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(54) Title: DEVICE FOR PUMPING FLUID FROM A WELLBORE

(57) Abstract: The invention provides a device for pumping fluid from a wellbore, comprising a piston member arranged in a pump chamber in a manner allowing the piston member to perform a series of pump strokes whereby at each pump stroke a volume of said fluid is pumped out of the pump chamber by the piston member. A fluid conduit is arranged so as to induce each pump stroke of the piston member by a selected fluid pressure increase in the fluid conduit. The device further comprises a storage chamber for receiving said volume of fluid from the pump chamber and pressurising means for applying hydraulic pressure to the volume of fluid in the storage chamber, an outlet channel for discharging the volume of fluid from the storage chamber into the fluid conduit, and closure means for closing the outlet channel during each pump stroke of the piston member.

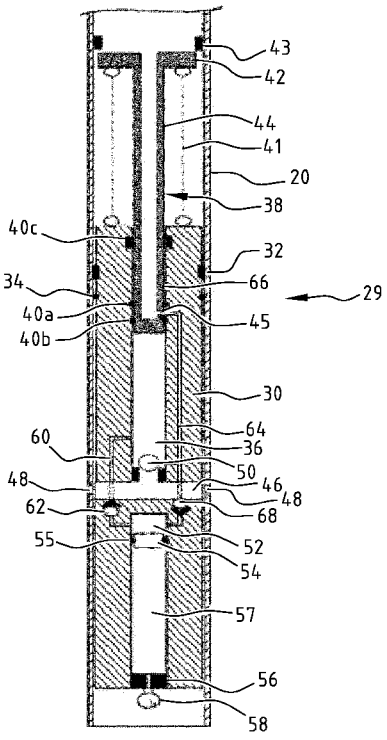


FIG. 2

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DEVICE FOR PUMPING FLUID FROM A WELLBORE

The present invention relates to a device and a method for pumping fluid from a wellbore formed in an earth formation.

In hydrocarbon wells, such as gas wells, it frequently occurs that water, for instance from the surrounding earth formation or condensed water, accumulates in the wellbore. Part of the formation water or condensed water generally flows out of the wellbore together with the produced gas. However, over time a significant amount of water may accumulate in the lower portion of the wellbore. Other liquids, such as gas condensate, may also accumulate in the wellbore.

The accumulated liquid in the wellbore is potentially detrimental to the production of hydrocarbon gas from the wellbore. Therefore, generally there is a need to remove the accumulated liquid from the wellbore using a technique referred to as deliquefaction.

US-2010/0051282-A1 discloses a pump arranged in a wellbore, which pump is driven by a power fluid that is pumped through an inflow conduit passing through a production tubing of the wellbore. The formation water pumped by the pump is mixed with the power fluid and discharged from the wellbore via a fluid return line passing through the production tubing.

In view of the limited diameter of a wellbore and the correspondingly limited available space, it is a drawback of the known pump system that separate fluid conduits are needed in the wellbore for driving the downhole pump and for discharging the pumped water to surface.

WO-86/02412 discloses a surface powered pump unit for pumping oil or water from wells. The pump unit comprises a downhole pump connected to surface via a conventional tubing string.

It is an object of the invention to provide an improved device for pumping fluid from a wellbore.

In accordance with the invention there is provided a device for pumping fluid from a wellbore formed in an earth formation, comprising:

- a piston member arranged in a pump chamber in a manner allowing the piston member to perform a series of pump strokes whereby at each pump stroke a volume of said fluid is pumped out of the pump chamber by the piston member;
- a fluid conduit arranged so as to induce each pump stroke of the piston member by a selected fluid pressure increase in the fluid conduit;
- a storage chamber for receiving said volume of fluid from the pump chamber and pressurising means for applying hydraulic pressure to the volume of fluid in the storage chamber;
- an outlet channel for discharging the volume of fluid from the storage chamber into the fluid conduit; and
- closure means for closing the outlet channel during each pump stroke of the piston member.

The invention also relates to a method of pumping fluid from a wellbore formed in an earth formation, the method comprising:

- providing a piston member arranged in a pump chamber in a manner allowing the piston member to perform a series of pump strokes whereby at each pump stroke a volume of said fluid is pumped out of the pump chamber by

the piston member;

- applying a selected fluid pressure increase in a fluid conduit arranged so as to induce each pump stroke of the piston member by the selected fluid pressure increase;

- receiving said volume of fluid from the pump chamber in a storage chamber and applying hydraulic pressure to the volume of fluid in the storage chamber using pressurising means;

- discharging the volume of fluid from the storage chamber into the fluid conduit via an outlet channel; and

- closing the outlet channel during each pump stroke of the piston member using closing means.

With the device and the method of the invention it is achieved that the fluid conduit serves both for driving the device to perform the pump cycles, and for discharging fluid that is pumped out of the wellbore. The ability to use a single fluid conduit for these two functionalities obviates the need to install and operate separate fluid conduits for driving the downhole pump and for discharging the pumped fluid, as is the case in the prior art.

Suitably the device comprises an inlet for inflow of said volume of fluid from the wellbore into the pump chamber, the inlet being provided with first valve means preventing outflow of fluid from the pump chamber via the inlet.

To prevent backflow of pumped fluid into the pump chamber, the pump chamber suitably is in fluid communication with the storage chamber via a transfer channel provided with second valve means preventing flow of fluid from the storage chamber to the pump chamber via the transfer channel.

To prevent fluid from flowing directly from the fluid conduit to the storage chamber, preferably the outlet channel is provided with third valve means preventing flow of fluid from the fluid conduit to the storage chamber via the outlet channel.

Suitably the pressurising means includes a reciprocating member arranged in the storage chamber and means for exerting a force to the reciprocating member so as to press the reciprocating member against the volume of fluid in the storage chamber. For example, said means for exerting a force to the reciprocating member comprises a volume of compressed gas, such as Nitrogen gas.

In an advantageous embodiment of the device, the outlet channel debouches into the pump chamber, and the closure means comprises a wall portion of the piston member that closes the outlet channel during each pump stroke of the piston member.

The volume of fluid may be efficiently discharged from the storage chamber if the wall of the piston member is provided with a passage that provides fluid communication between the outlet channel and the interior of the conduit in between successive pump strokes of the piston member.

In each pump stroke the piston member moves from a first end position to a second end position. Advantageously said passage provides fluid communication between the outlet opening and the interior of the fluid conduit when the piston member is in the first end position.

In a practical application, the wellbore is provided with a production tubing for transporting produced hydrocarbon fluid to surface, wherein the pump device is

positioned in a lower portion of the production tubing, and wherein the fluid conduit extends through the production tubing to surface.

The device is suitably arranged to pump water from a body of water via the fluid conduit to surface, which body of water has entered the wellbore from the surrounding earth formation.

Suitably the pump device or a part thereof is retrievably connected to the conduit so as to allow the pump device or said part thereof to be retrieved through the fluid conduit to surface by means of a wire line. This may be done, for example, for maintenance purposes.

The piston member generally performs a series of return strokes alternatingly with the series of pump strokes, whereby each return stroke suitably is induced by a spring that is compressed during each pump stroke by virtue of said selected fluid pressure increase in the fluid conduit.

The invention will explained hereinafter in more detail and by way of example with reference to the accompanying drawings, in which:

Fig. 1 schematically shows an exemplary wellbore provided with the device for pumping fluid from the wellbore in accordance with the invention;

Fig. 2 schematically shows a first embodiment of a pump assembly of the device for pumping fluid from the wellbore;

Fig. 3 schematically shows a second embodiment of a pump assembly of the device for pumping fluid from the wellbore;

Fig. 4 schematically shows a third embodiment of a pump assembly of the device for pumping fluid from the wellbore; and

Fig. 5 shows the third embodiment with some components disassembled.

In the Figures and the detailed description hereinafter, like reference signs relate to like components.

Referring to Fig. 1 there is shown a wellbore 1 that has been drilled from surface 3 through an earth formation 4 to a reservoir layer 6 of the earth formation. The reservoir 6 comprises hydrocarbon gas and may be located at a depth of, for example, 3000 m. The wellbore 1 is lined with casings 8A-C and a liner 8D arranged in a conventional nested arrangement. The casings 8A-C extend from a wellhead 9 at surface into the wellbore 1. A Christmas tree 10 is provided on top of the wellhead 9. The liner 8D is suspended from casing 8C by a liner hanger 12 arranged at a down hole location, and extends from there to the reservoir layer 6. A lower portion 14 of the liner 8D is provided with perforations 15 to allow hydrocarbon fluid from the reservoir layer 6 to enter the lower portion 14 of the liner.

A production tubing 16 extends from wellhead 9 and Christmas tree 10 through the interior of casing 8C and liner 8D, into the lower liner portion 14. The production tubing 16 is internally provided with a sub-surface safety valve (sssv) 17 that is controlled by a hydraulic control line (not shown) extending from surface 3 into the wellbore 1 along the outside of the production tubing 16. The sub-surface safety valve 17 is located at a depth of, for example, approximately 100 m, and is adapted to close the production tubing in the event of an emergency. A production packer 18 is provided between the production tubing 16 and the liner 8D to seal a lower portion of the wellbore 1 where the inlet of the production tubing 16 is

located, from an upper portion of the wellbore 1. The wellbore 1 contains a body of water 19 that has entered the wellbore from the surrounding earth formation.

A fluid conduit in the form of a coiled tubing 20 extends from the wellhead 9 at surface through the interior of the production tubing 16, to near the open lower end of the production tubing 16. The coiled tubing 20 is supplied from a large reel (not shown) and may have an outer diameter of, for example, 2.5 - 8.5 cm. At the lower end of the coiled tubing 20 there is provided a pump assembly 22 for pumping water from the body of water 19 out of the wellbore 1 via the coiled tubing. The coiled tubing 20 is fluidly connected to an outlet conduit 24 provided at the Christmas tree 10, and to a surface pump 26 for selectively increasing the fluid pressure in the coiled tubing 20 by pumping water into the coiled tubing. The outlet conduit 24 is provided with a valve (not shown) that closes the outlet conduit when the surface pump 26 is actuated. The production tubing 16 is at surface fluidly connected to a flow line 28 for transporting hydrocarbon gas that is produced from the reservoir layer 6 via the production tubing 16.

Referring further to Fig. 2 there is shown a schematic representation of a first embodiment 29 of the pump assembly 22. The first embodiment 29 comprises a cylindrical housing 30 positioned inside the coiled tubing 20 at the lower end thereof and fixedly connected to the coiled tubing by a lock ring 32. A seal ring 34 seals the housing 30 relative to the wall of the coiled tubing.

An upper part of the housing 30 is provided with a cylindrical pump chamber 36 in which a piston member 38 is arranged. The piston member 38 is axially movable in

the pump chamber 36 between an upper position and a lower position, and is provided with annular seals 40a, 40b to seal the piston member to the wall of the pump chamber. The wall of the pump chamber 36 is provided with an annular seal 40c for additional sealing. A compression spring 41 is provided between a flanged upper end 42 of the piston member 38 and the housing 30 so as to bias the piston member 38 against a stop ring 43 at the inner surface of the coiled tubing 20. When the flanged upper end 42 is biased against the stop ring 43, the piston member 38 is in the upper position. The piston member 38 has a tubular portion 44 which, at its upper end, is in fluid communication with the interior of the coiled tubing 20. The wall of the tubular portion 44 is provided with a radial passage 45 located between the annular seals 40a, 40b. The housing 30 has a fluid inlet 46 that is in fluid communication with the body of water 19 via inlet openings 48 provided in the wall of the coiled tubing 20. A check valve 50 is arranged between the fluid inlet 46 and the pump chamber 36 to allow flow of fluid from the fluid inlet 46 to the pump chamber 36, and to prevent flow of fluid from the pump chamber 36 to the fluid inlet 46.

A lower part of the housing 30 is provided with a cylindrical storage chamber 52 in which a reciprocating member 54 is arranged, the reciprocating member 54 being freely movable in axial direction in the storage chamber 52 between an upper position and a lower position. An annular seal 55 is provided between the reciprocating member 54 and the wall of the storage chamber 52. The storage chamber 52 is at the lower end thereof closed by means of a plug 56. The portion of the storage chamber 52 that is located between the reciprocating member 54 and

the plug 56 is filled with compressed Nitrogen gas, and is referred to as the gas chamber 57. The plug 56 is provided with a pressure gauge 58 for measuring the pressure of the Nitrogen gas.

A transfer channel 60 is formed in the housing 30, which transfer channel provides fluid communication between the pump chamber 36 and the storage chamber 52. A first check valve 62 allows flow of fluid from the pump chamber 36 to the storage chamber 52 via the transfer channel 60 and prevents flow of fluid through the transfer channel in reverse direction.

The storage chamber 52 has an outlet channel 64 formed in the housing 30, which outlet channel is at its upper end aligned with the passage 45 in the wall of the piston member 38 when the piston member is in the upper position. Thus, when the piston member 38 is in the upper position, the outlet channel 64 provides fluid communication between the storage chamber 52 and the coiled tubing 20. When the passage 45 is not aligned with the outlet channel 64, that is, when the piston member moves toward its lower position or moves from the lower position to the upper position, the outlet channel 64 is closed by a wall portion 66 of the piston member so that flow of fluid from the storage chamber 52 to the coiled tubing 20 is blocked. Further, the outlet channel 64 is provided with a second check valve 68 that allows flow of fluid from the storage chamber 52 to the coiled tubing 20 and prevents flow of fluid from the coiled tubing 20 to the storage chamber 52.

Referring further to Fig. 3 there is shown a second embodiment 70 of the pump assembly 22. The second embodiment 70 of the pump assembly is largely similar to the first embodiment 29 of the pump assembly, however

differing therefrom in the following aspects. The second embodiment 70 includes a housing 72 connected to the lower end of the coiled tubing 20, for example by a threaded connection. The housing 72 includes lower and upper housing sections 72a, 72b which are interconnected by a threaded connection 73.

An insert member 74 extends into an upper end of housing section 72a and into a lower end of housing section 72b. Annular spaces 78a to 78d are provided between the insert member 74 on one hand and the housing sections 72a, 72b on the other hand. The annular spaces 78a-d are sealed from each other and from the pump chamber 36 by appropriate annular seals (not shown). The insert member 74 has a fluid inlet 82 in fluid communication with the body of water 19 via annular space 78c and an inlet opening 84 in housing section 72a. The first check valve 62 is provided to allow flow of fluid from the fluid inlet 82 to the pump chamber 36, and to prevent flow of fluid from the pump chamber to the fluid inlet.

The storage chamber 52 has an outlet channel 64 formed by a bore 88 in the lower housing section 72a, a bore 89 in the insert member, and a bore 90 in the upper housing section 72b. The tubular portion 44 of the piston member 38 is provided with a series of radial passages 45 located between the annular seals 40a, 40b.

The bore 90 is at its upper end aligned with the passages 45 in the wall of the piston member 38 when the piston member is in the upper position. Thus, in this position the outlet channel 64 provides fluid communication between the storage chamber 52 and the coiled tubing 20. When the passages 45 are not aligned with the bore 90, that is, when the piston member moves

toward its lower position or moves from the lower position to the upper position, the outlet channel 64 is closed by the wall portion 66 of the piston member so that flow of fluid from the storage chamber 52 to the coiled tubing 20 is blocked. The second check valve 68 allows flow of fluid from the storage chamber 52 to the coiled tubing 20 via the outlet channel 64 and prevents flow of fluid through the outlet channel in reverse direction.

Referring further to Figs. 4 and 5 there is shown a third embodiment 92 of the pump assembly 22. The third embodiment 92 of the pump assembly is largely similar to the second embodiment 70 of the pump assembly, however differing therefrom in the following aspects. The third embodiment 92 comprises a housing 94 connected to the lower end of the coiled tubing 20, for example by a threaded connection. The housing 94 includes lower and upper housing sections 94a, 94b which are interconnected e.g. by a threaded connection. A tube 95 extends around the upper housing section 94b whereby an annular space 96 is defined between the tube 95 and the upper housing section 94b. The tube 95 is at both ends thereof sealed to the upper housing section 94b by suitable seals (not shown).

An insert member 97 extends into an upper end of housing section 94a and into a lower end of housing section 94b. The insert member 97 is retrievable from the housing 94 by means of a wireline (not shown) that may be lowered from surface into the wellbore. The wireline is connectable into a tubular upper portion 98 of the insert member 97, which upper portion is latched to housing section 94b by a latching mechanism 99. A lower portion 100 of the insert member is axially adjustable relative

to the upper portion 98. Annular spaces 102a-c are provided between the lower portion 100 on one hand and the housing sections 94a, 94b on the other hand. The annular spaces 102a-c are sealed from each other and from the pump chamber 36 by appropriate annular seals (not shown). The insert member 97 is provided with a fluid inlet 104 that is in fluid communication with the body of water 19 via an inlet opening 106 in housing section 94a. A check valve 108 is provided to open or close the fluid communication between the conduit 20 and the fluid inlet 104 and inlet opening 106.

The pump chamber 36 is in fluid communication with the storage chamber 52. The fluid communication is for instance via a transfer channel 110 formed in the tubular upper portion 98 of the insert member, a bore 112 provided in the insert member, and a bore 114 provided in the lower housing section 94a. The first check valve 62 allows flow of fluid from the pump chamber 36 to the storage chamber 52, but prevents flow of fluid in reverse direction.

The piston member 38 also is retrievable from the housing 94 by a wireline that is connectable into a tubular upper end 116 of the piston member. Thereto the piston member 38 is provided with a latching member 118 axially slidable relative to the tubular portion 44 of the piston member. The latching member 118 has fingers 120 that latch into a recess 121 at the inner surface of upper housing section 94b. The latching member 118 is provided with annular seals 122, 123 to seal the latching member to the tubular portion 44 of the piston member, and to housing section 94b.

The storage chamber 52 has an outlet channel 124 formed by bore 88 in the lower housing section 94a, a

bore 126 in the insert member, radial opening 111, annular space 96, and a series of radial bores 128 formed in upper housing section 94b. The radial bores 128 are aligned with the passages 45 in the wall of the piston member 38 when the piston member is in the upper position. Thus, in this position the outlet channel 124 provides fluid communication between the storage chamber 52 and the coiled tubing 20. When the passages 45 are not aligned with the radial bores 128, that is, when the piston member moves toward its lower position or moves from the lower position to the upper position, the outlet channel 124 is closed by the wall portion 66 of the piston member so that flow of fluid from the storage chamber 52 to the coiled tubing 20 is blocked. The second check valve 68 allows flow of fluid from the storage chamber 52 to the coiled tubing 20, but prevents flow of fluid in reverse direction.

During normal use of the first embodiment 29 of the pump assembly, the pump chamber initially contains a volume of water and the coiled tubing 20 is filled with water. A pump cycle of the pump assembly is started by actuating the surface pump 26 so as to induce a pressure increase in the water column in the coiled tubing 20. The magnitude of the pressure increase is selected such as to cause the piston member 38 to move from its upper position to its lower position thereby performing a pump stroke whereby the volume of water is pumped out of the pump chamber 36 and into the storage chamber 52 via the transfer channel 60. As a result the reciprocating member 54 moves downwardly and compresses the Nitrogen gas in the gas chamber 57. During the pump stroke, outflow of water from the storage chamber 52 via the outlet channel

64 is prevented since the outlet channel is blocked at its upper end by wall portion 66 of the piston member 38.

Upon arrival of the piston member 38 at its lower position, actuation of the surface pump 26 is stopped so that the fluid pressure in the coiled tubing 20 drops. As a result, the compression spring 41 causes the piston member 38 to move back to its upper position. The piston member 38 thereby draws a further volume of water from the wellbore 1 into the pump chamber 36 via the fluid inlet 46. As the piston member 38 arrives at its upper position, the radial passage 45 of the piston member 38 becomes aligned with the outlet channel 64. The outlet channel 64 is thereby no longer blocked by the wall portion 66 of the piston member, and the compressed Nitrogen gas in the gas chamber 57 causes the reciprocating member 54 to move upwardly thereby pumping the volume of water via the outlet channel 64 into the tubular portion 44 of the piston member 38 and thence further into the coiled tubing 20. From there, the volume of water flows is discharged via the outlet conduit 24 at surface. A next pump cycle is then started in similar manner whereby said further volume of water is pumped out of the wellbore, etc.

Normal use of the second embodiment 70 of the pump assembly is substantially similar to normal use of the first embodiment 29. During each pump cycle, the volume of water is pumped from the pump chamber 36 to the storage chamber 52 via the transfer channel 60, and from the storage chamber 52 to the coiled tubing 20 via the outlet channel 64. In case the pump assembly 70 needs to be disassembled, e.g. for maintenance purpose, the housing sections 72a, 72b are disconnected from each other at the threaded connection 73. Thereafter, the

insert member 74 can be removed from the housing sections 72a, 72b.

Normal use of the third embodiment 92 of the pump assembly is substantially similar to normal use of the first embodiment 29. During each pump cycle, the volume of water is pumped from the pump chamber 36 to the storage chamber 52 via the transfer channel 110, and from the storage chamber 52 to the coiled tubing 20 via the outlet channel 124.

Should it be required to retrieve the piston member 38 to surface, e.g. for maintenance purpose, a wireline is lowered into the coiled tubing 20 and connected to the tubular upper end 116 of the piston member. The wireline is then pulled back whereupon the fingers 120 of the latching member 118 unlatch from the recess 121 in the housing section 94b, and the piston member 38 together with the latching member 118 is retrieved to surface through the coiled tubing.

After the piston member 38 has been retrieved to surface, the insert member 97 also may be retrieved by means of the wireline that is lowered into the coiled tubing 20 and connected to the tubular upper portion 98 of the insert member 97. The wireline is then pulled back whereupon the latching mechanism 99 unlatches, and the insert member 97 is retrieved to surface through the coiled tubing.

In a variation of the detailed embodiments described above, a conductor cable extends from surface to the downhole pump assembly through the interior of the coiled tubing or outside the coiled tubing. The conductor cable may be used for transmitting downhole data to surface, for example data on the water level in the wellbore, downhole temperature, or downhole pressure.

The description above describes exemplary embodiments of the present invention, wherein various modifications are conceivable within the scope of the appended claims. Features of respective embodiments may for instance be combined.

C L A I M S

1. A pump device for pumping fluid from a wellbore, comprising:

- a piston member (38) movably arranged in a pump chamber (36) between a first position and a second position, in a manner allowing the piston member to perform a series of pump strokes, whereby at each pump stroke a volume of said fluid is pumped out of the pump chamber (36) by the piston member;

- a fluid conduit (20) arranged to move the piston member (38) from the first position to the second position by a selected fluid pressure increase in the fluid conduit;

- an inlet channel (60) connecting the pump chamber to a storage chamber (52) for receiving said volume of fluid from the pump chamber (36);

- first valve means (62) arranged in the inlet channel for allowing fluid flow from the pump chamber (36) to the storage chamber (52) and for preventing fluid flow from the storage chamber to the pump chamber;

- pressurising means (57) for applying hydraulic pressure to the volume of fluid in the storage chamber (52);

- an outlet channel (64) for discharging the volume of fluid from the storage chamber (52) into the fluid conduit (20);

- second valve means (68)for allowing fluid flow from the storage chamber (52) to the pump chamber (36) and for preventing fluid flow from the pump chamber to the fluid conduit (20);

- a fluid inlet (46) for inflow of said volume of fluid from the wellbore into the pump chamber (36);

and

- third valve means (50) to prevent outflow of fluid from the pump chamber (36) to the fluid inlet (46).

2. The device of claim 1, wherein the pressurising means include a reciprocating member (54) arranged in the storage chamber (52) and force means (57) for exerting a force to the reciprocating member (54) to press the reciprocating member against the volume of fluid in the storage chamber (52).

3. The device of claim 2, wherein said force means (57) comprise a volume of compressed gas.

4. The device of claim 3, wherein said volume of compressed gas comprises Nitrogen gas.

5. The device of any one of claims 1 to 4, wherein the second valve means comprise an opening (45) in a wall of the piston member (38).

6. The device of claim 5, wherein the opening (45) provides fluid communication between the outlet channel (64) and the interior of the conduit (20) in between successive pump strokes of the piston member for opening the outlet channel (64) when the opening (45) is aligned with the outlet channel, and for closing the outlet channel when the opening is not aligned with the outlet channel.

7. The device of 6, wherein the opening (45) provides fluid communication between the outlet channel (64) and the interior of the fluid conduit (20) when the piston member (38) is in the first position.

8. The device of any one of claims 1 to 7, wherein the wellbore is provided with a production tubing for transporting produced hydrocarbon fluid to surface, wherein the pump device is positioned in a lower portion

of the production tubing, and wherein the fluid conduit extends through the production tubing to surface.

9. The device of any one of claims 1 to 8, wherein the wellbore contains a body of water that has entered the wellbore from the surrounding earth formation, and wherein the device is arranged to pump water from the body of water via the fluid conduit to surface.

10. The device of any one of claims 1 to 9, wherein the pump device or a part thereof is retrievably connected to the conduit so as to allow the pump device or said part thereof to be retrieved through the fluid conduit to surface by means of a wire line.

11. The device of any one of claims 1 to 10, wherein the piston member is arranged to perform a series of return strokes alternatingly with the series of pump strokes, and wherein the device further comprises a spring (41) for inducing each return stroke, the spring being adapted to be compressed during each pump stroke by said selected fluid pressure increase in the fluid conduit (20).

12. A method of pumping fluid from a wellbore formed in an earth formation, the method comprising:

- providing a piston member (38) movably arranged in a pump chamber (36) between a first position and a second position, in a manner allowing the piston member to perform a series of pump strokes, whereby at each pump stroke a volume of said fluid is pumped out of the pump chamber (36) by the piston member;

- applying a selected fluid pressure increase in a fluid conduit (20) to move the piston member from the first position to the second position to induce a pump stroke;

- receiving said volume of fluid from the pump

chamber (36) in a storage chamber (52) via an inlet channel (60);

- arranging first valve means (62) in the inlet channel (60) for allowing fluid flow from the pump chamber (36) to the storage chamber (52) and for preventing fluid flow from the storage chamber to the pump chamber;

- applying hydraulic pressure to the volume of fluid in the storage chamber (52) using pressurising means (57);

- discharging the volume of fluid from the storage chamber (52) into the fluid conduit (20) via an outlet channel (64); and

- arranging second valve means (68) in the outlet channel (64) for allowing fluid flow from the storage chamber (52) to the pump chamber (36) and for preventing fluid flow from the pump chamber to the fluid conduit (20); and

- arranging third valve means (50) for allowing inflow of said volume of fluid from the wellbore via a fluid inlet (46) into the pump chamber (36), and to prevent outflow of fluid from the pump chamber (36) to the fluid inlet (46).

13. The method of claim 12, wherein the piston member performs a series of return strokes alternating with the series of pump strokes, wherein each return stroke is induced by a spring force applied to the piston member using a spring (41), and wherein the spring is compressed during each pump stroke by application of said selected fluid pressure increase in the fluid conduit.

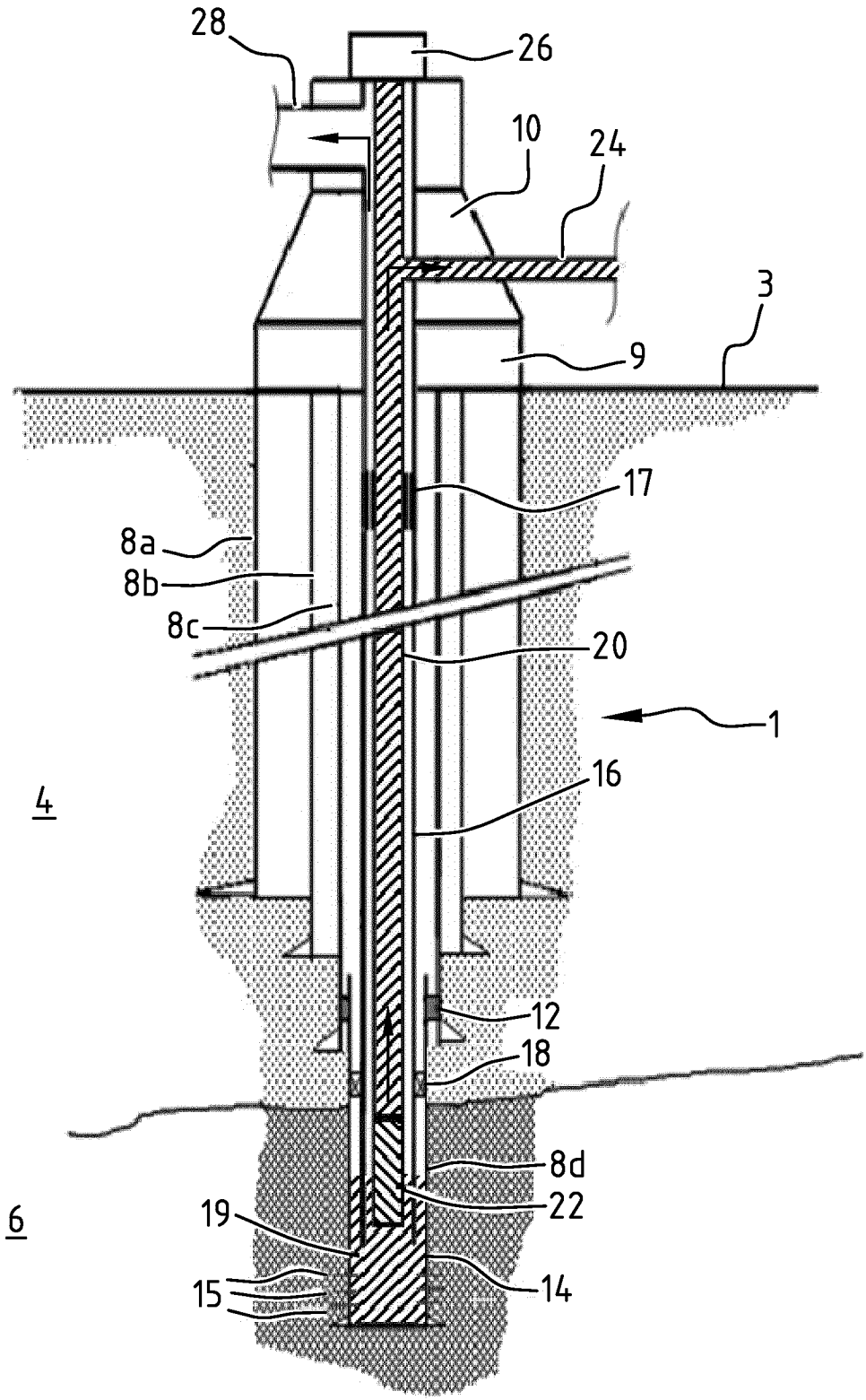


FIG. 1

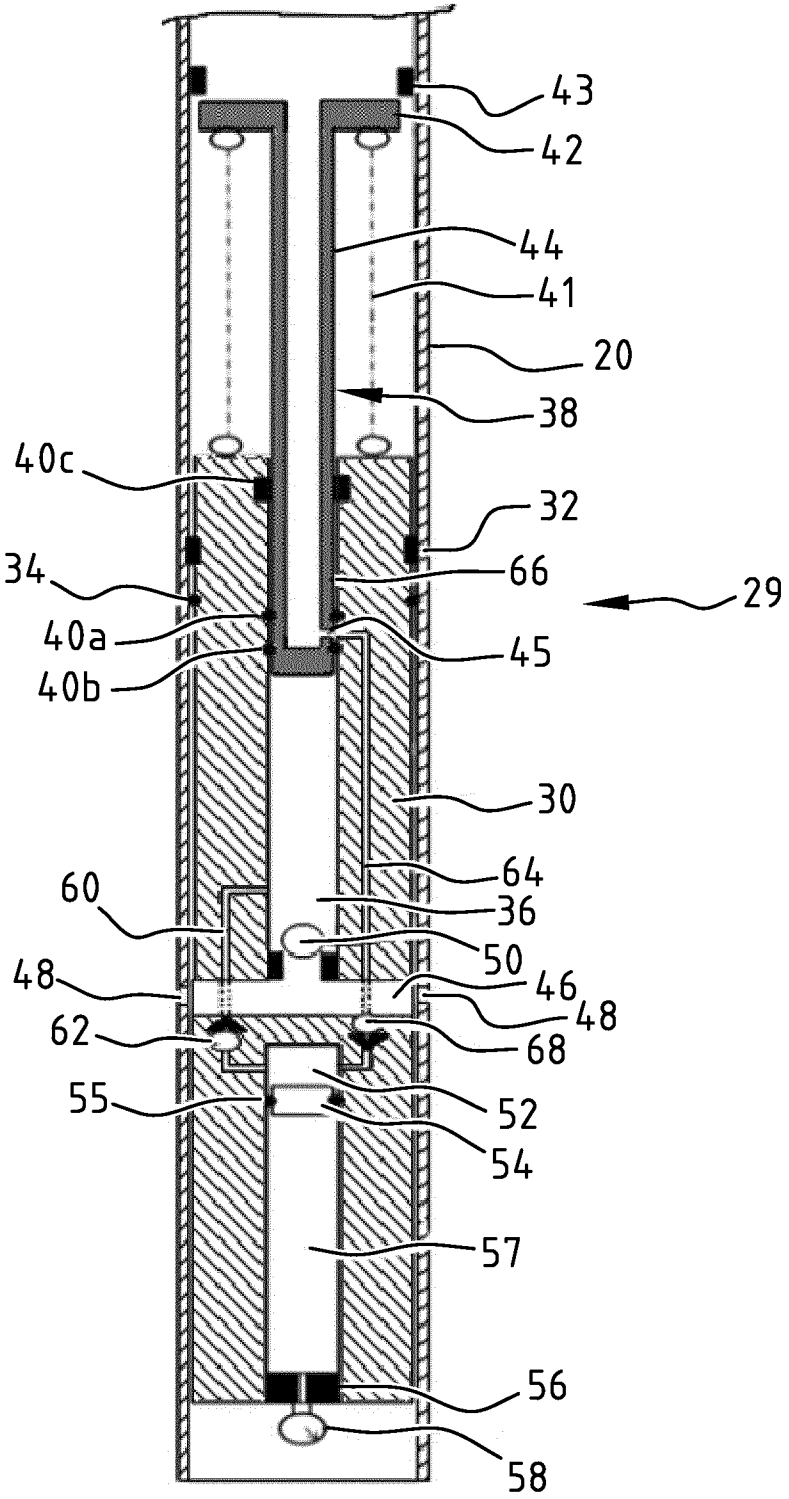

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45
40b
30
64
60
36
50
48
46
48
62
68
55
52
54
57
56
58

FIG. 2

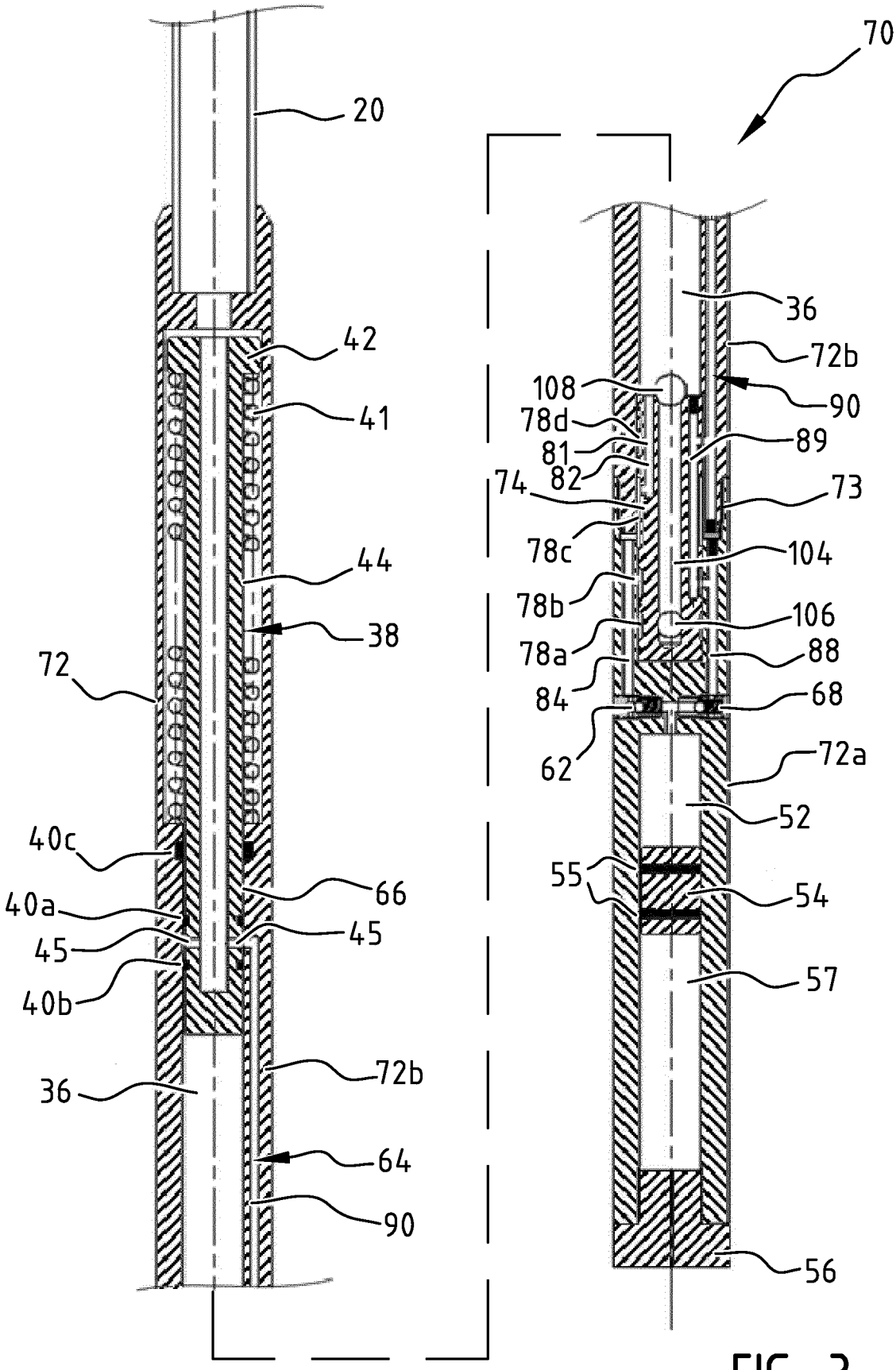

70
20
42
41
44
38
72
40c
66
40a
45
45
40b
72b
36
64
90
36
72b
108
90
78d
89
81
82
74
73
78c
104
78b
106
78a
88
84
68
62
72a
52
55
54
57
56

FIG. 3

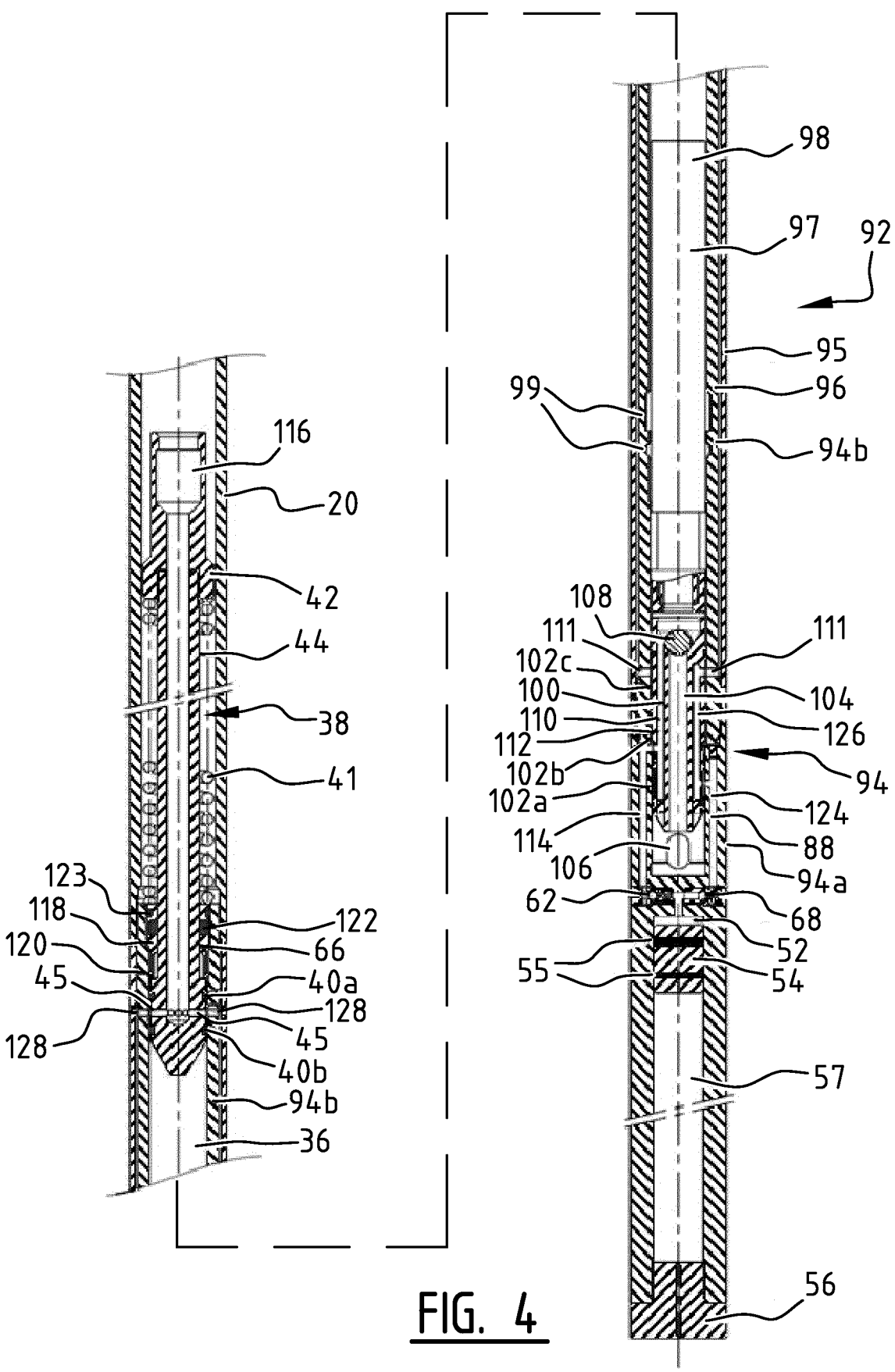

98
97
92
95
99
96
94b
116
20
42
44
38
41
123
118
120
45
128
122
66
40a
128
45
40b
94b
36
108
111
102c
100
110
112
102b
102a
114
106
62
55
111
104
126
94
124
88
94a
68
52
54
57
56

FIG. 4

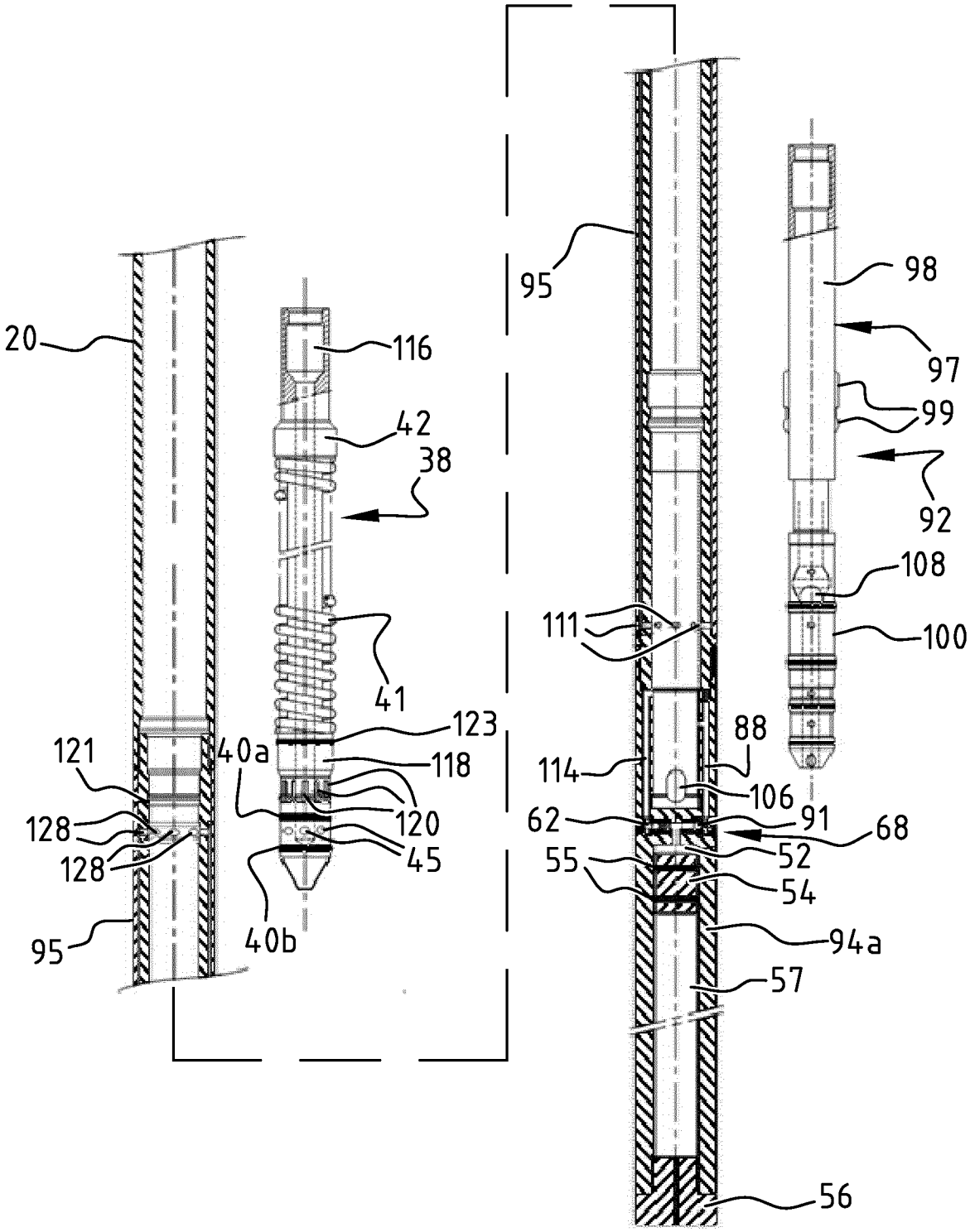

20
116
42
38
41
123
121
40a
118
120
128
128
45
95
40b
95
98
97
99
92
108
111
100
88
114
106
62
91
68
55
52
54
94a
57
56

FIG. 5