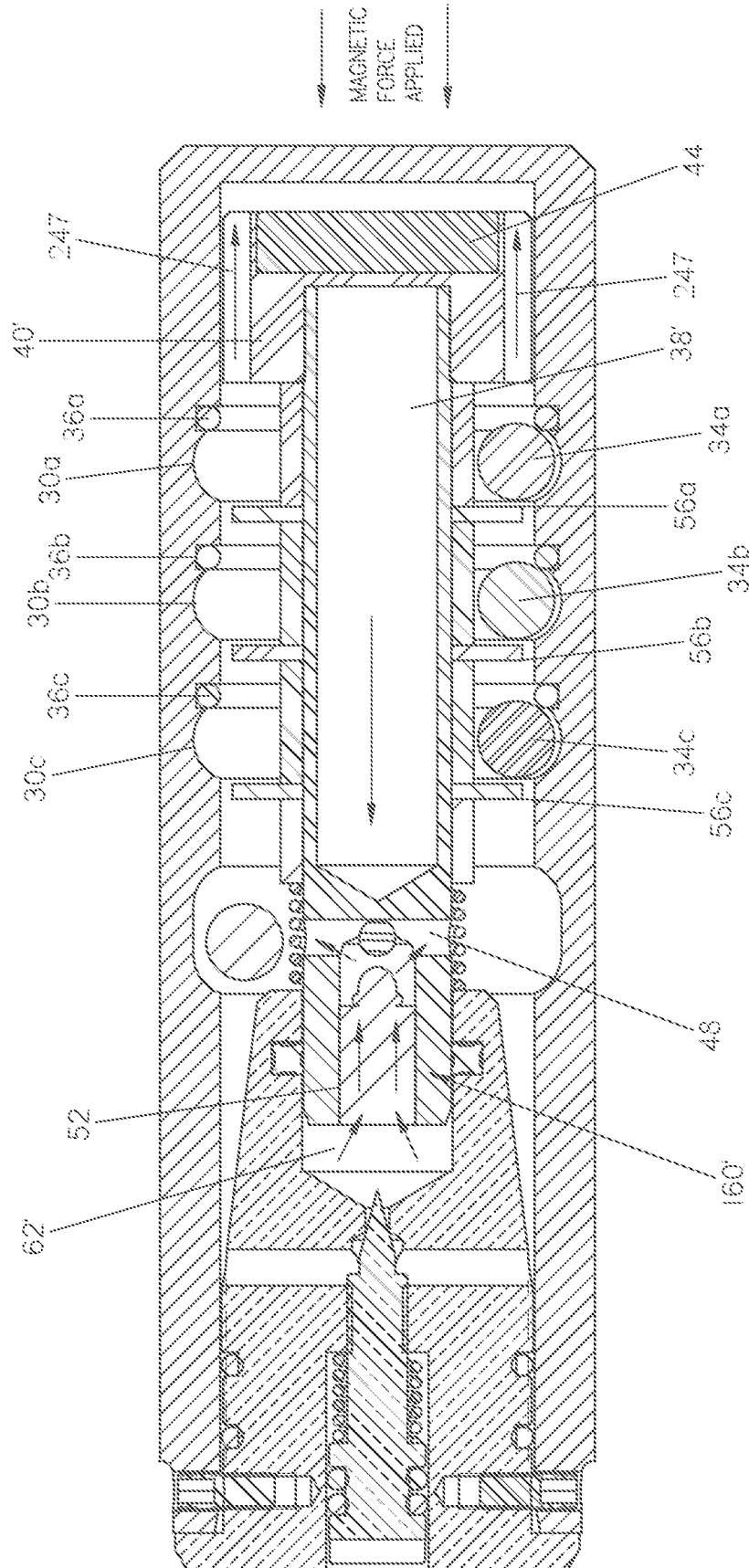


FIGURE 14

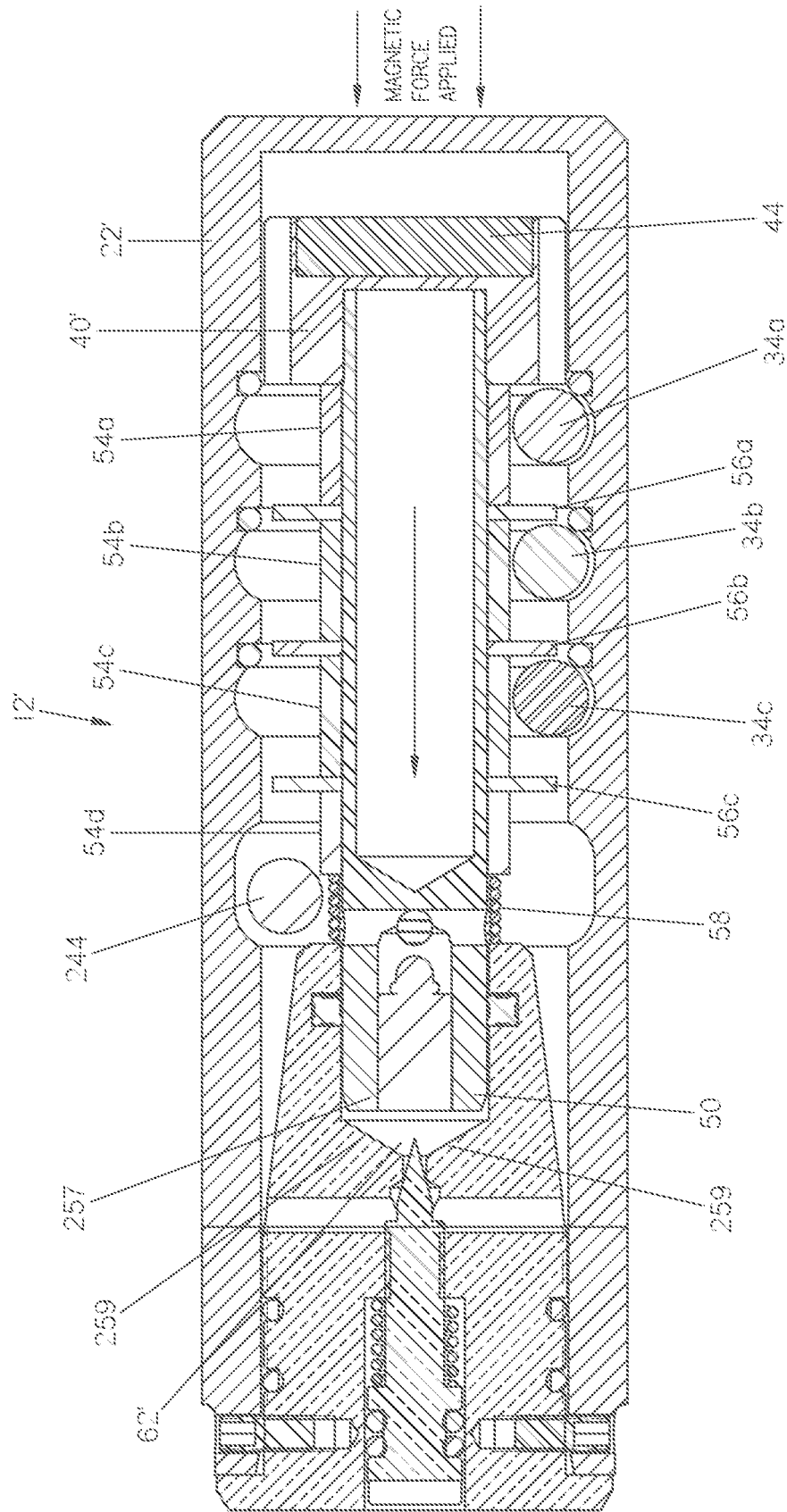


FIGURE 15

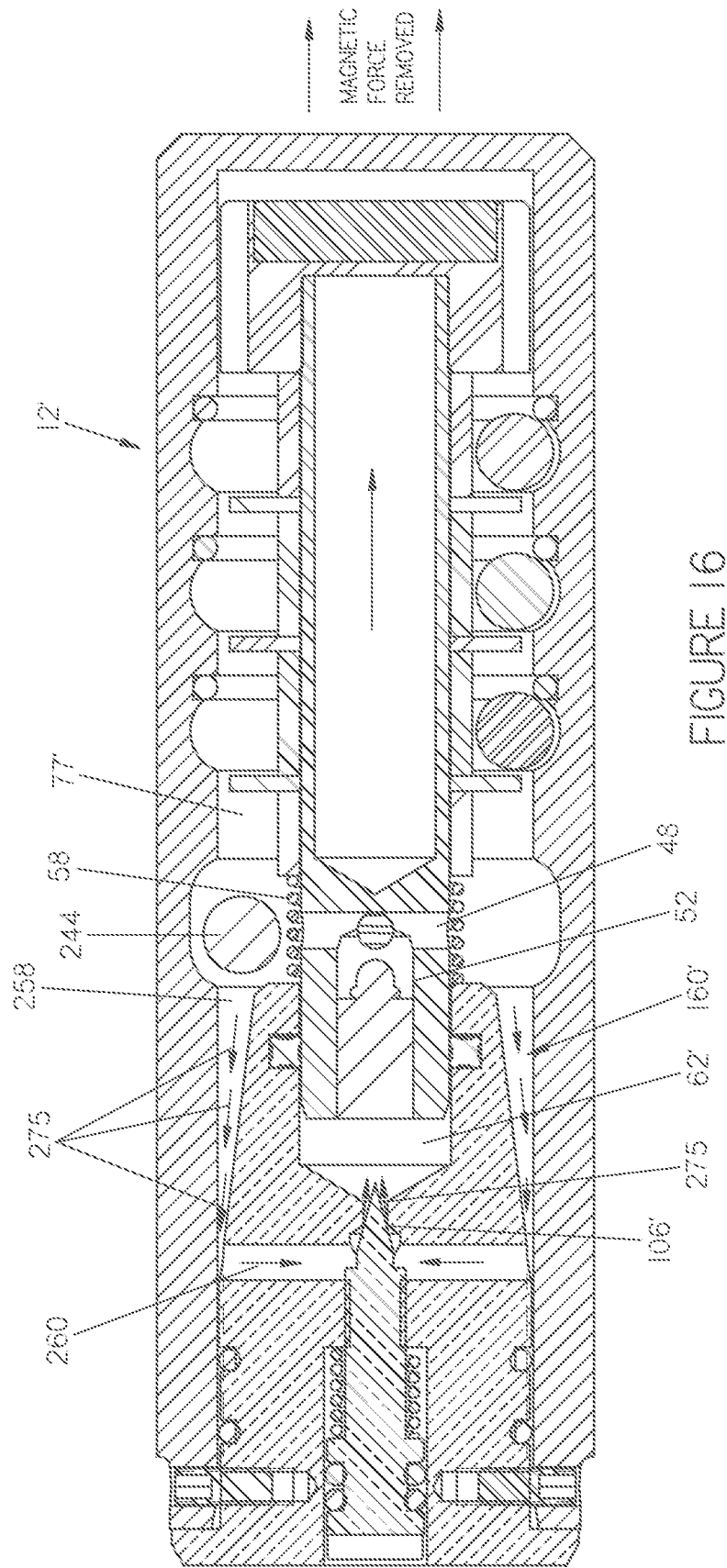


FIGURE 16

REFERENCES CITED IN THE DESCRIPTION

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