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(54) **OFFSHORE METHOD**

(57) The present invention relates to an offshore method for preparing a well for production of hydrocarbon-containing fluids from a wellbore, comprising installation of a drilling rig (4) for drilling at least part of the wellbore, drilling a first part (5) of the wellbore, installation of a surface casing (6), connecting a drilling blowout preventer (7) with a top of the surface casing, e.g. via a wellhead, i.e. directly or indirectly via a wellhead, drilling a second part (9) of the wellbore, installation of a production casing (10) having a first end part (11) being closest to the top of the surface casing and a second end part (12). The production casing comprising a plurality of annular barriers (20), each annular barrier having a tubular metal part (21) mounted as part of the production casing and an expandable metal sleeve (22) surrounding the tubular metal part and having an inner face (23) facing the tubular metal part and an outer face (24) facing an inner face (25) of the wellbore of the well, each end (26) of the expandable metal sleeve being connected with the tubular metal part, and an annular space between the inner face of the expandable metal sleeve and the tubular metal part, the expandable metal sleeve being configured to expand: expanding the expandable metal sleeves of the annular barriers in order that the expandable metal sleeves abut the inner face of the wellbore, installation of a plug (28) in the first end part of the production casing sealing off an inside of the production casing, disconnecting the drilling blowout preventer from the top of the surface casing, connecting a production tree (19) with a wellhead, disconnecting the drilling rig from the well, removing the plug, and initiating production. The invention also relates to a downhole system derived from the method according to the present invention.

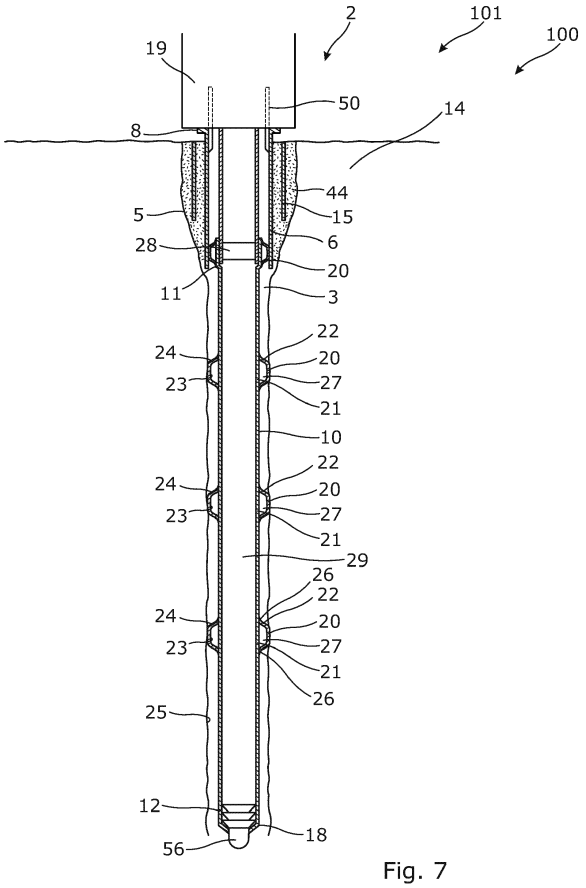

Fig. 7

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Description

[0001] The present invention relates to an offshore method for preparing a well for production of hydrocarbon-containing fluids from a wellbore. The invention also relates to a downhole system derived from the method according to the present invention.

[0002] The Deepwater Horizon oil spill, also referred to as the oil spill in the Gulf of Mexico or the Macondo blowout, is an oil spill which flowed unabated for three months in 2010. This blowout is considered one of the largest accidental marine oil spills in the history of the petroleum industry, and the spill stemmed from a seafloor oil gush which was a result of the 20 April 2010 explosion of the Deepwater Horizon rig which drilled on the Macondo Prospect. It is believed that one of the primary reasons for the cause of the blowout was a defective cement job during completion of the well. Cement is used to seal between a first tubular and a borehole wall and between the first tubular and the next tubular. The cement is injected, and for some reason, the cement settles in the intended space and during this process, unwanted pockets are formed in the cement or the cement disappears in an unexpected fracture in the formation. If the cement does not sufficiently fill the annular space, e.g. between the first tubular and the borehole wall, the oil may leak during production and gush through the cement or along the tubular, and an oil spill disaster may be a consequence of this.

[0003] After the Macondo blowout, ensuring well integrity has been an increased focus of governments around the world, and thus also of the oil industry. To this effect, the downhole barrier systems incorporated in the well completion designs have been brought into focus to improve the well integrity.

[0004] Due to the low price on an oil barrel, the recent focus has been on costs and how the wells can be completed at a lower cost, in order that the oil production can give return on investment at an earlier stage.

[0005] 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 offshore method providing a less expensive way of drilling and completing a well without jeopardising the safety and thus still ensuring well integrity.

[0006] 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 an offshore method for preparing a well for production of hydrocarbon-containing fluids from a wellbore, comprising:

- installation of a drilling rig for drilling at least part of the wellbore,
- drilling a first part of the wellbore,
- installation of a surface casing,
- connecting a drilling blowout preventer with a top of the surface casing, e.g. via a wellhead, i.e. directly or indirectly via a wellhead,
- drilling a second part of the wellbore,
- installation of a production casing having a first end part being closest to the top of the surface casing and a second end part, the production casing comprising a plurality of annular barriers, each annular barrier having a tubular metal part mounted as part of the production casing and an expandable metal sleeve surrounding the tubular metal part and having an inner face facing the tubular metal part and an outer face facing an inner face of the wellbore of the well, each end of the expandable metal sleeve being connected with the tubular metal part, and an annular space between the inner face of the expandable metal sleeve and the tubular metal part, the expandable metal sleeve being configured to expand,
- expanding the expandable metal sleeves of the annular barriers in order that the expandable metal sleeves abut the inner face of the wellbore,
- installation of a plug in the first end part of the production casing sealing off an inside of the production casing,
- disconnecting the drilling blowout preventer from the top of the surface casing,
- connecting a production tree with a wellhead,
- disconnecting the drilling rig from the well,
- removing the plug, and
- initiating production.

[0007] Furthermore, the drilling rig may be disconnected after the expandable metal sleeves of the annular barriers have been expanded before production is initiated.

[0008] The offshore method as described above may further comprise circulating cleaning fluids.

[0009] The offshore method as described above may further comprise circulating cleaning fluids before expansion of the expandable metal sleeves of the annular barriers for cleaning the wellbore from drilling mud.

[0010] Also, the installation of the production casing may be performed by means of a drill pipe connected to the first end part of the production casing.

[0011] Moreover, the production casing may comprise at least one valve arranged between two annular barriers, the valve being closed when disconnecting the drilling rig.

[0012] In addition, the production casing may comprise at least one valve arranged between two annular barriers, the valve being closed when disconnecting the drilling rig providing a well integrity barrier.

[0013] The offshore method as described above may further comprise installation of a downhole safety valve which is closed when disconnecting the drilling rig.

[0014] Moreover, the offshore method as described above may further comprise installation of a downhole safety valve which is closed when disconnecting the drilling rig, providing a well integrity barrier.

[0015] Additionally, the production casing below the

plug may be filled with liquid when disconnecting the drilling rig.

[0016] Furthermore, the production casing below the plug may be filled with liquid when disconnecting the drilling rig, providing a well integrity barrier.

[0017] Also, the production casing above the plug may be filled with liquid when disconnecting the drilling rig.

[0018] Also, the production casing above the plug may be filled with liquid when disconnecting the drilling rig, providing a well integrity barrier.

[0019] The liquid may be sea water or brine.

[0020] The offshore method as described above may further comprise cementing an annulus between the production casing and an inner face of the wellbore.

[0021] Moreover, the installation of the production casing may comprise a rotation of the production casing.

[0022] In addition, cleaning fluid, such as acid, may be circulated out of the second end part of the production casing while installing the production casing.

[0023] Further, cleaning fluid, such as acid, may be circulated out of the second end part of the production casing while installing the production casing for cleaning the wellbore from drilling mud.

[0024] A dart may be circulated to the second end of the production casing, landing and closing the second end part before expansion of the expandable metal sleeves of the annular barriers.

[0025] The offshore method as described above may further comprise hanging off the production casing in a liner hanger or in a wellhead.

[0026] Also, the production casing may have a receptacle at the first end.

[0027] Furthermore, the production casing may comprise gas lift valves.

[0028] Moreover, the liquid above the plug may be brine.

[0029] The plug may be a glass plug.

[0030] Finally, the present invention also relates to a downhole system derived from the offshore method as described above.

[0031] 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 partly cross-sectional view of an initial part of an offshore wellsite having a well being made by means of a drilling rig which has its legs founded in the seafloor adjacent to the well to be completed,

Fig. 2 shows the offshore wellsite of Fig. 1 where a drilling blowout preventer has been installed in the top of the well and a second part of the wellbore is being drilled,

Fig. 3 shows the offshore wellsite of Fig. 2 where a production casing is being installed,

Fig. 4 shows the offshore wellsite of Fig. 3 where expandable metal sleeves of annular barriers of the production casing are expanded to create zonal isolation,

Fig. 5 shows the offshore wellsite of Fig. 4 where an upper production casing is installed,

Fig. 6 shows the offshore wellsite of Fig. 5 where a plug is set in the production casing,

Fig. 7 shows the offshore wellsite of Fig. 6 where the drilling blowout preventer has been replaced with a production tree and the drilling rig has been disconnected,

Fig. 8 shows the well where the production has been initiated, and

Fig. 9 shows another offshore wellsite in which cement is displaced into the annulus before the annular barriers are expanded.

[0032] 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.

[0033] Fig. 1 shows a wellsite 100 where legs of a drilling rig 4 are mounted into a seabed 14 adjacent an offshore well 2 which is being prepared, i.e. drilled and completed for production of hydrocarbon-containing fluids from a wellbore 3. First, the drilling rig 4 is installed and a first part 5 of the wellbore is drilled, and then a conductor pipe 15 is arranged and after that, a surface casing 6 is arranged in the first part of the wellbore and both are cemented in place.

[0034] In Fig. 2, a drilling blowout preventer 7 has been connected with a top 8 of the surface casing, e.g. via a wellhead (not shown), thus the drilling blowout preventer 7 may be connected directly to or via a wellhead as shown in Fig. 9. Then, a second part 9 of the wellbore has been drilled by a drill string 41 and a drilling head 42.

[0035] Then a production casing 10 is installed, as shown in Fig. 3. The production casing 10 has a first end part 11 which is closest to the top 8 of the surface casing and the production casing further has a second end part 12 arranged low in the wellbore. The production casing 10 comprises a plurality of annular barriers 20. Each annular barrier has a tubular metal part 21 mounted as part of the production casing and an expandable metal sleeve 22 surrounding the tubular metal part. The expandable metal sleeve has an inner face 23 facing the tubular metal part and an outer face 24 facing an inner face 25 of the wellbore of the well. Each end 26 of the expandable metal sleeve is connected with the tubular metal part providing an annular space 27 (shown in Fig. 4) between the inner face of the expandable metal sleeve and the tubular metal part. The production casing is inserted into the wellbore

by means of drill pipe connected to the first end part 11, e.g. by means of a running tool 17 or a similar connection unit.

[0036] The expandable metal sleeve 22 is configured to expand, e.g. by pressurised fluid from within the production casing 10, as shown in Fig. 4, where the expandable metal sleeves 22 of the annular barriers 20 have been expanded in order that the outer face 24 of the expandable metal sleeves 22 abut the inner face 25 of the wellbore. The second end part 12 of the production casing 10 is closed by inserting a dart 56, circulated to the second end part 12 of the production casing 10 landing and closing the second end 18 of the production casing before expansion of the expandable metal sleeves 22 of the annular barriers 20.

[0037] In Fig. 5, a second and upper production casing 10A is installed in the first part of the wellbore overlapping the lower production casing 10, 10B by docking into a receptacle 58 at the first end part 11 of the lower production casing 10. Seals are provided therebetween. Thus, the production casing 10 in Fig. 5 comprises an upper production casing 10A and a lower production casing 10B. In another embodiment, the production casing 10 extends all the way to the seabed.

[0038] In Fig. 6, a plug 28 is installed in the first end part 11 of the production casing 10 sealing off an inside 29 of the production casing. The plug is set in the upper production casing 10A in fig. 6, but it may also be set in the lower production casing 10B in another embodiment.

[0039] When having the plug installed, the wellbore is sealed off, and the drilling blowout preventer can safely be disconnected from the top 8 of the surface casing 6, as shown in Fig. 7, where also a production tree 19 has been connected with a wellhead 50 at the top 8 of the surface casing 6. Then the drilling rig is disconnected from the well 2, as shown in Fig. 7. A downhole safety valve 54 may be installed, as shown in Fig. 8.

[0040] After disconnecting the drilling blowout preventer and the drilling rig 4 and after connecting the production tree 19, the plug is removed and production of hydrocarbon containing fluid is initiated, e.g. early production or straight to production, as shown in Fig. 8. Thus, the drilling rig 4 is disconnected after the expandable metal sleeves 22 of the annular barriers 20 have been expanded and before production is initiated. In this way, the annular barriers 20 provide a first well integrity barrier between the wall of the wellbore and the production casing 10. The plug, shown in Figs. 6 and 7, provides a second well integrity barrier in the production casing 10. The cement 44 between the first part of the wellbore and the conductor pipe and the cement between the conductor pipe and the surface casing provides a third well integrity barrier. If a downhole safety valve 54 (shown in Fig. 8) is installed before disconnecting the drilling rig, the closed downhole safety valve provides a fourth well integrity barrier, and thus creates a well integrity barrier when disconnecting the rig. The production casing 10 below the plug is filled with liquid when disconnecting the drilling rig which provides a well integrity barrier and thus a fifth well integrity barrier. The production casing 10 above the plug is filled with liquid when disconnecting the drilling rig which provides a well integrity barrier and thus a sixth well integrity barrier. In the first end part 11 of the production casing 10, an annular barrier 20 is expanded providing a well integrity barrier between the surface casing and the production casing, providing a seventh well integrity barrier. Thus, providing a plug and having expanded all the annular barriers, it is safe to disconnect the drilling rig before initiating production and thus approximately 45 days of rig time can be saved, minimising costs by at least 30-50 million US dollars. The many well integrity barriers provide even further safety if the authority requires.

[0041] Before expanding the expandable metal sleeves of the annular barriers, cleaning fluid such as acid, is circulated out of the second end 12 of the production casing 10, e.g. while installing the production casing, to clean the wellbore from drilling mud. When inserting the production casing, a rotation of the production casing may be performed to ease the insertion of the production casing into the wellbore. The plug may be a glass plug or a similar plug.

[0042] In Fig. 8, the production casing comprises at least one valve 53 arranged between two annular barriers 20. The valve is closed when disconnecting the drilling rig providing a well integrity barrier being an eighth well integrity barrier. The production casing also comprises gas lift valves 59 in order to provide a gas lift if needed later on.

[0043] The liquid below or above the plug may be sea water or well fluid, and the liquid may also be brine so that the liquid can always be circulated if needed before production.

[0044] The offshore method as described in relation to describing the above figures, may also comprise cementing an annulus 55 between the production casing and an inner face of the wellbore, as shown in Fig. 9. The cement 44 is displaced down in the production casing 10 and it is arranged in front of the dart in order that the cement is forced out of the second end 18 by forcing the dart downwards by a pressurised fluid upstream of the dart. When the dart seats in the seat in the second end of the production casing 10, the production casing is pressurised and the expandable metal sleeves of the annular barriers are expanded by the pressurised fluid entering through openings in the tubular metal part of the production casing, allowing the pressurised fluid to enter the space of the annular barriers and thus forcing the expandable metal sleeves radially outwards. The method may further comprise hanging off the production casing in a liner hanger 57 or in a wellhead 50, as shown in Fig. 9. The invention further relates to the downhole system 101 derived from the above described method.

[0045] The valves of the production casing 10 may be opened e.g. by applying acid to dissolve an acid dissolvable plug or they may be opened by an intervention tool,

such as a key tool engaging e.g. grooves in a sliding sleeve.

[0046] By 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.

[0047] By an annular barrier is meant an annular barrier comprising a tubular metal part mounted as part of the well tubular metal structure and an expandable metal sleeve surrounding and connected to the tubular part defining an annular barrier space.

[0048] By a production casing, intermediate casing, surface casing or well tubular metal structure is meant any kind of pipe, tubing, tubular, liner, string etc. used downhole in relation to oil or natural gas production.

[0049] In the event that the tool is not submergible all the way into the casing, a downhole tractor can be used to push the tool all the way into position in the well. The downhole tractor may have projectable arms having wheels, wherein the wheels contact the inner surface of the casing for propelling the tractor and the tool forward in the casing. A downhole tractor is any kind of driving tool capable of pushing or pulling tools in a well downhole, such as a Well Tractor®.

[0050] 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. An offshore method (1) for preparing a well (2) for production of hydrocarbon-containing fluids from a wellbore (3), comprising:

   - installation of a drilling rig (4) for drilling at least part of the wellbore,
   - drilling a first part (5) of the wellbore,
   - installation of a surface casing (6),
   - connecting a drilling blowout preventer (7) with a top (8) of the surface casing, e.g. via a wellhead (50),
   - drilling a second part (9) of the wellbore,
   - installation of a production casing (10) having a first end part (11) being closest to the top of the surface casing and a second end part (12), the production casing comprising a plurality of annular barriers (20), each annular barrier having a tubular metal part (21) mounted as part of the production casing and an expandable metal sleeve (22) surrounding the tubular metal part and having an inner face (23) facing the tubular metal part and an outer face (24) facing an inner face (25) of the wellbore of the well, each end (26) of the expandable metal sleeve being connected with the tubular metal part, and an annular space (27) between the inner face of the expandable metal sleeve and the tubular metal part, the expandable metal sleeve being configured to expand,
   - expanding the expandable metal sleeves of the annular barriers in order that the expandable metal sleeves abut the inner face of the wellbore,
   - installation of a plug (28) in the first end part of the production casing sealing off an inside (29) of the production casing,
   - disconnecting the drilling blowout preventer from the top of the surface casing,
   - connecting a production tree (19) with a wellhead (50),
   - disconnecting the drilling rig from the well,
   - removing the plug, and
   - initiating production.

2. An offshore method according to claim 1, wherein the drilling rig is disconnected after the expandable metal sleeves of the annular barriers have been expanded before production is initiated.

3. An offshore method according to claim 1 or 2, further comprising circulating cleaning fluids

4. An offshore method according to any of the preceding claims, wherein the installation of the production casing is performed by means of a drill pipe (52) connected to the first end part of the production casing.

5. An offshore method according to any of the preceding claims, wherein the production casing comprises at least one valve (53) arranged between two annular barriers, the valve being closed when disconnecting the drilling rig.

6. An offshore method according to any of the preceding claims, further comprising installation of a downhole safety valve (54) which is closed when disconnecting the drilling rig.

7. An offshore method according to any of the preceding claims, wherein the production casing below the plug is filled with liquid when disconnecting the drilling rig.

8. An offshore method according to any of the preceding claims, wherein the production casing above the plug is filled with liquid when disconnecting the drilling rig.

9. An offshore method according to any of claims 7 or 8, wherein the liquid is sea water.

10. An offshore method according to any of the preceding claims, further comprising cementing an annulus (55) between the production casing and an inner face of the wellbore.

11. An offshore method according to any of the preceding claims, wherein the installation of the production casing comprises a rotation of the production casing.

12. An offshore method according to any of the preceding claims, wherein a cleaning fluid, such as acid, is circulated out of the second end part of the production casing while installing the production casing.

13. An offshore method according to any of the preceding claims, further comprising hanging off the production casing in a liner hanger (57) or in a wellhead (50).

14. An offshore method according to any of the preceding claims, wherein the plug is a glass plug.

15. A downhole system derived from the method according to any of claims 1-14.

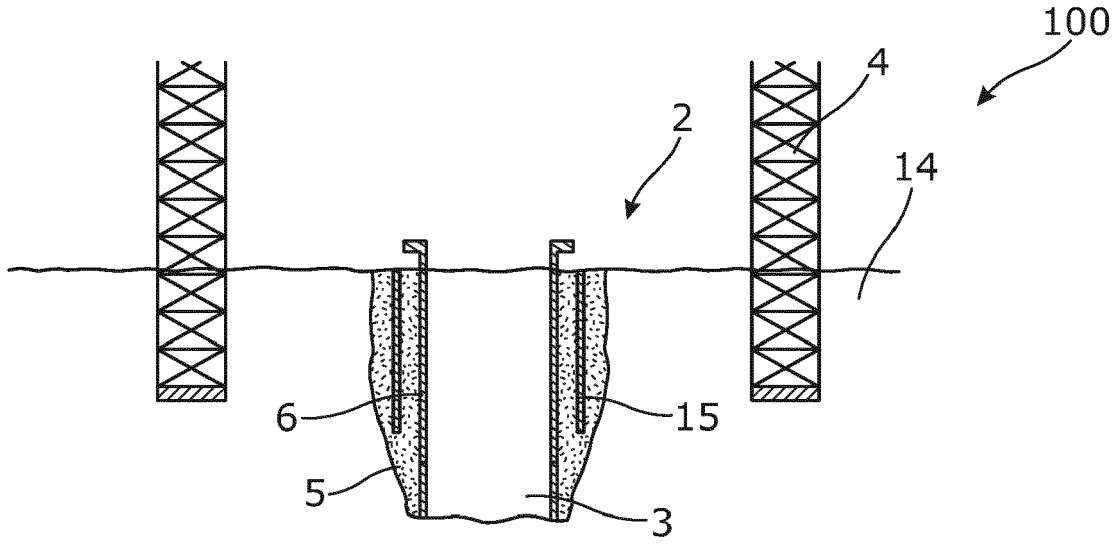

Fig. 1

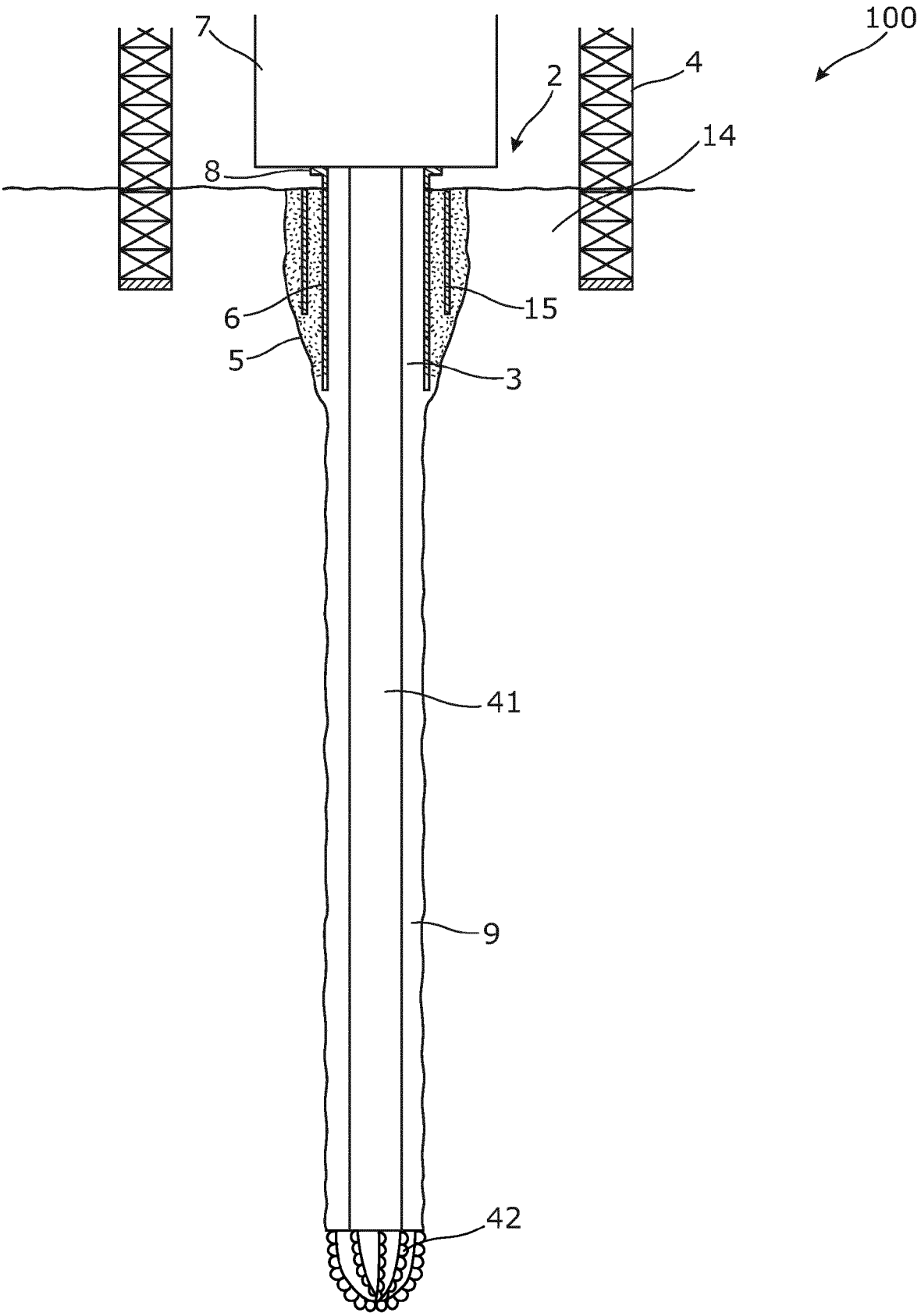

Fig. 2

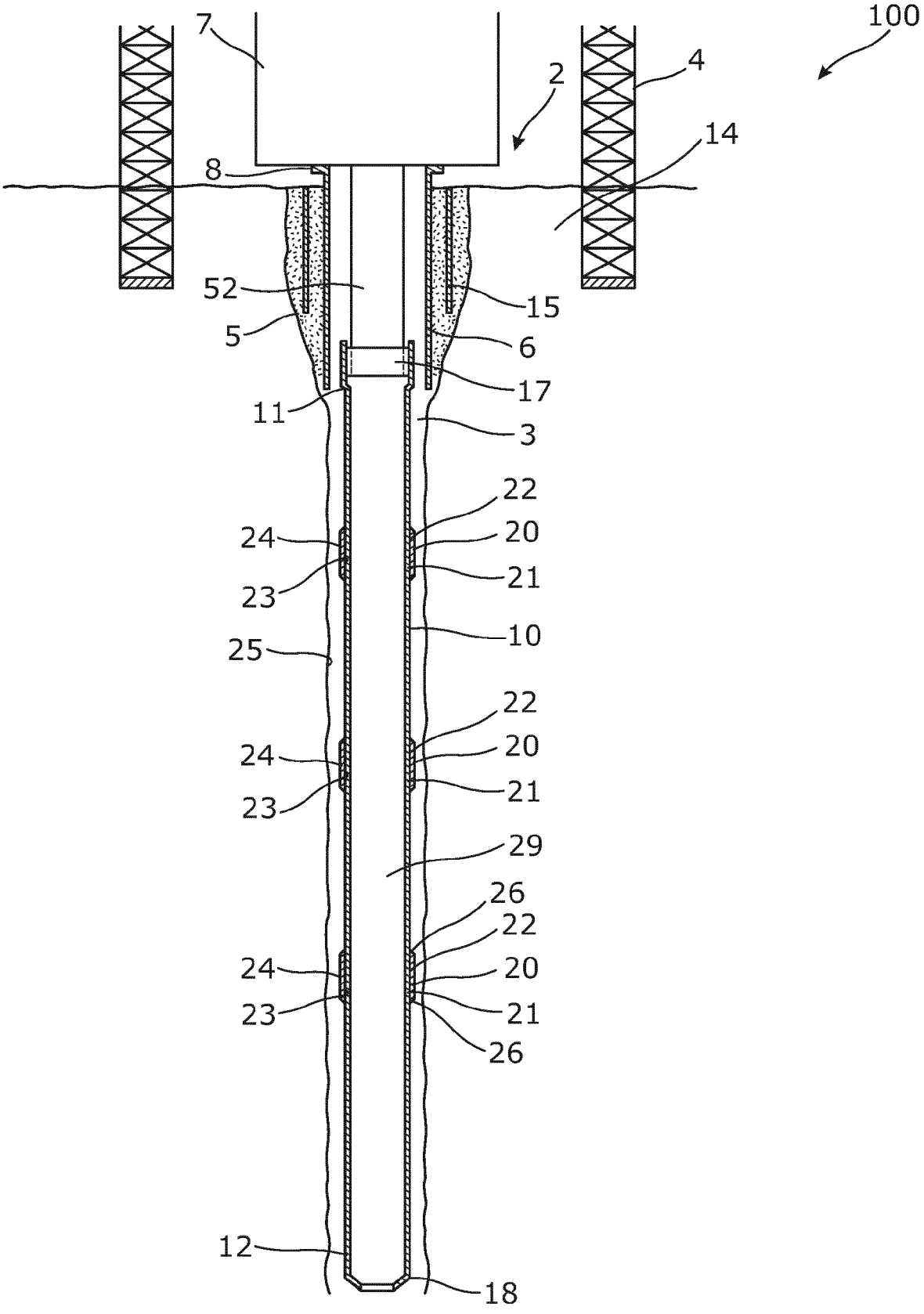
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Fig. 3

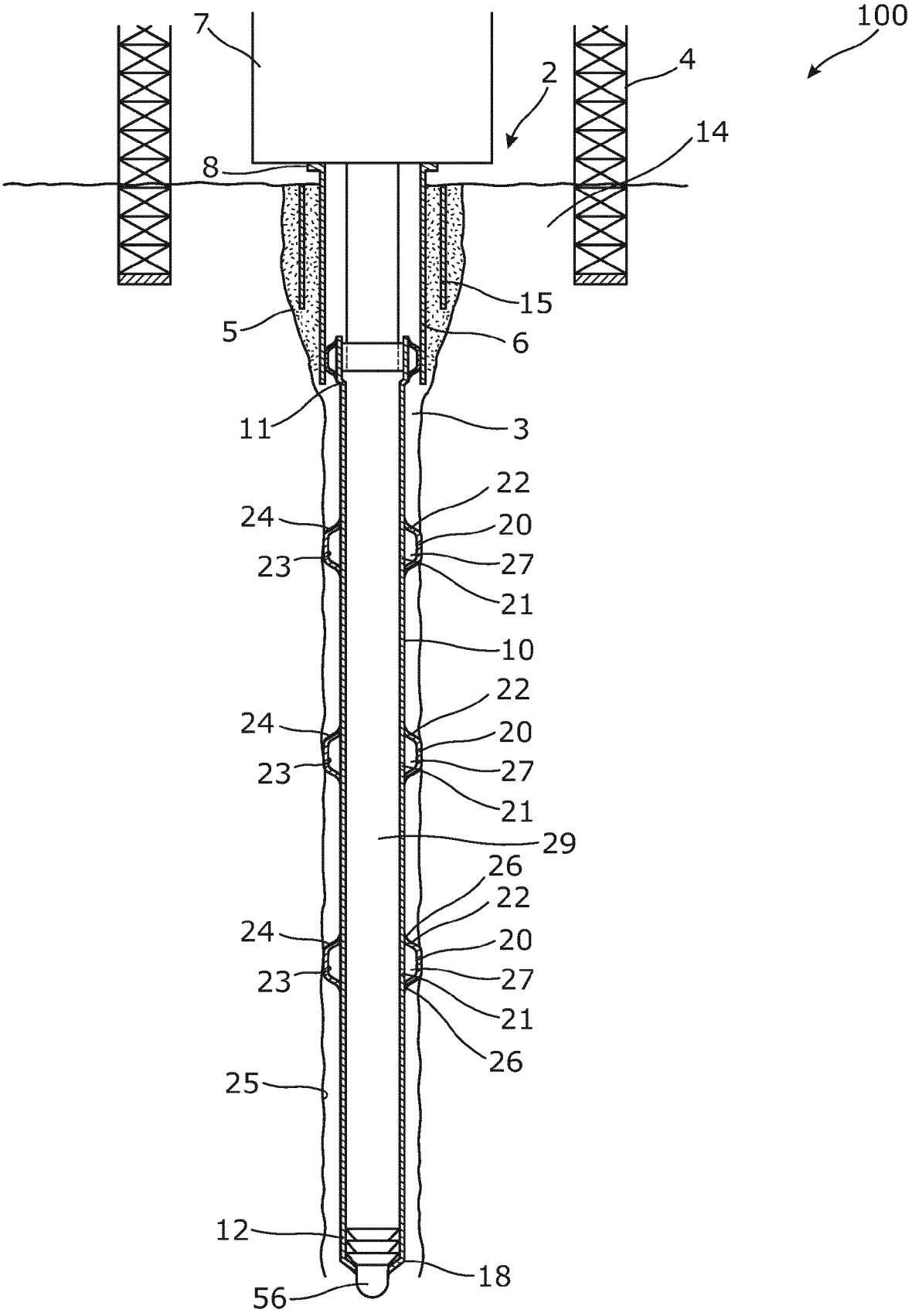
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Fig. 4

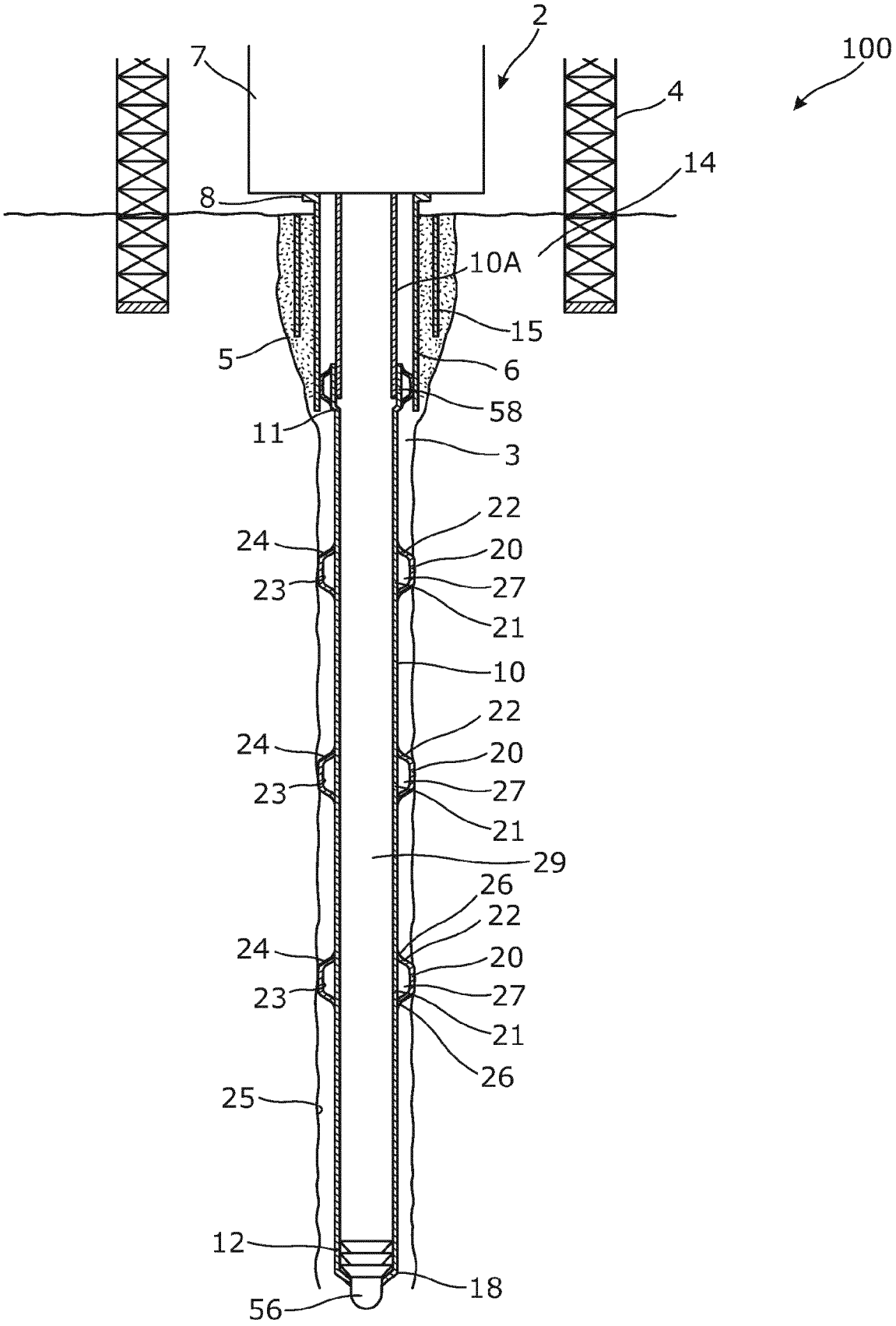
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Fig. 5

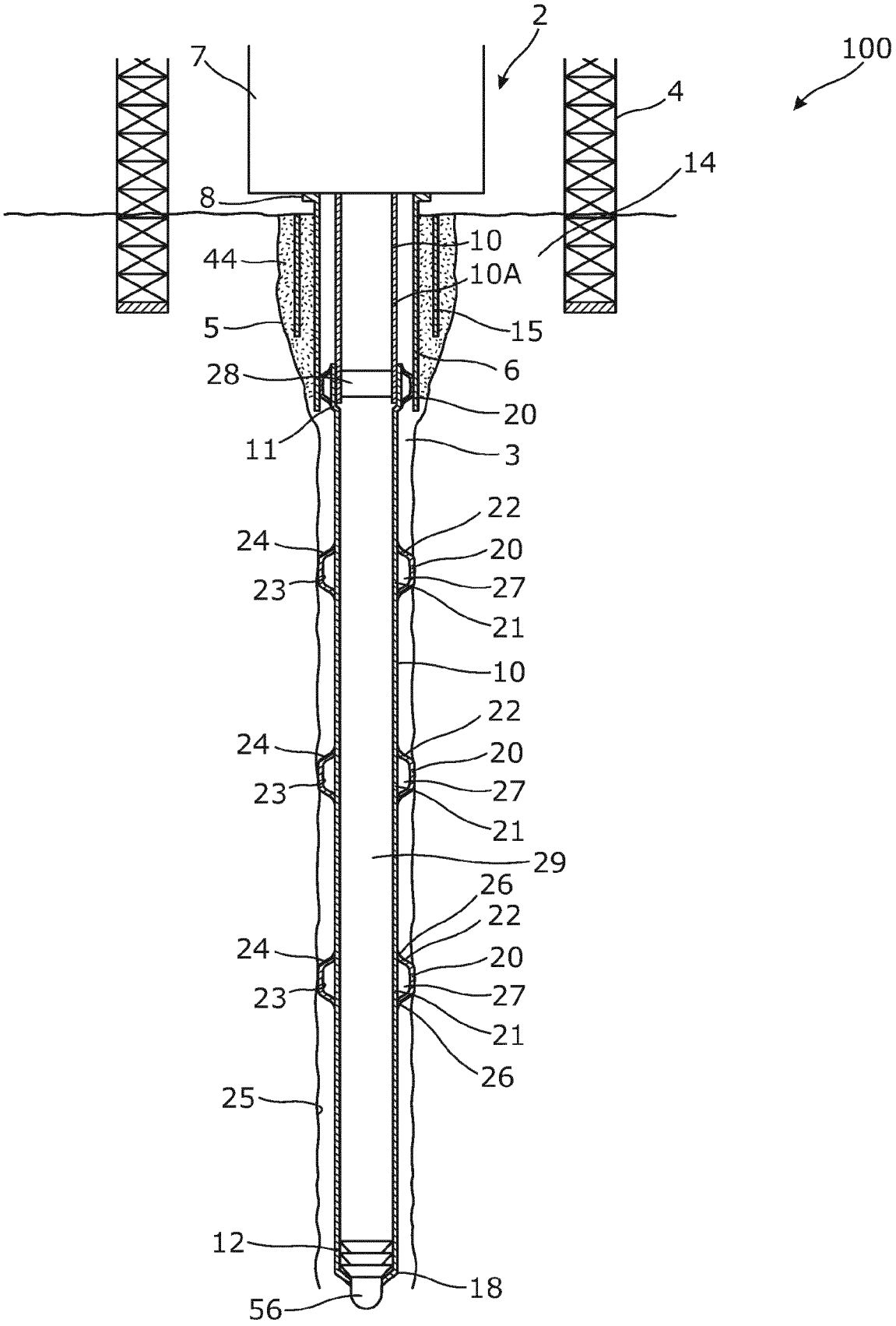
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Fig. 6

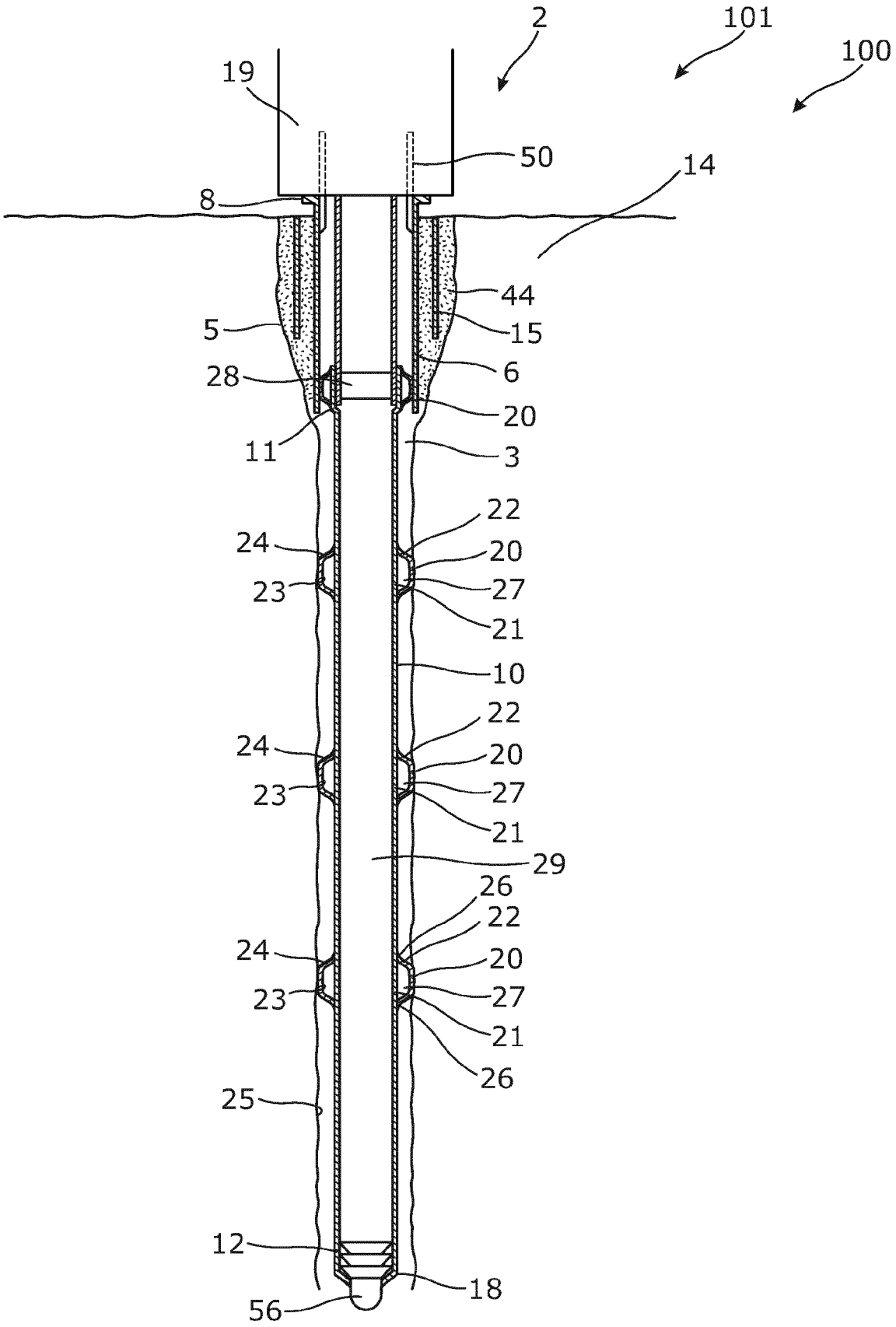
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Fig. 7

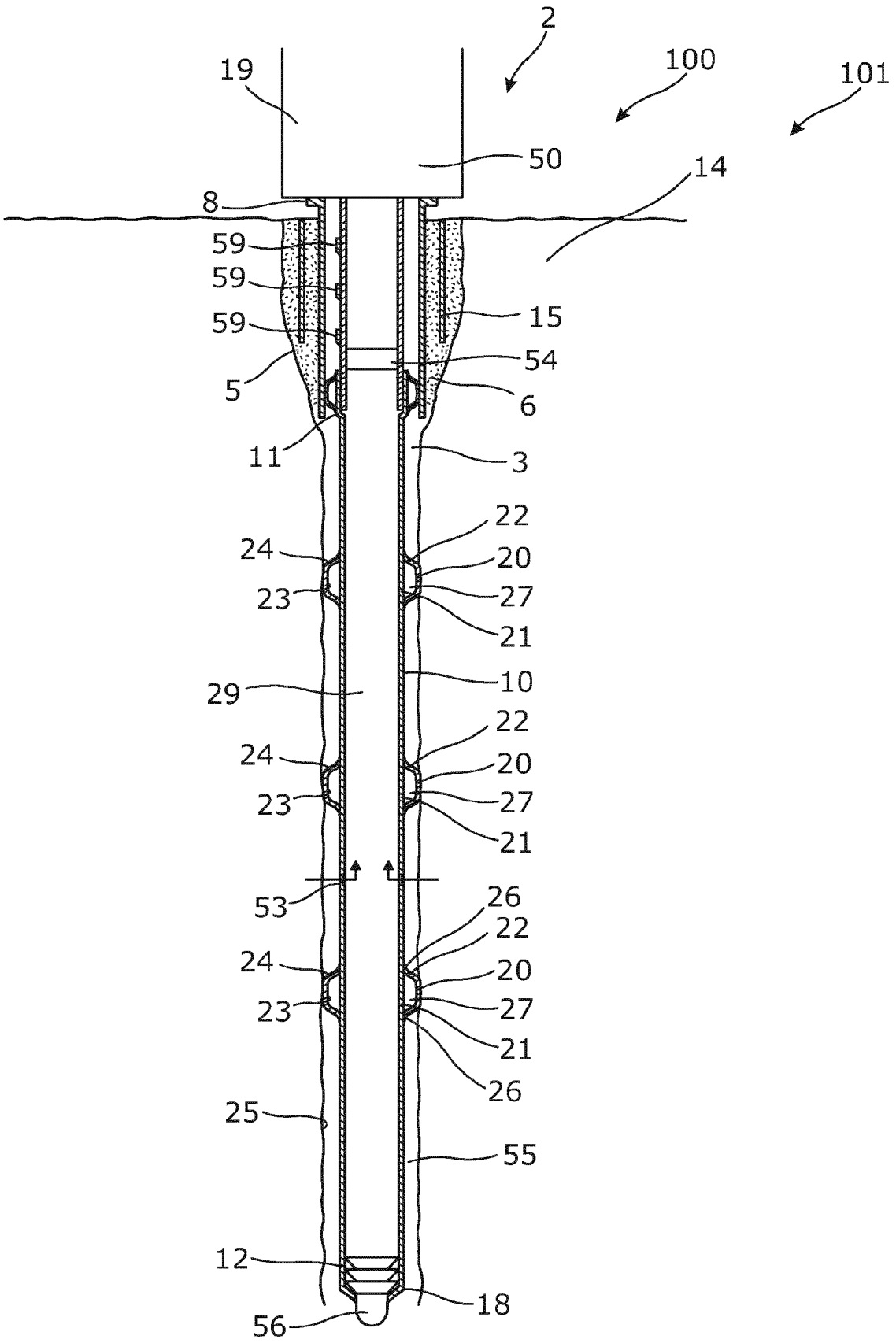
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Fig. 8

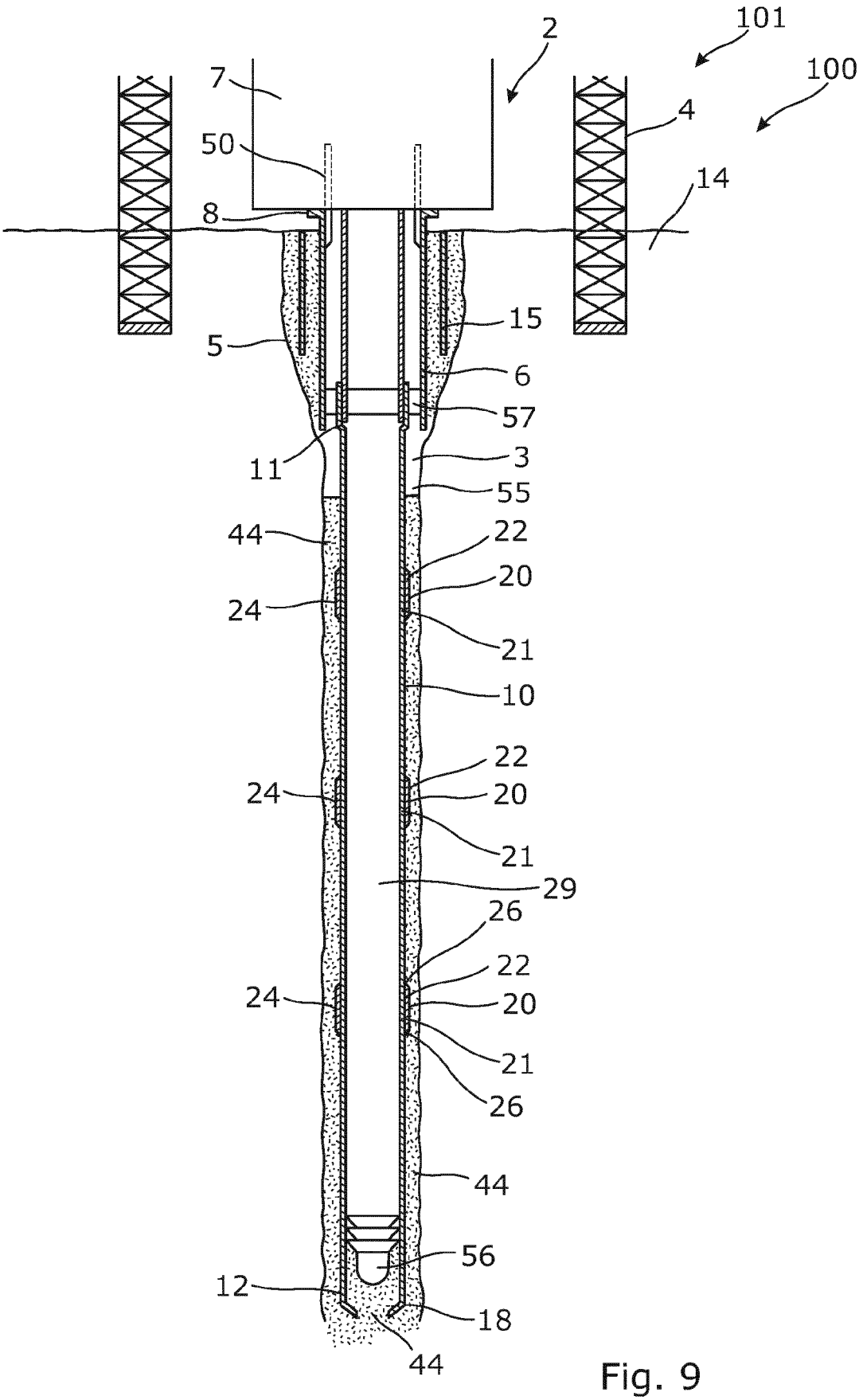
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Fig. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 18 16 0315

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2014/067992 A2 (WELLTEC AS [DK]) 8 May 2014 (2014-05-08) * page 7, line 29 - page 13, line 3; figures * -----	1-15	INV. E21B33/127 E21B43/10

TECHNICAL FIELDS SEARCHED (IPC)

E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	10 September 2018	Maukonen, Kalle

CATEGORY OF CITED DOCUMENTS

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