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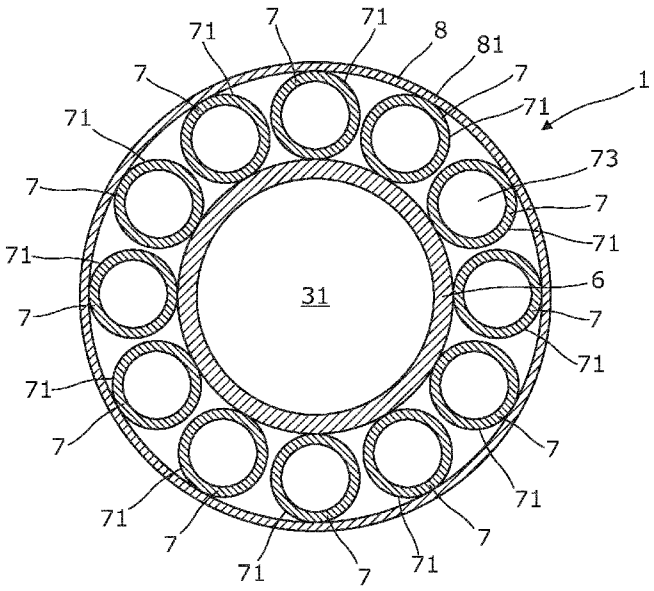
(54) Title: AN ANNULAR BARRIER HAVING EXPANSION TUBES

Fig. 2b



(57) Abstract: The present invention relates to an annular barrier (1) for mounting as part of a well tubular structure (3), the annular barrier being adapted to be expanded in an annulus (2) between the well tubular structure and an inside wall (41) of a borehole (4). The annular barrier comprises a tubular part (6) extending in a longitudinal direction, one or more an expandable tube(s) (7) each having a centre axis (72) extending outside the tubular part in the longitudinal direction, and a sealing element (8) in the form of an expandable sleeve provided on an outer surface of the one or more expandable tube(s) for providing sealing against the inside wall of the borehole, the expandable sleeve extending on the outside of the one or more expandable tube(s). Furthermore, the invention relates to a method of expanding an annular barrier in an annulus and to a downhole system.

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AN ANNULAR BARRIER HAVING EXPANSION TUBES

Field of the invention

The present invention relates to an annular barrier for mounting as part of a well tubular structure, the annular barrier being adapted to be expanded in an annulus between the well tubular structure and an inside wall of a borehole. Furthermore, the invention relates to a method of expanding an annular barrier in an annulus and to a downhole system.

Background art

In hydro-carbon producing wells, annular barriers or packers are often used to seal off a section of the borehole, such as an oil producing zone in the formation. The section may be sealed off to avoid excessive amounts of water flowing into the production casing from other parts of the borehole.

Known annular barriers often comprise a tubular part extending in a longitudinal direction, such as a casing surrounded by an expandable sleeve. The expandable sleeve is expanded in an annulus between the casing and an inside wall of a borehole. In such a construction, the expandable sleeve is often arranged substantially concentrically in relation to the tubular part, and a centre axis of the expandable sleeve coincides with a centre axis of the tubular part. The centre axis of the expandable sleeve thus extends inside the tubular part.

When designing a well, it is difficult to establish the exact diameter of the borehole. Further, the diameter may vary substantially along the extension of the borehole due to changes in the composition of the formation. The walls of the borehole may for example partly collapse during or after drilling, or fluid flowing in the well may erode the walls, thereby affecting the diameter of the borehole.

Several drawbacks exist in relation to annular barriers of the prior art. Known annular barriers may be expanded to have an outer diameter of maximum 20-30% beyond the outer diameter of the casing. This may be adequate in some parts of the well, however, in sections of the well having an increased diameter,

it may not to sufficient to provide a proper seal between the casing and the wall of the borehole.

Summary of the invention

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 annular barrier being able to seal a larger annulus surrounding a well tubular structure.

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 annular barrier for mounting as part of a well tubular structure, the annular barrier being adapted to be expanded in an annulus between the well tubular structure and an inside wall of a borehole, and the annular barrier comprising:

- a tubular part extending in a longitudinal direction, and
- an expandable tube having a centre axis extending outside the tubular part in the longitudinal direction.

Hereby, the annular barrier may be sufficiently expanded for sealing a larger annulus than annular barriers of the prior art.

In an embodiment of the invention, a centre axis of the expandable tube may be arranged outside the tubular part.

Furthermore, the centre axis of the expandable tube may coil around the tubular part in the longitudinal direction.

Moreover, the expandable tube may coil around the tubular part in the longitudinal direction.

In an embodiment, an inner space of the expandable tube may be in fluid communication with an inner passage of the tubular part.

Additionally, a cross-section of the expandable tube in a relaxed position may be substantially oval-shaped.

Further, a shape of a cross-section of the expandable tube in a relaxed position may comprise multiple creases.

In addition, a cross-section of the expandable tube in an expanded position may be substantially circular.

In one embodiment, the annular barrier may comprise a plurality of expandable tubes extending on the outside of the tubular part in the longitudinal direction.

The annular barrier according to the invention may further comprise a sealing element provided on an outer surface of the one or more expandable tube(s) for providing sealing against the inside wall of the borehole.

Moreover, the sealing element may be an expandable sleeve extending on the outside of the one or more expandable tube(s).

In addition, the sealing element may be made of metal, polymer, elastomer, rubber or a swellable material.

Furthermore, the one or more expandable tube(s) may at least partly be embedded in a sealing material.

The annular barrier may further comprise one or more sealing bands encircling the sealing element or the expandable sleeve to provide additional sealing.

Moreover, the annular barrier may comprise a connecting part arranged on the outside of the tubular part for attaching the one or more expandable tube(s) to the tubular part.

In an embodiment, the connection part may attach one end of each of the one or more expandable tube(s) to the tubular part.

Additionally, the annular barrier may comprise a second connection part for attaching the opposite end of each of the one or more expandable tube(s) to the tubular part.

Furthermore, the annular barrier may comprise a fixed connection part and a sliding connection part for attaching opposite ends of the one or more expandable tube(s).

In an embodiment of the annular barrier, the connection part may comprise one or more fluid channel(s) for providing fluid communication between the inner space of the one or more expandable tube(s) and the inner passage of the tubular part.

Moreover, an outer diameter of the annular barrier in an expanded position may be up to 150% of an outer diameter of the tubular part.

In addition, an outer diameter of the annular barrier in an expanded position may be 140% to 150% of an outer diameter of the tubular part.

Hereby, the annular barrier may be able to provide sufficient sealing in wellbores having a greatly varying inner diameter.

The present invention furthermore relates to a method of expanding an annular barrier as described above in an annulus between a well tubular structure and an inside wall of a borehole, the method comprising the step of:

- expanding the one or more expandable tube(s) by injecting a fluid into an inner space of the expandable tube(s), whereby a cross-section of the expandable tube(s) is transformed from a substantially oval shape to a substantially circular shape.

In an embodiment, the fluid may be injected into the inner space by pressurising an inner passage of the tubular part, and a fluid is thereby injected into the well tubular structure, providing fluid communication between the inner passage of the tubular structure and the inner space of the expandable tube(s).

Finally, the invention relates to a downhole system comprising:

- a well tubular structure, and
- one or more annular barrier(s) as described above, mounted as part of the well tubular structure.

Brief description of the drawings

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

Figs. 1a and 1b show longitudinal cross-sectional views of an annular barrier in a relaxed position and an expanded position, respectively,

Fig. 2a shows a cross-sectional view of the annular barrier of Fig. 1a along lines 2a-2a´,

Fig. 2b shows a cross-sectional view of the annular barrier of Fig. 1b along lines 2b-2b´,

Fig. 2c shows a transverse cross-sectional view of another annular barrier comprising expandable tubes partially embedded in a sealing element,

Fig. 3a shows an annular barrier in a relaxed position, comprising a coiled tube,

Fig. 3b shows a longitudinal cross-sectional view of the annular barrier of Fig. 3a,

Fig. 3c shows a cross-sectional view of the annular barrier of Fig. 3a along lines 3c-3c´,

Fig. 4a shows the annular barrier of Fig. 3a in an expanded position,

Fig. 4b shows a longitudinal cross-sectional view of the annular barrier of Fig. 4a,

Figs. 5a and 5b show longitudinal cross-sectional views of another annular barrier in a relaxed position and an expanded position, respectively, comprising a sealing element provided on an outer surface of the expandable tube,

Figs. 6a and 6b show longitudinal cross-sectional views of another annular barrier in a relaxed position and an expanded position, respectively, comprising a sealing element in the form of an expandable sleeve,

Figs. 7a and 7b show longitudinal cross-sectional views of another annular barrier in a relaxed position and an expanded position, respectively, comprising yet another configuration of a sealing element, and

Fig. 8 shows a downhole system comprising an annular barrier.

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

Figs. 1a and 1b show an annular barrier 1 for being mounted as part of a well tubular structure 3 in a downhole system 100 as shown in Fig. 8. The annular barrier 1 comprises a tubular part 6 extending in a longitudinal direction and a plurality of expandable tubes 7 extending outside the tubular part 6, also shown in Figs. 2a and 2b. The expandable tubes 7 are arranged around the periphery of the tubular part 6, and a centre axis 72 of each of the expandable tubes thus extends outside the tubular part 6 in the longitudinal direction of the annular barrier 1. This is in contrast to the design of prior art annular barriers, as described under background art, where the tubular part extending in a longitudinal direction, such as a casing, surrounded by an expandable sleeve encircles the tubular part. The expandable tubes 7 are attached to the tubular part 6 via a connection part 9. The connection part 9 comprises fluid channels 91 for providing fluid communication between an inner space 73 of each of the expandable tubes and an inner passage 31 of the tubular part 6. The fluid channel 91 extends between an aperture 61 in the tubular part 6 and an inlet 74 provided in one end of each of the expandable tubes 7.

As shown in Fig. 1a, one end of the expandable tubes 7 is attached to the connection part 9. An opposite end of the expandable tubes (not shown in Fig. 1a) may also be attached to a connection part 9 arranged on the outside of the tubular part 6. This is similar to the connection part shown in Fig. 1a, with the exception of the fluid channels which are only required in one of the connection parts. The annular barrier 1 further comprises a sealing element 8 provided on an outer surface 71 of the plurality of expandable tubes 7. In Fig. 1a, the sealing element 8 is an expandable sleeve 81, at least one end of which engages in a

sealing relationship with the tubular part 6. Hereby, the expandable sleeve 81 is adapted to provide a sealing barrier between the tubular part 6 and the inside wall 41 of the borehole 4, since the expandable tubes 7, when expanded, force the expandable sleeve towards the inside wall of the borehole 4. In the annular barrier shown in Fig 1a, the expandable sleeve 81 is attached to the connection part 9, however, it may also be attached directly to the tubular part 6 or to the expandable tubes 7. The sealing element 8 and/or the expandable sleeve 81 may be made of metal, polymer, elastomer, rubber, a swellable material, etc. Having a sealing element made of a swellable material may further increase the sealing effect of the sealing element or the expandable sleeve 81 as the material may be designed to swell when it comes into contact with specific types of fluid, such as water or other well fluids present in the borehole, an injected liquid or gas, etc. Further, the annular barrier 1 may comprise additional sealing bands 82 provided outside the sealing element 8 or expandable sleeve 81 for providing additional sealing against the inside wall 41 of the borehole 4.

In Fig. 1a, the expandable tube 7 is shown in a relaxed position, whereas Fig. 1b shows the same expandable tube in an expanded position. In order to expand the expandable tube 7, fluid is injected into the inner space 73 of the tube via the fluid channel 91 in the connection part 9 from the inner passage 31 of the tubular part 6 fluidly connected to a well tubular structure 3, as shown in Fig. 8. The fluid is pressurised from the top of the well, and the well tubular structure 3 is thereby pressurised to be able to expand the expandable tubes 7. In the expanded position, the expandable tube 7 increases the outer diameter D1e of the annular barrier 1.

Figs. 2a and 2b are cross-sectional views of the annular barrier shown in Figs. 1a and 1b, respectively. In Fig. 2a, the annular barrier 1 is shown in a relaxed position before expansion. The expandable tubes 7 are attached to and kept in place along the axial extension of the annular barrier 1 by the connection part 9, and the inlet 74 shown in one end of each of the expandable tubes 7 is connected with fluid channels in the connection part. As shown in Fig. 2a, cross-sections of the expandable tubes 7 in the relaxed position are substantially oval-shaped. When the expandable tubes 7 are expanded into the expanded position, as shown in Fig. 2b, the cross-sections of the expandable tubes are transformed from the substantially oval shape to a substantially circular shape. Hereby, the outer diameter D1 of the annular barrier 1 is significantly increased, and the

expandable sleeve 81 is forced outwards, as shown in Fig. 2b. By providing a plurality of expandable tubes 7 having a substantially oval-shaped cross-section around the periphery of the tubular part 6, the outer diameter D1 of the annular barrier 1 may be increased from a smaller diameter to a larger diameter. This is done by expanding the expandable tubes 7 by means of fluid and thereby changing the shape of the cross-section of the expandable tubes 7 and/or by stretching the material of the expandable tubes. In another configuration (not shown), the expandable tubes 7 may have a cross-sectional shape in a relaxed position and comprise multiple creases. By pressurising the expandable tubes 7, the creases are smoothened, and the outer effective diameter of the expandable tubes may be increased.

In Fig. 2c, a cross-sectional view of another configuration of an annular barrier is shown. In this configuration, the expandable tubes 7 are at least partially embedded in the sealing element 8. Thus, the sealing element 8 expands as the expandable tubes are expanded, thereby increasing the outer diameter of the sealing element. The sealing element is thus moved outwards from the tubular part during expansion. In another embodiment, the expandable tubes 7 are partly or fully embedded in the sealing element 8 and the sealing element 8 may only partly surround the expandable tubes 7, the sealing element thereby not being arranged between the expandable tubes and the tubular part 6.

Another configuration of an annular barrier according to an embodiment of the invention is shown in Figs. 3a and 3b. This annular barrier 1 comprises a tubular part 6 extending in a longitudinal direction and an expandable tube 7 extending outside the tubular part 6. The expandable tube 7 is coiled around the tubular part 6 in the longitudinal direction. As shown in Fig. 3c, the expandable tube 7 is attached to the tubular part 6 via a connection part 9 comprising a fluid channel 91 for providing fluid communication between an inner space 73 of the expandable tube and the inner passage 31 via an aperture 61 in the tubular part. An opposite end of the expandable tube (not shown in Figs. 3a and 3b) may also be attached to a connection part arranged on the outside of the tubular part 6, similar to the connection part shown in Figs. 3a, 3b and 3c, with the exception of the fluid channel which is only required in one of the connection parts. In another configuration (not shown), the annular barrier may comprise multiple parallelly extending expandable tubes coiled around the tubular part. Furthermore, both

connection parts may have fluid channels connected with the inner space 73 of the tube.

In Figs. 3a and 3b, the expandable tube 7 is shown in a relaxed position, whereas Figs. 4a and 4b show the same expandable tube in an expanded position. As previously described, the expandable tube 7 is expanded by injecting a fluid into the inner space 73 via the fluid channel 91 in the connection part 9. Also, during expansion, the cross-sections of the expandable tubes 7 are transformed from a substantially oval shape to a substantially circular shape, whereby the outer diameter D1 of the annular barrier is significantly increased. As the expandable tube 7 is coiled around the tubular part 6, expansion of the expandable tube 7 may cause changes in the mutual angle of windings and/or numbers of windings of the coiled expandable tube. Further, the expansion of the expandable tube 7 has the effect that the outer unexpanded diameter $D1_u$ shown in Fig. 3b is increased to an outer expanded diameter $D1_e$, as shown in Fig. 4b. As the outer diameter is increased, the extension of the expandable tube 7 in the longitudinal direction is affected if the length of the expandable tube is to be kept constant. One end of the expandable tube 7 may therefore be attached to a sliding connection part (not shown). Alternatively, the expandable tube 7 may be attached to the tubular part 6 in only one end, as shown in Fig. 3a. The expandable tube 7 may also be attached to fixed points along the tubular part 6 in both ends. However, this requires the material of the expandable tube to be able to withstand some stretching or thinning in the longitudinal direction of the expandable tube.

In another configuration, the annular barrier 1 of Fig. 3a further comprises a sealing element 8 provided on an outer surface 71 of the plurality of expandable tubes 7, as shown in Fig. 5a. In the shown configuration, the sealing element 8 extends along the length of the expandable tube and is provided on the outermost part of the outer surface 71 of the expandable tube 7, potentially facing the inside wall 41 of the borehole 4. In another configuration (not shown), the sealing element 8 may be provided around part of or on the entire outer surface 71 of the expandable tube 7 in part of or the entire length of the expandable tube 7. The sealing element 8 may also be constructed as an expandable sleeve 81 having at least one end engaging in a sealing relationship with the tubular part 6, as shown in Figs. 6a and 6b. Further, the annular barrier 1 may comprise additional sealing bands 82 provided outside the expandable

sleeve 81. The sealing element 8 or expandable sleeve 81 is adapted to provide a sealing barrier between the tubular part 6 and the inside wall 41 of the borehole 4 as the expandable tubes 7 are expanded and thereby force the sealing element 8 or expandable sleeve 81 towards the inside wall 41 of the borehole 4. As previously described, the expandable sleeve 81 may be attached to the connection part 9, directly to the tubular part 6 or to the expandable tubes 7.

Figs. 7a and 7b show yet another configuration of the annular barrier 1 where the expandable tube 7 is at least partially embedded in the sealing element 8. Thus, the sealing element 8 expands as the expandable tubes are expanded, thereby increasing the outer diameter of the sealing element, and the sealing element is moved outwards away from the tubular part during expansion.

When the annular barriers 1 described above are expanded, the outer diameter D1e of the annular barrier in an expanded position, as shown in Fig. 4b for exemplary purposes, is up to 150% of an outer diameter D2 of the tubular part, also shown in Fig. 4b for exemplary purposes. Preferably, the outer diameter D1e of the annular barrier 1 may be expanded to have an outer diameter of 140% to 150% of the outer diameter D2 of the tubular part 6. By such degree of expansion, the annular barrier 1 may be able to provide sufficient sealing in wellbores having a greatly varying inner diameter.

Fig. 8 shows a downhole system 100 comprising a plurality of annular barriers 1. For illustrative purposes, the downhole system 100 is shown as comprising annular barriers 1 of different configurations. However, the annular barriers 1 comprised in a downhole system may all be the same, all be different or a combination thereof. The downhole system 100 further comprises an intermediate casing 101 provided with two annular barriers 102 expanded in an annulus 2 between the intermediate casing 101 and an inside wall 41 of a borehole 4 for ensuring the pressure integrity of the well. Inside the intermediate casing 101, an upper section of a well tubular structure 3 is provided, and another annular barrier 103 provides a sealing relationship between the intermediate casing 101 and the well tubular structure 3. The well tubular structure 3 extends from the intermediate casing 101 down into the well.

The downhole system 100 further comprises a plurality of valve sections 105 for letting hydrocarbon-containing fluid into an inner space 31 of the well tubular

structure 3. The valve section 105 may contains inflow control valves 106 and/or a fracturing valve 107. Further, a screen 108 may be arranged opposite the valves. The well tubular structure 3 may be a production casing or injection casing and/or comprise a multitude of other functional elements, such as sliding sleeves, screens, gravel packs, etc.

In use, one or more annular barriers 1 are mounted as part of a well tubular structure 3, such as a casing, and lowered into a borehole 4. When the annular barriers 1 are to be expanded, e.g. when a hydro carbon producing zone of the formation is to be sealed off, the well tubular structure 3 is pressurised from within by injecting a fluid. As the inner space 73 of the one or more expandable tube(s) 7 of the annular barrier(s) 1 is in fluid communication with the pressurised inner space 31 of the tubular part 6, the one or more expandable tube(s) are expanded.

Furthermore, the expandable tubes 7 may be made of any kind of suitable metal.

The expandable sleeve 81 of the annular barrier 1 may be made of metal, polymers, an elastomeric material, silicone or natural or synthetic rubber.

The fluid used for expanding the expandable tubes 7 may be any kind of well fluid present in the borehole surrounding the tool and/or the well tubular structure 3. Also, the fluid may be cement, gas, water, polymers or a two-component compound, such as powder or particles mixing or reacting with a binding or hardening agent. Part of the fluid, such as the hardening agent, may be present in the cavity between the tubular part 6 and the expandable tube 7 before injecting a subsequent fluid into the cavity.

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.

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

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 annular barrier (1) for mounting as part of a well tubular structure (3), the annular barrier being adapted to be expanded in an annulus (2) between the well tubular structure and an inside wall (41) of a borehole (4), and the annular barrier comprising:

- a tubular part (6) extending in a longitudinal direction,
- one or more expandable tubes (7) each having a centre axis (72) extending outside the tubular part in the longitudinal direction, and
- a sealing element (8) in the form of an expandable sleeve (81) provided on an outer surface (71) of the one or more expandable tube(s) for providing sealing against the inside wall of the borehole, the expandable sleeve (81) extending on the outside of the one or more expandable tube(s).

2. An annular barrier according to claim 1, wherein the centre axis of the expandable tube coils around the tubular part in the longitudinal direction.

3. An annular barrier according to claim 1 or 2, wherein an inner space (73) of the expandable tube (7) is in fluid communication with an inner passage (31) of the tubular part.

4. An annular barrier according to any of the preceding claims, wherein a cross-section of the expandable tube in a relaxed position is substantially oval-shaped.

5. An annular barrier according to any of the preceding claims, wherein a cross-section of the expandable tube in an expanded position is substantially circular.

6. An annular barrier according to any of the preceding claims, wherein the annular barrier comprises a plurality of expandable tubes (7) extending on the outside of the tubular part in the longitudinal direction.

7. An annular barrier according to any of the preceding claims, further comprising a connecting part (9) arranged on the outside of the tubular part (3) for attaching the one or more expandable tube(s) to the tubular part.

8. An annular barrier according to any of the preceding claims, wherein the connection part comprises one or more fluid channel(s) (91) for providing fluid communication between the inner space of the one or more expandable tube(s) and the inner passage (31) of the tubular part.

9. An annular barrier according to any of the preceding claims, wherein an outer diameter (D1e) of the annular barrier in an expanded position is up to 150% of an outer diameter (D2) of the tubular part.

10. An annular barrier according to any of the preceding claims, wherein an outer diameter (D1e) of the annular barrier in an expanded position is 140% to 150% of an outer diameter (D2) of the tubular part.

11. A method of expanding an annular barrier (1) according to any of the claims 1-10 in an annulus (2) between a well tubular structure (3) and an inside wall (41) of a borehole (4), the method comprising the step of:
- expanding the one or more expandable tube(s) by injecting a fluid into an inner space (73) of the expandable tube(s) (7), whereby a cross-section of the expandable tube(s) is transformed from a substantially oval shape to a substantially circular shape.

12. A downhole system (100) comprising:
- a well tubular structure (3), and
- one or more annular barrier(s) (1) according to any of the claims 1-10, mounted as part of the well tubular structure (3).

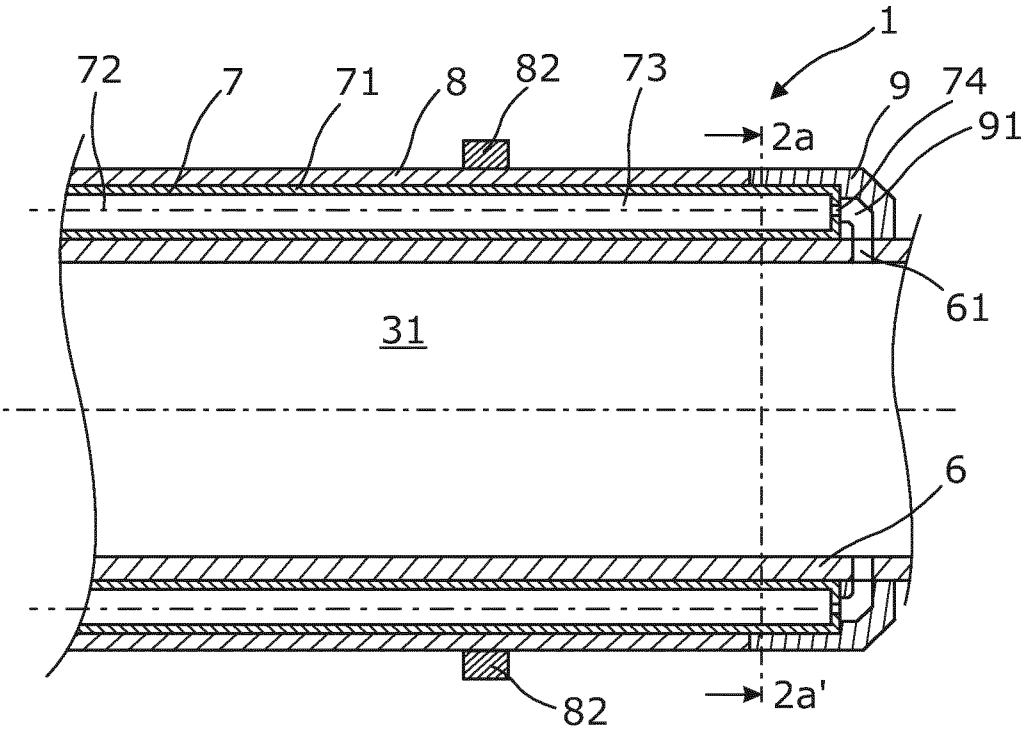
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Fig. 1a

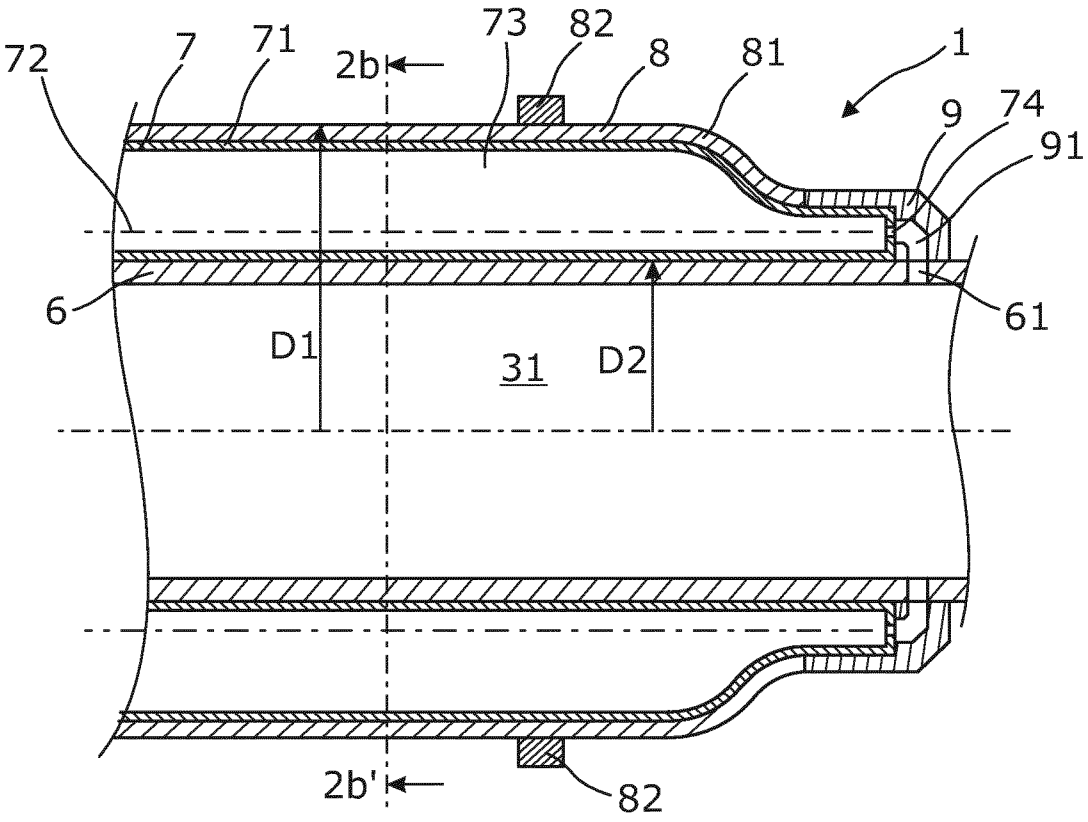
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Fig. 1b

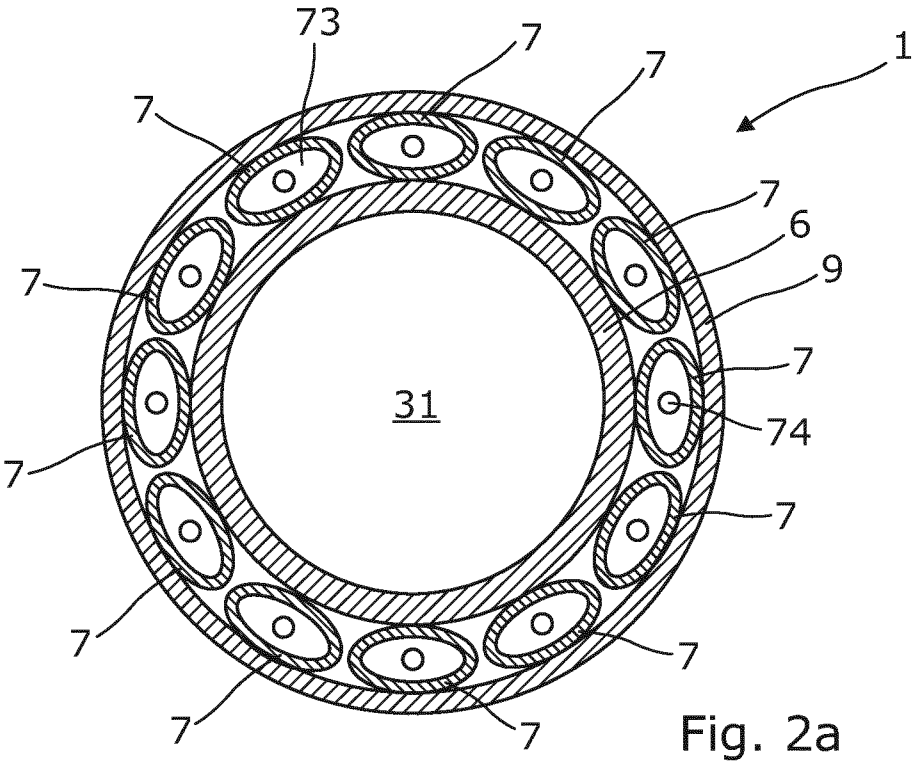
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Fig. 2a

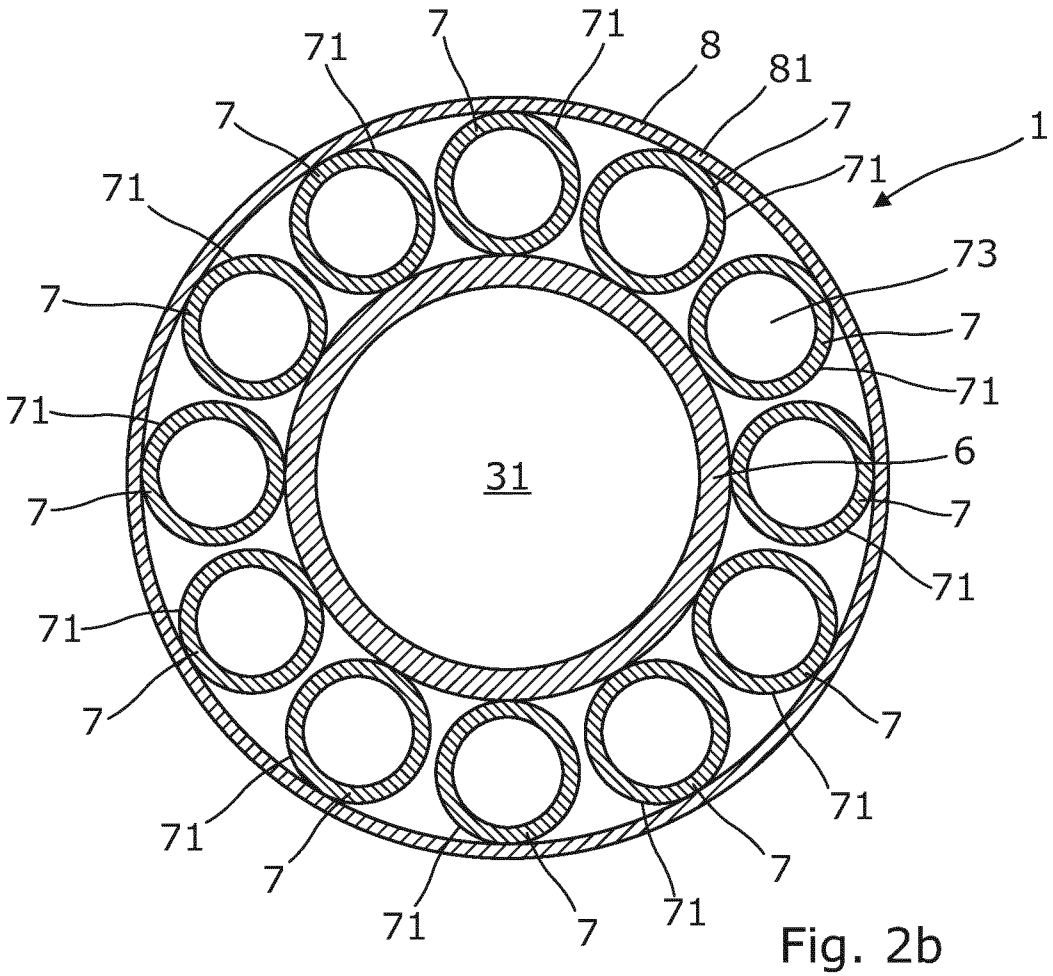
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Fig. 2b

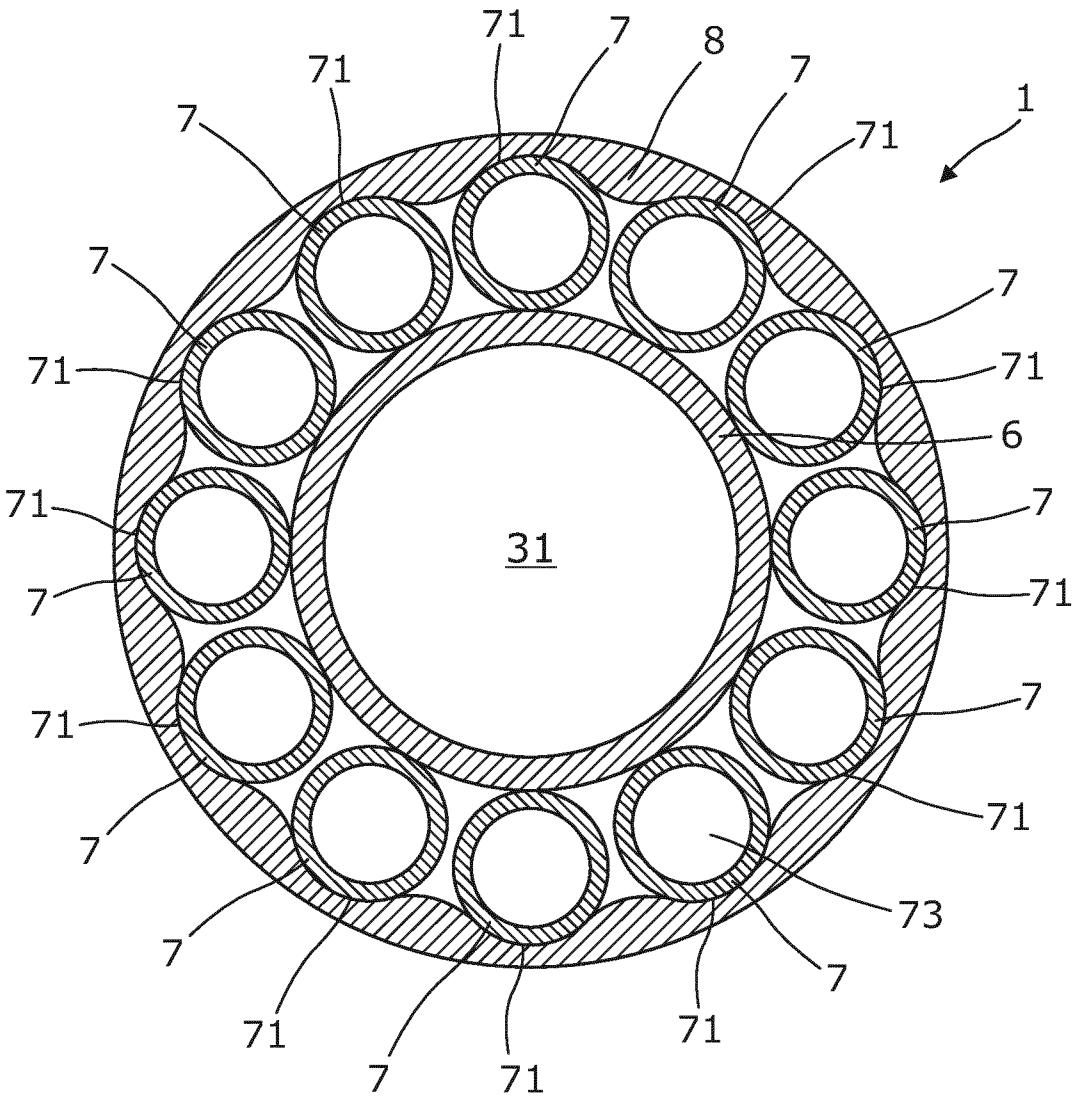

Fig. 2c

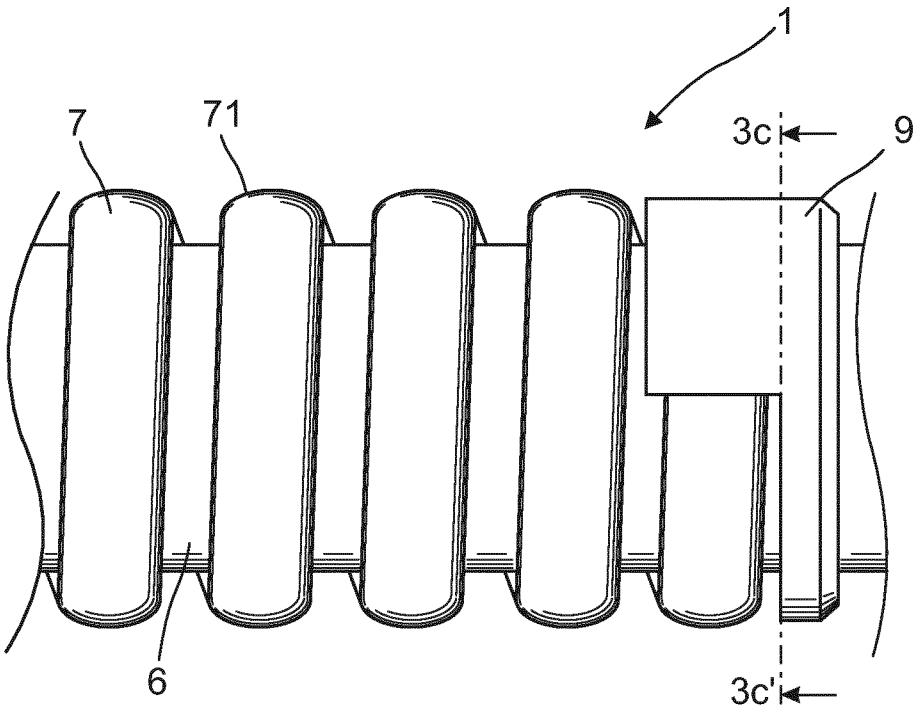

Fig. 3a

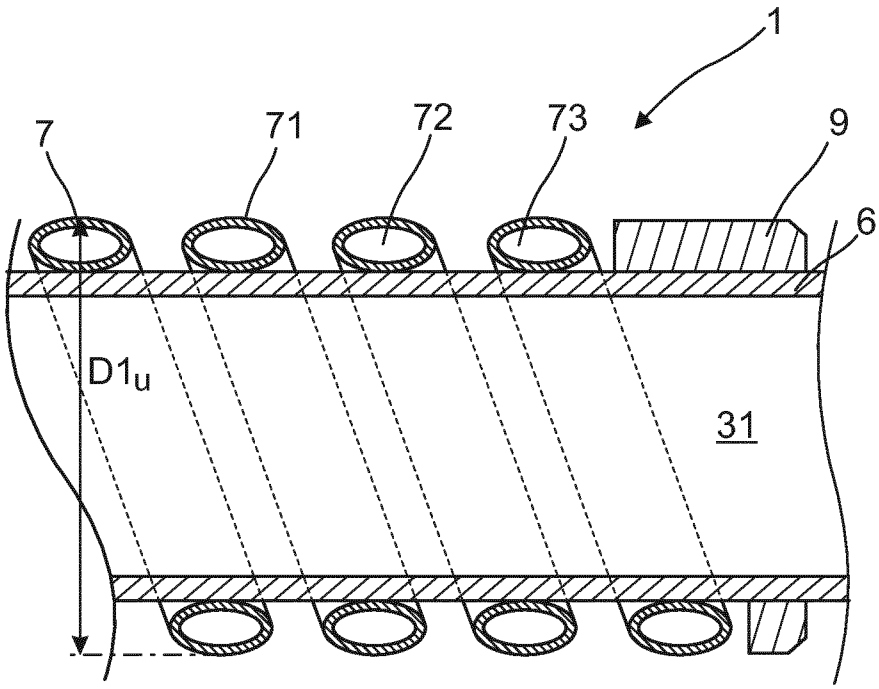

Fig. 3b

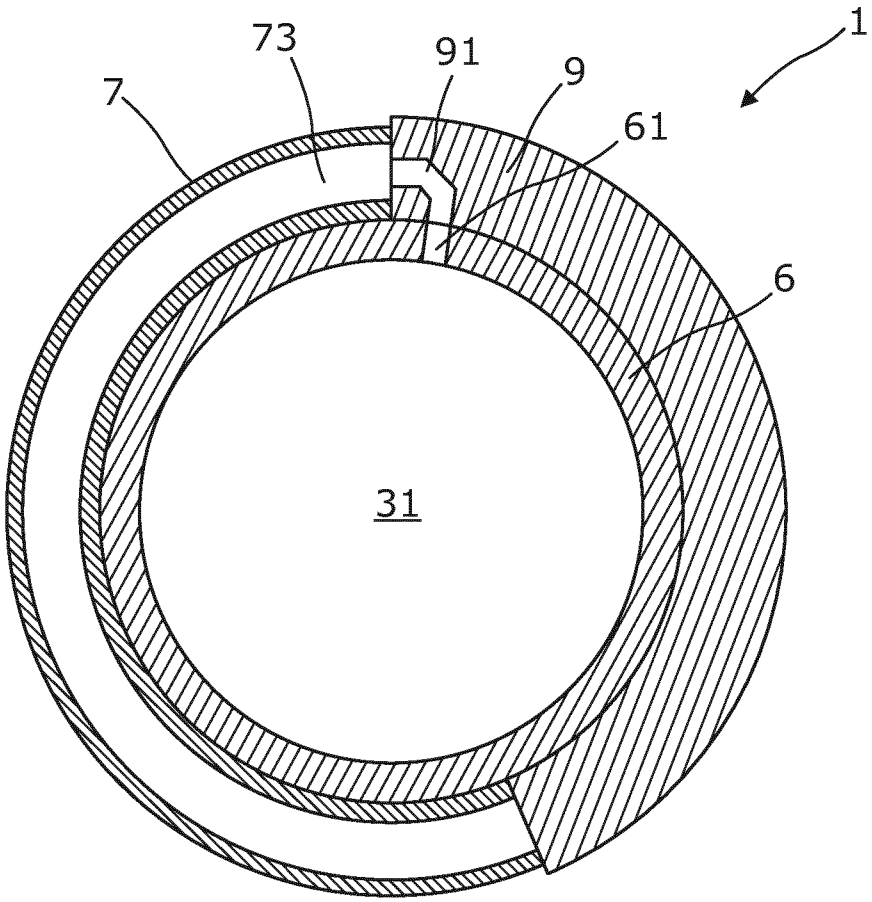

Fig. 3c

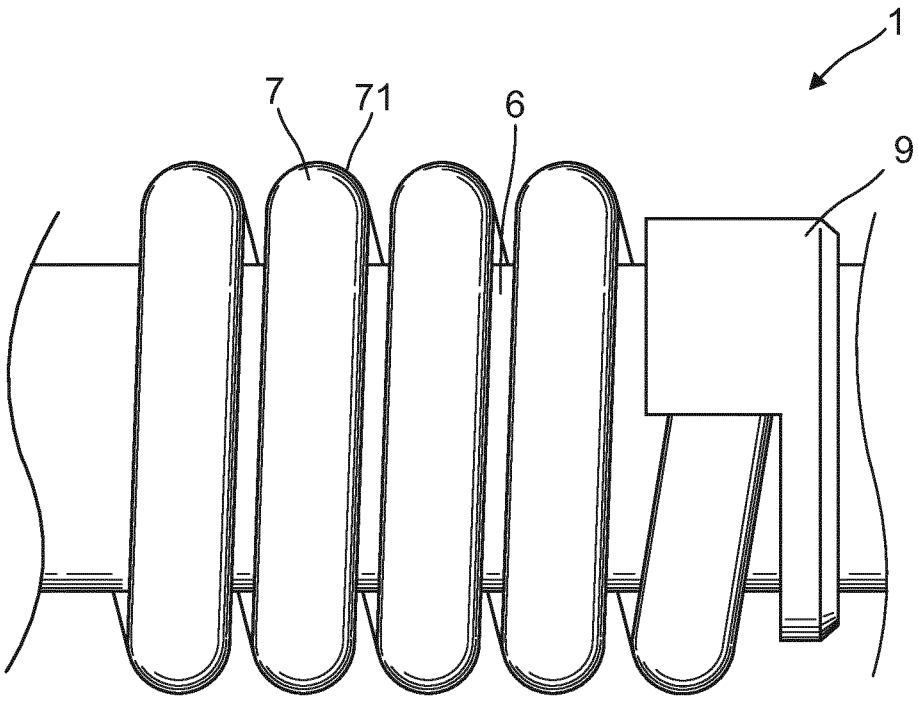

Fig. 4a

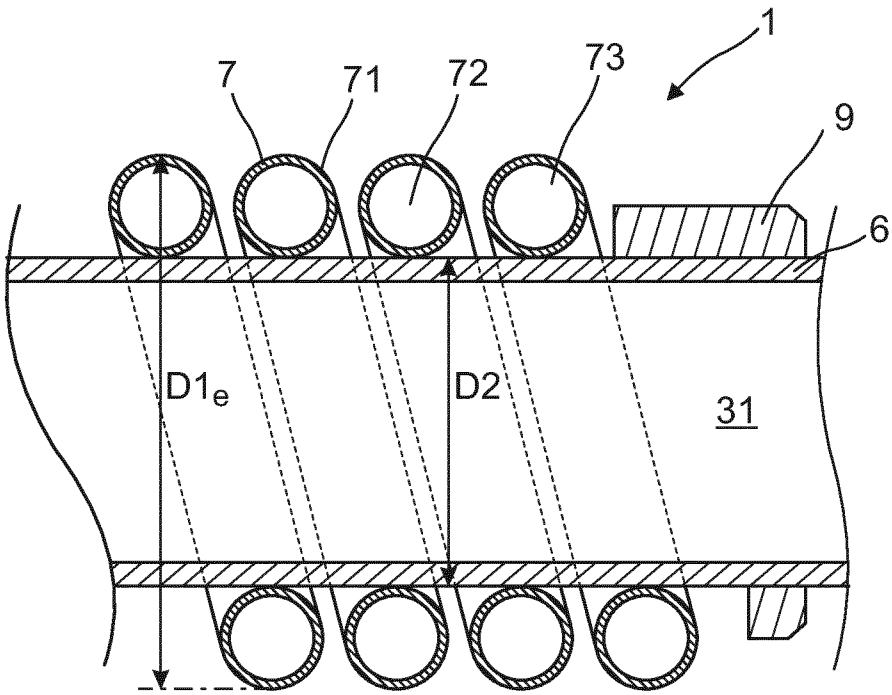

Fig. 4b

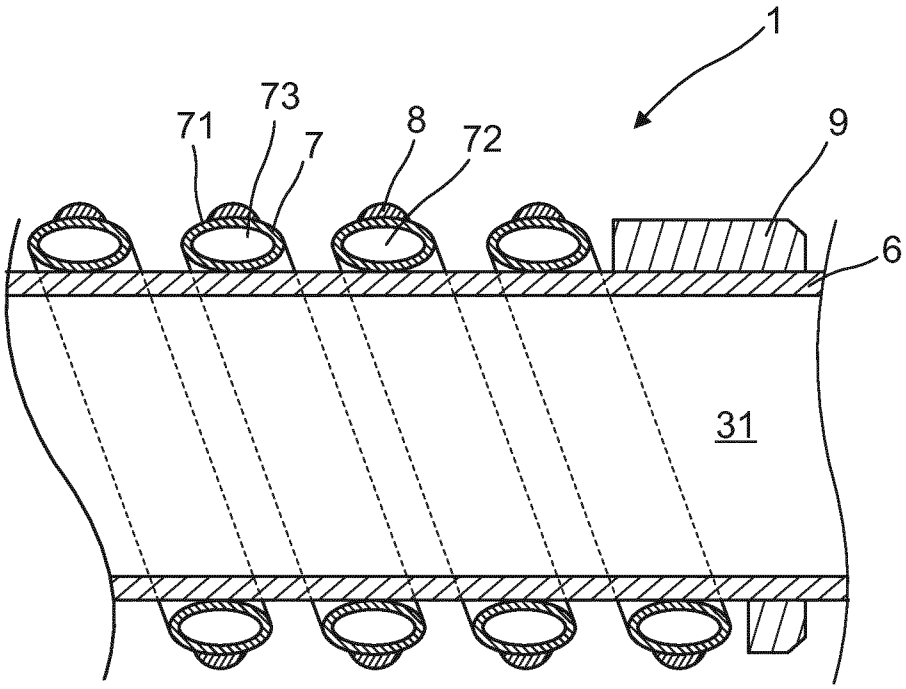

Fig. 5a

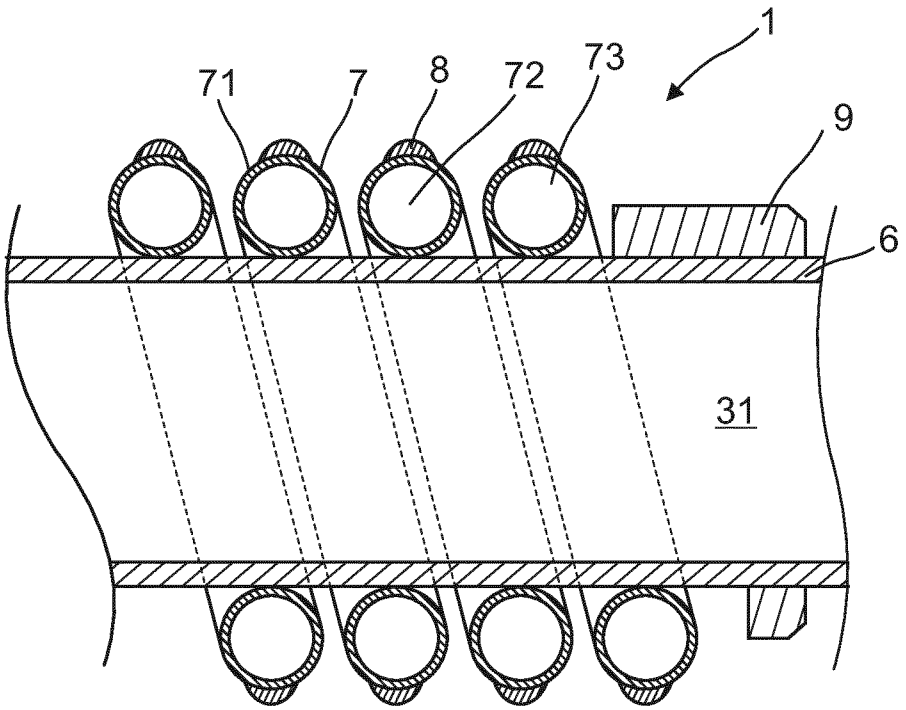

Fig. 5b

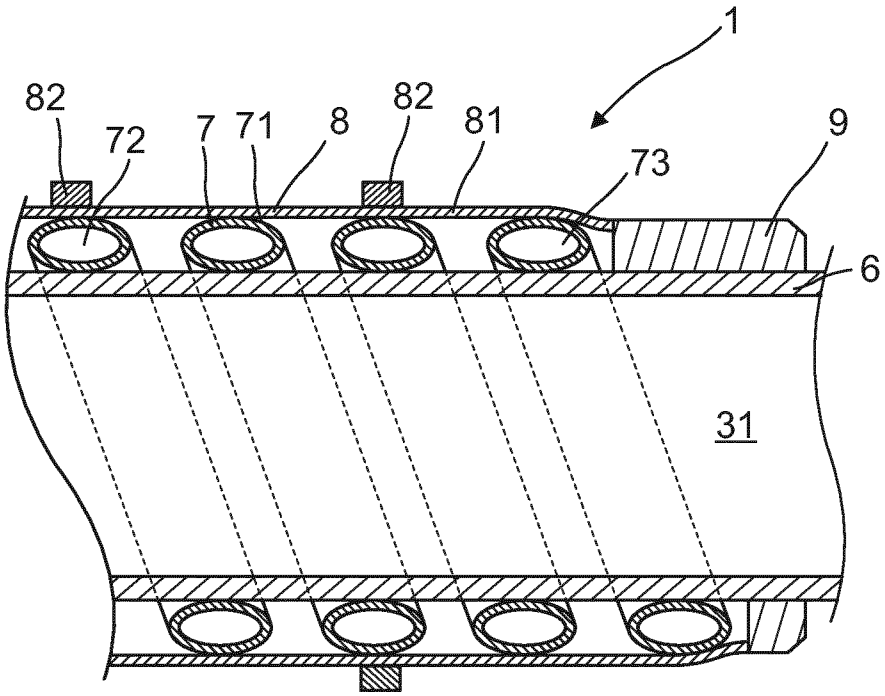

Fig. 6a

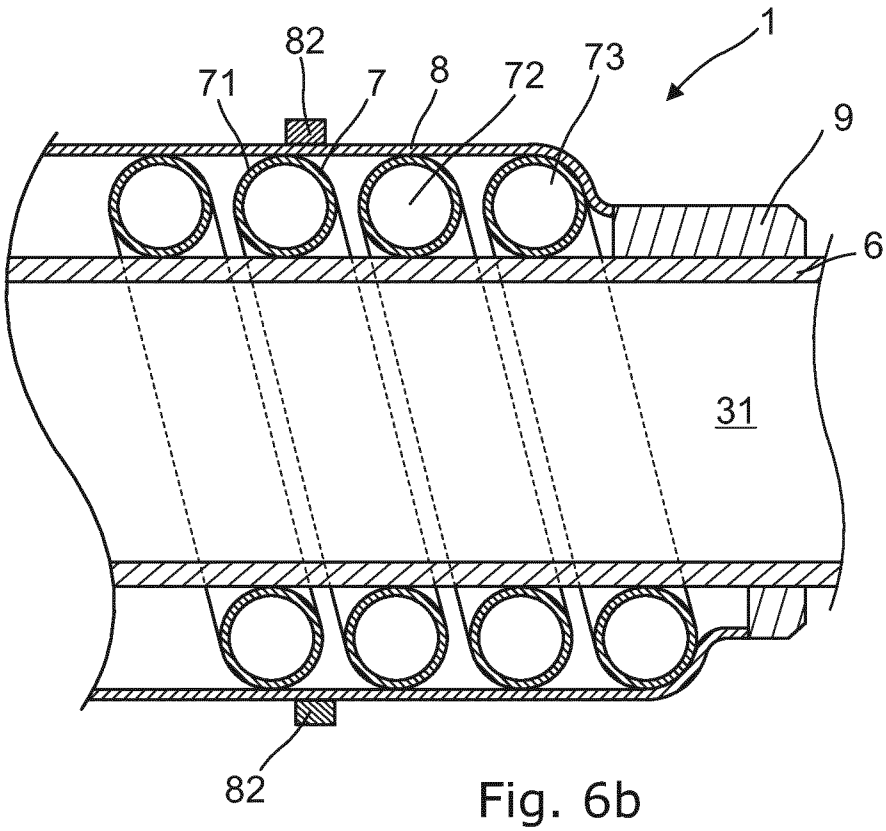

Fig. 6b

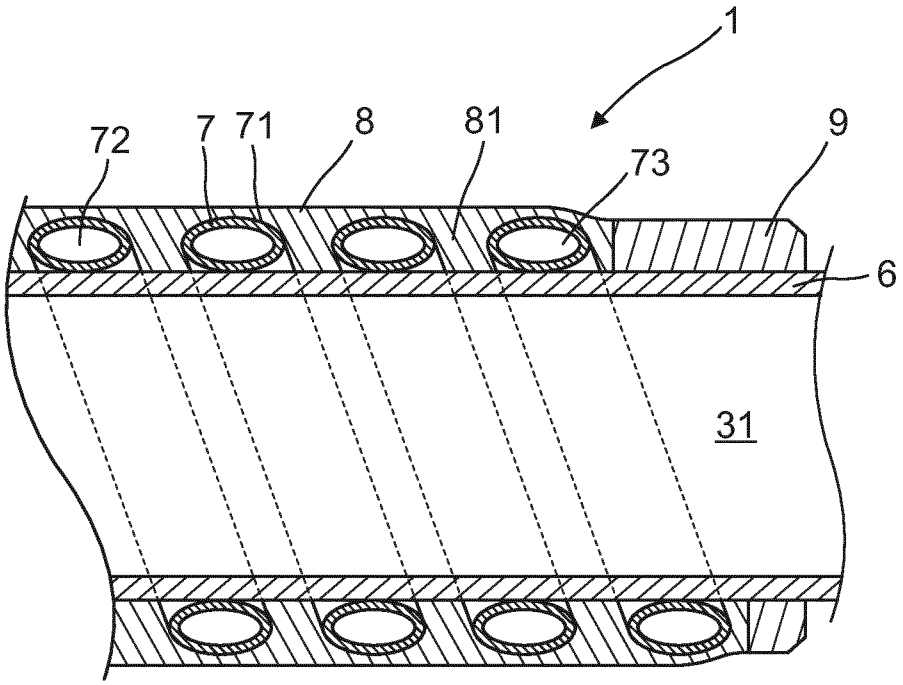

Fig. 7a

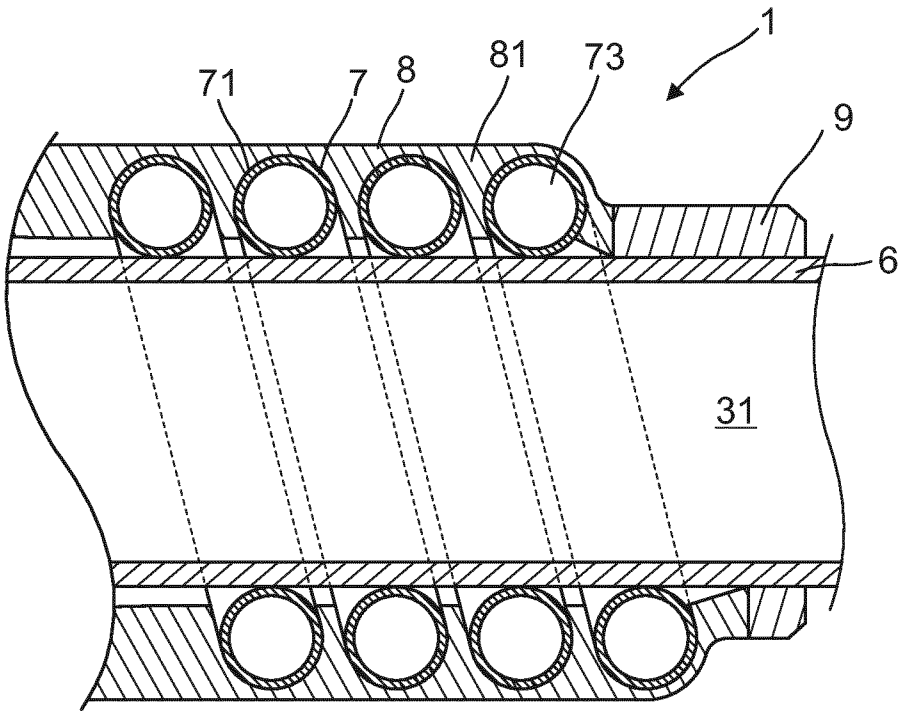

Fig. 7b

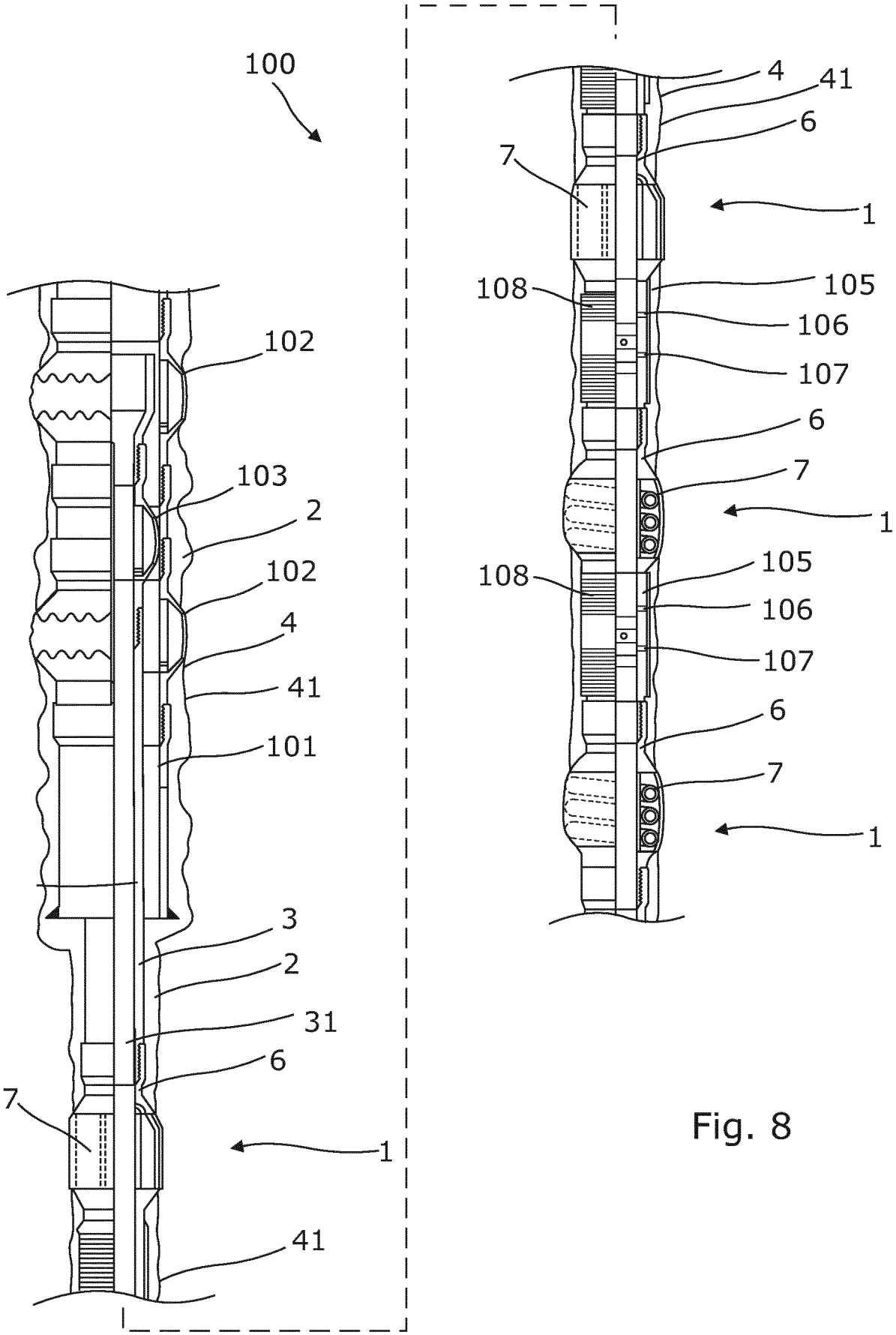
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Fig. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/056469

A. CLASSIFICATION OF SUBJECT MATTER
INV. E21B33/12 E21B33/127
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2009/001069 A2 (METCALFE PAUL DAVID [GB]) 31 December 2008 (2008-12-31) page 22, line 19 - page 24, line 17	1-12
A	US 2005/016740 A1 (ALDAZ WALTER [MY] ET AL) 27 January 2005 (2005-01-27) the whole document	1-12
A	US 2004/055758 A1 (BREZINSKI MICHAEL M [US] ET AL) 25 March 2004 (2004-03-25) figure 42	1-12

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
22 April 2013	03/05/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Ott, Stéphane

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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