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(54) **SUBMERSIBLE PUMP ASSEMBLY AND METHOD FOR USE OF SAME**

TAUCHPUMPENANORDNUNG UND VERFAHREN ZUR VERWENDUNG DERSELBEN

ENSEMBLE POMPE SUBMERSIBLE ET PROCÉDÉ D’UTILISATION ASSOCIÉ

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Description

TECHNICAL FIELD OF THE INVENTION

[0001] This invention relates, in general, to submersible pump assemblies and, in particular, to submersible pump assemblies for the removal of fluid mediums with low viscosity, such as water or light crude oil, during hydrocarbon production from a well, for example.

BACKGROUND OF THE INVENTION

[0002] Without limiting the scope of the present invention, the background will be described in relation to aging hydrocarbon producing wells where water encroachment may occur. In a healthy, optimally producing well, high pressure hydrocarbon or oil flow has the ability to lift this liquid to the surface. Over time, however, as the pressures in the formation decline and water production increases, the flow conditions change. The reservoir pressure may no longer be sufficient to unload the well such that water accumulates in the lower section of the well forming a column which further retards hydrocarbon production. Several pump-based solutions have been suggested to overcome the fluid accumulation problem and restore the flow rate of hydrocarbon producing wells. Plunger-type pump assemblies are limited by travel speed and typically operate in low pressure, lower production hydrocarbon producing wells in an advanced well life. Centrifugal-type pump assemblies are able to handle high production requests, but typically have a higher operational cost than plunger-type pump assemblies.

[0003] Further, as mentioned, over time, as the pressures in the formation decline and water production increases, the flow conditions and pressure conditions change. In existing pump assemblies, a rotational speed of a drive unit may be adjusted to compensate for the change in pressure conditions at a cost to the pump assemblies efficiency. Accordingly, there is a need for improved submersible pump assemblies and method for use of the same that efficiently operate across different hydrocarbon producing wells over the life of the hydrocarbon producing well.

[0004] US 2013/043023 A1 discloses a a wellbore pumping system submerged into a wellbore for unloading liquid from a wellbore comprising well fluid, such as gas, having a wellbore pressure, comprising a pump having an inlet and an outlet, a tubing fluidly connected with the outlet of the pump, and a driving unit connected with and powered by a cable, such as a wireline, and having a rotatable drive shaft for driving the pump, wherein the pump is a reciprocating pump. US 7 736 133 B2 discloses upstream and downstream pump assemblies that are mounted in a capsule having a bulkhead between the upstream and downstream pump assemblies, and dividing the capsule into upstream and downstream chambers sealed from each other. EP 0 840 009 B1 discloses a high pressure pump for fuel injection in diesel engines, the high pressure pump having a cam-operated pump piston which can move back and forth in a pump cylinder, and an electromagnetic valve controlling flow of fuel between a low pressure circuit and a working chamber of the of the pump cylinder.

SUMMARY OF THE INVENTION

[0005] It would be advantageous to achieve a submersible pump assembly and method for use of same that would improve upon existing limitations in functionality. It would also be desirable to enable a mechanical-based solution that would provide enhanced operational efficiently across different producing wells or other environments requiring the removal of fluid mediums with low viscosity, such as water or light crude oil. To better address one or more of these concerns, a submersible pump assembly and method for use of the same are disclosed. In one aspect, some embodiments include a cylinder block having cylinders and pistons. A drive shaft is rotatably supported in the cylinder block and coupled to a drive unit. An inclined leading plate is coupled to the pistons and the drive shaft such that pistons are configured to be axially driven in a reciprocating motion within the cylinders upon rotation of the inclined leading plate. A suction port and a pressure port are each located in fluid communication with the cylinders. In one operational mode, the fluid medium is transferred from the suction port to the pressure port during the reciprocating motion of the pistons, when the pistons are actively pumping. In another operational mode, the fluid medium is circulated through the suction chamber.

[0006] In another aspect, some embodiments include a submersible pump assembly for transference of a fluid medium with low viscosity is disclosed. In these embodiments, the submersible pump assembly includes multiple pump units co-axially aligned with a common drive shaft, a common suction chamber, and a common pressure chamber. Each of the pump units includes an active operational mode wherein the fluid medium is transferred from the common suction chamber to the common pressure chamber as well as an inactive operational mode wherein the fluid medium is circulated through the common suction chamber. Each of the pump units is individually actuatable.

[0007] In a still further aspect, some embodiments include multiple pump units co-axially aligned with a common drive shaft. Each of the multiple pump units is individually controllable such that the multiple pumps are serially positioned and controllable in parallel. Each of the multiple pump units include a drive shaft, which is rotatably supported in the cylinder block and coupled to a drive unit. An inclined leading plate is coupled to the pistons and the drive shaft such that pistons are configured to be axially driven in a reciprocating motion within the cylinders upon rotation of the inclined leading plate. A suction port and a pressure port are each located in fluid communication with the cylinders. These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] For a more complete understanding of the features and advantages of the present invention, reference is now made to the detailed description of the invention along with the accompanying figures in which corresponding numerals in the different figures refer to corresponding parts and in which:

Figure 1 is a schematic illustration depicting one embodiment of an onshore hydrocarbon production operation employing a submersible pump assembly, according to the teachings presented herein;
Figure 2 is a schematic illustration depicting one embodiment of the hydrocarbon production operation of figure 1 in a first stage of removing a fluid medium with low viscosity;
Figure 3 is a schematic illustration depicting one embodiment of the hydrocarbon production operation of figure 1 in a second stage of removing a fluid medium with low viscosity;
Figure 4 is a schematic diagram depicting one embodiment of the submersible pump assembly of figure 1; and
Figure 5 is a schematic diagram depicting a cross section of the submersible pump assembly of figure 4 taken along line 5-5.

DETAILED DESCRIPTION OF THE INVENTION

[0009] While the making and using of various embodiments of the present invention are discussed in detail below, it should be appreciated that the present invention provides many applicable inventive concepts, which can be embodied in a wide variety of specific contexts. The specific embodiments discussed herein are merely illustrative of specific ways to make and use the invention, and do not delimit the scope of the present invention.

[0010] Referring initially to figure 1, therein is depicted one embodiment of a submersible pump assembly 10 being employed in an onshore hydrocarbon production operation 12, which may be producing oil, gas, or a combination thereof, for example. A wellhead 14 is positioned over a subterranean hydrocarbon formation 16, which is located below a surface 18. A wellbore 20 extends through the various earth strata including the subterranean hydrocarbon formation 16. A casing string 24 lines the wellbore 20 and the casing string 24 is cemented into place with cement 26. Perforations 28 provide fluid communication from the subterranean hydrocarbon formation 16 to the interior of the wellbore 20. A packer 22 provides a fluid seal between a production tubing 30 and the casing string 24. Composite coiled tubing 34, which is a type of production tubing 30, runs from the surface 18, wherein various surface equipment 36 is located, to a fluid accumulation zone 38 containing a fluid medium F having a low viscosity, such as hydrocarbons like oil or gas, fracture fluids, water, or a combination thereof. As shown, the submersible pump assembly 10 is coupled to a lower end 40 of the production tubing 30.

[0011] Referring now to figure 2 and figure 3, as shown, the submersible pump assembly 10 is positioned in the fluid accumulation zone 38 defined by the casing string 24 cemented by the cement 26 within the wellbore 20. The submersible pump assembly 10 is incorporated into a downhole tool 50 connected to the lower end 40 of the production tubing 30 and, more particularly, the submersible pump assembly 10 includes a housing 52 having a drive unit 54 coupled by a coupling unit 56 to serially positioned pump units 58, 60, 62, which are, in turn, coupled to an intervention unit 64 and a connector 66. The pump unit 58 may include ports 68, 70. Similarly, the pump unit 60 may include ports 72, 74 and the pump unit 62 may include ports 76, 78. The various ports 68, 70, 72, 74, 76, 78 may be assigned various inlet or outlet functions or be sealed shut. It should be appreciated that a variety of pump unit-configurations may be employed and number of pump units, as well as ports, may vary depending on the particular application that the submersible pump assembly 10 is assigned. By way of example, in one implementation, the pump units 58, 60, 62 may share a common inlet port.

[0012] In operation, to begin the processes of transferring the fluid medium F, the submersible pump assembly 10 is positioned in the fluid accumulation zone 38. Initially, as shown best in figure 2, the submersible pump assembly 10 is completely submerged in the fluid medium F, which, as mentioned, may include hydrocarbons such as oil and/or gas, fracture fluid, water, or combinations thereof. The submersible pump assembly 10 is actuated and selective operation of one or more of the pump units 58, 60, 62 begins. As time progresses, as shown best in figure 3, the submersible pump assembly 10 pumps the fluid medium F, which may be a production fluid or a production inhibiting fluid, for example, to the surface 18. The process of pumping the fluid medium F continues until the submersible pump assembly 10 is stopped.

[0013] In some embodiments, the submersible pump assembly 10 includes modularity to provide multiple pump units in a serial arrangement in a single volume represented by the housing 52. The serial arrangement of the multiple pump units, however, provides for parallel operation with concurrent use of the pump units 58, 60, 62 to ensure redundancy. **In** particular, selective operation of the pump units 58, 60, 62 achieve total available low rate as well as a variable flow rate through the selective application of ON/OFF states to each of the pump units 58, 60, 62.

[0014] Referring now to figure 4 and figure 5, the submersible pump assembly 10 for transference of the fluid medium F with low viscosity is depicted in additional detail. As previously discussed, the housing 52 includes a drive unit 54 coupled by a coupling unit 56 to serially positioned pump units 58, 60, 62, which are, in turn, coupled to an intervention unit 64 and a connector 66, which, as shown, connects the submersible pump assembly 10 to the production tubing 30. The intervention unit 64 may be co-axially aligned with the pump units 58, 60, 62 and permit the fluid medium F to bypass the pump units 58, 60, 62 as shown by arrow C. The housing 52 may include housing members for each of the drive unit 54 and pump units 58, 60, 62. The pump units 58, 60, 62 are co-axially aligned with a common drive shaft 90. The common drive shaft 90 may permit each of the pump units 58, 60, 62 to have its own drive shaft section with drive shaft sections united by special shape joint couplings and driven in a serial arrangement by the drive unit 54. The common drive shaft 90 provides non-interfered power transmission to each of the pump units 58, 60, 62 via the central shaft hole for the common drive shaft 90. Each of the pump units 58, 60, 62 may be the same with respect to structure and function.

[0015] A suction chamber 92 and a pressure chamber 94 are each located in fluid communication with the pump units 58, 60, 62. The suction chamber 92 may include peripheral positioning and service each of the pump units 58, 60, 62 and provide a common suction chamber, which allows concurrent or parallel access by all of the pump units to a low pressure side of the fluid medium F being pumped. The suction chamber 92 includes an inlet port 96 with respective connection ports 98, 100, 102 to each of the pump units 58, 60, 62. The inlet port 96 may be positioned in fluid communication with port 68, for example. Each of the pump units 58, 60, 62 include respective connection ports 105, 107, 109 to the suction chamber 92. The pressure chamber 94 may also include peripheral positioning and service each of the pump units 58, 60, 62 and provide a common pressure chamber, which allows concurrent or parallel access by all of the pump units 58, 60, 62 to a high pressure side of the fluid medium F being pumped. The pressure chamber 94 includes an outlet port 101 with respective connection ports 104, 106, 108 establishing fluid communication from the pump units 58, 60, 62 to the production tubing 30 at the connector 66. The suction chamber 92 and the pressure chamber 94 provide each of the pump units 58, 60, 62 access to the fluid medium F. As all of the pump units 58, 60, 62 share the common suction chamber 92 and the common pressure chamber 94, the number of pump units 58, 60, 62 may be modified as required. That is, any number of pump units 58, 60, 62 may be employed and the number of pump units 58, 60, 62 employed will depend on the application. In one implementation, a pump unit 58, 60, 62 may be designed with respect to available fluid medium F capacity, i.e., flow that can be attained in combination with the drive unit rotational speed and the selected suction chamber cross-section. The common suction chamber 92 and the common pressure chamber 94 are peripherally positioned and the size of the common suction chamber 92 and the common pressure chamber 94 defines the maximum possible pump unit flow rate of the fluid medium F.

[0016] By way of example and not by way of limitation, with respect to the pump unit 58, a cylinder block 120 has multiple cylinders, including, for example, cylinders 122, 124, formed therein. The connection port 98 is connected to the suction chamber 92 to provide fluid communication to the cylinders 122, 124. The connection port 104 is also located in fluid communication with the cylinders 122, 124. The connection port 105 is located in fluid communication with the cylinders 122, 124 as well. A respective number of pistons 126, 128 are slidably received in each of the cylinders 122, 124 and appropriately sealed thereat. The common drive shaft 90 is rotatably supported in the cylinder block 120 and the common drive shaft 90 is coupled to, and under the power of, the drive unit 54. The cylinder block 120 is utilized to guide and support the pistons 126, 128. The cylinder block 120 may have equidistantly spaced bores serving as the cylinders 122, 124 to accept the matching pistons 126, 128. The cylinder block 120 may include low friction sliding bushings that connect the cylinder block 120 and the pistons 126, 128. Sets of seals may be appropriately positioned within the cylinder block 120. The pistons 126, 128 push the fluid medium towards the pressure chamber 94. In one implementation, each of the pistons 126, 128 have circumferentially drilled holes that supply the fluid medium to the pistons 126, 128 from the suction chamber 92.

[0017] In one implementation, an inclined leading plate 130 is coupled to the pistons 126, 128 and the common drive shaft 90. The inclined leading plate 130 includes a tilt angle alpha that is selectively adjustable. Further, the inclined leading plate 130 is coupled to the pistons 126, 128 such that the pistons 126, 128 are configured to be axially driven in a reciprocating motion within the cylinders 122, 124 upon rotation of the inclined leading plate 130. A respective number of two-ball links 132, 134 connect the inclined leading plate 130 to the pistons 126, 128. The inclined leading plate 130 is secured in place by sealing member 136 and bearing members 138 proximate an interface with the coupling unit 56. A retainer plate 140 is secured to the inclined leading plate 130 with a bearing member 142. The two-ball links 132, 134, in turn, are secured to the inclined leading plate 130 at the retainer plate 140. The two-ball links 132, 134 are designed to transfer linear, reciprocating motion from the retainer plate 140 to the pistons 126, 128. The form of the two-ball links 132, 134 may be conditioned by the kinematic motion of the retainer plate 140 and the pistons 126, 128. As shown, a lubrication subsystem 144 may be co-located with the two-ball links 132, 134. In one embodiment, the lubrication subsystem reduces the friction between the pistons 126, 128, the two-ball links 132, 134, and the inclined leading plate 130 at the retainer plate 140.

[0018] In one embodiment, the kinematic motion of the pistons 126, 128 is achieved via a properly selected geometry of the inclined leading plate 130. The angle of a contact surface with respect to the common drive shaft 90 connects the inclined leading plate 130 to the retainer plate 140 and the pistons 126, 128. Total inclination of the inclined leading plate 130 is limited by an inner diameter of the housing 52. The retainer plate 140 may be designed to hold and guide the two-ball links 132, 134 such that each of the two-ball links 132, 134 may freely rotate but still transmit axial force to the appropriate piston 126, 128. The sealing member 136 may be designed to hold wear-resistant components and sealing components that prevent the fluid medium from contacting the inclined leading plate 130. In this manner, the inclined leading plate 130 is lubricated by the lubrication subsystem 144. Many low viscosity fluids do not have sufficient lubricating properties for high-load conditions, like the conditions that may be found proximate the two-ball links 132, 134. Therefore, the sealing and lubrication components at the two-ball links 132, 134 ensure sufficient lubrication when the pump unit 58 is being utilized with low viscosity fluid mediums.

[0019] Check valves 146, 148 are serially positioned within the cylinder block 120 at the cylinder 122 to service the piston 126. Similarly, check valves 150, 152 are serially positioned within the cylinder block 120 at the cylinder 122 to service the piston 126. The check valves 150, 152 cooperate to prevent backpressure by opening during an intake stroke and closing during an exhaust stroke. A valve plate connection 154 is positioned at the cylinder block 120 and secured to a valve plate 156 actuatable by a drive member 158. The valve plate 156 may be utilized to control the flow of the fluid medium F, on a pump unit-by-pump unit basis, by rotating the valve plate 156 by a predetermined angle via the driver member 158. For example, in one embodiment, the valve plate 156 may be set to a parallel arrangement whereby the fluid medium F is permitted to flow into the pressure chamber 94 during active pumping. Alternatively, the valve plate 156 may be set to a perpendicular arrangement whereby the fluid medium F returns to the suction chamber 92, via the connection port 105, for example, with respect to the pump unit 58. It should be appreciated that the valve plate 156 includes proper sealing components to prevent any connection between the suction chamber 92 and the pressure chamber 94. By way of example, a sealing member 160 positioned at the junction between the pump unit 58 and the pump unit 60 prevents any leaking at the connection between the suction chamber 92 and the pressure chamber 94. Similarly, a sealing member 162 positioned at the junction between the pump unit 60 and the pump unit 62 also prevents any leaking at the connection between the suction chamber 92 and the pressure chamber 94. A connection assembly 170 represents the flanges, gaskets, seals, and other physical components that connect the pump unit 58 to the coupling unit 56. Similarly, a connection assembly 172 is positioned between the pump unit 58 and the pump unit 60; a connection assembly 174 is positioned between the pump unit 60 and the pump unit 62; and a connection assembly 176 is positioned between the pump unit 62 and the intervention unit 64. The housing 52 of the submersible pump assembly 10 also provides the space for communication lines, control and service lines, acquisition and data lines, and power lines. The size and positioning of these additional utilities does not diminish the strength of operation of the submersible pump assembly 10.

[0020] In an active pumping or active operational mode when the pistons 126, 128 are active, the fluid medium F is transferred from the connection port 98 at the suction chamber 92 to the connection port 104 at the pressure chamber 94 during the reciprocating motion of the pistons 126, 128. That is, the fluid medium F flows as shown by arrows A and arrows B. On the other hand, in an inactive pumping or inactive operational mode when the pistons 126, 128 are circulating the fluid medium F, the fluid medium F is transferred from the connection port 98 at the suction chamber 92 through the cylinder block 120 and out of the connection port 105 to the suction chamber 92, as shown by arrows A and arrows B'. During active pumping, the submersible pump assembly 10 generates flow of fluid medium F by creating a positive pressure difference between the suction side at the suction chamber 92 and the pressure side at the pressure chamber 94. The pressure difference is achieved by the radial positioning of the moving pistons 126, 128 with an accompanying number of the check valve pairs, such as check valves 146, 148, 150, 152, that open and close in an alternating manner to prevent the pressurized fluid medium F from running back. That is, each of the check valves 146, 148, 150, 152 prevents backpressure by, with respect to the pistons 126, 128, opening during an intake stroke and closing during an exhaust stroke. The design of the submersible pump assembly 10 allows each pump unit 58, 60, 62 to selectively pump fluid medium F into the pressure sided at the pressure chamber 94 in an active operational mode or circulate the fluid medium F through the suction chamber 92 during an inactive operational mode when the pump units 58, 60, 62 are pumping to circulate the fluid medium F. During the inactive pumping mode, an individual pump unit 58, 60, 62 does not add anything to the total pumping flow rate since the fluid medium F is circulating to and from the suction chamber 92. In this inactive operational mode, a pump unit is not loaded and may be idle or redundant and continue in this mode of operation indefinitely.

[0021] The submersible pump assembly 10 presented herein functions to remove fluid mediums with low viscosity, such as water or light crude oil, for example. As discussed, the submersible pump assembly 10 provides for installation in confined spaces such as pipes, below or above the ground level, near or at a remote location. Optionally, the submersible pump assembly 10 may be utilized with other downhole tools, such as hydrocarbon and solid particle separators, sensors, and measuring devices, for example. Further, as discussed, any number of pump units 58, 60, 62 may be utilized in the submersible pump assembly 10 to provide redundancy as well as, through selectively actuation, calibration of the fluid medium transference required. Further, in instances of multiple pump units, like pump units 58, 60, 62, each of the pump units 58, 60, 62, may individually and selectively actuated to pump the fluid medium F from the suction chamber 92 to the pressure chamber 94 or circulate the fluid medium F through the suction chamber 92.

[0022] The order of execution or performance of the methods and techniques illustrated and described herein is not essential, unless otherwise specified. That is, elements of the methods and techniques may be performed in any order, unless otherwise specified, and that the methods may include more or less elements than those disclosed herein. For example, it is contemplated that executing or performing a particular element before, contemporaneously with, or after another element are all possible sequences of execution.

[0023] While this invention has been described with reference to illustrative embodiments, this description is not intended to be construed in a limiting sense. Various modifications and combinations of the illustrative embodiments as well as other embodiments of the invention, will be apparent to persons skilled in the art upon reference to the description without departing from the scope of the invention as defined by the appended claims.

Claims

1. A submersible pump assembly (10) for transference of a fluid medium with low viscosity, the submersible pump assembly (10) comprising:

a plurality of pump units (58, 60, 62) having a central axis co-axially aligned with a common drive shaft (90);
a common suction chamber (92) and a common pressure chamber (94), being respectively positioned at the periphery of the submersible pump assembly (10) and in alignment with the central axis, the common suction chamber (92) providing the plurality of pump units (58, 60, 62) concurrent and parallel access to the fluid medium under low pressure;
each of the plurality of pump units (58, 60, 62) including a first operational mode wherein the fluid medium is transferred from the common suction chamber (92) to the common pressure chamber (94); **characterized by**
each of the plurality of pump units (58, 60, 62) including a second operational mode wherein the fluid medium is circulated through the common suction chamber (92); and
each of the plurality of pump units (58, 60, 62) being individually actuatable to select one of the first operational mode and the second operational mode.

2. The submersible pump assembly (10) as recited in claim 1, wherein the submersible pump assembly (10) forms a portion of a downhole tool (50).

3. The submersible pump assembly (10) as recited in claim 1, wherein the common pressure chamber (94) provides concurrent and parallel access for the plurality of pump units (58, 60, 62) to the fluid medium under high pressure.

4. The submersible pump assembly (10) as recited in claim 1, wherein the first operational mode further comprises active pumping of the fluid medium from the common suction chamber (92) to the common pressure chamber (94).

5. The submersible pump assembly (10) as recited in claim 1, wherein the second operational mode further comprises inactive pumping of the fluid medium with circulation of the fluid medium through the common suction chamber (92).

6. The submersible pump assembly (10) as recited in claim 1,
wherein a size of the common suction chamber (92) and the common pressure chamber (94) defines a maximum possible flow rate of the fluid medium.

7. The submersible pump assembly (10) as recited in claim 6,
each of the plurality of pump units (58, 60, 62) comprising:

a cylinder block (120) having a plurality of cylinders (122, 124) formed therein;
a first port (68) located in fluid communication with the plurality of cylinders (122, 124) and the common suction chamber (92);
a second port (70) located in fluid communication with the plurality of cylinders (122, 124) and the common pressure chamber (94);
a third port (72) located in fluid communication with the plurality of cylinders (122, 124) and the common suction chamber (92);
a respective plurality of pistons (126, 128) slidably received in each of the plurality of cylinders (122, 124);
the common drive shaft (90) being rotatably supported in the cylinder block (120), the common drive shaft (90) being coupled to a drive unit (54);
an inclined leading plate (130) coupled to the plurality of pistons (126, 128) and the drive shaft (90), a tilt angle of the inclined leading plate (130) is selectively adjustable, the inclined leading plate (130) coupled to the plurality of pistons

(126, 128) such that the plurality of pistons (126, 128) are configured to be axially driven in a reciprocating motion within the plurality of cylinders (122, 124) upon rotation of the inclined leading plate (130); and
a respective plurality of two-ball links (132, 134) connecting the inclined leading plate (130) to the plurality of pistons (126, 128).

Patentansprüche

1. Tauchpumpenanordnung (10) zur Förderung eines flüssigen Mediums mit niedriger Viskosität, wobei die Tauchpumpenanordnung (10) umfasst:

   Eine Vielzahl von Pumpeneinheiten (58, 60, 62) mit einer zentralen Achse, die koaxial mit einer gemeinsamen Antriebswelle (90) ausgerichtet ist;
   eine gemeinsame Saugkammer (92) und eine gemeinsame Druckkammer (94) aufweist, die jeweils an der Peripherie der Tauchpumpenanordnung (10) positioniert und mit der zentralen Achse ausgerichtet sind, wobei die gemeinsame Saugkammer (92) der Vielzahl von Pumpeneinheiten (58, 60, 62) gleichzeitigen und parallelen Zugriff auf das flüssige Medium unter niedrigem Druck bereitstellt;
   jede der Vielzahl von Pumpeneinheiten (58, 60, 62) umfasst eine erste Betriebsart, bei der das flüssige Medium aus der gemeinsamen Saugkammer (92) zur gemeinsamen Druckkammer (94) transferiert wird; **dadurch gekennzeichnet, dass**
   jede der Vielzahl von Pumpeneinheiten (58, 60, 62) eine zweite Betriebsart umfasst, wobei das flüssige Medium durch die gemeinsame Saugkammer (92) zirkuliert wird; und sich jede der Vielzahl von Pumpeneinheiten (58, 60, 62) einzeln betätigen lässt, um eine der ersten Betriebsart und der zweiten Betriebsart zu selektieren.

2. Tauchpumpenanordnung (10) nach Anspruch 1, wobei die Tauchpumpenanordnung (10) einen Teil eines Bohrlochwerkzeugs (50) bildet.

3. Tauchpumpenanordnung (10) nach Anspruch 1, wobei die gemeinsame Druckkammer (94) gleichzeitigen und parallelen Zugriff für die Vielzahl von Pumpeneinheiten (58, 60, 62) auf das flüssige Medium unter hohem Druck bereitstellt.

4. Tauchpumpenanordnung (10) nach Anspruch 1, wobei die erste Betriebsart weiter das aktive Pumpen des flüssigen Mediums aus der gemeinsamen Saugkammer (92) zur gemeinsamen Druckkammer (94) umfasst.

5. Tauchpumpenanordnung (10) nach Anspruch 1, wobei die zweite Betriebsart weiter das inaktive Pumpen des flüssigen Mediums mit Zirkulation des flüssigen Mediums durch die gemeinsame Saugkammer (92) umfasst.

6. Tauchpumpenanordnung (10) nach Anspruch 1, wobei eine Größe der gemeinsamen Saugkammer (92) und der gemeinsamen Druckkammer (94) eine maximal mögliche Durchflussrate des flüssigen Mediums definiert.

7. Tauchpumpenanordnung (10) nach Anspruch 6, wobei jede der Vielzahl von Pumpeneinheiten (58, 60, 62) umfasst:

   Einen Zylinderblock (120) mit einer darin gebildeten Vielzahl von Zylindern (122, 124);
   eine erste Öffnung (68), die sich in Flüssigkeitsverbindung mit der Vielzahl von Zylindern (122, 124) und der gemeinsamen Saugkammer (92) befindet;
   eine zweite Öffnung (70), die sich in Flüssigkeitsverbindung mit der Vielzahl von Zylindern (122, 124) und der gemeinsamen Druckkammer (94) befindet;
   eine dritte Öffnung (72), die sich in Flüssigkeitsverbindung mit der Vielzahl von Zylindern (122, 124) und der gemeinsamen Saugkammer (92) befindet;
   eine jeweilige Vielzahl von Kolben (126, 128), die verschiebbar in jedem der Vielzahl von Zylindern (122, 124) aufgenommen sind;
   wobei die gemeinsame Antriebswelle (90) drehbar im Zylinderblock (120) gelagert ist, wobei die gemeinsame Antriebswelle (90) an eine Antriebseinheit (54) gekoppelt ist;
   wobei eine schräge Vorderplatte (130) an die Vielzahl von Kolben (126, 128) und die Antriebswelle (90) gekoppelt ist, ein Neigungswinkel der schrägen Vorderplatte (130) selektiv einstellbar ist, die schräge Vorderplatte (130) so an die Vielzahl von Kolben (126, 128) gekoppelt ist, dass die Vielzahl von Kolben (126, 128) konfiguriert sind, axial in einer Hin- und Herbewegung innerhalb der Vielzahl von Zylindern (122, 124) bei Drehung der schrägen Platte (130) angetrieben zu werden; und
   wobei eine jeweilige Vielzahl von Zwei-Kugelgelenken (132, 134) die schräge Vorderplatte (130) mit der Vielzahl von Kolben (126, 128) verbindet.

Revendications

1. Ensemble pompe submersible (10) pour le transfert d'un milieu fluide à faible viscosité, l'ensemble pompe submersible (10) comprenant :

une pluralité d'unités pompes (58, 60, 62) comportant un axe central coaxial avec un arbre d'entraînement commun (90) ;
une chambre d'aspiration commune (92) et une chambre de pression commune (94), respectivement positionnées à la périphérie de l'ensemble pompe submersible (10) et alignées avec l'axe central, la chambre d'aspiration commune (92) assurant à la pluralité d'unités pompes (58, 60, 62) un accès simultané et parallèle au milieu fluide sous basse pression ;
chaque unité pompe de la pluralité d'unités pompes (58, 60, 62) comprenant un premier mode de fonctionnement, le milieu fluide étant transféré de la chambre d'aspiration commune (92) à la chambre de pression commune (94) ;
l'ensemble pompe submersible étant **caractérisé en ce que** :
chaque unité pompe de la pluralité d'unités pompes (58, 60, 62) comprend un second mode de fonctionnement, le milieu fluide étant mis en circulation dans la chambre d'aspiration commune (92) ; chaque unité pompe de la pluralité d'unités pompes (58, 60, 62) peut être actionnée individuellement pour sélectionner l'un des premier et second modes de fonctionnement.

2. Ensemble pompe submersible (10) selon la revendication 1, l'ensemble pompe submersible (10) formant une partie d'un outil de fond de trou (50).

3. Ensemble pompe submersible (10) selon la revendication 1, la chambre de pression commune (94) assurant à la pluralité d'unités pompes (58, 60, 62) un accès simultané et parallèle au milieu fluide sous haute pression.

4. Ensemble pompe submersible (10) selon la revendication 1, le premier mode de fonctionnement comprenant en outre le pompage actif du milieu fluide de la chambre d'aspiration commune (92) à la chambre de pression commune (94).

5. Ensemble pompe submersible (10) selon la revendication 1, le second mode de fonctionnement comprenant en outre le pompage inactif du milieu fluide avec circulation du milieu fluide dans la chambre d'aspiration commune (92).

6. Ensemble pompe submersible (10) selon la revendication 1, une taille de la chambre d'aspiration commune (92) et de la chambre de pression commune (94) définissant un débit possible maximum du milieu fluide.

7. Ensemble pompe submersible (10) selon la revendication 6, chaque unité pompe de la pluralité d'unités pompes (58, 60, 62) comprenant :

un bloc-cylindres (120) comportant une pluralité de cylindres (122, 124) formés dans celui-ci ;
un premier orifice (68) situé en communication fluidique avec la pluralité de cylindres (122, 124) et la chambre d'aspiration commune (92) ;
un deuxième orifice (70) situé en communication fluidique avec la pluralité de cylindres (122, 124) et la chambre de pression commune (94) ;
un troisième orifice (72) situé en communication fluidique avec la pluralité de cylindres (122, 124) et la chambre d'aspiration commune (92) ;
une pluralité respective de pistons (126, 128) reçus coulissants dans chaque cylindre de la pluralité de cylindres (122, 124) ;
l'arbre d'entraînement commun (90) étant supporté rotatif dans le bloc-cylindres (120), l'arbre d'entraînement commun (90) étant accouplé à une unité d'entraînement (54) ;
une plaque d'attaque inclinée (130) accouplée à la pluralité de pistons (126, 128) et à l'arbre d'entraînement (90), un angle d'inclinaison de la plaque d'attaque inclinée (130) étant réglable de manière sélective, la plaque d'attaque inclinée (130) étant couplée à la pluralité de pistons (126, 128) de telle sorte que la pluralité de pistons (126, 128) soient configurés pour être entraînés axialement selon un déplacement de va-et-vient à l'intérieur de la pluralité de cylindres (122, 124) lors de la rotation de la plaque d'attaque inclinée (130) ; et
une pluralité respective de liaisons à deux rotules (132, 134) reliant la plaque d'attaque inclinée (130) à la pluralité de pistons (126, 128).

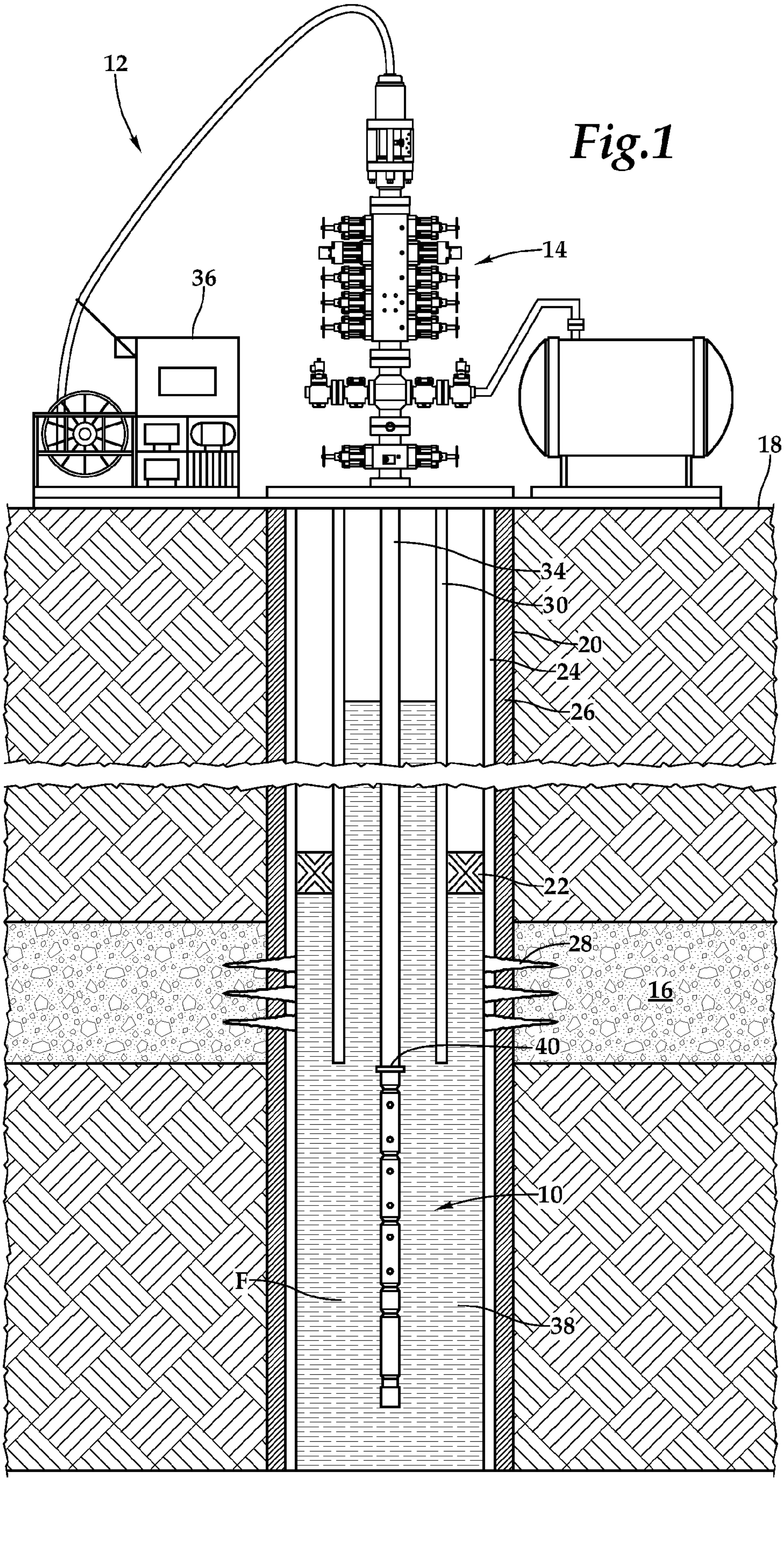
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Fig.1
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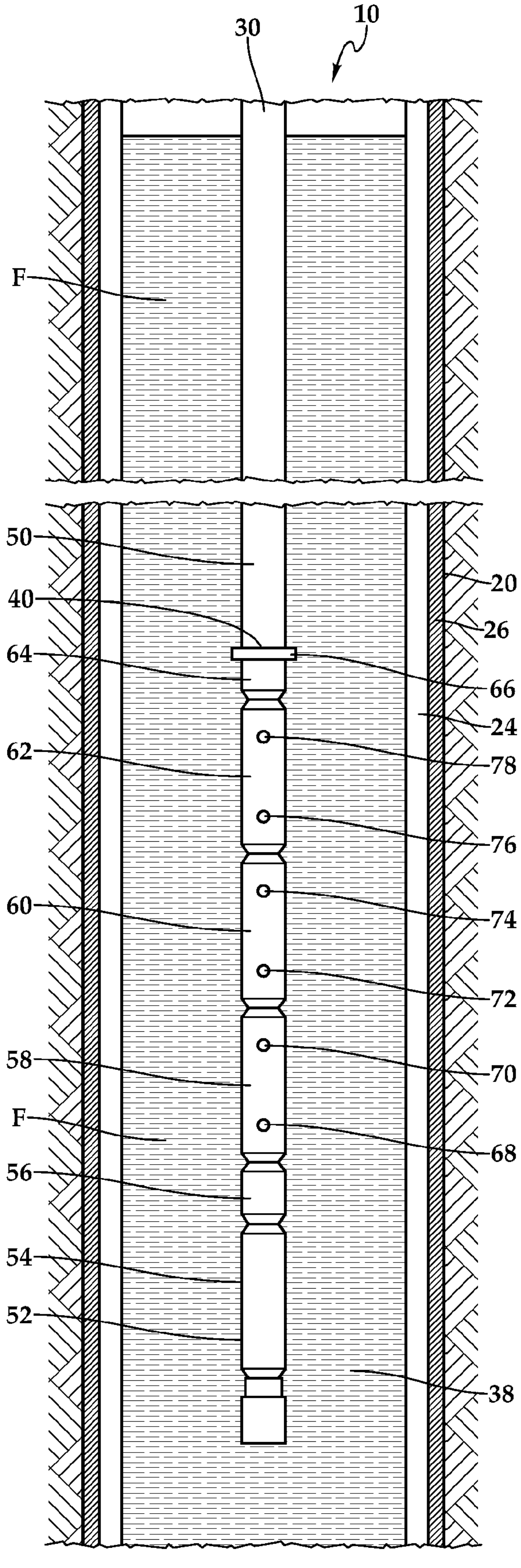
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Fig.2

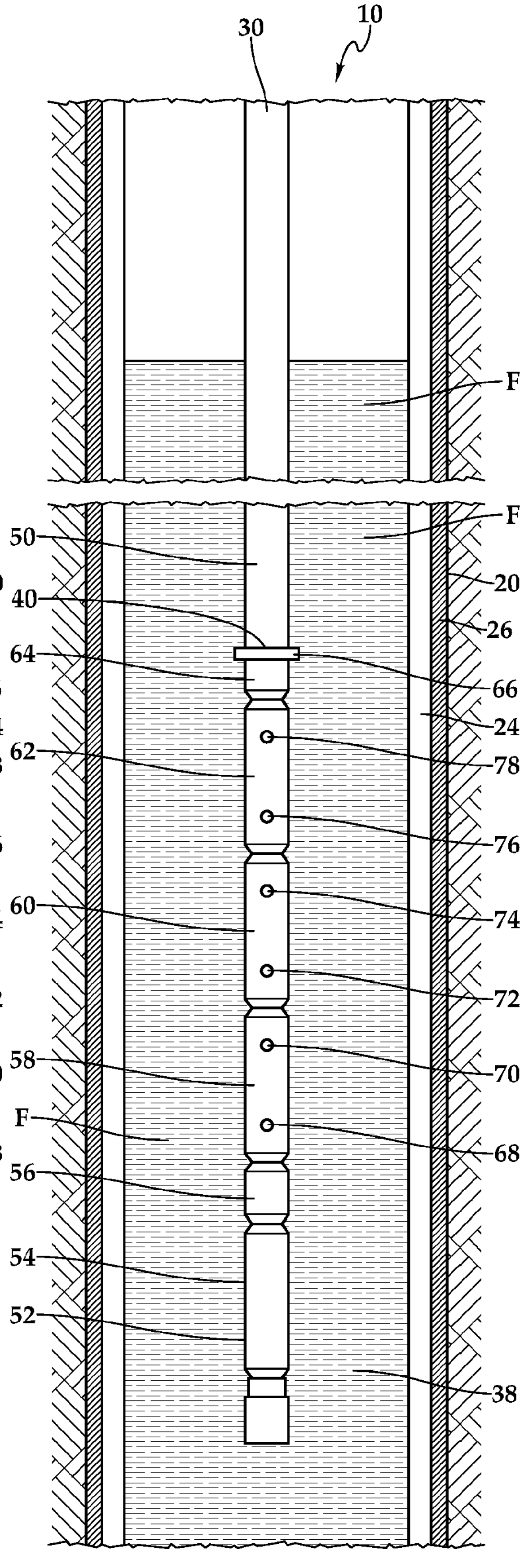
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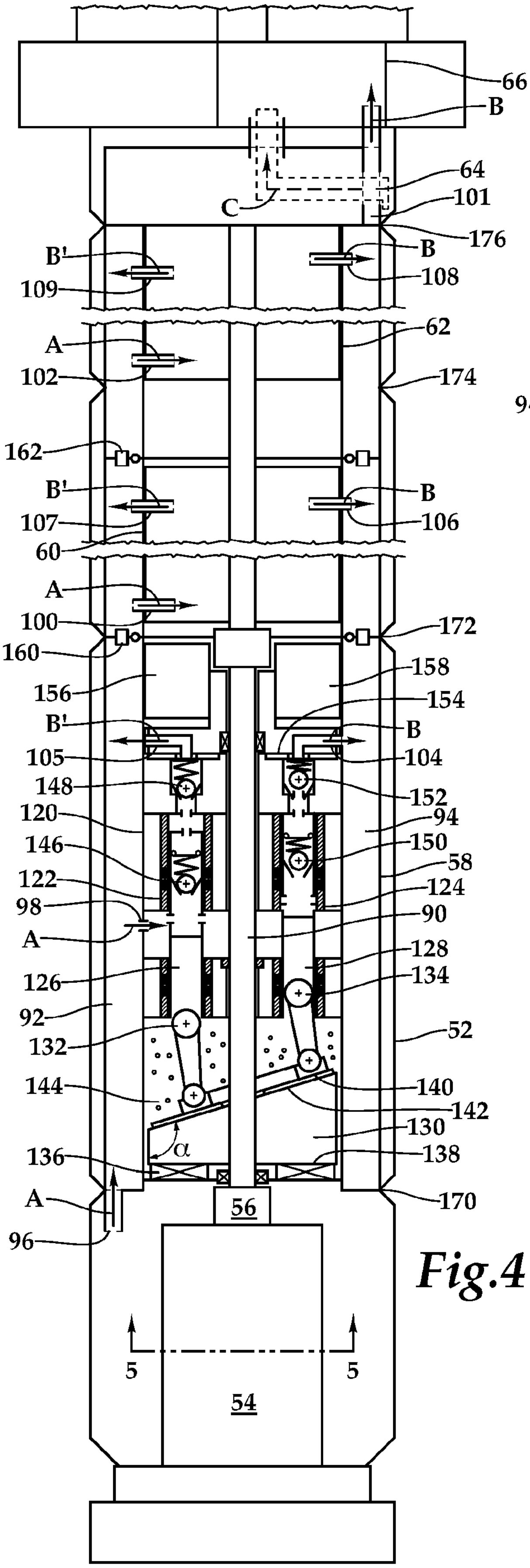
Fig.3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C
176
B'
B
109
108
62
A
102
174
162
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B
107
106
60
A
100
172
160
156
158
154
B'
B
105
104
148
152
120
94
146
150
58
122
124
98
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A
128
126
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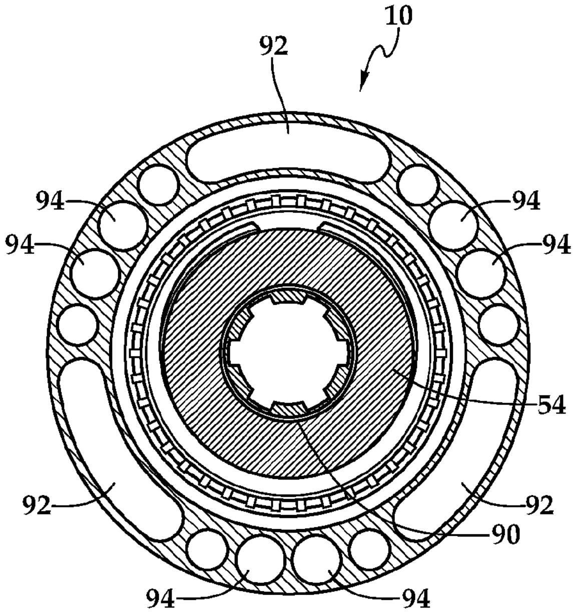
Fig.4


10
92
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54
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90
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94

Fig.5

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- US 2013043023 A1 **[0004]**
- US 7736133 B2 **[0004]**
- EP 0840009 B1 **[0004]**