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(54) **A completion method and a downhole system**

(57) The present invention relates to a completion method for implementing a casing in a well containing liquid and having a top. The method comprises the steps of providing a one-way valve in a casing wall in a first end of the casing; filling the casing with gas; lowering the casing into the well while the liquid in the well prevents the gas from escaping through the valve; and introducing the first end of the casing into a substantially horizontal part of the well, whereby the gas provides buoyancy to the first end of the casing while moving the casing further into the well. Furthermore, the invention relates to a downhole system for carrying out the completion method.

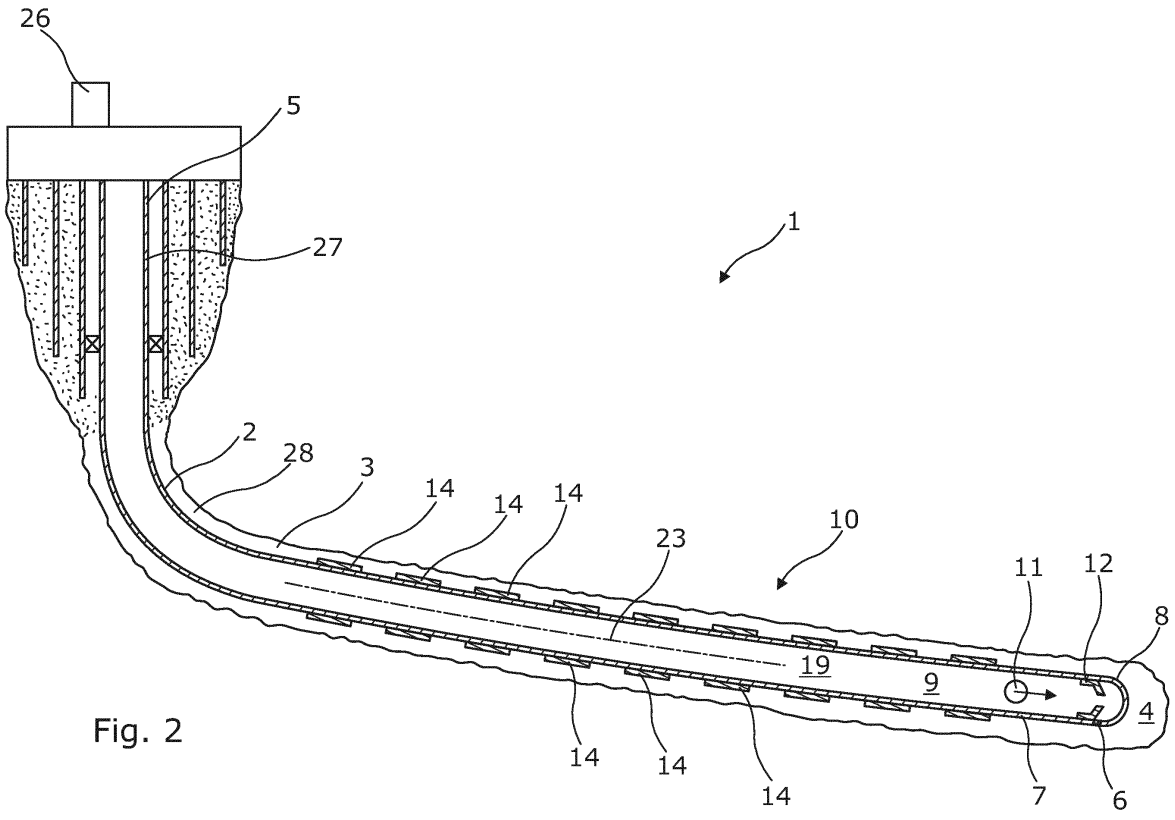

Fig. 2

EP 2 813 669 A1

Description

Field of the invention

[0001] The present invention relates to a completion method for implementing a casing in a well containing liquid and having a top. Furthermore, the invention relates to a downhole system for carrying out the completion method.

Background art

[0002] When completing a cased well, the casing is assembled at the rig and lowered into the borehole. Along the vertical part of the well, the force of gravity facilitates the lowering process, but when the casing enters the more horizontal part of the borehole, much more force is required to submerge the casing, and at some point, the casing cannot be pushed any further. Therefore, the length of cased wells is limited to the point where the casing by conventional methods cannot be submerged any further.

Summary of the invention

[0003] It is an object of the present invention to wholly or partly overcome the above disadvantages and drawbacks of the prior art. More specifically, it is an object to provide an improved completion method or completion system by which cased wells can be longer than by known methods/systems.

[0004] The above objects, together with numerous other objects, advantages and features, which will become evident from the below description, are accomplished by a solution in accordance with the present invention by a completion method for implementing a casing in a well containing liquid and having a top, the method comprising the steps of:

- providing a one-way valve in a casing wall in a first end of the casing,
- filling the casing with gas,
- lowering the casing into the well while the liquid in the well prevents the gas from escaping through the valve, and
- introducing the first end of the casing into a substantially horizontal part of the well, whereby the gas provides buoyancy to the first end of the casing while moving the casing further into the well.

[0005] In an embodiment, the completion method may further comprise the step of arranging the casing in a final position.

[0006] Furthermore, the completion method may further comprise the step of filling the casing with fluid and pressurising the fluid in order for the fluid to enter through the valve at the end of the casing to flush or clean the well.

[0007] Moreover, the completion method may further comprise the step of dropping a ball into the fluid in the casing and catching the ball in a slidable ball seat arranged at the first end of the casing, closer to the top of the well than the valve.

[0008] Finally, the completion method may further comprise the step of pressurising the fluid until the slidable ball seat slides into a position where the seat covers the valve, thereby closing the first end of the casing.

[0009] In an embodiment, the casing may further comprise annular barriers having tubular parts mounted as part of the casing and an expandable sleeve surrounding the tubular part with an opening through which fluid enters to expand the sleeve.

[0010] The completion method may further comprise the step of pressurising the fluid in the casing and expanding the expandable sleeves of the annular barriers.

[0011] Also, the completion method may further comprise the step of connecting the casing with a drill pipe/string before lowering the casing into the well.

[0012] In an embodiment, the fluid entering through the valve may be a cleaning fluid.

[0013] The present invention furthermore relates to a downhole system for carrying out the completion method for implementing a casing in a well containing liquid and having a top according to any of the preceding claims, the system comprising:

- the casing having a casing wall defining an inner space and having a first end, and
- a one-way valve arranged in the wall at the first end to prevent the liquid from entering the inner space.

[0014] The downhole system may further comprise a ball seat at the first end of the casing, the ball seat being arranged closer to the top of the well than the valve.

[0015] In one embodiment, the ball seat may be slidable from a first position to a second position, in which second position the ball seat closes an inlet of the valve.

[0016] Furthermore, the valve may comprise a burst disc for closing the valve when the disc is burst.

[0017] The downhole system may further comprise a plurality of annular barriers having tubular parts mounted as part of the casing, and an expandable sleeve surrounding the tubular part with an opening through which fluid enters in order to expand the sleeve.

[0018] Moreover, the downhole system may further comprise inflow control valves.

[0019] In an embodiment, the expandable sleeve may be made of metal and may be connected with the tubular part by means of connection parts, and the valve may be arranged in a part of the casing wall being parallel with an axial extension of the casing so that the ball seat having a tubular wall part is able to cover an inlet of the valve when being slided.

[0020] In another embodiment, the system may further comprise sliding sleeves arranged opposite the inflow control valves.

[0021] Additionally, the system may further comprise

frac ports for ejecting fluid out of the casing into the formation to fracture the formation.]

[0022] Finally, the system may further comprise a pump for pressurising the fluid.

Brief description of the drawings

[0023] The invention and its many advantages will be described in more detail below with reference to the accompanying schematic drawings, which for the purpose of illustration show some non-limiting embodiments and in which

Fig. 1 shows a cross-sectional view of a downhole system,

Fig. 2 shows the system of Fig. 1 in which a ball has been dropped,

Fig. 3A shows a, cross-sectional view of an end of the casing of Fig. 1, where the seat is in a first position,

Fig. 3B shows a cross-sectional view of an end of the casing of Fig. 1, where the seat is in a second position,

Fig. 4 shows a cross-sectional view of another embodiment of the end of the casing,

Fig. 5 shows a cross-sectional view of an annular barrier,

Fig. 6 shows the system of Fig. 1 where the annular barriers have been expanded, and

Fig. 7 shows a cross-sectional view of an end of the casing having a one-way valve.

[0024] All the figures are highly schematic and not necessarily to scale, and they show only those parts which are necessary in order to elucidate the invention, other parts being omitted or merely suggested.

Detailed description of the invention

[0025] Fig. 1 shows a downhole system 1 comprising a casing 2 arranged in a well 3 containing liquid 4. The well has a top 5 connected with a completion rig. The casing has a first end 8 arranged opposite the top end of the well. The casing has a casing wall 7 defining an inner space 19, and a one-way valve 6 is arranged in the wall at the first end in such a way that liquid in the annulus 28 is prevented from entering the inner space. The casing is filled with gas 9, such as air, which may be pressurised by means of a pump 26 fluidly connected with a second end 27 of the casing near the top. When introducing the first end 8 of the casing into a horizontal part 10 of the well, the gas 9 provides buoyancy to the first end while moving the casing further into the well comprising the liquid 4. This makes it much easier to insert the casing further into the well, and it makes it possible to make longer cased wells than with known systems, since a casing filled with gas can be pushed further into the borehole than a casing filled with liquid. By having a one-way valve arranged in the front end of the casing, it is still possible to subsequently fill the casing with liquid to flush or clean the annulus to perform a so-called "mud clean-out job" after the casing has been arranged in its final position. Thus, the valve hinders liquid from entering the well while the casing is being submerged, but subsequently allows liquid to enter to perform a mud clean-out.

[0026] When the well has been flushed, a ball 11 is dropped into the casing, as shown in Figs. 2 and 3A, which flows with the liquid until seating in a ball seat 12 arranged at the first end 8 of the casing, closer to the top of the well than the valve. The valve is arranged in a part of the casing wall 7 which is parallel with an axial extension 23 of the casing. In this way, a tubular wall part 24 of the ball seat 12 is able to cover an inlet 20 of the valve when the ball seat is being slided into a position opposite the valve. When the ball has been seated, the liquid pressure forces the ball seat to slide from a first position, shown in Fig. 3A, to a second position, shown in Fig. 3B, in which second position the ball seat closes the inlet 20 of the valve.

[0027] In Fig. 4, the valve comprises a burst disc 21 which is adapted to close the valve when the disc is burst by the seat 12 sliding along the inner face 31 of the casing.

[0028] As disclosed in Fig. 1, the downhole system 1 further comprises a plurality of annular barriers 14. The annular barriers each comprises a tubular part 15 mounted as part of the casing, as shown in Fig. 5. An expandable sleeve 16 surrounds the tubular part which has an opening 17 through which fluid enters in order to expand the sleeve, as indicated by the dotted line. The expandable sleeve is made of metal and is connected with the tubular part by means of connection parts 32. One connection part may be slidable while another may be fixed in relation to the tubular part. When the ball 11 is dropped and seated in the ball seat 12, the ball seat 12 slides and closes the valve 6, and the liquid pressure inside the casing can be increases to a pressure high enough to expand the annular barriers, as shown in Fig. 6.

[0029] In Fig. 7, the one-way valve 6 is arranged in the end of the casing having a ball seat where a ball is arranged between the seat and the bottom of the casing and is pressed against the ball seat by means of a coiled spring which functions as a one-way valve preventing fluid from the well from entering the casing while the casing is submerged into the well. The bottom of the casing has apertures for letting fluid enter through the valve 6 and further into the well.

[0030] As seen in Figs. 1 and 6, the downhole system 1 further comprises inflow control valves 22 which may be opened after completion of the well, which initiated

the production of hydrocarbon-containing fluid from the reservoir. The downhole system 1 may further comprise sliding sleeves arranged opposite the inflow control valves, which sleeves may subsequently be slided by means of a wireline tool. The downhole system 1 may further comprise frac ports 25 for ejecting fluid out of the casing and into the formation in order to fracture the formation to gain access to the hydrocarbon-containing fluid in the reservoir.

[0031] Completing a well according to the present invention begins by providing a one-way valve in a casing wall in a first end of the casing, the second end of the casing being closest to the top of the well. Then, the casing is filled with gas, such as air, and lowered into the well while the liquid in the well prevents the gas from escaping through the valve. When the first end of the casing is introduced into a horizontal part of the well, the gas provides buoyancy to the first end of the casing while moving the casing further into the well. Subsequently, the casing is filled with fluid, such as a liquid or a mixture of gas and liquid, and the fluid enters through the valve at the end of the casing in order to flush or clean the annulus surrounding the casing and thus clean the well. The fluid entering through the valve may be a cleaning fluid.

[0032] When the well has been cleaned, a ball is dropped into the fluid in the casing, and the ball flows with the fluid until it is caught in a slidable ball seat in the first end of the casing, closer to the top of the well than the valve. The fluid pressures the ball and moves the ball seat into a position where the seat covers the valve, thereby closing the first end of the casing.

[0033] Subsequently, the pressure is further increased and the expandable sleeves of the annular barriers are expanded one by one until all the sleeves are expanded.

[0034] By fluid or well fluid is meant any kind of fluid that may be present in oil or gas wells downhole, such as natural gas, oil, oil mud, crude oil, water, etc. By gas is meant any kind of gas composition present in a well, completion, or open hole, and by oil is meant any kind of oil composition, such as crude oil, an oil-containing fluid, etc. Gas, oil, and water fluids may thus all comprise other elements or substances than gas, oil, and/or water, respectively.

[0035] By a casing is meant any kind of pipe, tubing, tubular, liner, string etc. used downhole in relation to oil or natural gas production.

[0036] Although the invention has been described in the above in connection with preferred embodiments of the invention, it will be evident for a person skilled in the art that several modifications are conceivable without departing from the invention as defined by the following claims.

Claims

1. A completion method for implementing a casing (2) in a well (3) containing liquid (4) and having a top (5), the method comprising the steps of:

- providing a one-way valve (6) in a casing wall (7) in a first end (8) of the casing,
- filling the casing with gas (9),
- lowering the casing into the well while the liquid in the well prevents the gas from escaping through the valve, and
- introducing the first end of the casing into a substantially horizontal part (10) of the well, whereby the gas provides buoyancy to the first end of the casing while moving the casing further into the well.

2. A completion method according to claim 1, further comprising the step of arranging the casing in a final position.

3. A completion method according to any of the preceding claims, further comprising the step of filling the casing with fluid and pressurising the fluid in order for the fluid to enter through the valve at the end of the casing to flush or clean the well.

4. A completion method according to any of the preceding claims, further comprising the step of dropping a ball (11) into the fluid in the casing and catching the ball in a slidable ball seat (12) arranged at the first end of the casing, closer to the top of the well than the valve.

5. A completion method according to any of the preceding claims, further comprising the step of pressurising the fluid until the slidable ball seat slides into a position where the seat covers the valve, thereby closing the first end of the casing.

6. A completion method according to any of the preceding claims, wherein the casing further comprises annular barriers (14), each annular barrier having a tubular part (15) mounted as part of the casing and an expandable sleeve (16) surrounding the tubular part with an opening (17) through which fluid enters to expand the sleeve.

7. A completion method according to any of the preceding claims, further comprising the step of pressurising the fluid in the casing and expanding the expandable sleeves of the annular barriers.

8. A completion method according to any of the preceding claims, further comprising the step of connecting the casing with a drill pipe/string (18) before lowering the casing into the well.

9. A downhole system (1) for carrying out the completion method for implementing a casing (2) in a well

(3) containing liquid (4) and having a top (5) according to any of the preceding claims, the system comprising:

- the casing having a casing wall (7) defining an inner space (19) and having a first end (8), and
- a one-way valve (6) arranged in the wall at the first end to prevent the liquid from entering the inner space.

10. A downhole system according claim 9, further comprising a ball seat (12) at the first end of the casing, the ball seat being arranged closer to the top of the well than the valve.

11. A downhole system according claim 10, wherein the ball seat is slidable from a first position to a second position, in which second position the ball seat closes an inlet (20) of the valve.

12. A downhole system according any of claims 9-11, wherein the valve comprises a burst disc (21) for closing the valve when the disc is burst.

13. A downhole system according any of claims 9-12, further comprising a plurality of annular barriers (14) having tubular parts (15) mounted as part of the casing, and an expandable sleeve (16) surrounding the tubular part with an opening (17) through which fluid enters to expand the sleeve.

14. A downhole system according any of claims 9-13, further comprising inflow control valves (22).

15. A downhole system according any of claims 9-13, wherein the expandable sleeve is made of metal and is connected with the tubular part by means of connection parts, and the valve is arranged in a part of the casing wall being parallel with an axial extension (23) of the casing so that the ball seat having a tubular wall part (24) is able to cover an inlet (20) of the valve when the ball seat is being slided.

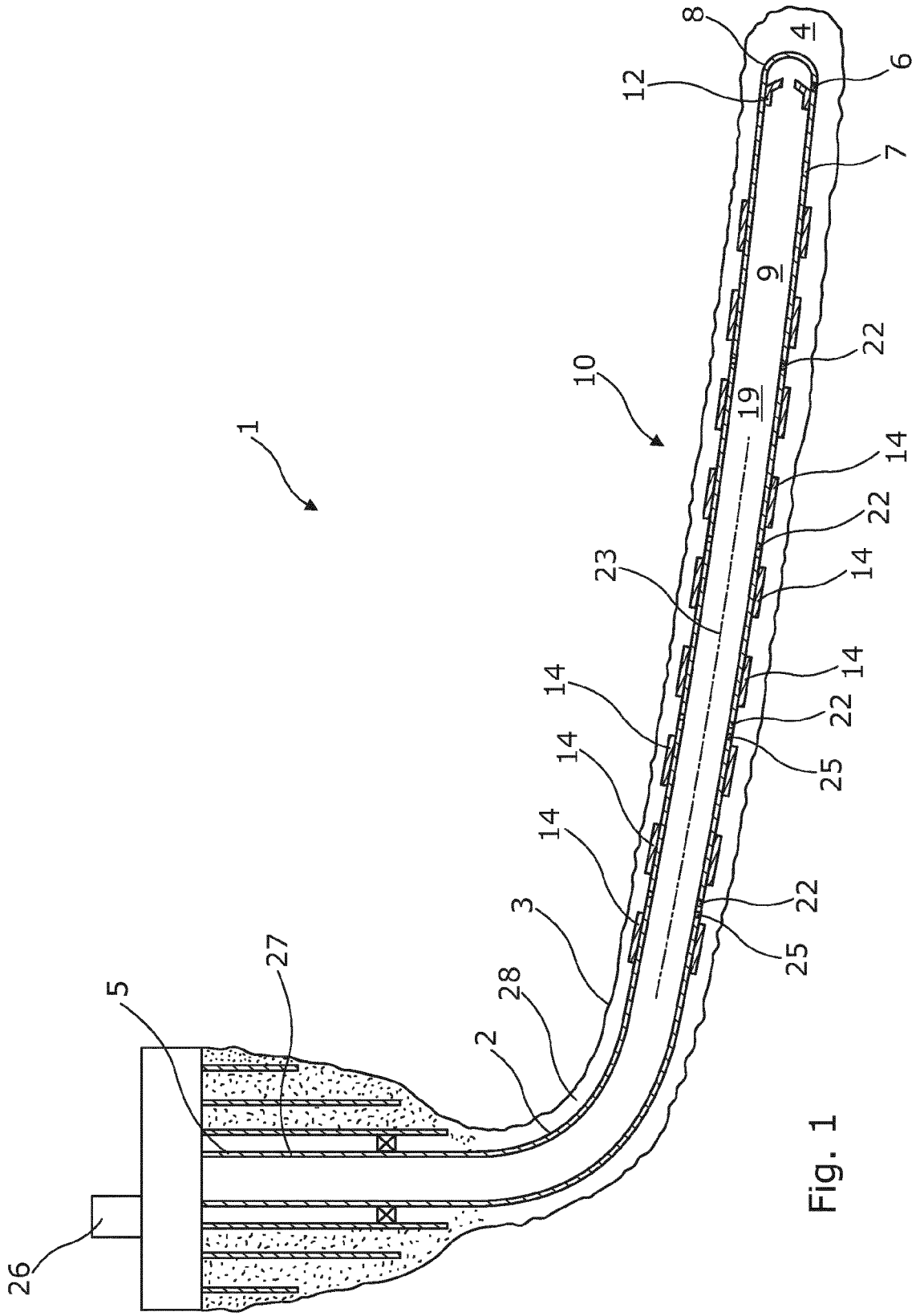

Fig. 1

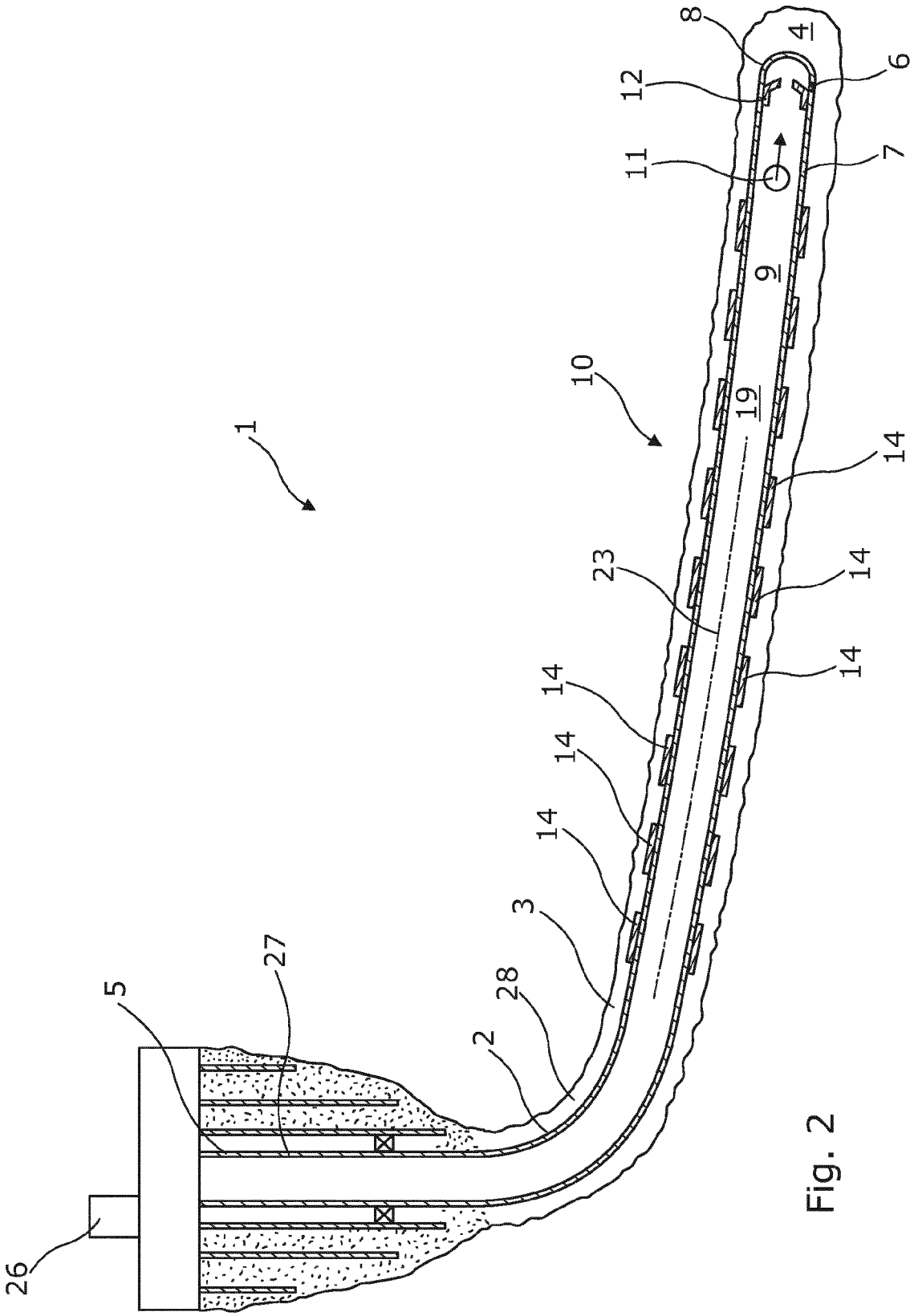

Fig. 2

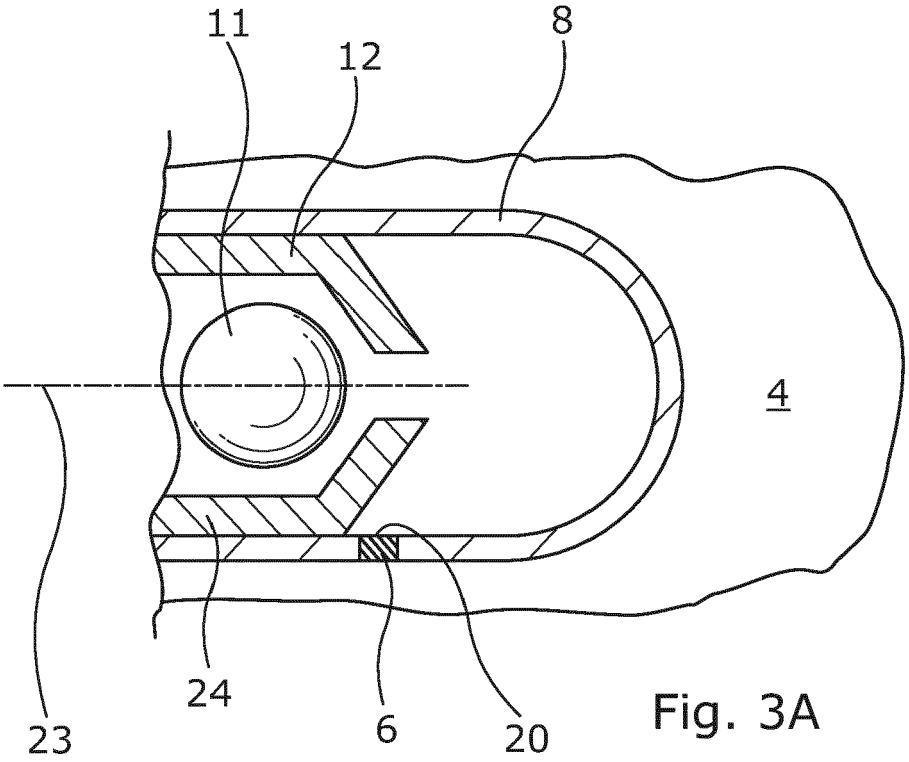

Fig. 3A

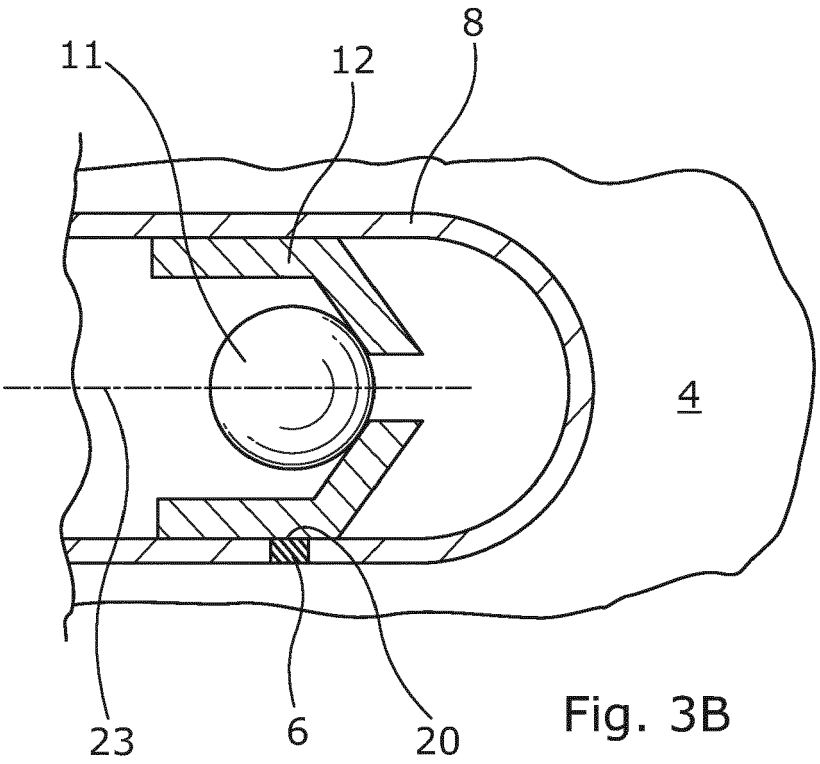

Fig. 3B

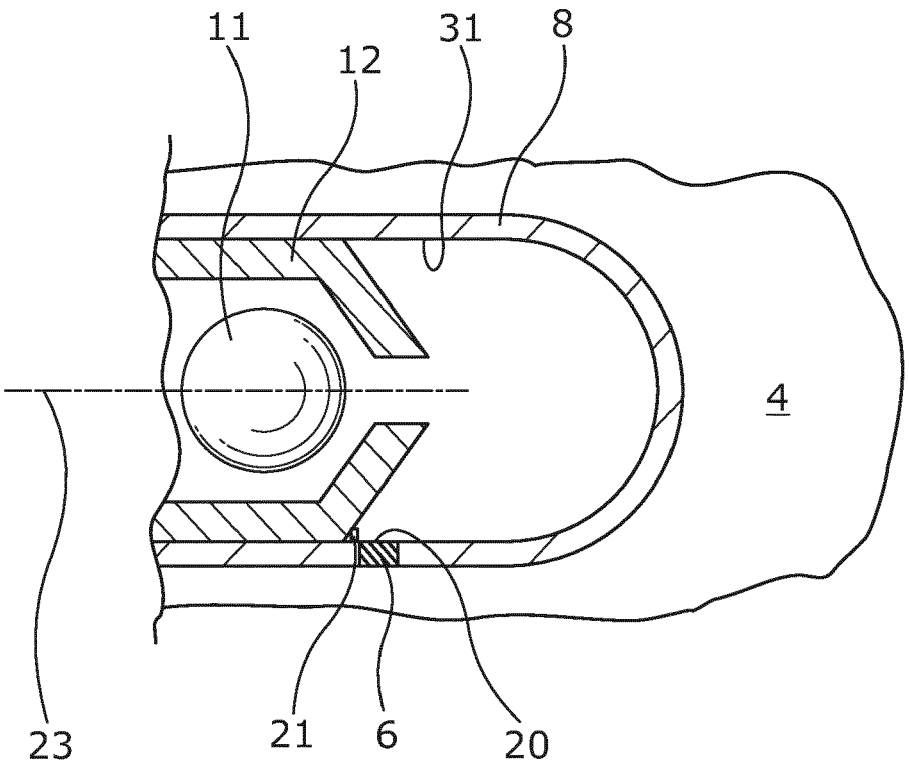

Fig. 4

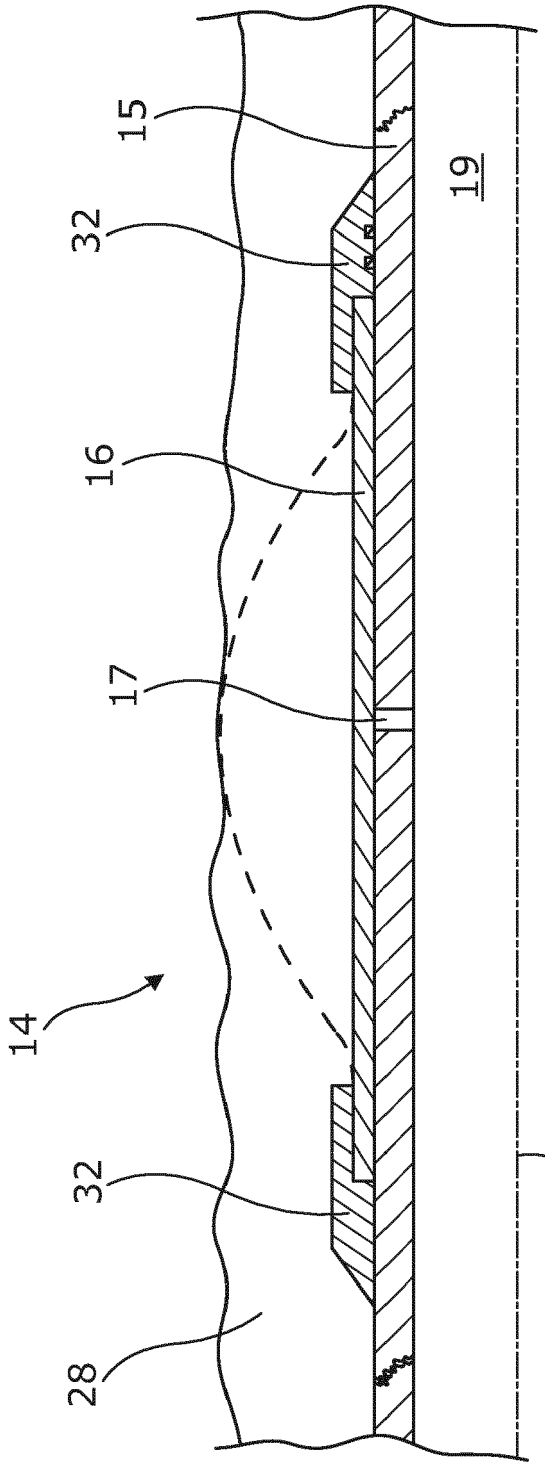

Fig. 5

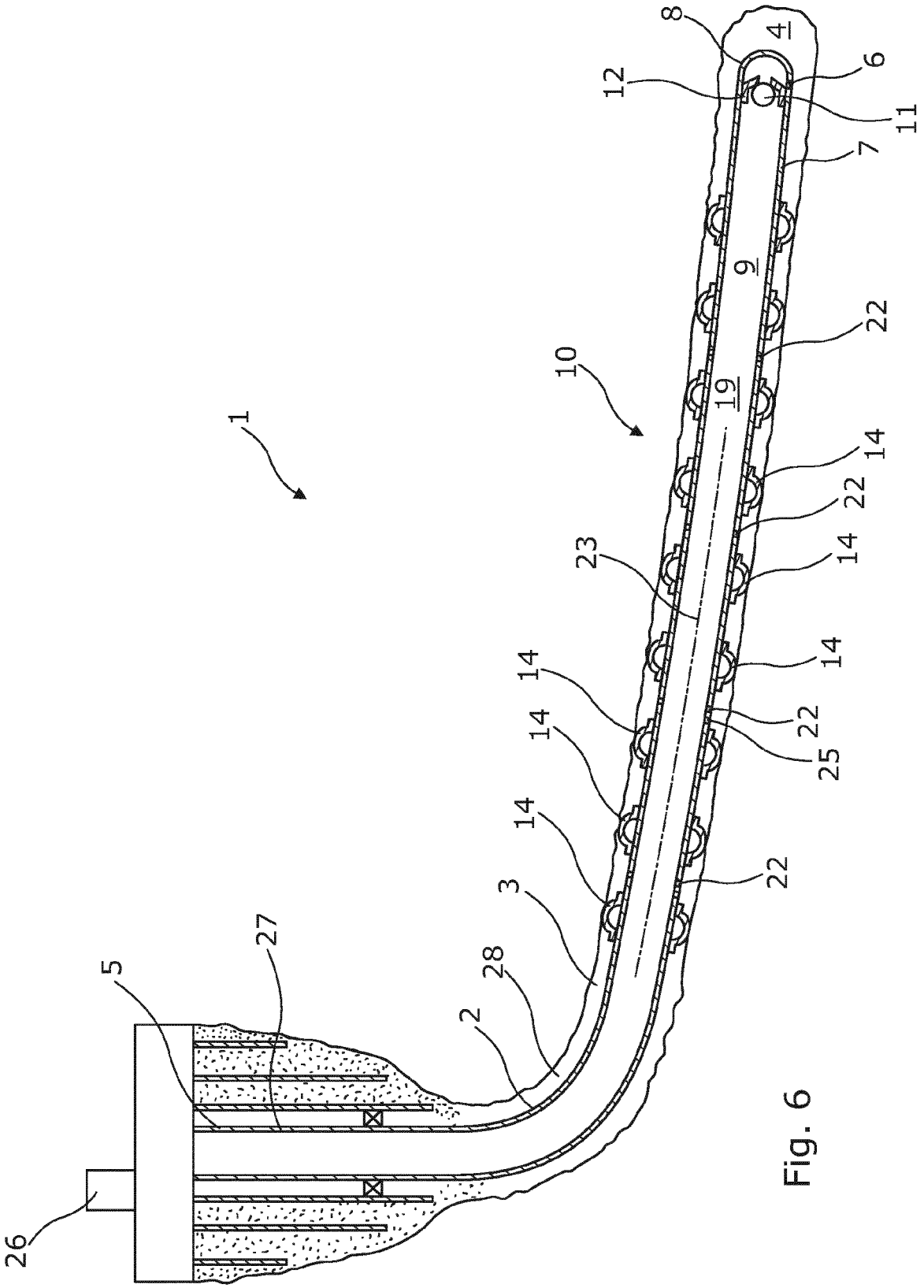

Fig. 6

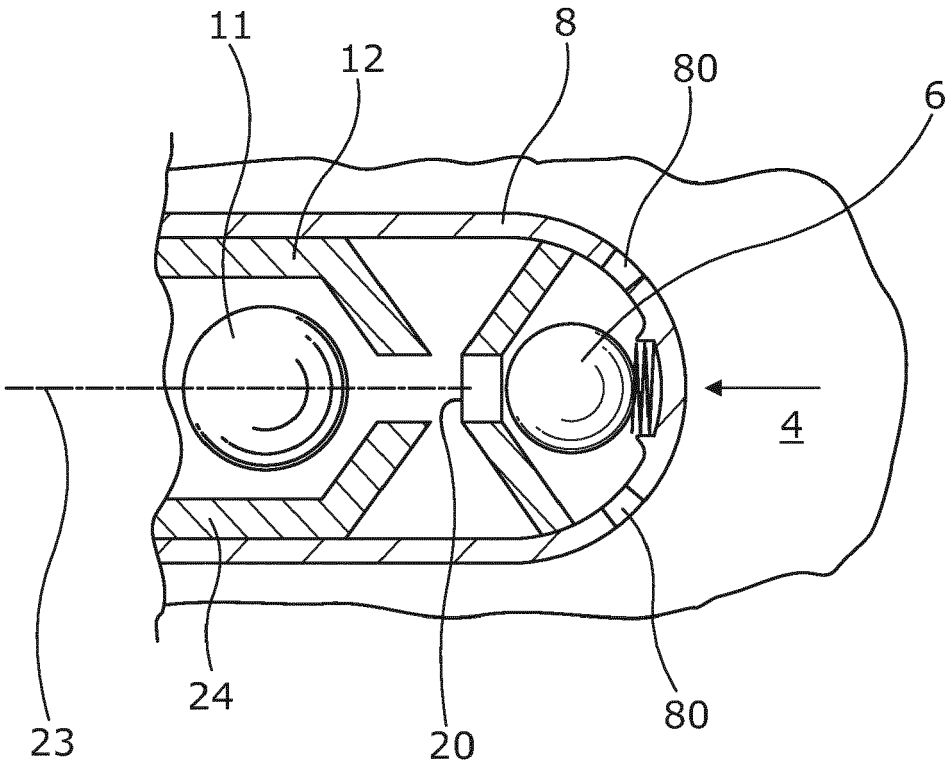

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 13 17 2062

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 November 2013	Wehland, Florian

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EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT

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