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[Continued on next page]

(54) Title: ELECTRICAL SUBMERSIBLE MOTOR

(57) Abstract: A fluid system for a pump, which includes a down-hole rotating shaft and bearings inside a housing, and where a fluid volume around shaft is circulated from outside housing through a filter, so that only clean non-abrasive fluid is permitted inside fluid volume pump to draw fluid around the shaft. A fluid expeller is included to expel fluid from the accumulated volume of fluid through the filter to purge the filter.

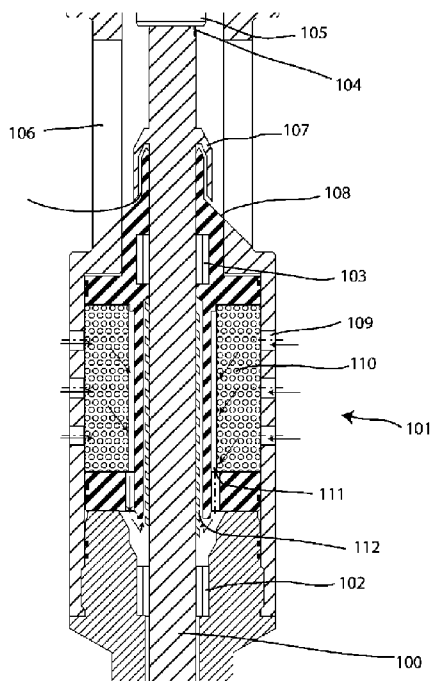


FIGURE 4



MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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Description

[0001] ELECTRICAL SUBMERSIBLE MOTOR

[0002] FIELD OF THE INVENTION

[0003] The invention relates to a fluid filter to extend the protector life or eliminate protector of a canned electrical submersible motor.

[0004] BACKGROUND OF THE INVENTION

[0005] In a variety of wellbore environments, electric submersible pumping systems are used to lift fluids from a subterranean location. Although electric submersible pumping systems can utilize a wide variety of components, examples of basic components comprise a submersible pump, a submersible motor and a motor protector. The submersible motor powers the submersible pump, and the motor protector seals the submersible motor from well fluid.

[0006] The motor protector also balances the internal motor oil pressure with external pressure. Motor protectors often are designed with a labyrinth system and/or an elastomeric bag system. The labyrinth system uses the difference in specific gravity between the well fluid and internal motor oil to maintain separation between the fluids. The elastomeric bag system relies on an elastomeric bag to physically isolate the motor oil from the well fluid while balancing internal and external pressures. Additionally, motor protectors often have an internal shaft that transmits power from the submersible motor to the submersible pump. The shaft is mounted in journal bearings positioned in the motor protector.

[0007] Such protectors function well in many environments. However, in abrasive environments, the run life of the motor protector can be detrimentally affected. The abrasive sand causes wear in motor protector components, such as the journal bearings. Attempts have been made to increase run life by populating the motor protector with journal bearings made from extremely hard materials to reduce wear caused by the abrasive sand.

[0008] In general, the present invention relates to a motor protector for use in an electric submersible pumping system, or potentially the elimination of the protector in the event of a “canned” motor.

[0009] For non-canned motors, the protector is designed to seal a submersible motor from well fluid and to keep the motor oil pressure generally balanced with external pressure.

[0010] SUMMARY OF THE INVENTION

[0011] According to the present invention, there is provided a means for preventing sand/solids from entering the motor rotor cavity.

[0012] According to further aspect of the invention, there is provided a means for preventing sand/solids from entering the motor protector rotor cavity.

- [0013] According to a further aspect of the invention, the outer most bearing is continuously flushed with filtered well bore fluid.
- [0014] According to further aspect of the invention, the motor rotor cavity is pressure balanced by a filter medium which allows fluid to both enter and leave the rotor cavity but no solids can enter the rotor cavity.
- [0015] According to a further aspect of the invention positive fluid flow is promoted at the use of a flow energising device.
- [0016] According to a further aspect of the invention any sand/solid is deflected away from the top of the protector or output shaft from the motor.
- [0017] According to a further aspect of the invention the rotor cavity will operate with filtered wellbore fluids.
- [0018] According to a further aspect of the invention, the rotor cavity will match the pressure outside of the motor instantaneously as the filter medium provides direct communication between the two.
- [0019] According to a further aspect of the invention, the pump bearings will be lubricated with filtered fluid.
- [0020] According to a further aspect of the invention the filter is back flushed.
- [0021] This invention protects the outer seal and bearing of the protector by circulating clean filtered fluid from the inside to the outside.
- [0022] This invention for canned motors ensures only clean filtered fluid can enter the rotor cavity.
- [0023] Clean filtered fluid in the rotor cavity ensures long run life.
- [0024] Canned motor ensures motor windings do not fail because of protector failure.
- [0025] BRIEF DESCRIPTION OF THE DRAWINGS
- [0026] Figure 1 is a front elevation view of an electric submersible pumping system disclosed in a wellbore, according to an embodiment of the present invention;
- [0027] Figure 2 is a longitudinal sectional view taken generally along an axis of a motor protector illustrated in figure 1
- [0028] Figure 3 is a longitudinal section side view of the flow promotion device fitted between the protector and pump inlet.
- [0029] Figure 4 is a more detailed section side view of the flow promotion device shown in figure 3.
- [0030] Figure 5 is a longitudinal section side view of a canned motor with the filter inlet/outlets fitted at its upper and lower ends.
- [0031] Figure 6 is a more detailed section side view of output end of the motor shown in figure 5.
- [0032] Figure 7 is a more detailed section side view of the lower end of the motor shown in figure 5.

- [0033] Figure 8 is a similar view to figure 3 with the pump section above the flow promotion device highlighted.
- [0034] Figure 9 is a more detailed section side view of the part highlighted in figure 8.
- [0035] Figure 10 is a section side view of the back flush mechanism
- [0036] Figure 11 is a similar view to figure 9, with the back flush in operation
- [0037] Figure 12 is a more detailed of the back flush mechanism shown in the view indicated of figure 11
- [0038] In the following description, numerous details are set forth to provide an understanding of the present invention. However, it will be understood by those of ordinary skill in the art that the present invention may be practiced
- [0039] without these details and that numerous variations or modifications from the described embodiments may be possible.
- [0040] The present invention generally relates to a system and method for reducing detrimental effects of sand on motor protectors. The system and method are useful with, for example, a variety of downhole production systems, such
- [0041] as electric submersible pumping systems. However, the devices and methods of the present invention are not limited to use in the specific applications that are described herein.
- [0042] Referring generally to FIG. 1, an example of a pumping system 10, such as an electric submersible pumping system, is illustrated according to an embodiment of the present invention. Pumping system 10 may comprise a variety of components depending on the particular application or environment in which it is used. In this example, however, pumping system 10 includes a submersible pump 12, a submersible motor 14 and a motor protector 16.
- [0043] Pumping system 10 is designed for deployment in a well 18 within a geological formation 20 containing desirable production fluids, such as water or petroleum. A wellbore 22 typically is drilled and lined with a wellbore casing 24. Wellbore casing 24 includes a plurality of openings or perforations 26 through which production fluids flow from formation 20 into wellbore 22.
- [0044] Pumping system 10 is deployed in wellbore 22 by a deployment system 28 that may have a variety of forms and configurations. For example, deployment system 28 may comprise tubing, such as coil tubing or production tubing, connected to pump 12 by a connector 32. Power is provided to submersible motor 14 via a power cable 34. Motor 14, in turn, powers pump 12 which draws production fluid in through a pump intake 36, and pumps the production fluid to the surface via tubing 30.
- [0045] It should be noted that the illustrated submersible pumping system 10 is merely an example. Other components can be added to this system and other deployment systems may be implemented. Additionally, the production fluids may be pumped to the

surface through tubing 30 or through the annulus formed between deployment system 28 and wellbore casing 24. In any of the many potential configurations of submersible pumping system 10, motor protector 16 is used to seal the submersible motor 14 from well fluid in wellbore 22 and to generally balance the internal pressure within submersible motor 14 with the external pressure in wellbore 22.

[0046] Referring generally to FIG. 2, an embodiment of motor protector 16 is illustrated in greater detail. Motor protector 16 comprises an outer housing 38 within which a drive shaft 40 is rotatably mounted via a plurality of bearings 42, such as journal bearings. Outer housing 38 may be formed of one or more housing components. Also, the motor protector 16 is divided into a plurality of sections, including a head section 44 disposed generally at an upper end of the protector. An additional section (or sections) is disposed below head section 44 and functions as a fluid separation section to separate wellbore fluid that may enter head section 44 from internal motor oil used to lubricate submersible motor 14. The sections also facilitate balancing of internal and external pressures. In the embodiment illustrated, a labyrinth section 46 is disposed below head section 44, and a pair of elastomeric bag sections 48 are disposed below labyrinth section 46.

[0047] Labyrinth section 46 comprises a labyrinth 50 that uses the difference in specific gravity of the well fluid and the internal motor oil to maintain separation between the internal motor oil and the well fluid. Each bag section uses an elastomeric bag 52 to physically isolate the internal motor oil from the well fluid. It should be noted that the motor protector sections may comprise a variety of section types. For example, the motor protector may comprise one or more labyrinth sections, one or more elastomeric bag sections, combinations of labyrinth and bag sections as well as other separation systems. A series of fluid ports or channels 54 connect each section with the next sequential section. In the embodiment illustrated, a port 54 is disposed between head section 44 and labyrinth section 46, between labyrinth section 46 and the next sequential bag section 48, between bag sections 48 and between the final bag section 48 and a lower end 56 of motor protector 16.

[0048] Motor protector 16 may comprise a variety of additional features. For example, a thrust bearing 58 may be deployed proximate lower end 56 to absorb axial loads placed on shaft 40 by the pumping action of submersible pump 12. The protector also may comprise an outward relief mechanism 60, such as an outward relief valve. The outward relief valve releases excessive internal pressure that may build up during, for example, the heating cycle that occurs with start-up of electric submersible pumping system 10. Motor protector 16 also may comprise an inward relief mechanism 62, such as an inward relief valve. The inward relief valve relieves excessive negative pressure within the motor protector. For example, a variety of situations, such as system cool

down, can create substantial internal pressure drops, i.e. negative pressure, within the motor protector. Inward relief mechanism 62 alleviates the excessive negative pressure by, for example, releasing external fluid into the motor protector to reduce or avoid mechanical damage to the system caused by this excessive negative pressure.

[0049] Referring to figures 3 and 4 there is shown the output shaft from the protector 100 passing through the assembly 101, the shaft 100 is supported in bearings 102 and 103, and drives the pump via splined output 104 via coupling 105. The pump inlet is shown as passages 106. In the event the pump is stopped and sand particles fall out of suspension, they will contact the deflector 107 mounted on the shaft, fall on the sloping surface 108 and fall into the annulus around the pump.

[0050] When the shaft 100 is rotating, fluid is drawn through ports 109 through a filter medium 110 into a gallery 111 and pressurized by a screw type pump mechanism 112 back through the bearing 103 and underneath the deflector 113. This ensures only clean fluid without any damaging solid particles in it is above the protector, maximising the protector's life. In addition, because the bearing 103 will not deteriorate due to erosion, no additional vibrations will be generated.

[0051] Referring to figures 5 to 7, there is shown a canned motor assembly. This is where the stator 120 is physically isolated from the rotor cavity 122 by a tube 124. This is particularly advantageous with this invention, as the protector can be eliminated. At the output end above the thrust bearing assembly 114 is an identical mechanism 125 described in relation to figure 4. At the motors lower end, the rotor cavity 115 is equalised with the fluid around the outside of the motor via a filter medium 117 and ports 118 and 119. The filter medium can be selected to filter any particle size and have sufficiently volume to have a predicable long life. The filter medium could be made of different layers with different filtering capabilities. The bearing inside the rotor cavity should be capable of running in either oil or water and made from a suitable material such as tungsten carbide.

[0052] Referring to figures 8 and 9, the flow outlet from the pressuring pump 112 exits from below the flow outlet protector 107 via a narrower channel 130, and also exits via port 131 into a centre bore of the pump drive shaft 132. At the coupling 133 there are o-rings 134 and 135 which seal on respective shafts 136 and 137, so the pressurised filtered fluid is pumped into a centre bore of the pump shaft 138. Some of the fluid exits the bore of pump shaft 138 through a port 139. At pump bearings 141 a passage 140 allows filtered fluid to lubricate the pump bearing 141 before passing into the discharge fluid. Several bearings 141 having such passages 140 are distributed along the entire pump shaft length. This feature ensures a long bearing life, and a long endurance of the pump especially in a production fluid with sand other solid particles.

[0053] This feature could also be used to supply clear fluids to drilling assembly bearings,

and other systems exposed to abrasive fluids.

- [0054] Referring to figures 10 to 12, there is shown a back flushing mechanism 220. Referring particularly to figure 12, on the main shaft 100 a cam 200 reciprocates a piston 201 in a piston bore 202, clean fluid is fed into the piston bore 202 via passage 203, on each stroke of the piston 201 a small volume of fluid is displaced past the check valve 204 into the chamber 205. The annular piston 206 is displaced downwards against spring 207. A rod 208 attached to the piston unseats a valve 209 so that the collet fingers 216 and pushed out of recess 217 which allows the fluid accumulated in the chamber 210 to back flush the filter via passage 211 and check valve 212. After the spring 207 displaces the piston fully back to the wall 213, it resets the valve 209. The check valve 212, is returned to non-active position by spring member 214, fluid can then pass by the valve 212 into passage 215 to be circulated where required. The charging operation of the back flush mechanism is then repeated. Typical cycle time for the back flush mechanism will be 6-12 hours so the filter will have regular back flushes. This could be changed depending upon the fluid type being filtered.
- [0055] In general, any suitable type of pump may be used in conjunction with this cleaned fluid arrangement; the rotor shaft may include an additional pumping means, even a simple feature formed on the rotor shaft which tends to induce a fluid flow.

Claims

- [Claim 0001] A fluid system for a pump, which includes
a downhole rotating shaft and bearings inside a housing
a fluid volume around shaft
a circulating fluid from outside housing through filter
such that only clean non-abrasive fluid is permitted inside fluid volume
pump to draw fluid around the shaft.
- [Claim 0002] A fluid system according to the previous claim wherein there is
included a fluid expeller to expel fluid from the accumulated volume of
fluid through the filter to purge the filter.
- [Claim 0003] A fluid system according to either previous claim wherein there is
included a fluid passage through bearing or bearings.
- [Claim 0004] A fluid system according to any previous claim wherein there is
included a protector hood to deflecting falling solids coming out of
suspension
- [Claim 0005] A fluid system according to any previous claim wherein there is
included a bore through the shaft
- [Claim 0006] A fluid system according to any previous claim wherein there is
included a valve and inlet port
a piston
and a valve and outlet port
to backflush the system
- [Claim 0007] A fluid system according to claim 6 wherein there is cam on the shaft
to drive the fluid through the inlet valve.
- [Claim 0008] A fluid system according to any previous claim wherein two such
systems are included at each end of a rotor.
- [Claim 0009] A fluid system according to any previous claim wherein there is a
continuous fluid flow through rotor

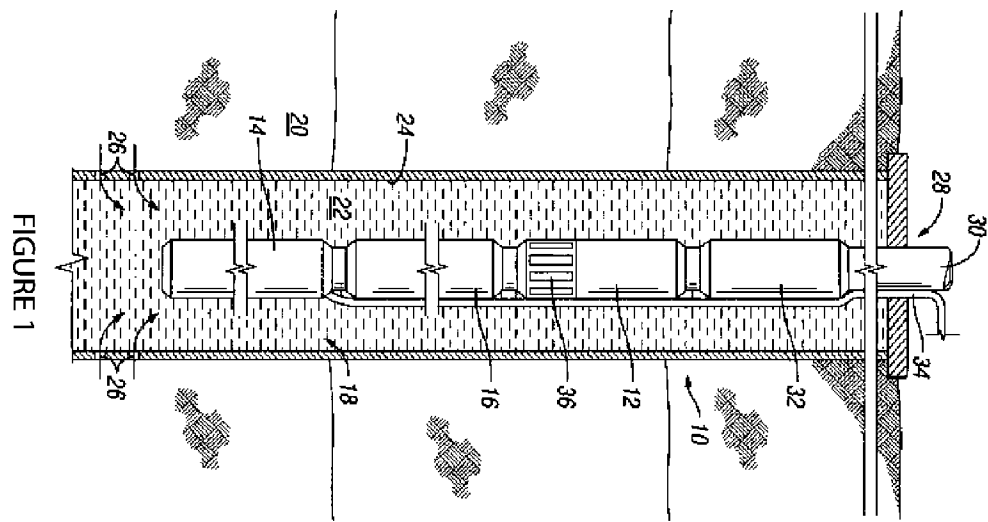


FIGURE 1

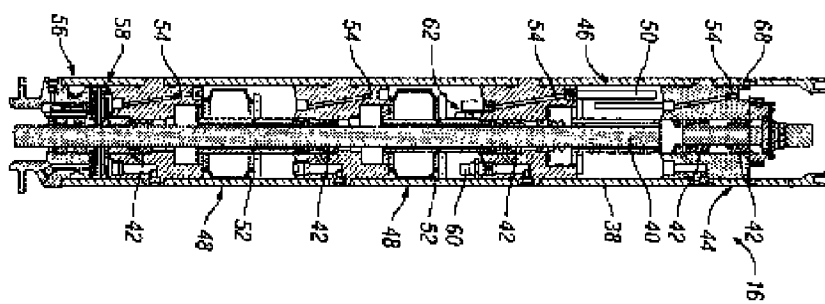


FIGURE 2

FIGURE 3

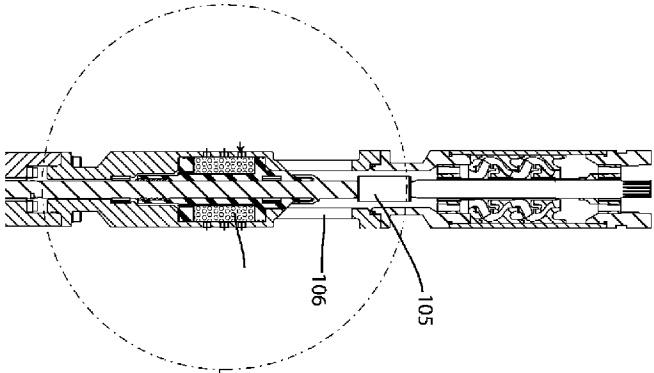
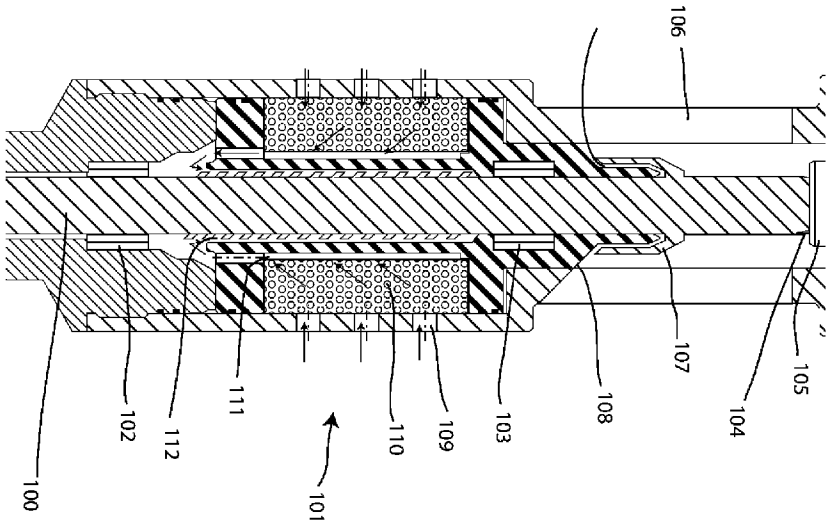


FIGURE 4



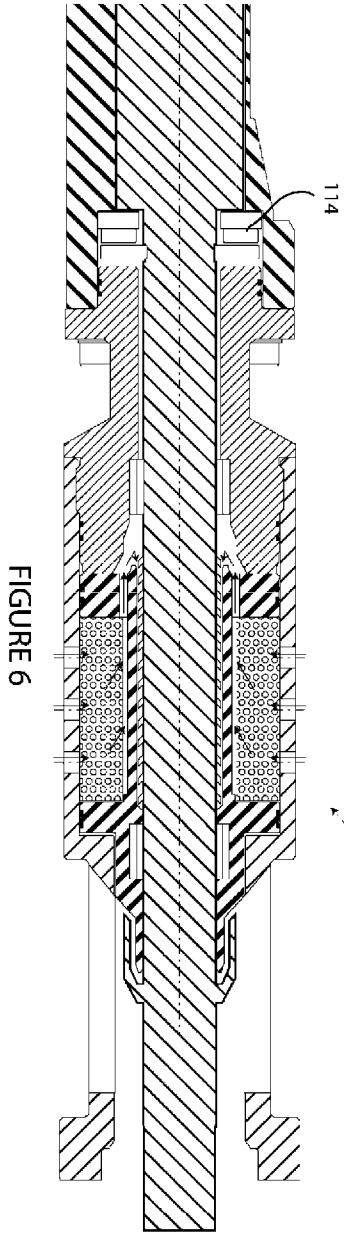
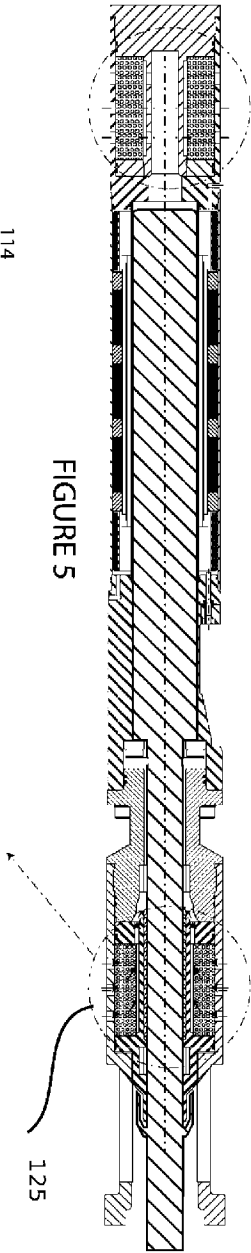
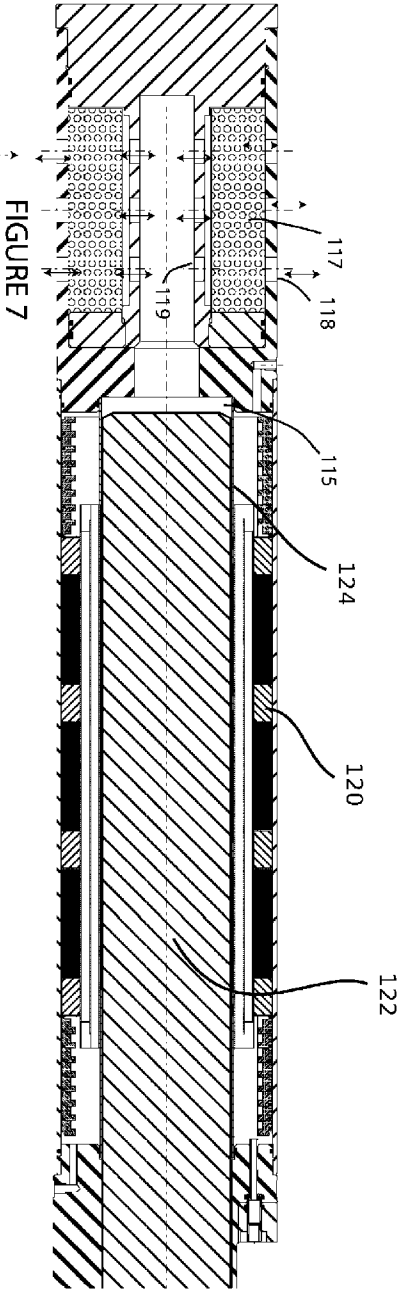


FIGURE 8

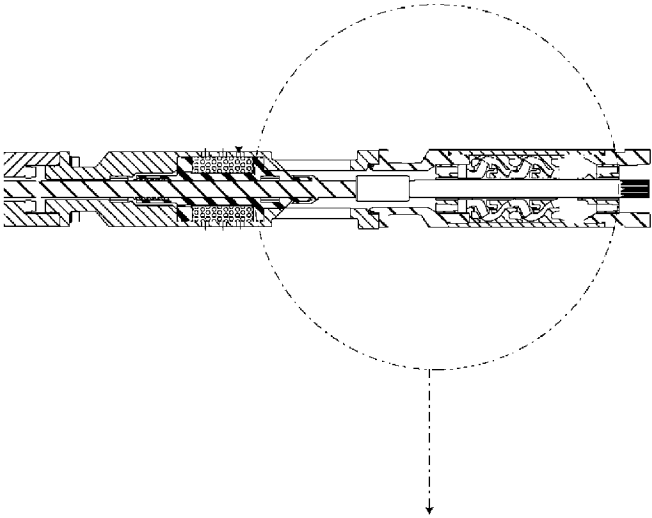
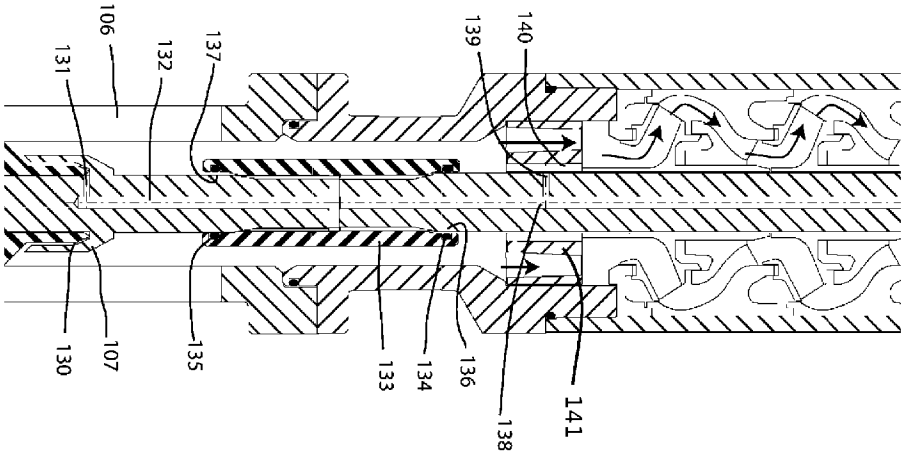


FIGURE 9



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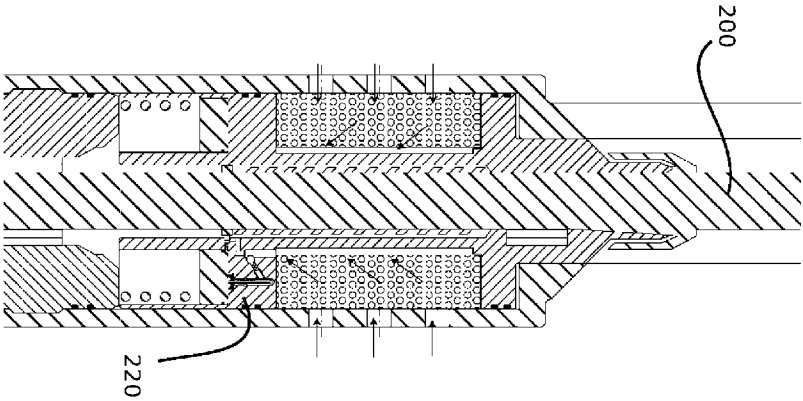


FIGURE 10

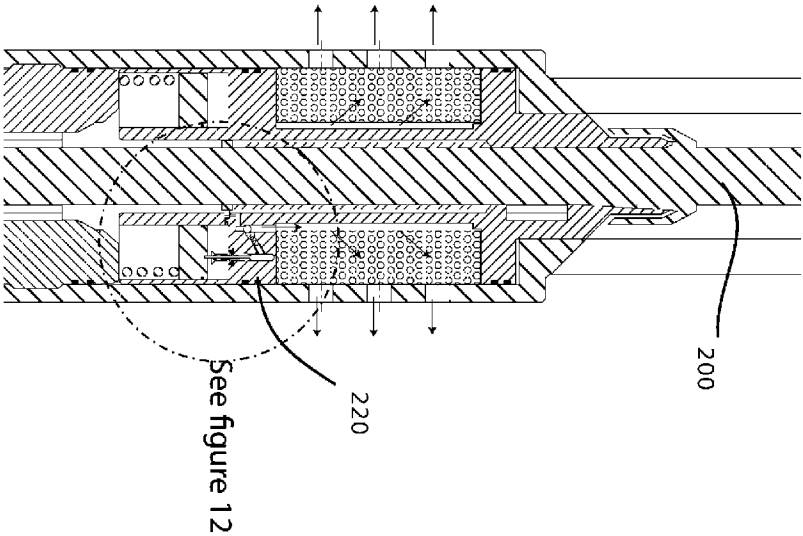
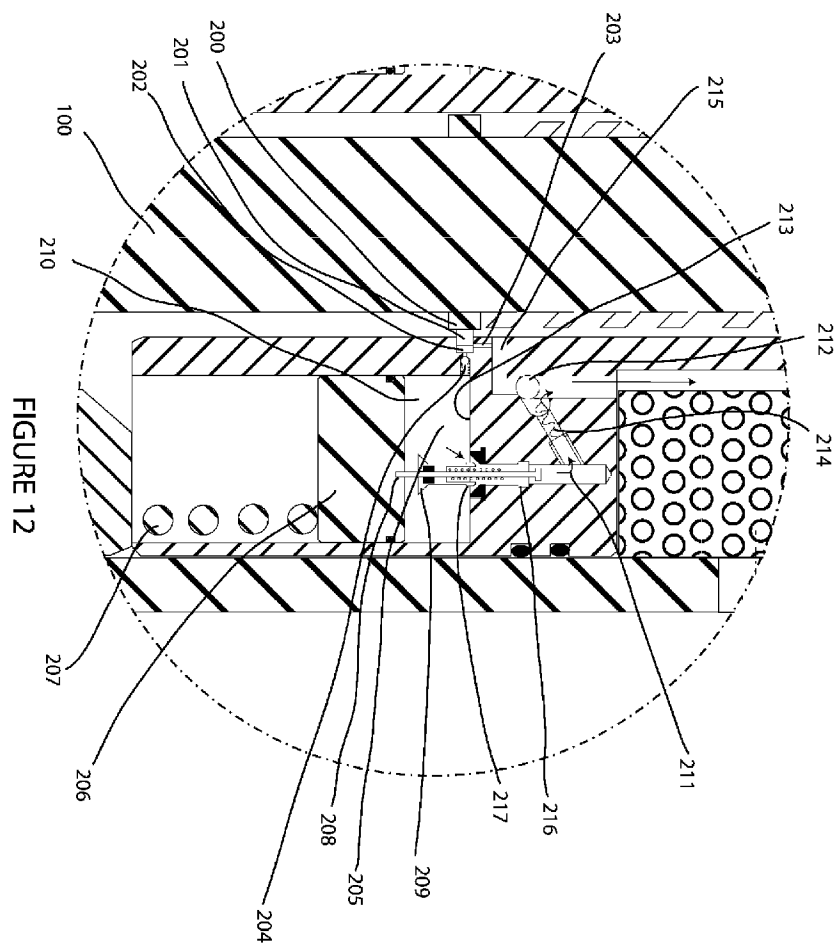


FIGURE 11



INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2016/051225

A. CLASSIFICATION OF SUBJECT MATTER

INV. F04D7/04 E21B43/12 F04D13/10 F04B47/06 F04C13/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04D E21B F04B F04C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/064034 A1 (DAVIS GREGORY AUSTIN [US] ET AL) 5 March 2015 (2015-03-05) paragraph [0060] - paragraph [0066] paragraph [0071] - paragraph [0072] figures 3-10 -----	1-6,8,9
X	US 2009/304526 A1 (FORD MICHAEL BRENT [US]) 10 December 2009 (2009-12-10) paragraph [0044] - paragraph [0046] figures 1-2 -----	1
X	US 5 494 109 A (SCHMITT KENNETH J [US]) 27 February 1996 (1996-02-27) column 2, line 32 - line 43 figures 1, 2a-2f -----	1,2,6,7



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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26/07/2016

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2016/051225

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015064034	A1	05-03-2015	NONE

US 2009304526	A1	10-12-2009	CA 2667695 A1 09-12-2009
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