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(54) **A downhole collection tool**

(57) The present invention relates to a downhole system (100) for collecting an object in a well (4). The downhole system for collecting an object in a well comprises a casing (3) comprising a plurality of tubular sections (5), and a restriction (6) having a first inner diameter (D_r), an object (2) having an outer diameter (D_o) which is larger than the first inner diameter of the restriction in order that the object is capable of seating in the restriction, and a collection tool (1) comprising a tool section (7) adapted to provide an axial force in a first direction, and a collecting section (8) having an outer diameter, the collecting section being connected to the tool section and comprising an abutment edge (9) forming a leading edge (10A) when the tool section moves the collection section in the first direction for abutting the object, wherein the outer diameter of the collection section is smaller than the outer diameter of the object.

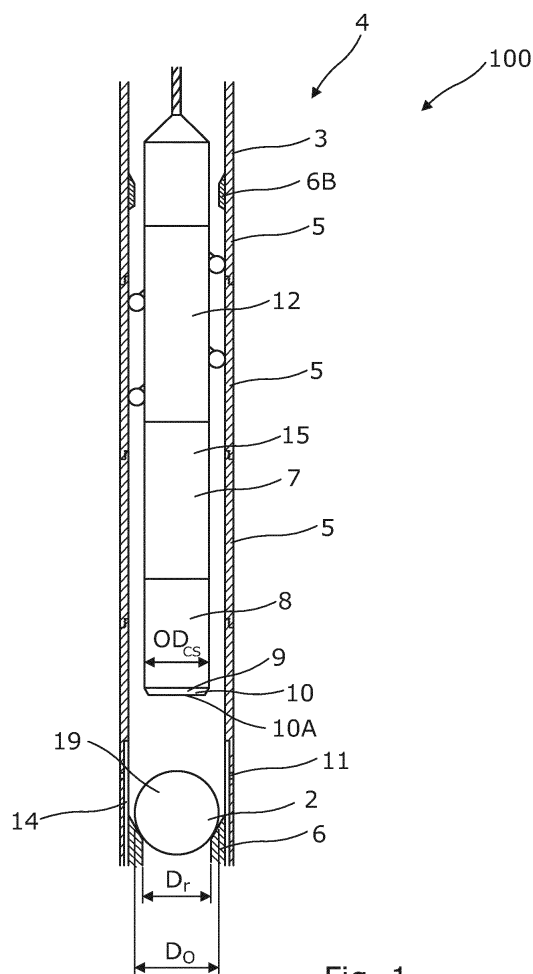


Fig. 1

Description

Field of the invention

[0001] The present invention relates to a downhole system for collecting an object in a well.

Background art

[0002] In order to fracture the formation to increase hydrocarbon-containing fluid production, a ball is dropped into a well casing. Furthermore, dropping of balls is also used to inject fluid into the formation from an injection well. The ball flows down the casing and seats in a ball seat of a sliding sleeve. Subsequently, the pressure is built up inside the casing upstream of the ball until the sleeve slides to open a fracturing port, and then the fluid is pumped out into the formation to fracture the formation. The most commonly used fracturing or injection process is to have balls of increasing diameter, so that the smallest ball is dropped first to seat in the seat of the sliding sleeve being most remote from the top of the well. Then the second smallest ball is dropped to seat in the sliding sleeve next to the previous sliding sleeve and so forth. In some ball drop systems, one ball is reused for opening at least two ports in that dogs are released when the sleeve has been opened.

[0003] After the fracturing or injection process, the balls need to be collected from the well in order to start the production of hydrocarbon-containing fluid from the reservoir or to inject injection fluid at a level below the ball. In an injection well, the balls are never brought to surface by the production fluid, as the production starts due to a higher pressure in the formation. The fluid in an injection well always flows from the top of the well to the bottom.

Summary of the invention

[0004] 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 downhole system comprising a tool for collection of an object, such as a ball seated in a restriction, in a casing while being able to also pass other restrictions in the casing to reach the object.

[0005] 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 downhole system for collecting an object in a well, comprising:

- a casing comprising:
 - a plurality of tubular sections, and
 - a restriction having a first inner diameter,
- an object having an outer diameter which is larger

than the first inner diameter of the restriction in order that the object is capable of seating in the restriction, and

- a collection tool comprising:
 - a tool section adapted to provide an axial force in a first direction, and
 - a collecting section having an outer diameter, the collecting section being connected to the tool section and comprising an abutment edge forming a leading edge when the tool section moves the collection section in the first direction for abutting the object,

wherein the outer diameter of the collection section is smaller than the outer diameter of the object.

[0006] The above-mentioned restriction may be a sliding sleeve.

[0007] Moreover, the restriction may have a ball seat.

[0008] Also, the restriction may have a casing shoe.

[0009] Additionally, the object may be a ball.

[0010] Furthermore, the tool section may comprise a means adapted to provide an adhering force between the collection section and the object, so that the object can be removed along with the collection tool.

[0011] Said means may be an axial force generator adapted to provide the axial force for forcing the abutment edge into the object and providing the adhering force. The abutment edge may have a cutting edge for cutting at least partly into the object.

[0012] Moreover, the abutment edge may have a sealing lip creating an inner space between the collection section and the object.

[0013] Also, the sealing lip may be made of a polymer or of natural or synthetic rubber.

[0014] Further, the tool section may comprise means adapted to provide an adhering force between the collection section and the object, the means being a pump adapted to provide a pressure difference in the inner space which provides the adhering force.

[0015] The collection section may comprise a retractable protective part which is arranged to form a leading part of the collection section when the tool moves towards the object.

[0016] In addition, the retractable protective part may have an at least partly circular cross-section and may be arranged within or outside the abutment edge.

[0017] Moreover, a shear pin may be arranged to prevent the retractable protective part from sliding axially before the axial force exceeds a predetermined threshold value.

[0018] The axial force generator as described above may comprise:

- an elongated piston housing having a first and a second end, and
- a piston provided on a shaft, the shaft penetrating the housing for transmitting the axial force to the col-

lection section,

wherein the piston is provided in the piston housing so that the shaft penetrates the piston and each end of the piston housing and divides the housing into a first chamber and a second chamber, and wherein the first chamber and/or the second chamber are/is fluidly connected to the pump via a duct, so that the pump can pump fluid into one chamber and/or suck fluid from the other chamber in order to move the piston within the housing and thereby move the collection section in the first direction.

[0019] Also, the axial force generator may generate the axial force in the range of 400-5,000 kg, preferably 500-3,000 kg.

[0020] Furthermore, the object may be made of a non-metallic material, such as polymer, blends of polymers and particles of non-plastic material, composite, phenolic, glass or ceramics; or aluminium, bronze or stainless steel. The polymer may be epoxy or polyether ether ketone (PEEK).

[0021] Moreover, the cutting edge may be inclining or tapering.

[0022] Additionally, the cutting edge may be a continuous or a non-continuous circumferencing edge.

[0023] The downhole system as described above may further comprise a driving unit for the system to be self-propelling.

Brief description of the drawings

[0024] 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-section view of a downhole system for collecting an object, such as a ball, in a casing of a well,

Fig. 1a shows another downhole system having an axial force generator,

Fig. 2 shows another downhole system for collecting an object,

Fig. 3 shows part of the downhole system of Fig. 2, comprising a sealing lip,

Figs. 4A-4C show partly cross-sectional views of a sliding sleeve for opening a fracturing port,

Fig. 5 shows the object seating in a fixed restriction,

Figs. 6 and 7 show the collection section having a retractable protective part, and

Fig. 8 shows a cross-sectional view of part of an axial force generator.

[0025] 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

[0026] Fig. 1 shows a downhole system 100 for collecting an object 2, such as a ball, in a casing 3 of a well 4. The casing comprises a plurality of tubular sections 5 and a restriction 6 having a first inner diameter D_r . The object has an outer diameter D_o which is larger than the first inner diameter of the restriction in order that the object is capable of seating in the restriction, e.g. to open a fracturing or injection port 11 by sliding a sleeve 14, to close off part of the well below the seated object, or to close a casing shoe in the end of the casing. The downhole system further comprises a collection tool 1 for collecting the object. The collection tool 1 comprises a tool section 7 adapted to provide an axial force F in a first direction to retrieve the object from the well. The collection tool 1 further comprises a collecting section 8 having an outer diameter OD_{CS} . The collecting section 8 is connected to the tool section 7 and comprises an abutment edge 9 forming a leading edge 10 when the tool section moves the collection section in the first direction for abutting the object. The outer diameter of the collection section is smaller than the outer diameter of the object so that the tool is able to pass previous restrictions 6B while still being able to abut a proper area of the object.

[0027] In the downhole system of Fig. 1, the tool section comprises a means adapted to provide an adhering force between the collection section and the object, so that the object can be removed along with the collection tool when retracting the tool from the well. The means is an axial force generator 15 adapted to provide the axial force for forcing the abutment edge 9 into the object and thus providing the adhering force by means of friction between the abutment edge 9 and the object 2. The abutment edge has a cutting edge for cutting at least partly into the object by pushing the cutting edge of the abutment edge into the object by means of the axial force generator 15. The cutting edge is a continuous circumferencing edge but may also be non-continuous. The abutment edge is then stuck in the object, and tests have shown that the object can hold up to 6,000 N when the axial force generator 15 forces the abutment edge and thus the cutting edge into the object by 3,000 N. Thus, the object is sufficiently fastened to the abutment edge for the object to be retrieved from the well even though the tool has to pass several restrictions along the way which results in several bumping movements while travelling up to 15 km before reaching the top of the well.

[0028] In Fig. 1a, the tool section 7 comprises means adapted to provide an adhering force between the col-

lection section and the object. The means is an axial force generator 15 adapted to provide the axial force for forcing the abutment cutting edge into the object and providing the adhering force between the abutting edge and the object by cutting into the object. An anchoring section 16 anchors the tool in the well, so that all axial force from the axial force generator is used to cut into the object.

[0029] In Fig. 2, the abutment edge has a sealing lip 17 creating an inner space 18 (illustrated in Fig. 3) between the collection section 8 and the object 2 when the sealing lip abuts the face 19 of the object 2. The sealing lip is made of a polymer or of natural or synthetic rubber and may be reinforced by metal strands or woven material, e.g. woven plastic, or by means of a similar solution. The tool section 7 comprises means adapted to provide an adhering force between the collection section and the object, the means being a pump 20 adapted to provide a pressure difference in the inner space 18 which provides the adhering force between the sealing lip 17 and the face 19 of the object 2.

[0030] As shown in Fig. 1, the downhole system may further comprise a driving unit 12, such as a downhole tractor, for the system to be self-propelling in a more horizontal part of the well. In Fig. 2, the downhole system comprises an anchoring section 16 which anchors the tool section in the casing. The downhole system may comprise both a driving unit 12 and an anchoring section 16.

[0031] When fracturing the formation surrounding the casing or injecting fluid into the formation, the restriction is a ball seat 21 in a sliding sleeve 14, as shown in Fig. 4A. As the pressure builds up, the ball 2 moves the sleeve 22 so as to open the fracturing port 11. In this embodiment, the sliding sleeve has dogs 23 which are pushed into a groove 24 when the sleeve 22 has been sufficiently slid as shown in Fig. 4B, and the object in the form of a drop ball is able to pass the sliding sleeve and move onto the next sliding sleeve to be opened further down the well. When the drop ball has opened all sleeves, the ball is seated in a fixed seat as shown in Fig. 5. Thus, the casing may have several restrictions 6, 6B (shown in Figs. 1 and 2) that the tool has to be capable of passing before reaching the object to be retrieved. The tool therefore needs to have an outer diameter which is smaller than that of the restriction, and then the outer tool diameter is also smaller than the outer diameter of the object, i.e. the ball. Thus, the tool 1 cannot have means enclosing the ball and thus enlarging the tool diameter and still be able to pass the restrictions as the tool moves up to the top of the well. By the collection section and the tool section having diameters which are smaller than that of the ball, the tool is still able to pass the restrictions when moving upwards, since the object could pass the same restrictions while moving downwards. By providing the adhering force in the form of the cutting edge pushed into the object or in the form of a pump providing a negative pressure in the inner space, the tool is capable of collecting the ball even though its diameter is restricted.

[0032] In an injection well, the ball often seats in a fixed seat for closing off the part of the well below the seated ball. In this way, the fluid is injected at the intended level and thus in the intended layer in the formation.

[0033] In Fig. 6, the collection section 8 comprises a retractable protective part 25 which is arranged to form a leading part 26 of the collection section when the tool moves towards the object 2. By having the retractable protective part 25, the cutting edge 10 of the collection section 8 is protected when the tool moves down the well passing restrictions and the like which may result in the tool bumping into the casing. The retractable protective part 25 has an at least partly circular cross-section. The retractable protective part 25 may have a non-continuous edge forming the leading edge but is in Fig. 6 shown as a continuous edge. The retractable protective part 25 is arranged within the abutment edge 9, but may also be arranged outside the abutment edge. As can be seen, the cutting edge is inclining or tapering radially inwards.

[0034] In order to be able to protect the cutting edge, a shear pin 27 is arranged to prevent the retractable protective part from sliding axially before the axial force exceeds a predetermined threshold value. When the axial force generator forces the collection section towards the object, the retractable protective part 25 is forced into the collection section 8 shearing the shear pin as shown in Fig. 7.

[0035] The axial force generator 15 may be a stroking tool as shown in Fig. 8 for providing the force F. The axial force generator 15 comprises an elongated piston housing 35 having a first 36 and a second 37 end, and a piston 38 provided on a shaft 39. The shaft penetrates the housing for transmitting the axial force to the collection section. The piston is provided in the piston housing so that the shaft penetrates the piston and each end of the piston housing and divides the housing into a first chamber 41 and a second 42 chamber. The first chamber and/or the second chamber are/is fluidly connected to the pump via a duct 43, so that the pump 32 can pump fluid 45 into one chamber and/or suck fluid from the other chamber in order to move the piston within the housing and thereby move the collection section in the first direction. The housing comprises a hollow housing 44 closed in each end by a ring 45 within the hollow housing, the rings having sealing means 46 for providing a sealing connection to the shaft.

[0036] The axial force generator generates the axial force which may be in the range of 4,000-50,000 N, preferably 5,000-30,000 N.

[0037] Furthermore, the object may be made of a non-metallic material, such as polymer, blends of polymers and particles of non-plastic material, composite, phenolic, glass or ceramics; or aluminium, bronze or stainless steel. The polymer may be epoxy or polyether ether ketone (PEEK).

[0038] The restriction may be any suitable restriction capable of receiving the object, thus the restriction may also be a casing shoe.

[0039] A stroking tool is a tool providing an axial force. The stroking tool comprises an electrical motor for driving a pump 32. The pump pumps fluid into a piston housing to move a piston acting therein. The piston is arranged on the stoker shaft. The pump may pump fluid into the piston housing on one side and simultaneously suck fluid out on the other side of the piston.

[0040] 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.

[0041] By a casing is meant any kind of pipe, tubing, tubular, liner, string etc. used downhole in relation to oil or natural gas production.

[0042] 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®.

[0043] 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 downhole system (100) for collecting an object in a well (4), comprising:

- a casing (3) comprising:

- a plurality of tubular sections (5), and
- a restriction (6) having a first inner diameter (D_r),

- an object (2) having an outer diameter (D_o) which is larger than the first inner diameter of the restriction in order that the object is capable of seating in the restriction, and

- a collection tool (1) comprising:

- a tool section (7) adapted to provide an axial force in a first direction, and
- a collecting section (8) having an outer diameter, the collecting section being connected to the tool section and comprising

an abutment edge (9) forming a leading edge (10A) when the tool section moves the collection section in the first direction for abutting the object,

wherein the outer diameter of the collection section is smaller than the outer diameter of the object.

2. A downhole system according to claim 1, wherein the tool section comprises a means (15, 20) adapted to provide an adhering force between the collection section and the object, so that the object can be removed along with the collection tool.

3. A downhole system according to claim 2, wherein the means is an axial force generator (15) adapted to provide the axial force for forcing the abutment edge into the object and providing the adhering force.

4. A downhole system according to claim 1 or 2, wherein the abutment edge has a cutting edge (10) for cutting at least partly into the object.

5. A downhole system according to claim 1, wherein the abutment edge has a sealing lip (17) creating an inner space (18) between the collection section and the object.

6. A downhole system according to claim 5, wherein the tool section comprises means adapted to provide an adhering force between the collection section and the object, the means being a pump (20) adapted to provide a pressure difference in the inner space which provides the adhering force.

7. A downhole system according to any of the preceding claims, wherein the collection section comprises a retractable protective part (25) which is arranged to form a leading part (26) of the collection section when the tool moves towards the object.

8. A downhole system according to claim 7, wherein the retractable protective part has an at least partly circular cross-section and is arranged within or outside the abutment edge.

9. A downhole system according to claims 7 or 8, wherein a shear pin (27) is arranged to prevent the retractable protective part from sliding axially before the axial force exceeds a predetermined threshold value.

10. A downhole system according to any of the preceding claims, wherein the axial force generator comprises:

- an elongated piston housing (35) having a first (36) and a second (37) end, and

- a piston (38) provided on a shaft (39), the shaft penetrating the housing for transmitting the axial force to the collection section (8),

wherein the piston is provided in the piston housing so that the shaft penetrates the piston and each end of the piston housing and divides the housing into a first chamber (41) and a second (42) chamber, and wherein the first chamber and/or the second chamber are/is fluidly connected to the pump via a duct (43), so that the pump can pump fluid into one chamber and/or suck fluid from the other chamber in order to move the piston within the housing and thereby move the collection section in the first direction.

11. A downhole system according to any of the preceding claims, wherein the axial force generator generates the axial force in the range of 4,000-50,000 N, preferably 5,000-30,000 N.

12. A downhole system according to any of the preceding claims, wherein the object is made of a non-metallic material, such as polymer, blends of polymers and particles of non-plastic material, composite, phenolic, glass or ceramics.

13. A downhole system according to any of the preceding claims, wherein the cutting edge is inclining or tapering.

14. A downhole system according to any of the preceding claims, wherein the cutting edge is a continuous or a non-continuous circumferencing edge.

15. A downhole system according to any of the preceding claims, further comprising a driving unit for the system to be self-propelling.

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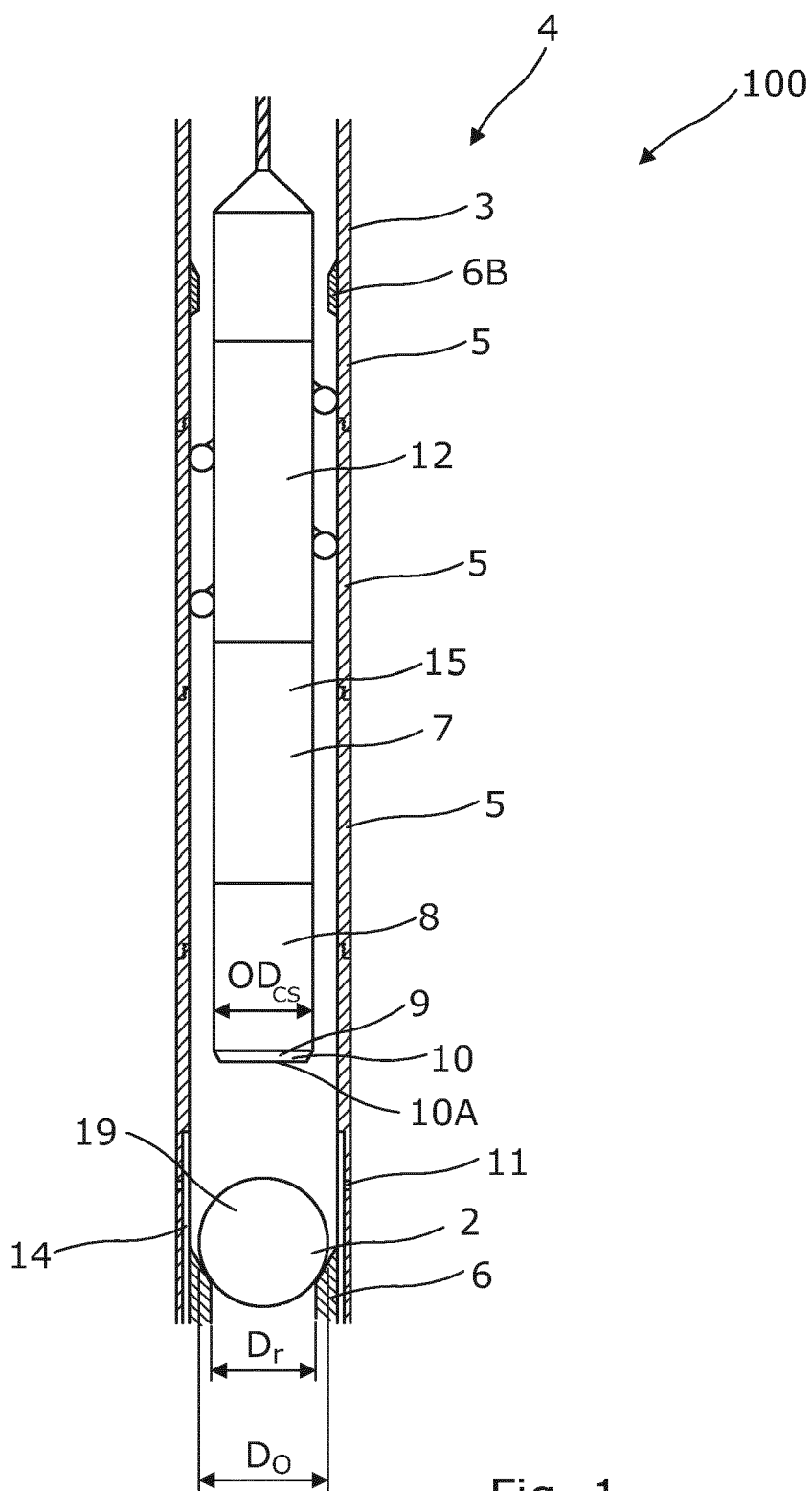


Fig. 1

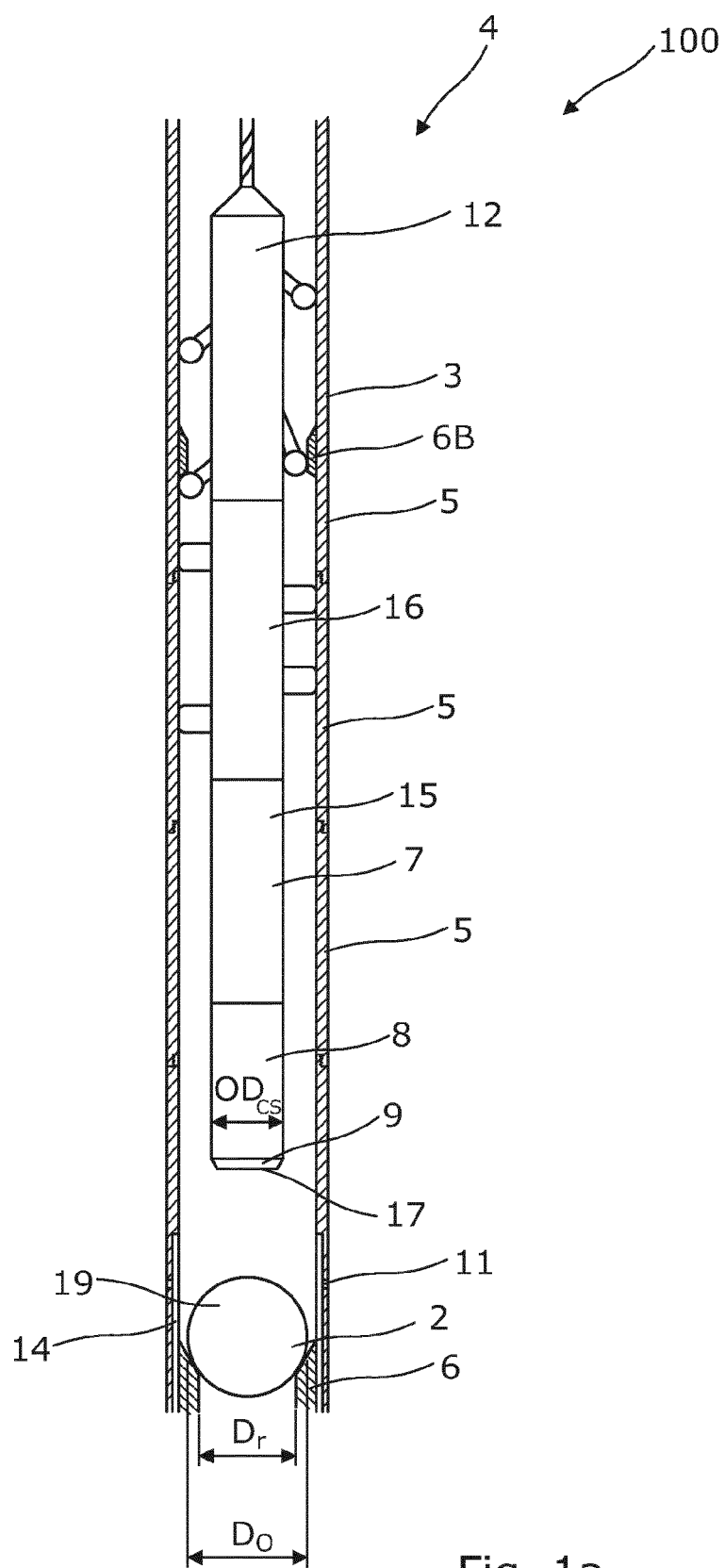


Fig. 1a

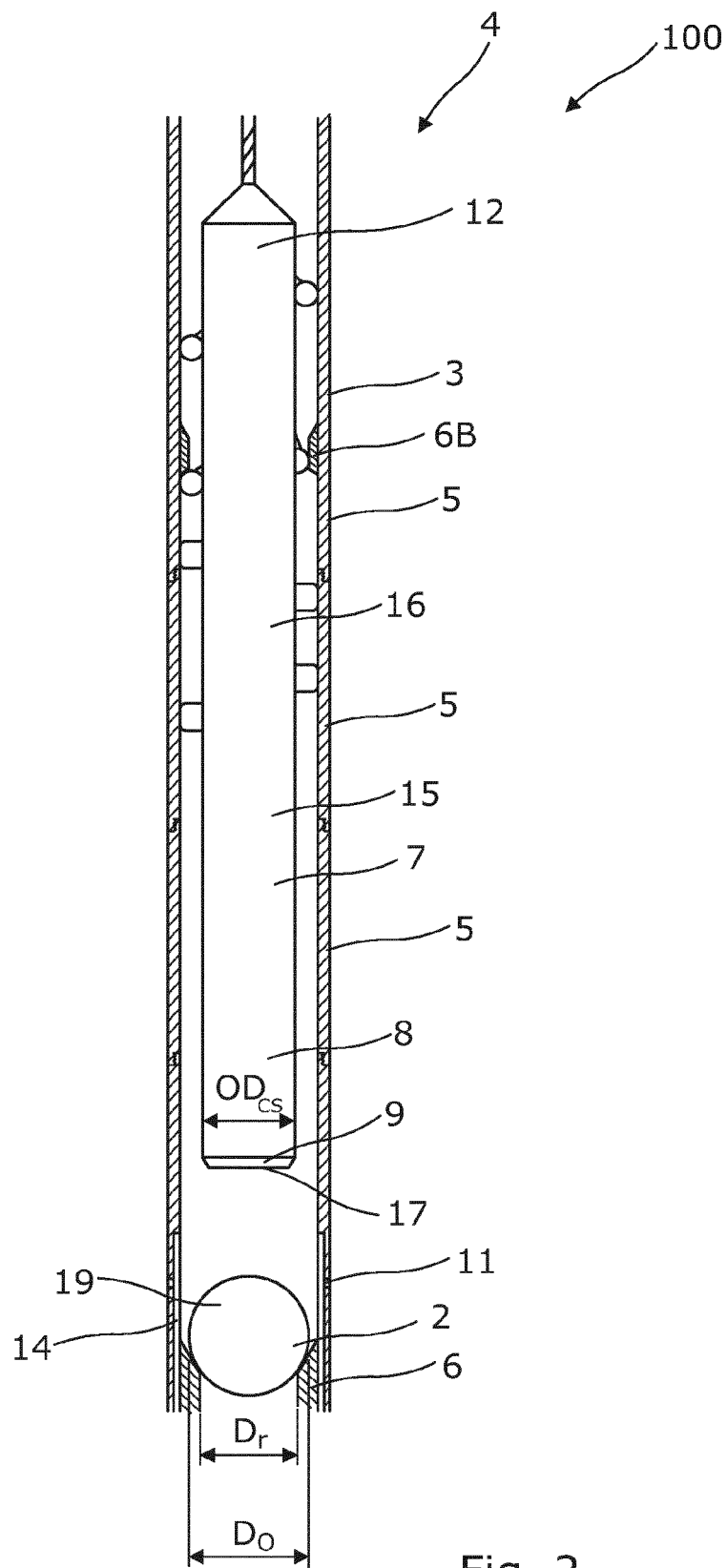


Fig. 2

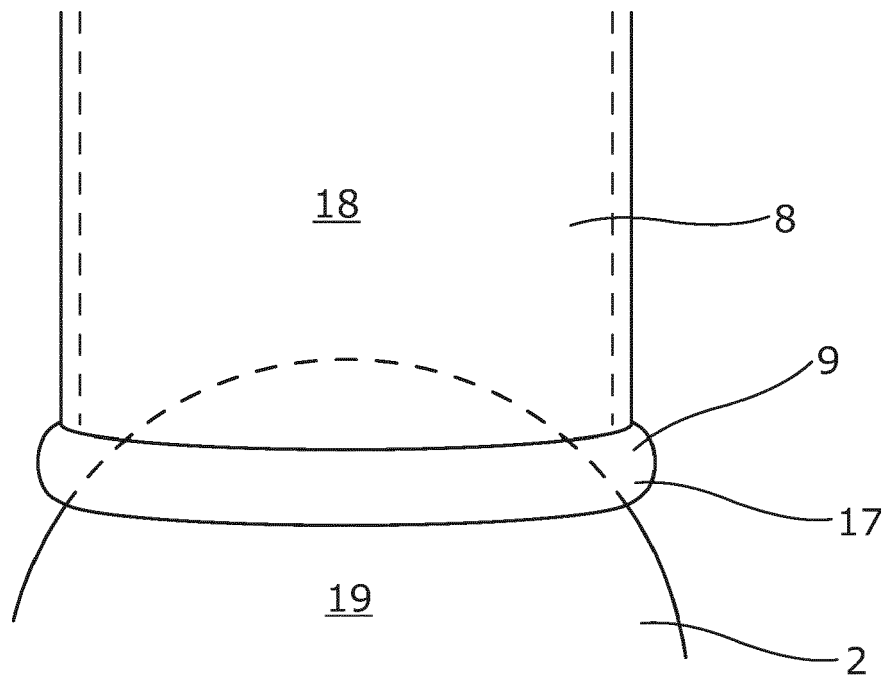


Fig. 3

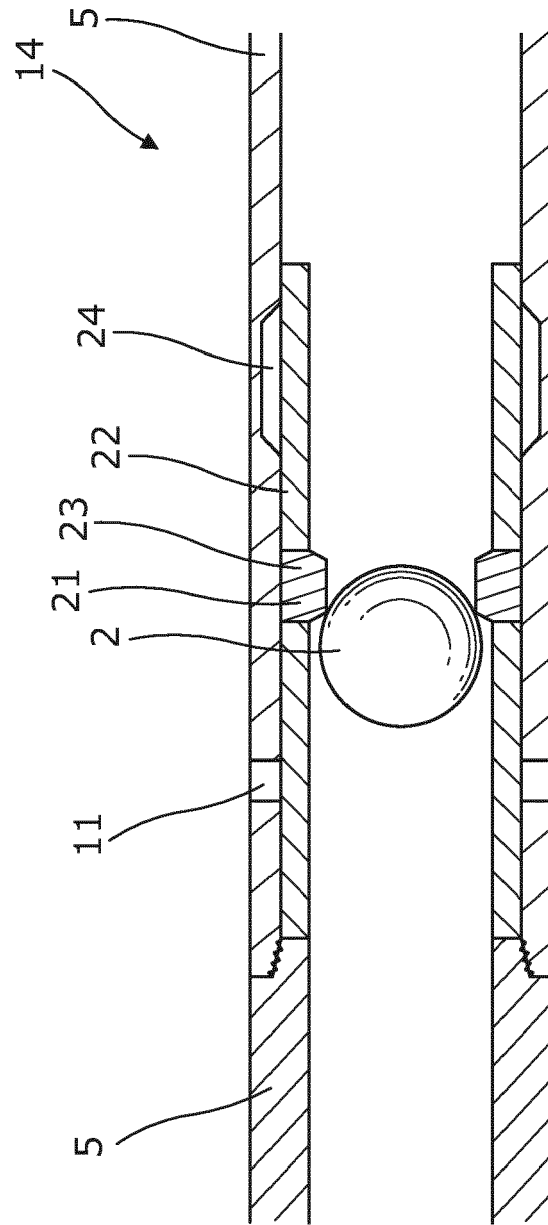


Fig. 4A

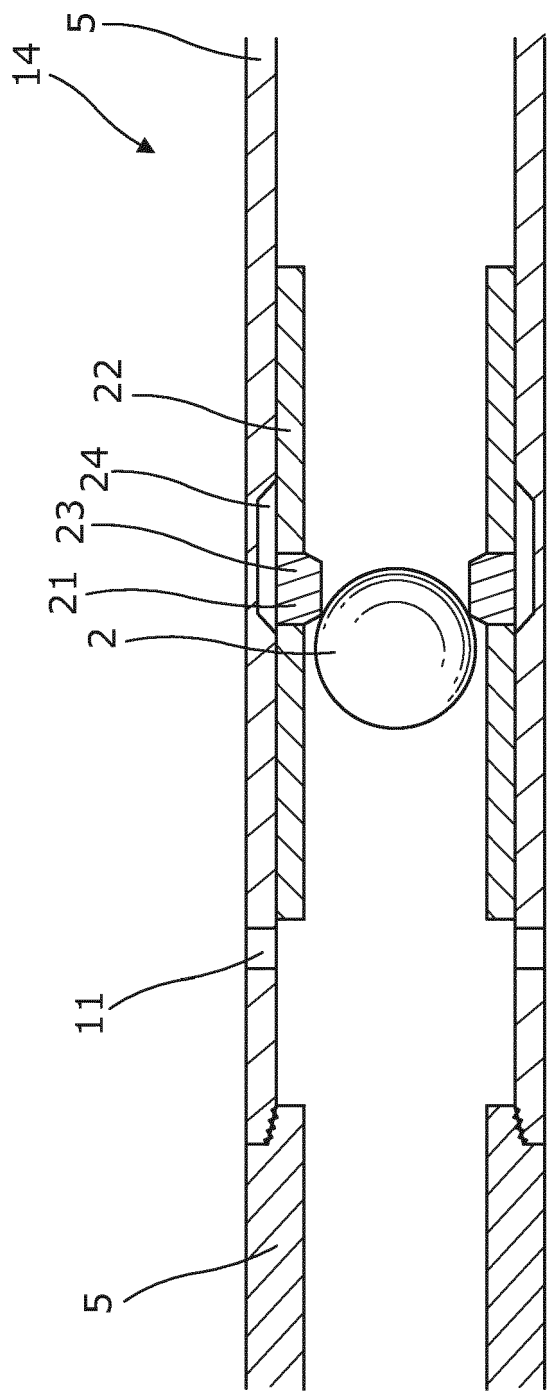


Fig. 4B

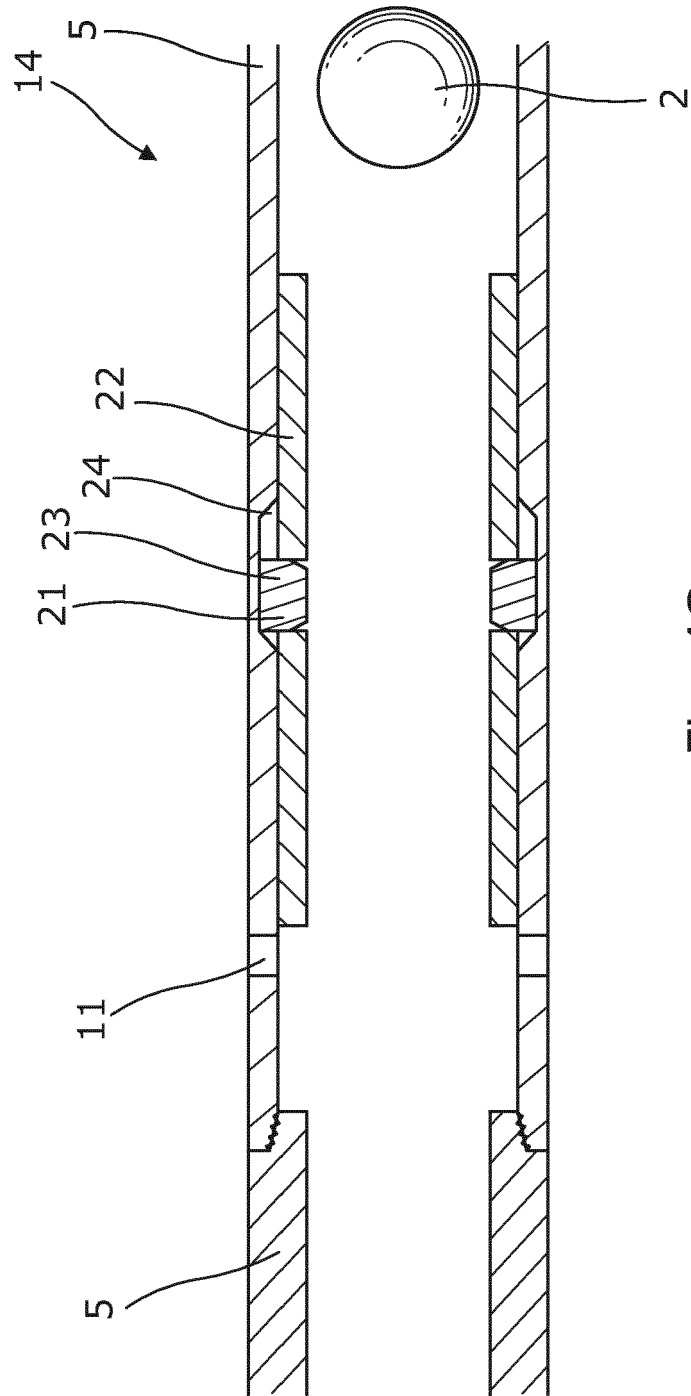


Fig. 4C

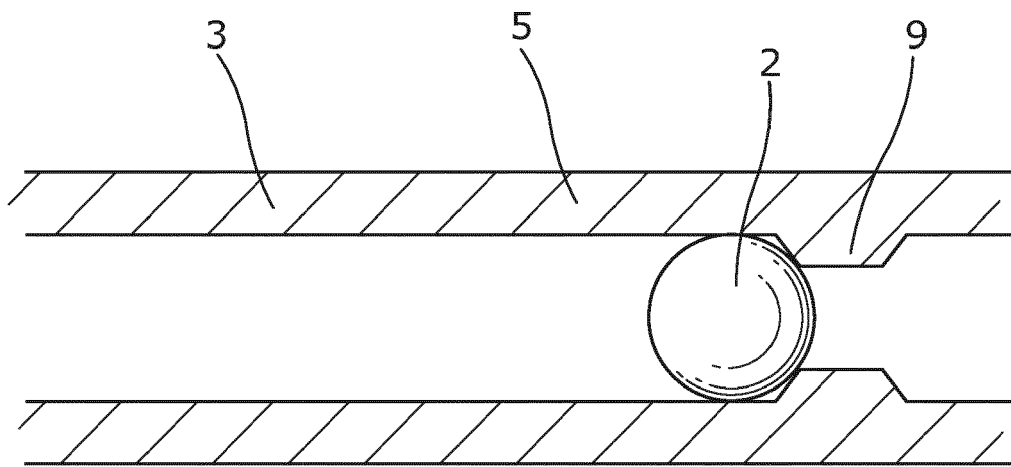


Fig. 5

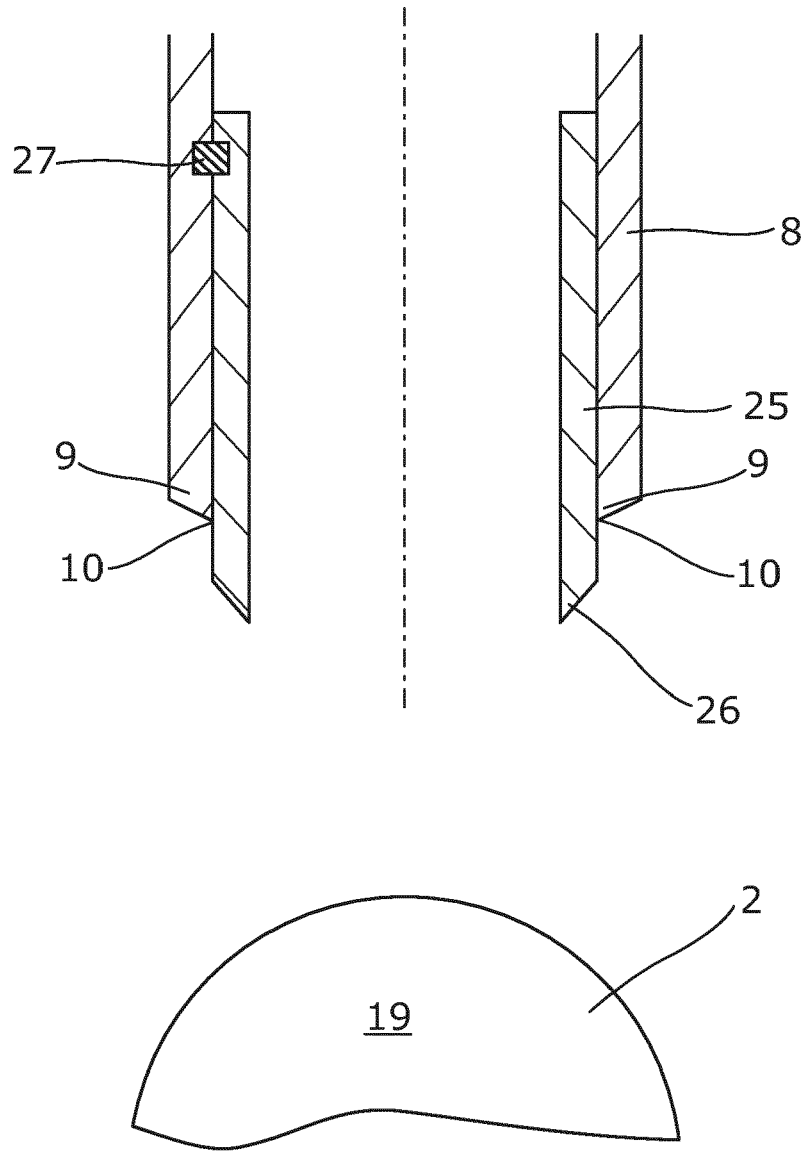


Fig. 6

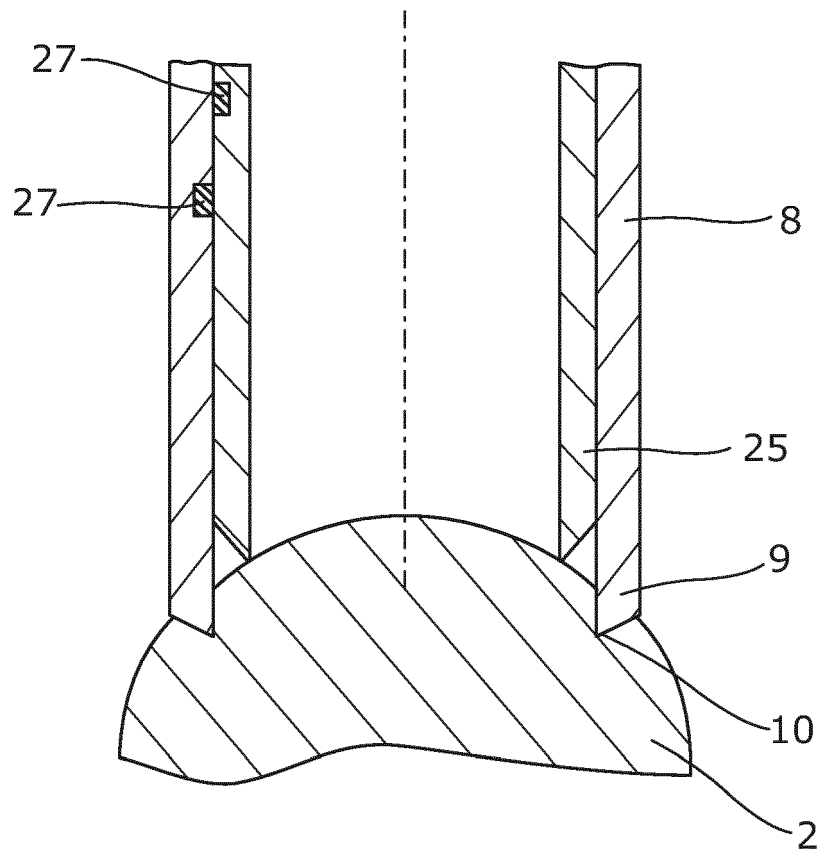


Fig. 7

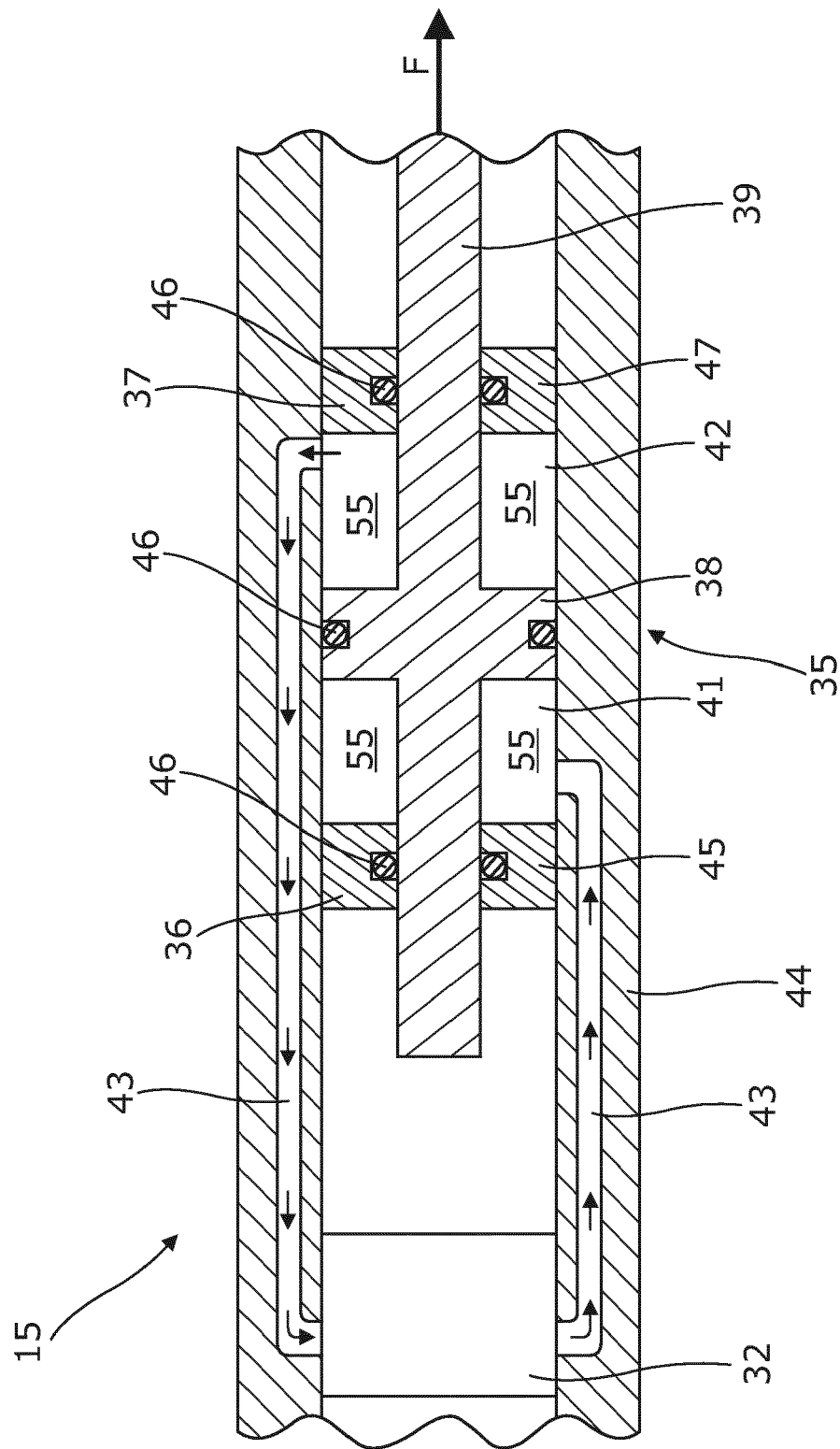


Fig. 8



EUROPEAN SEARCH REPORT

Application Number
EP 14 16 1754

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 2 599 952 A1 (WELLTEC AS [DK]) 5 June 2013 (2013-06-05) * the whole document *	1-15	INV. E21B31/12 E21B34/14 E21B34/00
A	US 1 528 089 A (STIMPERT GROVER G) 3 March 1925 (1925-03-03) * the whole document *	1-15	
A	US 1 421 159 A (HENRY BROWN CHARLES) 27 June 1922 (1922-06-27) * the whole document *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			E21B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 25 June 2014	Examiner Ott, Stéphane
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US 1421159 A	27-06-1922	NONE	

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