

(19)



(11)

EP 4 038 259 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
08.07.2026 Bulletin 2026/28

(21) Application number: **20788905.6**

(22) Date of filing: **02.10.2020**

(51) International Patent Classification (IPC):
E21B 33/13^(2006.01) E21B 28/00^(2006.01)

(52) Cooperative Patent Classification (CPC):
E21B 33/13; E21B 28/00

(86) International application number:
PCT/NL2020/050612

(87) International publication number:
WO 2021/066655 (08.04.2021 Gazette 2021/14)

(54) **VIBRATING CEMENT INJECTOR**

VIBRIERENDER ZEMENTINJEKTOR

INJECTEUR DE CIMENT VIBRANT

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(30) Priority: **03.10.2019 NL 2023957**

(43) Date of publication of application:
10.08.2022 Bulletin 2022/32

(73) Proprietor: **Callidus Capital B.V.
8445 PA Heerenveen (NL)**

(72) Inventor: **VEENSTRA, Feitze
8445 PA Heerenveen (NL)**

(74) Representative: **V.O.
P.O. Box 87930
2508 DH Den Haag (NL)**

(56) References cited:
**WO-A1-2005/042916 WO-A1-2017/096078
CN-A- 104 343 412 CN-A- 105 937 378
CN-B- 102 889 067 CN-U- 201 883 999
CN-U- 201 943 619 US-A1- 2013 186 686
US-A1- 2016 032 653 US-B1- 9 366 100
US-B1- 9 506 318**

EP 4 038 259 B1

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

FIELD OF THE INVENTION

[0001] The invention relates to a device for providing a closure in a conduit for closing the conduit.

BACKGROUND

[0002] When an oil or gas well is on its end of life, the well is abandoned. To prevent oil or gas from leaking out of the abandoned well, a cement plug is used to seal the well.

[0003] For sealing the well, a bridge plug may be placed in the production pipe of the well. Next, the production pipe may be cut and removed above this bridge plug. Finally, liquid cement may be injected into the production pipe, which forms a cement plug. This cement plug acts as a seal to prevent gasses to come out of the well, which gas may still be under significant pressure.

[0004] US9506318B1 discloses a method and system of cementing a well bore with vibration of a casing string as a fluid cement mixture is forced into the annulus between the casing string and the well bore as a curable fluid cement mixture is pumped through the casing string. A casing shoe and/or a casing collar have a vibration inducing mechanism for vibrating the shoe casing radially in response to the flow of fluid through the casing.

[0005] WO2005042916A1 discloses a method of running a bore-lining tubing string into a bore comprises running a tubing string, typically a liner string, into a bore while agitating the string. The agitation of the string reduces the friction between the string and the bore wall and thus facilitates the translation of the string into the bore. The agitation may also take place while the tubing is being cemented in the bore. Pressure pulses may be applied to fluid in the bore, which fluid may be cement slurry.

[0006] CN201943619U discloses an underground vibrated well fixing device. The underground vibrated well fixing device comprises a barrel body and a vibrating device positioned in the barrel body.

[0007] CN201883999U discloses a turbine type downhole vibration cementing device. The novel turbine type downhole vibration cementing device comprises an outer cylinder, a single-action turbine section, a double-action turbine section and a lower tray.

[0008] CN102889067 discloses a well fixing device capable of being multi-directionally vibrated. The well fixing device comprises a cylindrical body and the upper section of the body is provided with at least one worm wheel section.

[0009] US20130186686A1 discloses an apparatus for use in a horizontal section of a drill string. The apparatus includes a motor that is connected to the horizontal section of the drill string. The motor is adapted to impart vibrations in the horizontal section of the drill string, where the vibrations are at about the lateral resonant

frequency of the horizontal section of the drill string.

[0010] CN104343412 discloses an axial vibratory impulse well cementation method and device.

[0011] US9366100B1 discloses a vibrator apparatus to be positioned onto a pipe string. The apparatus is comprised of a tubular housing, a tubular stator having a radial fluid opening, and a rotating rotor shaft with a longitudinally extending fluid bore and at least one radially extending fluid passage that intermittently aligns with the stator fluid opening. A rotation generator is provided to rotate the rotor shaft in response to fluid flow.

[0012] US2016032653A1 discloses a downhole vibration tool, comprising: an outer housing having an inner surface that defines an inner bore; a flow diverter positioned within the inner bore, the flow diverter having an inner passage and an outer surface that defines a flow path between the inner surface of the outer housing and the flow diverter; a removable plug that blocks the inner passage, the plug being removable to open the inner passage; and a rotating member rotatably carried within the outer housing and downstream of the flow diverter, the rotating member comprising a rotor in fluid communication with the flow path and an eccentric mass.

SUMMARY

[0013] Closures, such as cement plugs, have a high risk of leaking well gasses, especially when the cement in liquid state is not applied properly. For example, gas bubbles may be trapped in the cement while it solidifies, or the cement may not fully fill the entire cross-section of the production pipe.

[0014] It is preferred to provide a closure which provides a better seal of a conduit, and/or to provide a device for providing the closure. A closure may for example be formed by a plug, a seal, or a combination thereof.

[0015] A first aspect provides a device for providing a closure in a conduit for closing the conduit, for example by injecting a filler material in the conduit. The device comprises an elongate body, comprising a filler material input provided at a proximal end, a filler material output provided downstream from the filler material input, and a filler material flow path between the filler material input and the filler material output. The device further comprises a rotor, at least partially provided in the filler material flow path and arranged to be rotatably driven by a filler material flow flowing through the filler material flow path, and a closure improvement unit, connected to the rotor such that the closure improvement unit is rotatably driveable by the rotor. In this aspect, the closure improvement unit comprises a radial vibration unit provided downstream of the rotor, the radial vibration unit comprising an eccentric weight, rotatably connected to the rotor and rotatable over an axis substantially parallel to the length of the elongate body, the radial vibration unit being rotationally connected to the rotor via one or more gears, such that the radial vibration unit is arranged to convert a rotation of the rotor into a radial vibration.

[0016] By virtue of the closure improvement unit, the closure of the conduit may be improved. For example may the closure be more gas-tight, more durable, have a better resistance to pressure on the closure, other, or a combination thereof.

[0017] The closure improvement unit requires an input of energy, which may be rotational energy provided by the rotor, which in turn receives energy from the flow of filler material over the filler material flow path in which the rotor is at least partially provided.

[0018] As such, no additional energy source may be required, which otherwise would for example have increased the weight of the device which has to be lowered into the well. Also, no additional energy conduit, such as electrical wires for powering an electric motor or conduits for providing pressurised hydraulic fluid for powering a hydraulic actuator may have to be lowered into the well to reach the device. Providing additional energy, for example electricity, hydraulic or pneumatic pressure may also be difficult or more costly if the device is lowered to substantial depths to reach the production pipe.

[0019] The rotor may be arranged to rotate over an axis substantially parallel to the length of the body. When the rotor is arranged as part of a positive displacement motor, the rotor also rotates over an axis substantially parallel to the length of the body.

[0020] As an example, the filler material may be cement or at least comprise cement or alternative filler material. The filler material may be at first provided as a substantially liquid substance, arranged to set into a substantially solid material to form a solid cement plug comprised by the closure.

[0021] To improve the closure, the closure improvement unit may comprise a radial vibration unit, connected to the rotor, such that the radial vibration unit is arranged to convert a rotation of the rotor into radial vibrations.

[0022] By virtue of radial vibrations provided to liquid cement as a filler material, gas bubbles may be pushed out of the liquid cement. Less gas bubbles may increase the quality of a cement plug formed by the liquid cement, comprised by the closure closing the conduit.

[0023] A filler material may comprise fluids and solid particles. For example, a filler material may comprise a cement, sand, gravel, silicates, salts such as magnesium, other chemicals, one or more polymers, oxides, and a liquid such as water to make the filler material sufficiently fluid to for example be pumpable, and/or allow it to flow through a conduit to the filler material input.

[0024] By virtue of radial vibrations provided to a filler material comprising solid particles suspended in a liquid, liquid may be driven away from space between the particles, causing the cement to densify. The particles may for example by virtue of gravity sink better or faster by applying the radial vibrations.

[0025] Preferably, the vibrations are provided radially relative to the flow of filler material. If the conduit is oriented substantially vertically, the radial vibrations may be substantially lateral vibrations relative to a direc-

tion in which the device is lowered into the conduit. The device may also be used for providing a closure for closing conduits which are substantially horizontal, or under any angle between horizontal and vertical. Respectively for horizontal and vertical conduits, the radial vibrations may be substantially vertical and horizontal.

[0026] In embodiments, the radial vibration unit may be provided downstream or upstream of the rotor. Hence, in use, the radial vibration unit may be provided below or above the rotor.

[0027] In embodiments of the device, the radial vibration unit comprises an eccentric weight, rotatably connected to the rotor and rotatable over an axis substantially parallel to the length of the body. Rotatably connected implies that rotational energy of the rotor can be transferred to the eccentric weight, for example by means of shafts, gears, belts, any other rotational connection element or any combination thereof. By virtue of the rotational connection, when the rotor rotates, the eccentric weight, placed apart from an axis of rotation over which the centre of gravity of the weight is rotated, may rotate as well.

[0028] The filler material output may be provided between the filler material input and the radial vibration unit. As such, the radial vibration unit may be provided within the cement plug while at least part of the cement plug is still in a liquid, i.e. uncured, and/or not solidified state. The radial vibrations provided to this liquid state part of the cement plug may increase its sealing properties as discussed above. When the filler material is liquid, for example as a suspension, particles comprised by the filler material may sink in the plug comprised by the closure, for example by virtue of gravity.

[0029] Embodiments of the device may further comprise a filler material buffer provided in the filler material flow path between the rotor and the filler material output, the filler material buffer being arranged for storing a predetermined volume of filler material. With an increase volume of filler material, an increase time delay may be provide between providing filler material to the filler material input and filler material actually flowing out of the filler material output. The filler material buffer may be a separate component, or may in embodiments be formed by the elongate body.

[0030] The filler material output may be provided at a proximal end of the filler material buffer. As such, first the filler material may fill up the filler material buffer before flowing out of the filler material output.

[0031] The filler material buffer may comprise a buffer storage space having a buffer input and a buffer output, wherein in use, the buffer input and the buffer output are provided at or near the top of the buffer storage space. In embodiments, the buffer input and the buffer output may be the same conduit or opening, wherein when the buffer is not entirely filled, the conduit or opening acts as the buffer input.

[0032] Embodiments of the device may further comprise a sealant reservoir with a sealant output provided at

a distal end of the elongated body, wherein the sealant reservoir comprises a storage volume for storing a sealant. The sealant may be used to form a seal before the filler material is injected. As such, the closure for closing the conduit may comprise a combination of a seal formed by sealant, and a plug formed by the filler material. In other embodiments, the closure comprises the seal or the plug.

[0033] When the closure comprises a plug formed by the filler material, for example a cement plug, it may be uncertain whether the cement plug fully or substantially fully forms a gas-tight and/or liquid-tight closure. As such, a seal may be applied as part of the closure, which seal is arranged to form a gas-tight and/or liquid-tight closure or at least a substantially gas-tight and/or liquid-tight closure.

[0034] The sealant material may be a different material from the filler material. When a sealant material is used, the filler material may be arranged to form a plug preventing a pressure from pushing the seal formed by the sealant material out of the conduit. Instead, the seal may be pushed against the plug, which may be a cement plug. The plug, by virtue of its weight, may press down on the seal. Depending on the sealant material and the filler material, the plug may be significantly larger than the seal and provide sufficient weight to aid to keep the sealant in place.

[0035] A barrier or pressure activated opening may be provided between the sealant reservoir and the sealant output, wherein the pressure activated opening is arranged to be opened if a pressure in the reservoir exceeds a pre-determined threshold. The barrier may comprise a fragile material, a weakened section, and/or valve, arranged to break, severe and/or otherwise open if the pressure in the reservoir has increased above the pre-determined threshold.

[0036] A barrier may in embodiments also be arranged as a valve, arranged to allow a fluid flow there through when provided with fluid under a pressure above the pre-determined threshold. A pressure activated opening may in embodiments be opened to form the sealant output.

[0037] In embodiments, the closure improvement unit further comprises a sealant driving mechanism arranged to decrease the volume of the sealant reservoir when the rotor rotates. With the decrease of the volume of the sealant reservoir, the pressure in the reservoir may be increased above the pre-determined threshold, which may cause the barrier to severe or break. If the viscosity of the sealant material is such that the sealant material does not flow out of the sealant output by virtue of gravity, the sealant driving mechanism may be used to provide sufficient pressure for pressing the sealant out of the reservoir.

[0038] The closure may be improved, as explained above, by applying a seal. For applying the seal, an energy input may be required, for example to apply sufficient pressure to the sealant material in the reservoir to open the pressure activate opening. By using rota-

tional energy of the rotor, which in turn is provided by the flow of filler material over the filler material flow path, no additional energy source may be required for applying the seal.

[0039] The sealant driving mechanism may be connected to the rotor via one or more gears, such that the rotational speed and/or torque of the sealant driving mechanism may be different from the rotational speed and/or torque of the rotor. If the sealant driving mechanism is connected to the rotor via the radial vibration unit, for example via the eccentric weight, the sealant driving mechanism may be connected to the radial vibration unit via one or more gears, such that the rotational speed and/or torque of the sealant driving mechanism may be different from the rotational speed and/or torque of the radial vibration unit.

[0040] It will be appreciated that the closure improvement unit may comprise the radial vibration unit, the sealant driving mechanism, or both. Both the radial vibration unit and the sealant driving mechanism may be used for improving the closure to close of the conduit.

[0041] In an embodiment, the sealant driving mechanism comprises a cylindrical member provided with a first thread and rotationally connected to the rotor, and a plunger delimiting the sealant reservoir having a second thread complementary to the first thread and/or arranged to engage with the first thread, wherein the plunger is arranged to be translated through the sealant reservoir by rotating the cylindrical member, thereby decreasing the volume of the sealant reservoir.

[0042] The device may be lowered into a deep well, where the ambient pressure exceeds pressure at sea level, or at the level in which the sealant reservoir has been filled with sealant material. Furthermore, the sealant material may be compressible, and as such a pressure on the pressure activated opening may cause the pressure activated opening to be moved inwards towards the sealant material. If the sealant material is sufficiently compressible, the pressure activated opening may unwillingly open due to the ambient pressure down in the well.

[0043] When the plunger and the sealant reservoir both comprise a through hole for providing a fluid connection between the storage volume and the surroundings of the sealant reservoir, the pressure on the pressure activated opening may be equalised. To prevent sealant material from leaking out through the through holes, a leakage barrier may be provided between the sealant material and the plunger, which leakage barrier is arranged to transfer the ambient pressure to the sealant material in the storage volume of the sealant reservoir.

[0044] Different embodiments are envisioned for the rotor. In general, a rotor may be defined as a device arranged for converting flow energy and/or fluid pressure of a flow of liquid into a rotational speed of the rotor. As such, the rotor may be arranged as a propeller, positive displacement motor, mud motor, progressive cavity pump, any body provided with blades arranged for con-

verting flow energy and/or fluid pressure of a flow of liquid into a rotational speed of the body, or any other rotor.

[0045] In a particular embodiment, the rotor may comprise a rotor hub and one or more rotor blades provided under an angle relative to the longitudinal axis of the rotor on an outer circumference of the rotor hub. Additionally or alternatively, the rotor comprises a hollow rotor body and one or more rotor blades provided under an angle relative to the longitudinal axis of the rotor on an inner surface of the hollow rotor body.

[0046] When the eccentric weight is rotationally connected to the rotor via one or more gears, the rotor may rotate at a different rotational speed than the eccentric weight with a different torque. The gears and the eccentric weight may be designed such to achieve a vibration frequency between 20 Hz and 2000 Hz, 50 Hz and 1000 Hz, 100 Hz and 500 Hz, or even between 150 Hz and 300 Hz, preferably around 200 Hz.

[0047] The gears may be chosen such to achieve a rotational speed of the eccentric weight of 1000 RPM or more, at least 5000 RPM, at least 10000 RPM, 12000 RPM or more, or even 15000 RPM or more.

[0048] The radial vibration unit may be provided between the sealant reservoir and the filler material buffer, and may further optionally be provided in a sealed chamber. The sealed chamber may prevent contact between the radial vibration unit or parts thereof, for example an eccentric weight, and filler material and/or sealant material. Such contact may hinder the rotation of the eccentric weight and decrease radial vibration.

[0049] The sealed chamber may be provided with a pressurised gas. The pressurised gas may be under a pre-determined pressure, for example related to a depth in the well to which the injection device 200 is to be lowered.

BRIEF DESCRIPTION OF THE FIGURES

[0050] The various aspects and embodiments will now be discussed in conjunction with figures. In the figures:

Fig. 1 shows part of a well that is to be abandoned with an embodiment of an injection device;

Fig. 2 shows a detailed isometric section view of part of an embodiment of an injection device;

Fig. 3 shows a cross-section of part of another embodiment of an injection device;

In Fig. 4, a situation is depicted in which cement is injected using an embodiment of the injection device;

In Fig. 5, another situation is depicted in which cement is injected using an embodiment of the injection device; and

Fig. 6, shows an embodiment of an injection device

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0051] Fig. 1 shows part of a well 100 that is to be closed by means of a cement plug as a seal. The well 100

comprises a production pipe 102, provided with a bridge plug 104, casing 106 and is provided in a rock formation 103. Lowered into a chamber 101 of the well 100 is an injection device 200 for injecting cement as a filler material in the well as a conduit for closing the well as an example of a device for providing a closure in a conduit for closing the conduit. The injection device 200 comprises a housing 208 as an elongate body, which housing 208 may be shaped as a hollow cylinder. The elongation direction of the housing 208 may be regarded as an axial direction, and a radial vibration may occur substantially perpendicular to this axial direction.

[0052] Chamber 101 may have been created prior to lowering the device 200 into the well 100, for example by removing tubing, milling away casing and cement all the way until the formation 103 is reached. As such, the chamber 101 in the formation 103 may form the conduit that is to be closed. Alternatively, the closure may be provided to the production pipe 102 or casing 106 as conduits, or any other conduit.

[0053] The injection device 200 is connected to a supply conduit 202, which may be provided on a reel 204. Via the supply conduit 202, liquid cement as a filler material may be provided to a cement input 206 as a filler material input, comprised by the housing 208 of the injection device 200. In Fig. 1, the top side of the device 200 is defined as the proximal end, provided nearest to the surface and furthest away from production pipe 102.

[0054] Provided downstream of the cement input 206 is a cement output 210 as a filler material output. As such, a cement flow path as a filler material flow path is provided between the cement input 206 and the cement output 210 through which liquid cement may flow. The cement flow path may be provided entirely inside housing 208.

[0055] Provided at least partially in the cement flow path is a rotor 212, which is arranged to be rotatably driven liquid cement flowing through the cement flow path. The liquid cement may flow by virtue of gravity and/or a pressure device such as a pump. Part of the flow energy of the liquid cement may be converted into rotational energy for rotating the rotor 212. The rotational speed of the rotor 212 may thus be related to the flow speed of the liquid cement flowing through the cement flow path.

[0056] The housing 208 may comprise a plurality of bearings for accommodating the rotor 212 in the housing 208 such that the rotor 212 can rotate relative to the housing 208. The bearings may be arranged such that axial movement of the rotor 212 relative to the housing 208 is substantially restricted.

[0057] In embodiments of the device, the rotor for rotatably driving the closure improvement unit may be arranged as a positive displacement motor. The rotor may as such be at one end provided with a flexible shaft, homokinetic coupling, cardan coupling or any other connection allowing the eccentric movement of one rotor end of the positive displacement motor.

[0058] When the device comprises a positive displace-

ment motor, at least part of the housing 208 may form the stator, and may as such be at least partially lined with spiraled lobes. For example to increase ease of manufacturing the lobes, the spiraled lobes may comprise an elastomer part, steel, another material or a combination thereof.

[0059] The embodiment of the injection device 200 as shown in Fig. 1 further comprises an eccentric weight 214 as part of a radial vibration unit. The eccentric weight 214 is provided downstream of rotor 212, which in use may imply that the eccentric weight 214 is provided below the rotor 212. The eccentric weight 214 is rotatable over an axis substantially parallel to the length of the housing 208. As such, when the eccentric weight 214 is rotated, at least a distal end 216 of the injection device 200 may vibrate radially.

[0060] Fig. 2 shows a detailed isometric section view of part of an embodiment of an injection device 200, comprising rotor 212 and eccentric weight 214. The rotor 212 is connected to a shaft 262, which in turn is connected to an optional gearbox 264. Shaft 262 may be a flexible shaft allowing additional movement next to rotation. The eccentric weight 214 is also connected to the gearbox 264, such that rotational energy of the rotor 212 may be transferred via the gearbox 264 to the eccentric weight 214.

[0061] The gearbox 264 may comprise a plurality of gears 265 with different numbers of teeth, and as such a rotational speed of the rotor 212 may be converted into a different rotational speed of the eccentric weight 214. Dependent for example on a desired radial vibration frequency and/or torque supplied to the eccentric weight 214, a particular gear ratio of the gearbox 264 may be chosen. For example, the rotational speed of the rotor 212 may be higher than the rotational speed of the eccentric weight 214, or the rotational speed of the rotor 212 may be lower than the rotational speed of the eccentric weight 214 by virtue of the gearbox 264.

[0062] The eccentric weight 214 is shown in Fig. 2 to be embodied as a tube or bar shaped body, which is bent such that sections of the tube shaped body are provided outside the axis of rotation of the eccentric weight 214. As such, the eccentric weight 214 may be rotationally asymmetric around its axis of rotation. The asymmetric part of the eccentric weight 214 may have relatively high mass relative to the symmetric part of the eccentric weight 214.

[0063] As a further option shown in Fig. 2, the cement output 210 is provided between the cement input 206 and the eccentric weight 214. As such, the eccentric weight 214 is not provided in the cement flow path. Also, when fluid cement flows out of the cement output 210, the eccentric weight 214 may cause the distal end 216 of the injection device 200 to vibrate radially in a region in which the liquid cement has been injected.

[0064] As an even further option shown in Fig. 2, the injection device 200 comprises a delay chamber 268 as a filler material buffer, arranged for storing a pre-determined volume of liquid cement. It will be appreciated that

Fig. 2 may have not been drawn to scale, and different components of the device 200 may be relatively larger or smaller in different embodiments of the device 200.

[0065] The delay chamber 268 is provided in the cement flow path between the cement input 206 and the cement output 210. When cement is provided to the cement input 206, by virtue of gravity and/or a further pressure device, it may flow past the rotor 212 to first fill up the delay chamber 268 before flowing out of the cement output 210. As such, the rotor 212 may be rotated for a longer time before liquid cement flows out of the cement output 210 compared to a situation with a filler material buffer. This longer time may provide sufficient time to first place the seal 256 or at least a part thereof.

[0066] The delay chamber 268 is in the embodiment of Fig. 2 positioned such that cement output 206 is provided at a proximal end of the delay chamber 268, which in use may imply that the cement output 206 is provided above the delay chamber 268. Since the delay chamber 268 may be filled up with liquid cement, it may be provided in the liquid cement flow path.

[0067] As an option shown in Fig. 2 which may also be present in other embodiments of the device 200, a flexible and preferably resilient coupling or connection 290 is provided between the housing part 291 which houses the rotor 212, and housing part 292 which houses the radial vibration unit, for example the eccentric weight 214. As such, the total vibrating mass may be lowered and more vibration energy may be provided to improve the closure, for example by vibrating filler material forming the cement plug as part of the closure.

[0068] Similarly, a flexible coupling may be provided between the housing part 292 which houses the radial vibration unit and the sealant reservoir 232. A flexible coupling may for example comprise flexible, elastic and/or resilient materials to decouple masses. Likewise, flexible and preferably resilient connections or couplings may be provided in the drivetrain, i.e. between the positive displacement motor and the eccentric weight 214 and/or other parts that are driven by the positive displacement motor.

[0069] As an even further option, the embodiment of the device 100 as shown in Fig. 2 comprises a valve 299 as a pressure activated opening, provided between the filler material input 206 and the delay chamber 268. The valve 299 may be arranged to prevent filler material from flowing into the delay chamber 268 if the filler material is under insufficient pressure.

[0070] For example, may the valve 299 be designed such that the pressure of the fluid column of filler material pressing onto the valve 299 - without activity of pumping the filler material - is insufficient for opening the valve. By providing additional pressure on the filler material, by for example using a pump, the pressure required for opening the valve 299 may be exceeded, and filler material is allowed to flow out of the valve 299 into the delay chamber 268 as the filler material buffer.

[0071] In alternative embodiments, the valve 299 may

be arranged as a pressure activated opening, as may as such comprise a fragile material, a weakened section, a valve, other, or a combination thereof, arranged to break, severe and/or otherwise open if the pressure on the pressure activated opening has increased above the pre-determined threshold.

[0072] Fig. 3 shows a cross-section of part of an embodiment of an injection device 200, providing a more detailed view of the distal end 216 of the device 200. This distal end 216 is provided closest to the production pipe 102 and the bridge plug 104. In the embodiment of the device 200 as shown in Fig. 3, the device 200 comprises a sealant reservoir 232 with a sealant output 234. The sealant reservoir 232 comprises a sealant storage volume 236 for storing a sealant material, which may be substantially fluid when provided in the sealant reservoir 232. The sealant material may be used for forming seal 256, before the cement is injected, as part of the closure for closing the conduit.

[0073] The sealant material may for example comprise a resin, and may comprise more than one component. For example may two or more components be mixed together to form the preliminary seal. When the sealant material comprises multiple components, multiple sealant reservoirs or sealant storage volumes may be provided to prevent contact between the different components before the sealant material is injected into the well to form the preliminary seal.

[0074] In another embodiment, one component may be provided in the sealant reservoir 232 and the second component may be provided cement input 206. In such embodiment, the closure may be provided by means of the plug thus formed, instead of a separate sealant and a cement on top thereof. Alternatively, after the second component has been provided through the cement input in order to react with the component from the sealant reservoir 232, cement may be provided as a further component of the closure. For this embodiment, the vibrator may be omitted, in particular if one or both of the components do not comprise solid particles and/or if no gas may be comprised in the mixture of the two components.

[0075] The sealant material may be flexible, elastic and/or mouldable polymer or polymerisable substance such that the seal may fit into the conduit such that the cross-section of the conduit is substantially fully or preferably fully covered. When such a sealant material is pressed against a cement plug due to a pressure of a gas originating from the well, the seal may be formed complementary to a surface of the cement plug against which it is pressed.

[0076] In the embodiment as shown in Fig. 3, the device 200 further comprises a sealant barrier 238 as a pressure activated opening provided between the sealant reservoir 232 and the sealant output 234. The barrier 238 is arranged to prevent the sealant material from leaking of the sealant output 234, for example while lowering the device 200 into the well.

[0077] To severe or break the sealant barrier 238, a pressure in the sealant reservoir 232 has to be increase above a pre-determined threshold. For increasing the pressure in the sealant reservoir 232 sufficiently to severe the sealant barrier 238, rotational energy from the rotor 212 may be used by a sealant driving mechanism 252. Since the rotor 212 is rotated by virtue of the flow of fluid cement, increasing the pressure in the sealant reservoir 232 may as such only occur when the flow of fluid cement is started, which may only be done after the device 200 is lowered into place.

[0078] In the embodiment of Fig. 3, the sealant driving mechanism 252 comprises a plunger 254 arranged to be translated through the sealant reservoir 232, wherein the plunger 254 delimits the sealant reservoir. For translating the plunger 254, the sealant driving mechanism 252 may in embodiments comprise a cylindrical housing as a cylindrical member, provided with a first thread. This cylindrical housing may be rotationally connected to the rotor 212, optionally via the eccentric weight 214 and/or one or more gear boxes.

[0079] In such an embodiment, the plunger 254 may be provided with a second thread complementary to the first thread. As such, the plunger 254 may be arranged to be translated through the sealant reservoir 232 by rotating the cylindrical housing. To prevent the plunger 254 from rotating with the cylindrical housing, the plunger 254 may be rotationally locked.

[0080] In Fig. 3, the plunger 254 is shown in a final position, and hence the sealant barrier 238 has been broken and sealant material has flown out of the sealant 234 output to form a seal 256. A clutch or slipping connection or end of thread may be provided between the sealant driving mechanism 252 and rotor 212 to prevent further rotation of the sealant driving mechanism 252 when the plunger 254 is in the final position. Alternatively, a clutch or slipping connection may be provided to the plunger 254 to allow the plunger to rotate with the cylindrical housing when the plunger is in the final position.

[0081] In the situation depicted in Fig. 3, and if the embodiment of the device 200 comprises a delay chamber 268, during the creation of the seal 256 by the sealant, no or substantially no fluid cement is flowing out of cement output 210 of the device 200 by virtue of the delay chamber 268. It may thus be substantially prevented that liquid cement falls on top of the seal 256 for some time until the delay chamber 268 is filled up. During this time, the seal 256, which may be made using a fluid sealant material, may set into a substantially solid material.

[0082] Depending on the sealant material and the filler material, it may be allowed that some mixing of the sealant material and the filler material occurs. In general, it may be preferred that the sealant material is injected first, and that the filler material is only injected after the seal is formed.

[0083] In further embodiments, it may be preferred to for at least some time simultaneously inject sealant material and filler material, such that sealant material may be

mixed in with the filler material while creating the filler material plug as part of the closure. The sealant material and filler material may be then chosen such that mixing the sealant material and the filler material for example enhances closing properties of the filler material, and that hence an improved closure may be obtained in the conduit.

[0084] The sealant material and filler material may thus chemically interact to form the closure, for example by solidifying and/or expanding. Before being injected, the sealant material and filler material may be kept separate to prevent the chemical reaction from happening before the device has reached the preferred location in the conduit where the closure has to be formed. In embodiments, a plurality of different sealant materials may be used, for example by providing a device comprising a plurality of separate sealant reservoirs and/or sealant driving mechanisms.

[0085] In Fig. 4, a situation is depicted in which cement is being injected using an embodiment of the injection device 200. Fluid cement is entering the device 200 via cement input 206, and is flowing past the rotor 212 causing the rotor 212 to rotate. If present, the delay chamber 268 has been filled up at this point, causing fluid cement to flow out of the cement output 210 or optional cement outputs 210.

[0086] The cement which has flown out of the device 200 is now forming the cement plug 244 as part of the closure for closing the conduit, and has increased up to a certain fluid cement level 242 which is in the situation depicted in Fig. 4 below the cement outputs 210.

[0087] Since the rotor 212 is being rotated, the eccentric weight 214 is also rotated, causing at least part of the device 200 to radially vibrate inside the liquid cement plug 244, as visualised by the curved lines in Fig. 4. By virtue of the radial vibrations, gas bubbles may be excited, causing them to move to the top, and/or optional particles comprised by the filler material may be compacted. As such, the liquid cement plug may become more compact and after solidifying, the solid cement plug may also become more compact with less or no gas bubbles trapped.

[0088] In the situation depicted in Fig. 5, the fluid level 242 of the fluid cement has risen above the cement outputs 210. A lower part of the cement plug 244 may have begun setting into solid cement.

[0089] Compared to the situation depicted in Fig. 4, the device 200 has risen away from the production pipe 102. This rising may be caused by a larger part of the device 200 being submerged in liquid cement of the liquid cement plug 244, which may cause the device 200 to, and/or by actively lifting the device 200 upwards. Because the device 200 is moving upwards, radial vibrations may be provided to a large section of the liquid cement plug 244 as it is being moved upwards. The final height of the cement plug may be lower than a height of the device 200, higher than a height of the device 200 and may even be a plurality of the height of the device 200 or

the radial vibration unit.

[0090] If the device 200 at least partially floats in the liquid cement, the tension on the supply conduit 202, which may be embodied as a coil or drill pipe, may drop by virtue of a buoyant force exerted on part of the device 200 submerges in the liquid cement. By measuring the tension on the supply conduit 202, from which the device 200 may be suspended, the fluid level 242 of the fluid cement may be determined. An absolute fluid level 242 may be determined, and/or a fluid level 242 relative to the device may be determined. The fluid level 242 may be used for controlling the height of the device 200 within the well. In embodiments, the buoyancy of the device 200 may be different, and as such in embodiments the device 200 may not float.

[0091] In different embodiments of the injection device 200, the entire device or a substantial part of it, including part of the housing 206 in which the rotor 212 is support, may be radially vibrated. In other embodiments, of the injection device 200, only a part of the injection device 200 may be radially vibrated, for example on the part of the injection device 200 provided below the rotor 212.

[0092] In the latter case, at least part of the housing 208 may be flexible and resilient, to allow a connection between the substantially stationary upper part in which the rotor 212 is provided and the radially vibrating lower part in which the eccentric weight 214 is provided. The flexible and resilient part of the housing 208 may as such act as a hinge or joint allow some degree of freedom between the stationary part and the vibrating part.

[0093] Next to part of the housing 208 being flexible and resilient, components such as the shaft 262 connecting the rotor 212 to the eccentric weight 214 may be arranged as flexible and/or resilient components to allow the required movements of the lower part relative to the upper part.

[0094] For optionally providing a separation between vibrating components and substantially not vibrating components, flexible couplings may be provided, for example between the radial vibration unit and the housing, between the radial vibration unit and the sealant reservoir 232, and/or between the radial vibration unit and any other component of the device 200. Separation may be advantageous when it is desired to lower the total amount of vibrating mass.

[0095] Fig. 6 depicts another embodiment of a device 200 for providing a closure in a conduit for closing the conduit. As an option which may also be provided to other embodiments of the device 200, the closure improvement unit comprises plunger 254 as part of the sealant driving mechanism 252.

[0096] Provided in the plunger 254 is through hole 261, and provided in the sealant reservoir 232 is through hole 262. By virtue of the through hole 262 of the sealant reservoir 232, a fluid connection is provided between the surroundings of the sealant reservoir 232 and a space 263 above the plunger 254. By virtue of the through hole 261 in the plunger 254, a fluid connection is provided

between space 263 and a space 284 between the sealant material in the storage volume 236 and the plunger 254. As such, a fluid connection is provided between the storage volume 236 and the surroundings of the sealant reservoir 232.

[0097] A leakage barrier 285 is provided to prevent sealant material in the storage volume 236 from leaking through the through hole 261 of the plunger 254. The leakage barrier 285 is arranged to be moved through the storage volume 236 by a ambient pressure, which is transferred to the leakage barrier 285 via through holes 262 and 261.

[0098] When the device 200 is lowered into a deep well, the ambient pressure for the device 200 may increase. This ambient pressure is also applied to the sealant barrier 238 at its outer side. If the sealant material 236 in the storage volume 236 would still be at a lower pressure, for example when the storage volume 236 is filled around sea level or at least at a higher point than the position of the device in the well, the sealant barrier 238 might open up unwillingly. By virtue of the through holes 261, 262, the pressure level at both side of the sealant barrier 238 may be substantially equal, preventing unwilling opening up of the sealant barrier 238.

[0099] The sealant driving mechanism further as shown in Fig. 6 further comprises a shaft 267 as a cylindrical member, provided with a first thread 268. The shaft 267 is rotationally connected via connection shaft 271 to the rotor 212. Note that for conciseness of Fig. 6, housing 208, rotor 212 and connection shaft 271 are only schematically depicted. Connection shaft 271 may in embodiments at least partially be formed by eccentric weight 214.

[0100] The shaft 267 comprises an unthreaded end 269 provided at a distal end. When the plunger 254 is lowered and when it reaches the unthreaded end 269, the plunger 254 may be uncoupled from the shaft 267, preventing blocking rotation of the rotor 212 when the plunger 254 reaches it lowest position - e.g. when substantially all sealant material has been pushed out of the storage volume 236.

[0101] In summary, an energy input may be required for improving a closure provided in a conduit. Since a conduit, such a underground well, may be difficult to reach, it may also be difficult to provide energy to this difficult to reach location. A device for providing a closure in a conduit for closing the conduit is envisioned comprising a rotor, driveable by a flow of filler material, and a closure improvement unit, connected to the rotor such that the closure improvement unit is rotatably driveable by the rotor. The closure improvement unit may comprise any device which use energy from the rotor to improve properties of the closure, for example a radial vibration unit for providing radial vibrations to filler material of the closure, and/or a sealant injection mechanism for injecting a sealant material to form a seal as part of the closure to improve the closure.

[0102] The invention is defined by the features speci-

fied in the appended claims.

Claims

1. Device (200) for providing a closure in a conduit (101) for closing the conduit, comprising:

- an elongate body (208), comprising:

- a filler material input (206) provided at a proximal end;
- a filler material output (210) provided downstream from the filler material input; and
- a filler material flow path between the filler material input and the filler material output;

- a rotor (212), at least partially provided in the filler material flow path and arranged to be rotatably driven by a filler material flow flowing through the filler material flow path; and

- a closure improvement unit (214, 252), connected to the rotor such that the closure improvement unit is rotatably driveable by the rotor,

wherein the closure improvement unit comprises a radial vibration unit provided downstream of the rotor, the radial vibration unit comprising an eccentric weight, rotatably connected to the rotor and rotatable over an axis substantially parallel to the length of the elongate body, the radial vibration unit being rotationally connected to the rotor via one or more gears, such that the radial vibration unit is arranged to convert a rotation of the rotor into a radial vibration.

2. Device according to claim 1, further comprising a sealant reservoir (232) with a sealant output (234) provided at a distal end (216) of the elongated body, wherein the sealant reservoir comprises a storage volume for storing a sealant.
3. Device according to claim 2, further comprising a pressure activated opening (238, 299) provided between the sealant reservoir (232) and the sealant output (234), wherein the pressure activated opening is arranged to be opened if a pressure in the reservoir exceeds a pre-determined threshold.
4. Device according to claim 2 or 3, wherein the closure improvement unit comprises a sealant driving mechanism (252), rotatably connected to the rotor, and arranged to decrease the storage volume of the sealant reservoir when the rotor rotates.
5. Device according to claim 4, wherein the sealant driving mechanism comprises:

- a cylindrical member provided with a first thread and rotationally connected to the rotor; and
- a plunger (254) delimiting the sealant reservoir having a second thread arranged to engage with the first thread;

wherein the plunger is arranged to be translated through the sealant reservoir by rotating the cylindrical member, thereby decreasing the storage volume of the sealant reservoir.

6. Device according to claim 5, wherein the plunger and the sealant reservoir both comprise a through hole (261, 262) for providing a fluid connection between the storage volume and the surroundings of the sealant reservoir.
7. Device according to any of the preceding claims, wherein the filler material output is provided between the filler material input and the radial vibration unit.
8. Device according to any of the preceding claims, further comprising a filler material buffer (268) provided in the filler material flow path between the rotor and the filler material output, the filler material buffer being arranged for storing a pre-determined volume of filler material, preferably wherein the filler material output is provided at a proximal end of the filler material buffer.
9. Device according to claim 8, wherein the filler material buffer comprises a buffer storage space having a buffer input and a buffer output, wherein in use, the buffer input and the buffer output are provided at or near the top of the buffer storage space.
10. Device according to any of the preceding claims, wherein:
 - the rotor comprises a rotor hub and one or more rotor blades provided under an angle relative to the longitudinal axis of the rotor on an outer circumference of the rotor hub; or
 - the rotor comprises a hollow rotor body and one or more rotor blades provided under an angle relative to the longitudinal axis of the rotor on an inner surface of the hollow rotor body; or
 - the elongate body comprises a bore and an inner wall, wherein the inner wall is provided with spiraled lobes.
11. Device according to any of the preceding claims, wherein the radial vibration unit is provided between the sealant reservoir and the filler material buffer.
12. Device according to any of the preceding claims, wherein the radial vibration unit is provided in a

sealed chamber.

13. Device according to claim 12, wherein the sealed chamber is provided with a pressurised gas.

Patentansprüche

1. Vorrichtung (200) zum Bereitstellen eines Verschlusses in einer Röhre (101) zum Schließen der Röhre, mit:

- einem länglichen Körper (208), aufweisend:

- einen Füllmaterialeingang (206), bereitgestellt an einem proximalen Ende;
- einen Füllmaterialausgang (210), bereitgestellt stromabwärts des Füllmaterialeingangs; und
- einen Füllmaterialströmungsweg zwischen dem Füllmaterialeingang und dem Füllmaterialausgang;

- einem Rotor (212), wenigstens teilweise bereitgestellt im Füllmaterialströmungsweg und dazu angeordnet, von einem durch den Füllmaterialströmungsweg strömenden Füllmaterialstrom drehbar angetrieben zu werden; und
- einer Verschlussverbesserungseinheit (214, 252), verbunden mit dem Rotor, sodass die Verschlussverbesserungseinheit durch den Rotor drehbar antreibbar ist,

wobei die Verschlussverbesserungseinheit eine dem Rotor nachgelagerte radiale Vibrationseinheit aufweist, wobei die radiale Vibrationseinheit ein drehbar mit dem Rotor verbundenes und über eine Achse im Wesentlichen parallel zur Länge des länglichen Körpers drehbares Exzentergewicht aufweist, wobei die radiale Vibrationseinheit über ein oder mehrere Zahnräder mit dem Rotor drehverbunden ist, sodass die radiale Vibrationseinheit dazu angeordnet ist, eine Drehung des Rotors in eine radiale Vibration umzuwandeln.

2. Vorrichtung nach Patentanspruch 1, die ferner einen Dichtmittelbehälter (232) mit einem Dichtmittelausgang (234) aufweist, bereitgestellt an einem distalen Ende (216) des länglichen Körpers, wobei der Dichtmittelbehälter ein Speichervolumen zum Speichern eines Dichtmittels aufweist.
3. Vorrichtung nach Patentanspruch 2, die ferner eine druckaktivierte Öffnung (238, 299) aufweist, bereitgestellt zwischen dem Dichtmittelbehälter (232) und dem Dichtmittelausgang (234), wobei die druckaktivierte Öffnung dazu angeordnet ist, geöffnet zu werden, wenn ein Druck im Behälter einen vorbestimm-

ten Schwellenwert überschreitet.

4. Vorrichtung nach Patentanspruch 2 oder 3, wobei die Verschlussverbesserungseinheit einen Dichtmittelantriebsmechanismus (252) aufweist, der drehbar mit dem Rotor verbunden und dazu angeordnet ist, das Speichervolumen des Dichtmittelbehälters zu verringern, wenn sich der Rotor dreht. 5
5. Vorrichtung nach Patentanspruch 4, wobei der Dichtmittelantriebsmechanismus Folgendes aufweist: 10
 - ein zylindrisches Element, versehen mit einem ersten Gewinde und mit dem Rotor drehverbunden; und 15
 - einen den Dichtmittelbehälter begrenzenden Kolben (254), der ein zweites Gewinde aufweist, das dazu angeordnet ist, mit dem ersten Gewinde in Eingriff zu gelangen; 20

wobei der Kolben dazu angeordnet ist, durch das Drehen des zylindrischen Elements durch den Dichtmittelbehälter verschoben zu werden, wodurch das Speichervolumen des Dichtmittelbehälters verringert wird. 25

- 6. Vorrichtung nach Patentanspruch 5, wobei sowohl der Kolben als auch der Dichtmittelbehälter jeweils ein Durchgangsloch (261, 262) aufweisen, um eine Fluidverbindung zwischen dem Speichervolumen und der Umgebung des Dichtmittelbehälters bereitzustellen. 30
- 7. Vorrichtung nach einem der vorhergehenden Patentansprüche, wobei der Füllmaterialausgang zwischen dem Füllmaterialeingang und der radialen Vibrationseinheit bereitgestellt ist. 35
- 8. Vorrichtung nach einem der vorhergehenden Patentansprüche, die ferner einen Füllmaterialpuffer (268) aufweist, der im Füllmaterialströmungsweg zwischen dem Rotor und dem Füllmaterialausgang angeordnet ist, wobei der Füllmaterialpuffer zum Speichern eines vorbestimmten Volumens an Füllmaterial angeordnet ist, wobei der Füllmaterialausgang vorzugsweise an einem proximalen Ende des Füllmaterialpuffers angeordnet ist. 40 45
- 9. Vorrichtung nach Patentanspruch 8, wobei der Füllmaterialpuffer einen Pufferspeicherraum mit einem Puffereingang und einem Pufferausgang aufweist, wobei der Puffereingang und der Pufferausgang im Gebrauch an oder nahe der Oberseite des Pufferspeicherraums angeordnet sind. 50 55
- 10. Vorrichtung nach einem der vorhergehenden Patentansprüche, wobei:

- der Rotor eine Rotornabe und einen oder mehrere Rotorblätter aufweist, die in einem Winkel relativ zur Längsachse des Rotors an einem Außenumfang der Rotornabe bereitgestellt sind; oder
- der Rotor einen hohlen Rotorkörper und einen oder mehrere Rotorblätter aufweist, die in einem Winkel relativ zur Längsachse des Rotors an einer Innenfläche des hohlen Rotorkörpers bereitgestellt sind; oder
- der längliche Körper eine Bohrung und eine Innenwand aufweist, wobei die Innenwand mit spiralförmigen Nocken versehen ist.

11. Vorrichtung nach einem der vorhergehenden Patentansprüche, wobei die radiale Vibrationseinheit zwischen dem Dichtmittelbehälter und dem Füllmaterialpuffer bereitgestellt ist.
12. Vorrichtung nach einem der vorhergehenden Patentansprüche, wobei die radiale Vibrationseinheit in einer abgedichteten Kammer bereitgestellt ist.
13. Vorrichtung nach Patentanspruch 12, wobei die versiegelte Kammer mit einem druckbeaufschlagten Gas versorgt ist.

Revendications

1. Dispositif (200) destiné à fournir une fermeture dans un conduit (101) pour fermer le conduit, comprenant :
 - un corps allongé (208), comprenant :
 - une entrée de matériau de remplissage (206) prévue sur une extrémité proximale ;
 - une sortie de matériau de remplissage (210) prévue en aval de l'entrée de matériau de remplissage ; et
 - un chemin d'écoulement de matériau de remplissage entre l'entrée de matériau de remplissage et la sortie de matériau de remplissage ;
 - un rotor (212) prévu au moins partiellement dans le chemin d'écoulement de matériau de remplissage et agencé pour être entraîné en rotation par un écoulement de matériau de remplissage s'écoulant à travers le chemin d'écoulement de matériau de remplissage ; et
 - une unité d'amélioration de fermeture (214, 252) connectée au rotor de sorte que l'unité d'amélioration de fermeture puisse être entraînée en rotation par le rotor,

dans lequel l'unité d'amélioration de fermeture comprend une unité de vibration radiale prévue en

- aval du rotor, l'unité de vibration radiale comprenant un poids excentrique connecté en rotation au rotor et pouvant tourner autour d'un axe sensiblement parallèle à la longueur du corps allongé, l'unité de vibration radiale étant connectée en rotation au rotor via un ou plusieurs engrenages, de sorte que l'unité de vibration radiale soit agencée pour convertir une rotation du rotor en une vibration radiale.
2. Dispositif selon la revendication 1, comprenant en outre un réservoir de produit d'étanchéité (232) ayant une sortie de produit d'étanchéité (234) prévue sur une extrémité distale (216) du corps allongé, dans lequel le réservoir de produit d'étanchéité comprend un volume de stockage pour stocker un produit d'étanchéité.
3. Dispositif selon la revendication 2, comprenant en outre une ouverture à activation par pression (238, 299) prévue entre le réservoir de produit d'étanchéité (232) et la sortie de produit d'étanchéité (234), dans lequel l'ouverture à activation par pression est agencée pour s'ouvrir si une pression dans le réservoir dépasse un seuil prédéterminé.
4. Dispositif selon la revendication 2 ou 3, dans lequel l'unité d'amélioration de fermeture comprend un mécanisme d'entraînement de produit d'étanchéité (252) connecté en rotation au rotor et agencé pour réduire le volume de stockage du réservoir de produit d'étanchéité lorsque le rotor tourne.
5. Dispositif selon la revendication 4, dans lequel le mécanisme d'entraînement de produit d'étanchéité comprend :
- un élément cylindrique pourvu d'un premier filetage et connecté en rotation au rotor ; et
 - un plongeur (254) délimitant le réservoir de produit d'étanchéité et ayant un deuxième filetage agencé pour se mettre en prise avec le premier filetage ;
- dans lequel le plongeur est agencé pour se déplacer le long du réservoir de produit d'étanchéité par la rotation de l'élément cylindrique, réduisant ainsi le volume de stockage du réservoir de produit d'étanchéité.
6. Dispositif selon la revendication 5, dans lequel le plongeur et le réservoir de produit d'étanchéité comprennent tous deux un trou traversant (261, 262) pour fournir une connexion fluide entre le volume de stockage et l'environnement du réservoir de produit d'étanchéité.
7. Dispositif selon l'une des revendications précédentes, dans lequel la sortie de matériau de remplissage
- est prévue entre l'entrée de matériau de remplissage et l'unité de vibration radiale.
8. Dispositif selon l'une des revendications précédentes, comprenant en outre un tampon de matériau de remplissage (268) prévu dans le chemin d'écoulement de matériau de remplissage entre le rotor et la sortie de matériau de remplissage, le tampon de matériau de remplissage étant agencé pour stocker un volume prédéterminé du matériau de remplissage, de préférence dans lequel la sortie de matériau de remplissage est prévue sur une extrémité proximale du tampon de matériau de remplissage.
9. Dispositif selon la revendication 8, dans lequel le tampon de matériau de remplissage comprend un espace de stockage de tampon ayant une entrée de tampon et une sortie de tampon, dans lequel, en cours d'utilisation, l'entrée de tampon et la sortie de tampon sont prévues en haut ou près du haut de l'espace de stockage de tampon.
10. Dispositif selon l'une des revendications précédentes, dans lequel :
- le rotor comprend un moyeu de rotor et une ou plusieurs pales de rotor prévues sous un angle par rapport à l'axe longitudinal du rotor sur une circonférence extérieure du moyeu de rotor ; ou
 - le rotor comprend un corps de rotor creux et une ou plusieurs pales de rotor prévues sous un angle par rapport à l'axe longitudinal du rotor sur une surface intérieure du corps de rotor creux ; ou
 - le corps allongé comprend un alésage et une paroi intérieure, dans lequel la paroi intérieure est pourvue de lobes en spirale.
11. Dispositif selon l'une des revendications précédentes, dans lequel l'unité de vibration radiale est prévue entre le réservoir de produit d'étanchéité et le tampon de matériau de remplissage.
12. Dispositif selon l'une des revendications précédentes, dans lequel l'unité de vibration radiale est prévue dans une chambre étanche.
13. Dispositif selon la revendication 12, dans lequel la chambre étanche est alimentée en gaz sous pression.

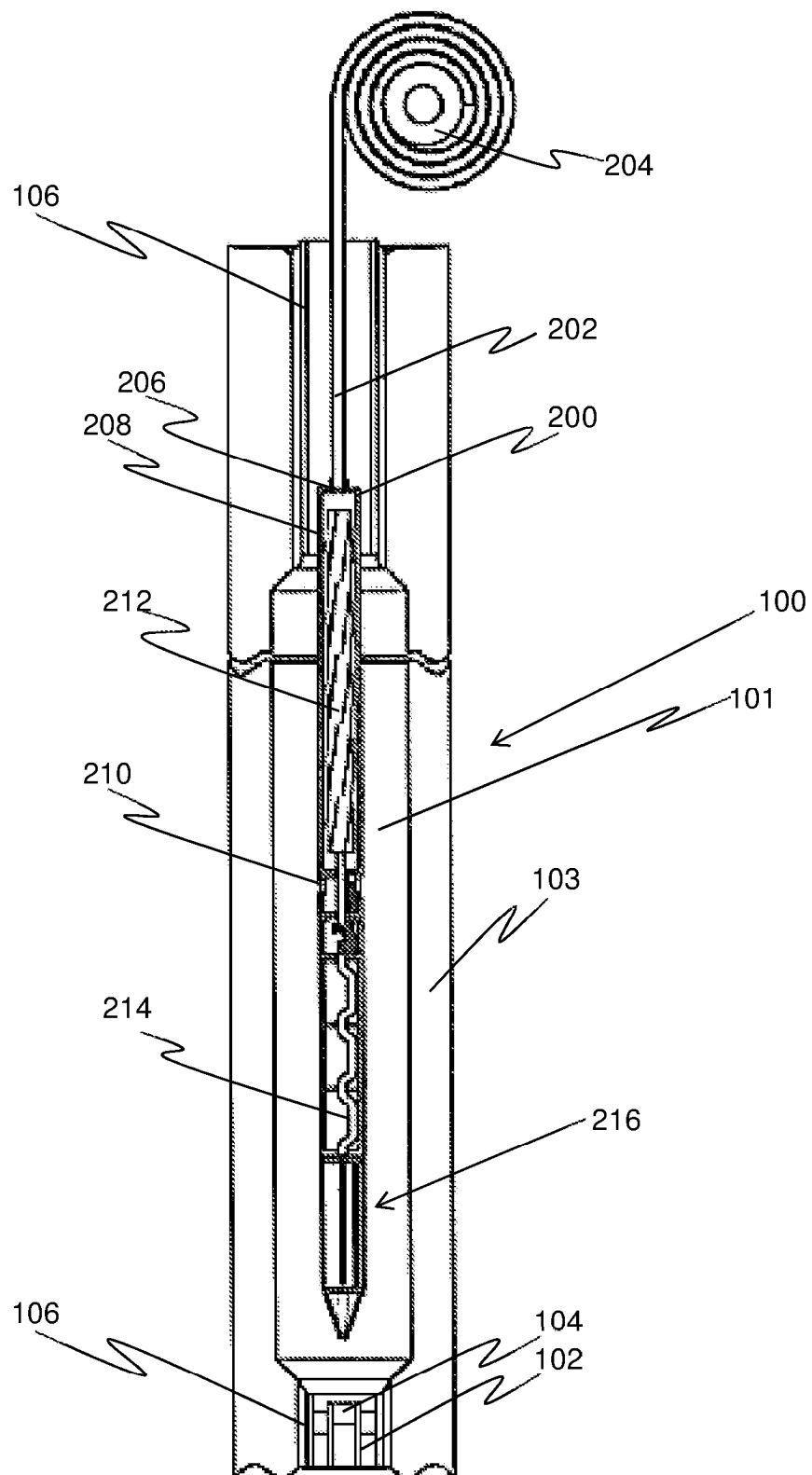


FIG 1

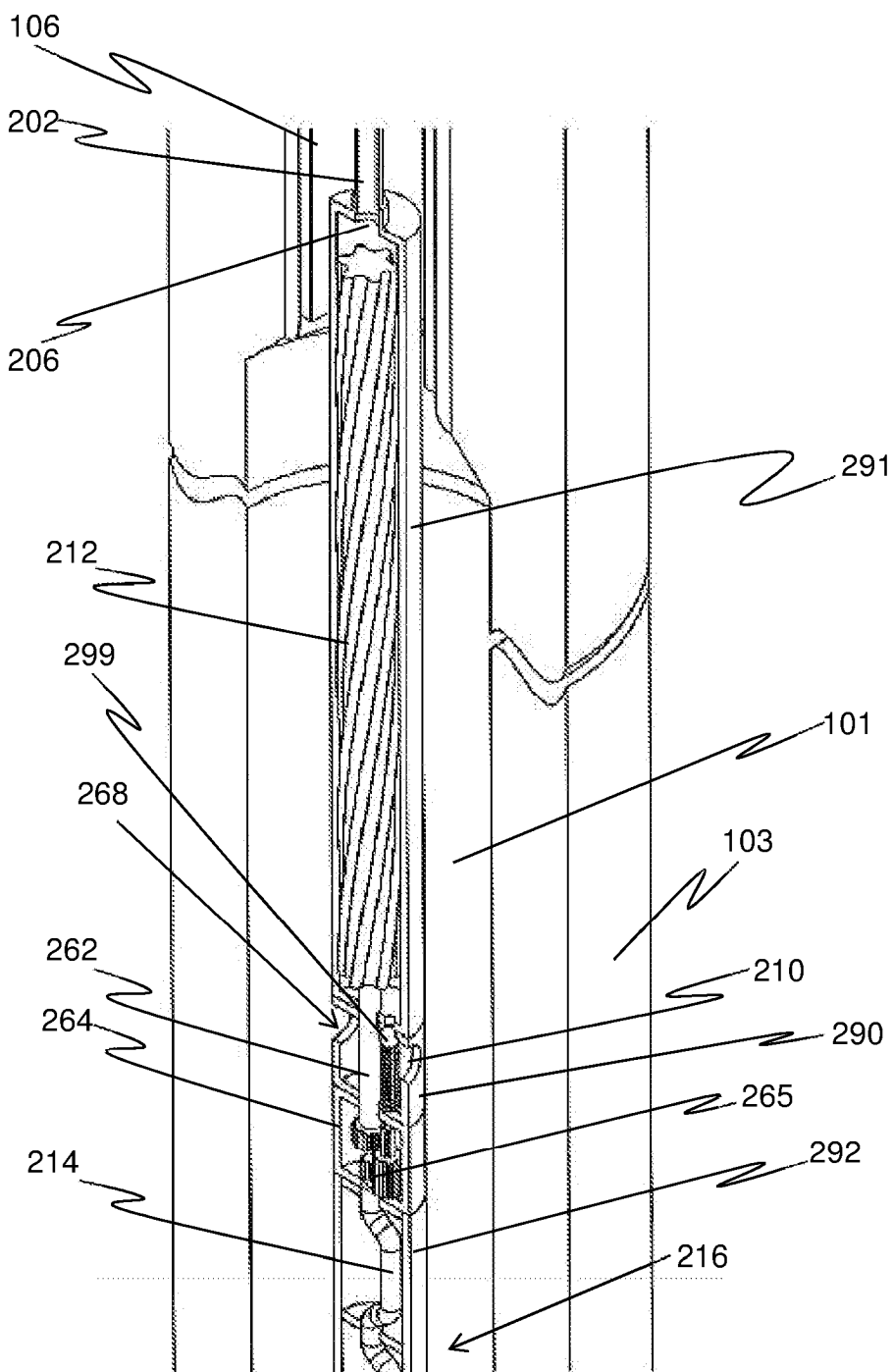


FIG 2

216

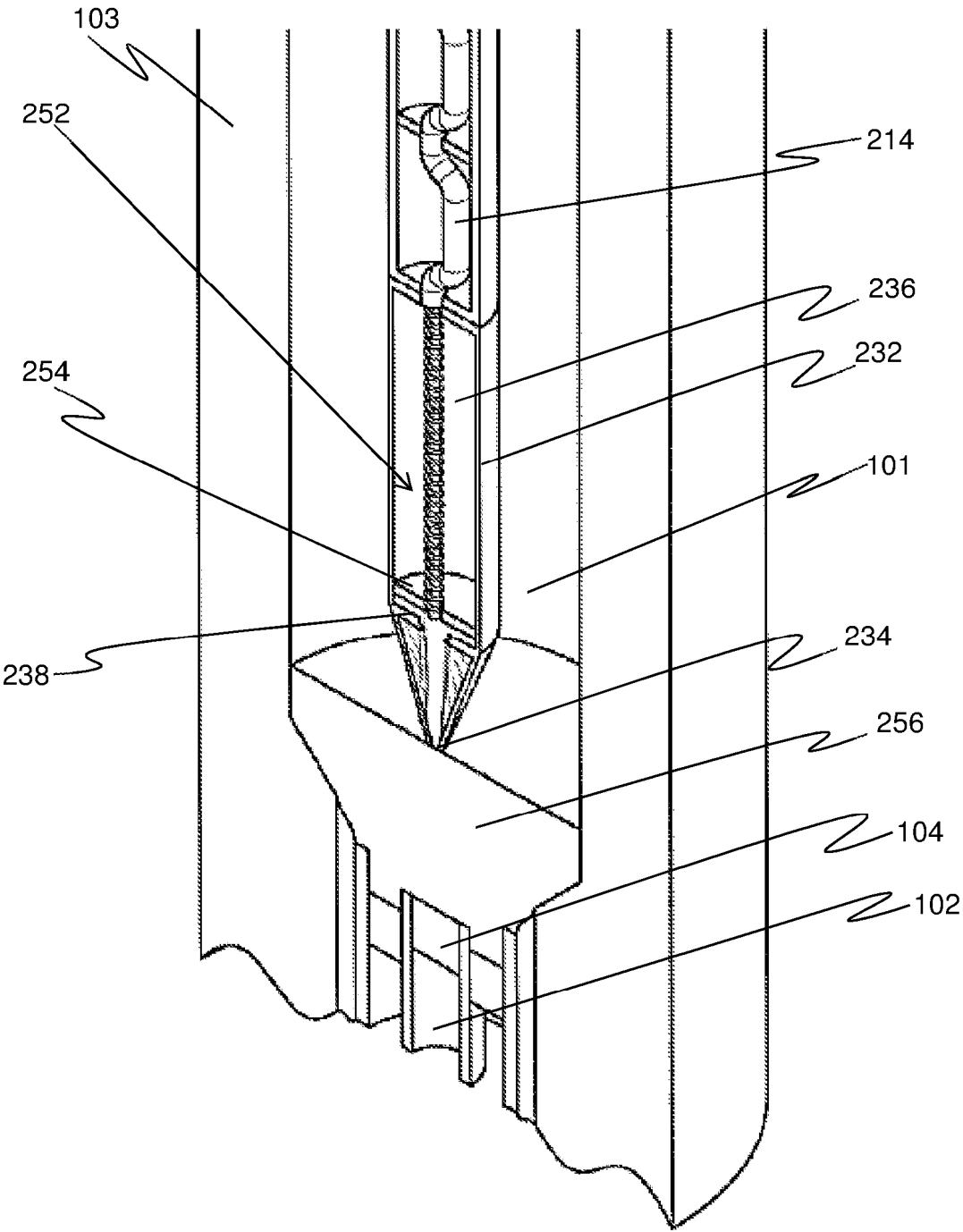


FIG 3

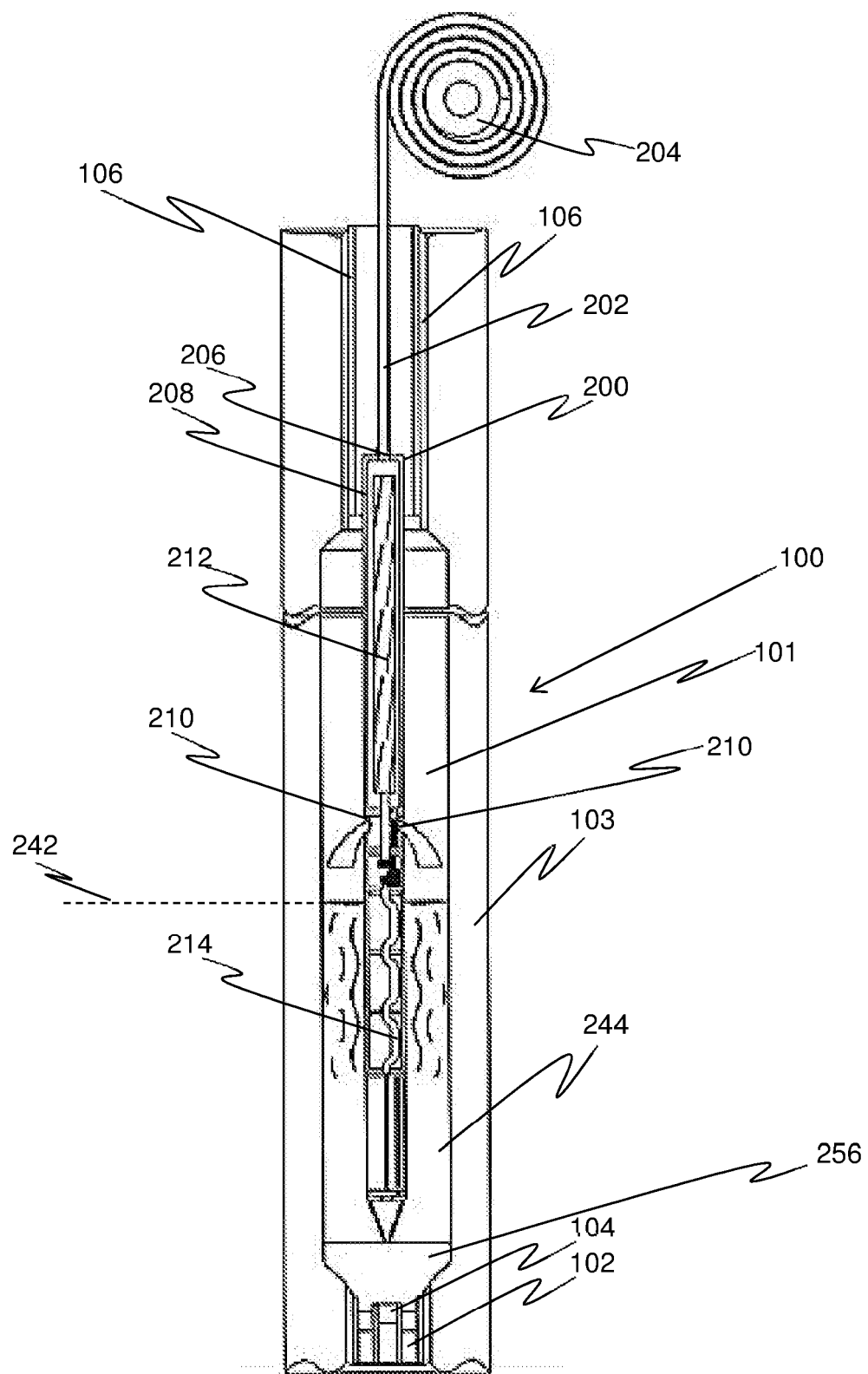


FIG 4

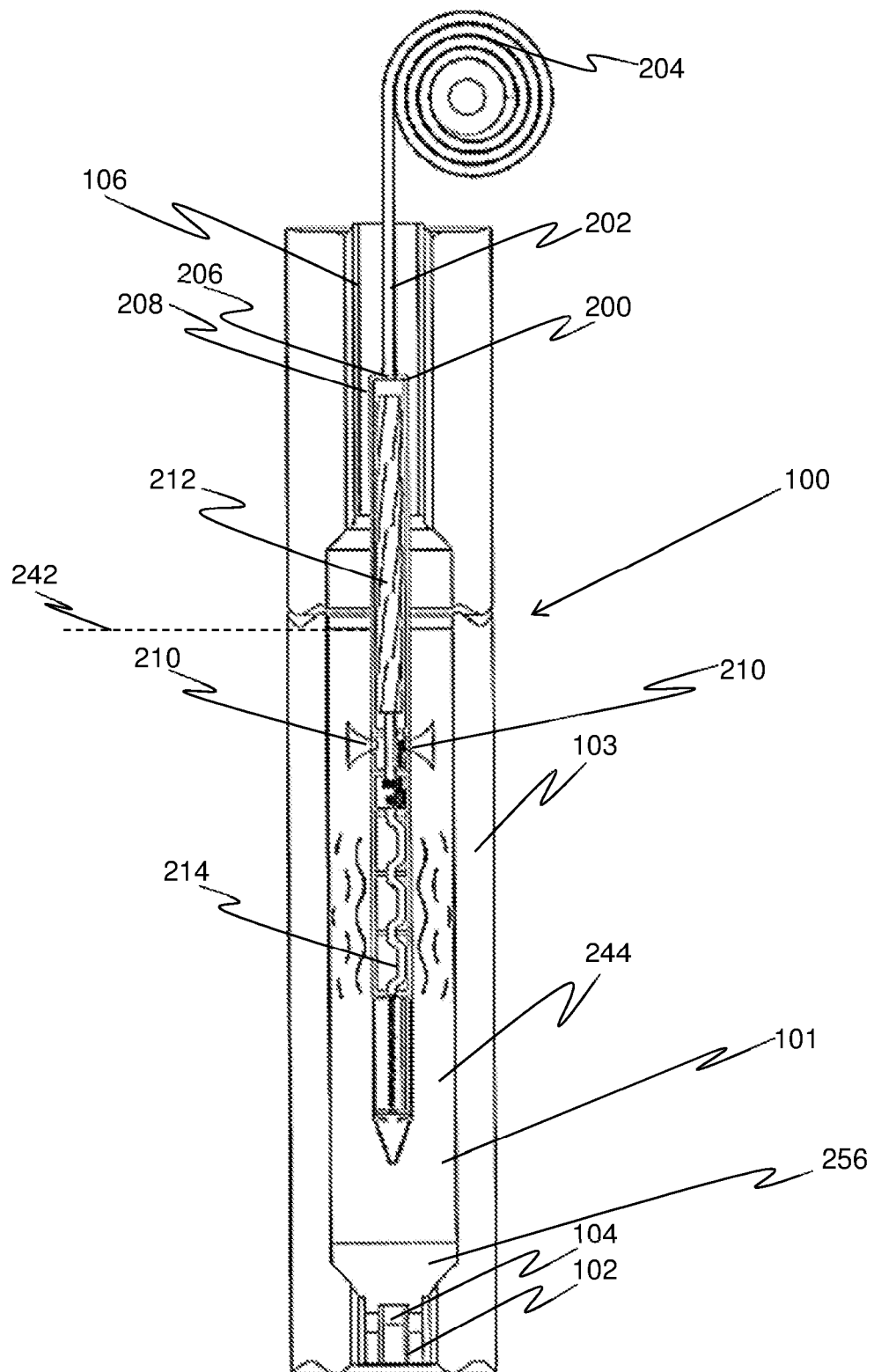


FIG 5

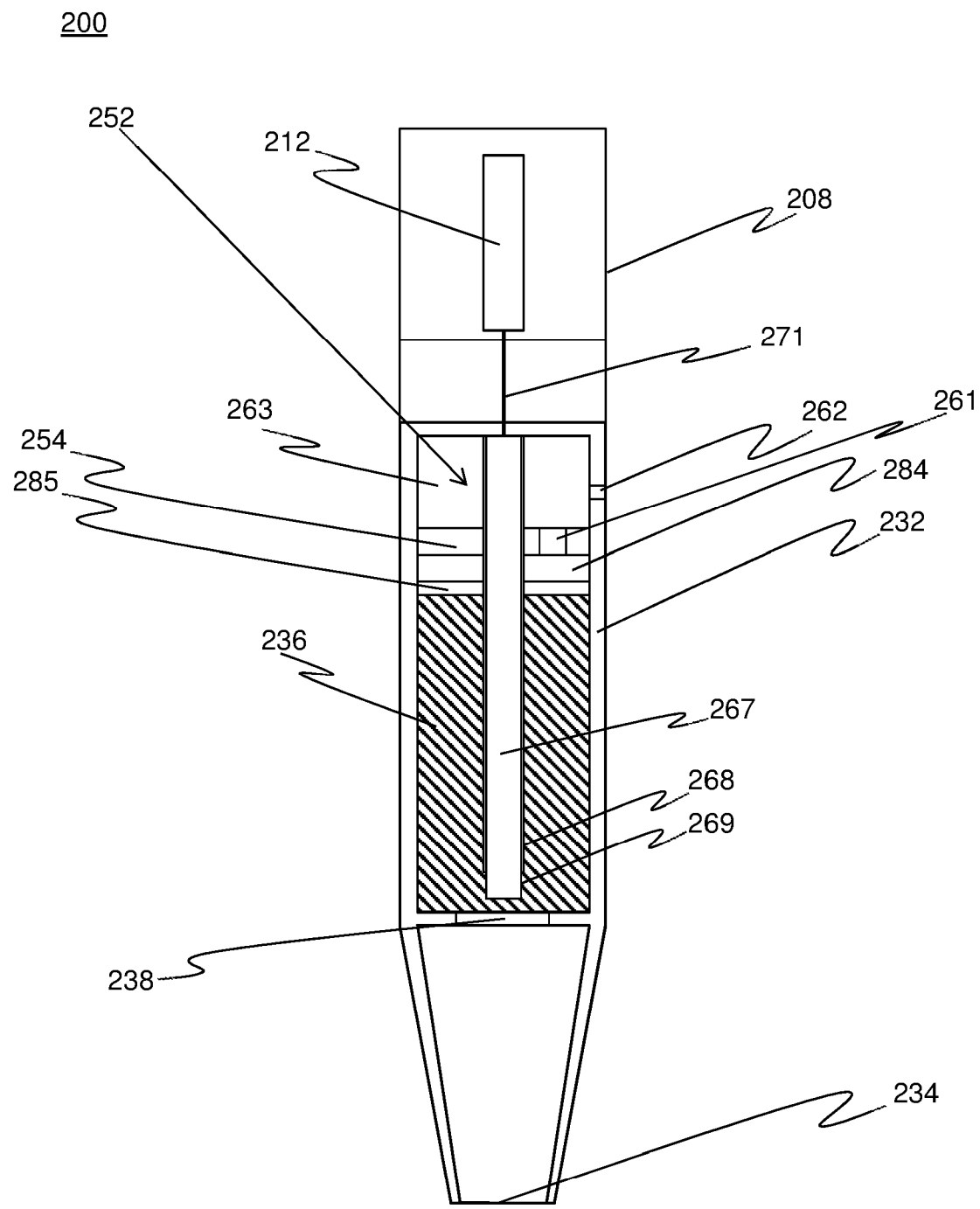


FIG 6

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 9506318 B1 [0004]
- WO 2005042916 A1 [0005]
- CN 201943619 U [0006]
- CN 201883999 U [0007]
- CN 102889067 [0008]
- US 20130186686 A1 [0009]
- CN 104343412 [0010]
- US 9366100 B1 [0011]
- US 2016032653 A1 [0012]