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(71) Applicant: **Welltec A/S**
3450 Allerød (DK)

(72) Inventors:
- **STÆHR, Lars**
  2600 Glostrup (DK)
- **Plessing, Hans**
  2830 Virum (DK)
- **Vasques, Ricardo Reves**
  2840 Holte (DK)

(74) Representative: **Hoffmann Dragsted A/S**
Rådhuspladsen 16
1550 Copenhagen V (DK)

(54) Patch for tubular and patch setting tool

(57) The tubular patch comprises a first end part (7), a second end part (8), and an intermediate part (9) intermediate the first and second end parts. The intermediate part has a thickness (ti) being smaller than that of the first and second parts so that when pressurised fluid is forced towards the intermediate part, the intermediate part is expanded.

The invention furthermore relates to a patch setting tool for sealing off an opening in a weak part of a casing in a well, a downhole patch setting system and a patch setting method.

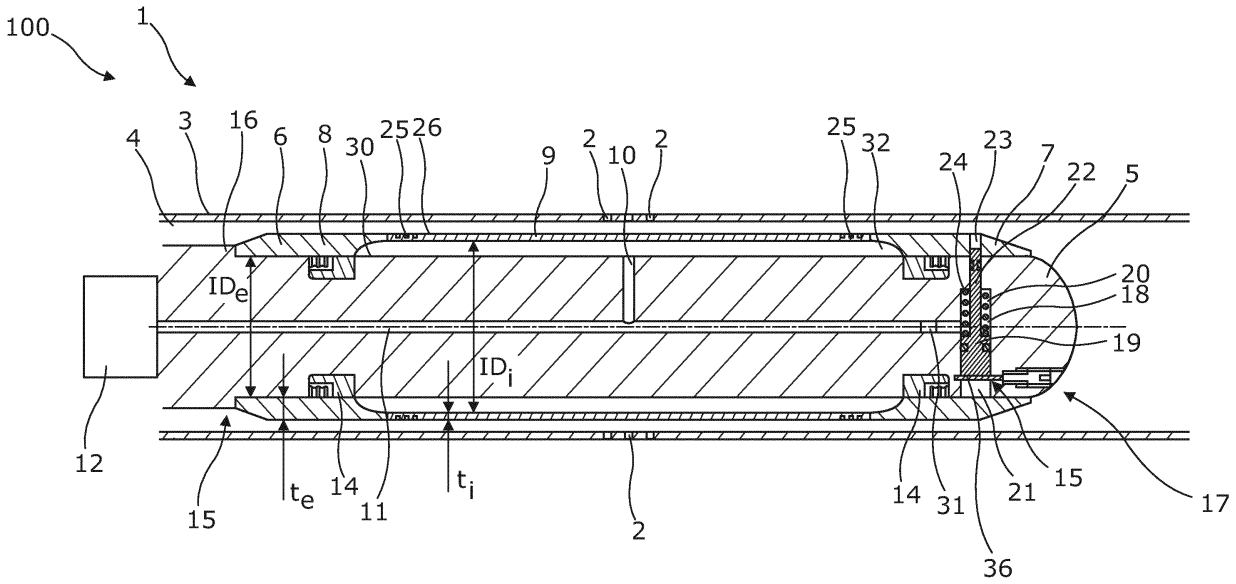

Fig. 1

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Description

Field of the invention

[0001] The present invention relates to a tubular patch adapted to surround a part of a tool body downhole and to a patch setting tool for sealing off an opening in a weak part of a casing in a well. Furthermore, the invention relates to a downhole patch setting system and a patch setting method.

Background art

[0002] In the past, many attempts have been made to set patches downhole to seal off openings in casings or liners by using expandable cones which are pulled through the patches in order to expand the patches to press against the inner surface of the casings. Since the cone and the patch have to pass some restrictions downhole, the cone has to be expandable, however, the attempts made have shown it to be very difficult to make a workable solution using an expandable cone. This is due to the fact that an expandable cone has mechanically movable parts which may get stuck, which prevents the cone from expanding and subsequently being retracted properly.

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 patch setting tool which has fewer mechanically movable parts than the prior art tools.

[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 tubular patch adapted to surround a part of a tool body downhole, comprising

- a first end part,
- a second end part, and
- an intermediate part intermediate the first and second end parts,
  wherein the intermediate part has a thickness being smaller than that of the first and second parts so that when pressurised fluid is forced towards the intermediate part, the intermediate part is expanded.

[0005] In an embodiment, the intermediate part may have an inner diameter being larger than that of the first and second end parts.

[0006] Furthermore, the intermediate part may have a thickness being less than 60% of the thickness of the first and second end parts, preferably less than 50% of the thickness of the first and second end parts.

[0007] Moreover, the intermediate part may be made mainly of metal.

[0008] Additionally, the intermediate part may be made of a material different from that of the first and second end parts.

[0009] Also, the second end part may have an indentation.

[0010] In addition, the intermediate part may have an outer face, and a patch sealing element may be arranged on the outer face.

[0011] Further, the end of the first and second end parts may taper towards the intermediate part.

[0012] Moreover, the intermediate part may be connected to the first and second end parts by means of friction welding.

[0013] Furthermore, the intermediate part may be made of a material being more elastic than a material of the first and second parts.

[0014] Also, the first and second end parts may be made of material which is acid-dissolvable.

[0015] Additionally, the material of the first and second end parts may be aluminium.

[0016] Finally, the material of the first and second end parts may be composite steel, plastic, reinforced plastic, fiber glass and/or carbon.

[0017] The present invention furthermore relates to a patch setting tool for sealing off an opening in a weak part of a casing in a well, comprising:

- a tool body having a fluid channel,
- a tubular patch as described above, the patch surrounding part of the tool body and having a first end part, a second end part and an intermediate part intermediate the first and second end parts,

wherein the intermediate part has a thickness being smaller than that of the first and second end parts, and wherein an aperture of the fluid channel faces the intermediate part, meaning that when pressurised fluid is forced out of the aperture, the intermediate part is expanded.

[0018] In an embodiment, the patch setting tool may further comprise a pump for pressurising a fluid.

[0019] In another embodiment, the patch setting tool may further comprise sealing elements arranged between the first and second end parts and the tool body.

[0020] In yet another embodiment, the patch setting tool may further comprising a holding means for holding the patch on the tool body.

[0021] Furthermore, the holding means may comprise a stop for preventing the patch from moving axially in one direction, wherein and the holding means further comprises a retractable retainer unit.

[0022] Moreover, the retainer unit may comprise a cylinder and a piston dividing the cylinder into a first chamber part and a second chamber part, wherein the first chamber part is fluidly connected with the fluid channel and the piston has a projection part engaging an indentation in the patch.

[0023] In addition, a spring may be arranged in the first chamber part.

[0024] Also, the retainer unit may comprise a breakable element arranged in the second chamber part for maintaining the projection part in engagement with the indentation.

[0025] Further, a valve may be arranged in the fluid channel upstream of the first chamber part.

[0026] Additionally, the valve may be activated at a certain differential pressure.

[0027] Furthermore, the sealing elements may comprise a split ring-shaped retaining element.

[0028] Also, the stop may be retractable.

[0029] Moreover, the stop may be axially movable in relation to the tool body.

[0030] The patch setting tool may further comprise a milling bit and an anchoring section having projectable anchors.

[0031] In an embodiment, the milling bit may be axially movable and rotatable in relation to the tool body.

[0032] The tool may further comprise a driving unit, such as a downhole tractor, for propelling the tool forward in the well.

[0033] Finally, the tool may comprise a plurality of patches.

[0034] The present invention furthermore relates to a downhole patch setting system comprising a patch setting tool as described above and a casing having an opening or a weak part.

[0035] Finally, the present invention relates to a patch setting method for setting a tubular patch as described above, using a patch setting tool as described above, the method comprising the steps of:

- inserting the patch setting tool into a casing in a well,
- positioning an intermediate part of the patch opposite an aperture to be sealed off or opposite a weak part,
- pressuring a fluid,
- letting the pressurised fluid through the aperture to expand the intermediate part by means of the pressurised fluid so that the intermediate part abuts the casing and seals off an opening or weak part,
- moving the tool away from the patch, and
- removing first and second end parts of the patch.

Brief description of the drawings

[0036] 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 patch setting tool in an unexpanded condition of a patch,

Fig. 2 shows the patch setting tool of Fig. 1 in which the patch has been expanded,

Fig. 3 shows the patch setting tool of Fig. 1 in which the patch has been released from the tool,

Fig. 4 shows the patch of Fig. 1 in which the tool has been removed from the patch,

Fig. 5 shows milling bits which are about the remove part of the patch,

Fig. 6 shows a cross-sectional view of a patch sealing off an opening in a casing, and

Fig. 7 shows several patches set in turn to seal off openings in the casing.

[0037] 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

[0038] Fig. 1 shows a patch setting tool 1 for sealing off an opening 2 in or weak part of a casing 3 in a well 4. The tool comprises a tool body 5 having a fluid channel 11 extending within the tool body and ending in an aperture 10 in an outer face 30 of the tool body. The tool 1 has a tubular patch 6 surrounding part of the tool body 5. The patch 6 has a first end part 7, a second end part 8 and an intermediate part 9 intermediate the first and second end parts. The intermediate part 9 has a thickness t_i being smaller than a thickness t_e of the first and second end parts 7, 8. The aperture 10 of the fluid channel 11 faces the intermediate part 9, meaning that when pressurised fluid is forced out of the aperture, the intermediate part is expanded as the pressurised fluid fills up a space 32 between the intermediate part and the outer face 30 of the tool body 5. The space 32 increases as the intermediate part 9 is expanded.

[0039] As can be seen in Fig. 1, the intermediate part 9 has an inner diameter ID_i being larger than an inner diameter ID_e of the first and second end parts 7, 8. Sealing elements 14 are arranged between the first and second end parts 7, 8 of the patch 6 and the tool body 5 so that the space 32 is sealed off and can be pressurised. The intermediate part 9 is fastened to the first and second end parts 7, 8, and as the pressurised fluid pressurise the patch 6 from within, only the intermediate part of the patch is expanded, as shown in Fig. 2. The first and second end parts 7, 8 have a substantial thickness compared to the intermediate part 9 to ensure that only the intermediate part is expanded and that the end parts are able to maintain the seals provided by the sealing elements 14. Thus, the intermediate part 9 may have a thickness being less than 60% of the thickness of the first and second end parts, preferably less than 50% of the thickness of the first and second end parts.

[0040] As shown in Fig. 1, the patch setting tool 1 com-

prises a pump 12 for pressurising the fluid in order to expand part of the patch 6. The pump 12 may also be arranged at the surface to pressurise the casing 3 from within and further into the tool body 5. The patch 6 is maintained around the tool body 5 as the tool 1 is submerged into the well 4 by means of a holding means 15 for holding the patch on the tool body. In one end of the patch 6, the holding means 15 comprises a stop 16 for preventing the patch from moving axially in a first direction, and in the other end of patch, the holding means further comprises a retractable retainer unit 17 retaining the patch in a direction opposite the first direction.

[0041] When the patch 6 has been expanded as shown in Fig. 2, the holding means 15 releases the patch, as shown in Fig. 3, and then, the tool 1 can be retracted from the patch, leaving the patch in the well opposite the openings 2 to be sealed off, as shown Fig. 4. Subsequently, the first and second end parts 7, 8 of the patch are removed, either by milling, as shown in Fig. 5, or by acid, leaving the intermediate part as the final patch, as shown in Fig. 6.

[0042] As shown in Figs. 1-3, the retractable retainer unit 17 comprises a cylinder 18 and a piston 19 movable within the cylinder and dividing the cylinder into a first chamber part 20 and second chamber part 21. The first chamber part 20 is fluidly connected with the fluid channel 11 so that the pressurised fluid can enter the first chamber part. The piston 19 has a projection part 22 engaging an indentation 23 in the second part of the patch 6 for holding the patch in the axial direction. The patch 6 is slid onto the tool body 5 over the projection part 22, and as the patch reaches the stop 16, the projection part engages the indentation 23, thereby preventing the patch from moving axially along the tool body as the tool 1 is submerged into the well 4 and also during expansion of the intermediate part 9.

[0043] A spring 24 is arranged in the first chamber part 20, forcing the piston 19 and the projection part 22 out of engagement with the indentation 23, thus helping the fluid move the piston to release the patch 6 from the tool body 5, as shown in Fig. 3.

[0044] The retractable retainer unit 17 comprises a breakable element 36, such as a shear pin, arranged in the second chamber part 21 for maintaining the projection part 22 in engagement with the indentation 23, as shown in Figs. 1 and 2. A valve 31 may be arranged in the fluid channel 11 upstream of the first chamber part 20. The valve 31 is activated at a certain differential pressure occurring when the space 32 has been pressurised and the intermediate part 9 has been expanded. Then, the pressure is built up even further and the valve 31 opens and lets the fluid into the first chamber part 20.

[0045] The sealing elements 14 may be any kind of seal and may comprise a split ring-shaped retaining element arranged in a groove in the tool body 5 between first and second circumferential edges, and the split ring-shaped retaining element has several windings so that when the patch 6 is expanded, the split ring-shaped retaining element partly unwinds. In this way, the sealing elements 14 are able to compensate for a slight movement of the first and second end parts 7, 8, should such movements occur.

[0046] In Figs. 1-3, the stop 16 is fixed, however, in another embodiment, the stop is retractable into the tool body 5 so that the tool body can pass a set patch 6 and move further into the casing 3. In this way, the patch setting tool may be reused for setting several patches in one run, as shown in Fig. 7, and the milling bits 33 shown in Fig. 5 may also be moved to remove the first and second end parts 7, 8 in the same run. In Fig. 5, the patch setting tool further comprises an anchoring section 34 having projectable anchors 35. The milling bits 33 are axially movable and rotatable in relation to the tool body to be able to remove the end parts.

[0047] As can be seen in Figs. 1-6, the intermediate part 9 has an outer face 26, and a patch sealing element 25 is arranged on the outer face 26 of the patch. In order to ease the expansion of the intermediate part 9 and to ensure that the intermediate part fully expands, the end of the first and second end parts tapers towards the intermediate part. In this way, the tapering parts of the first and second end parts become thinner as the intermediate part 9 is expanded.

[0048] As mentioned, the intermediate part 9 being connected to the first and second end parts may be performed by means of frictional welding. The ends of the parts are forced to abut each other, and the parts are rotated in relation to each other. A rotating pin between the parts may also be used. Thus, the intermediate part 9 may be made of a material being more elastic than a material of the first and second parts. The first and second end parts may be made of material which is acid-dissolvable, i.e. almost any metal, and preferably aluminium. The first and second end parts may also be made of stainless steel, composite steel, plastic, reinforced plastic, fiber glass and/or carbon.

[0049] To ease the expansion, the intermediate part 9 may be made of a material different from that of the first and second end parts. The material of the intermediate part may be more elastic.

[0050] The invention further relates to a downhole patch setting system 100 comprising the patch setting tool 1 and a casing 3 having an opening 2 or a weak part.

[0051] The patch is set by inserting the patch setting tool into the casing in a well, and the intermediate part 9 of the patch is positioned opposite the aperture to be sealed or opposite the weak part. Then, the fluid is pressurised, and the pressurised fluid is let through the aperture to expand the intermediate part by means of the pressurised fluid so that the intermediate part abuts the casing for sealing off the opening 2 or the weak part. Subsequently, the tool is moved away from the patch, and the first and second end parts of the patch are removed, either by milling the ends out or by injecting acid into the casing.

[0052] As shown in Fig. 7, several patches may be set

by using the patch setting tool. A first intermediate part of the patch first set extends in a straight line, and the second intermediate part of a second patch partly rests upon the first patch so that the sealing elements of the patch seal on the inner face of the first set patch. Similarly, the third intermediate part of a third patch rests against the second patch and seals to the inner face of the second patch. In this way, a larger region in the axial extension of the casing 3 can be sealed off, which is especially useful when sealing off a longer perforation zone.

[0053] The invention furthermore relates to a patch setting method for setting the tubular patch, using the patch setting tool. The method comprises the steps of inserting the patch setting tool into a casing in a well and positioning the intermediate part of the patch opposite the aperture to be sealed off or opposite a weak part. Then fluid is pressurised and let through the aperture to expand the intermediate part by means of the pressurised fluid so that the intermediate part abuts the casing and seals off the opening or weak part. Subsequently, the tool is moved away from the patch and the first and second end parts of the patch are removed.

[0054] 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.

[0055] By a casing is meant any kind of pipe, tubing, tubular, liner, string etc. used downhole in relation to oil or natural gas production.

[0056] In the event that the tool is not submergible all the way into the casing, a driving unit, such as 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®.

[0057] 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 tubular patch (6) adapted to surround a part of a tool body (5) downhole, comprising

- a first end part (7),
- a second end part (8), and
- an intermediate part (9) intermediate the first and second end parts,

wherein the intermediate part has a thickness (t_i) being smaller than that of the first and second parts so that when pressurised fluid is forced towards the intermediate part, the intermediate part is expanded.

2. A tubular patch according to claim 1, wherein the intermediate part has an inner diameter (ID_i) being larger than that of the first and second end parts.

3. A tubular patch according to claim 1 or 2, wherein the intermediate part has a thickness being less than 60% of the thickness of the first and second end parts, preferably less than 50% of the thickness of the first and second end pa rts.

4. A tubular patch according to any of the preceding claims, wherein the intermediate part is made mainly of metal.

5. A tubular patch according to any of the preceding claims, wherein the intermediate part is made of a material different from that of the first and second end parts.

6. A patch setting tool (1) for sealing off an opening (2) in a weak part of a casing (3) in a well (4), comprising:

- a tool body (5) having a fluid channel (11),
- the tubular patch (6) according to any of claims 1-5, the patch surrounding part of the tool body and having the first end part (7), the second end part (8) and the intermediate part (9) intermediate the first and second end parts,

wherein the intermediate part has a thickness being smaller than that of the first and second end parts, and wherein an aperture (10) of the fluid channel faces the intermediate part, meaning that when pressurised fluid is forced out of the aperture, the intermediate part is expanded.

7. A patch setting tool (1) according to claim 6, further comprising a pump (12) for pressurising a fluid.

8. A patch setting tool (1) according to claim 6 or 7, further comprising sealing elements (14) arranged between the first and second end parts and the tool body.

9. A patch setting tool (1) according to any of claims 6-8, further comprising a holding means (15) for holding the patch on the tool body.

10. A patch setting tool (1) according to claim 9, wherein the holding means comprises a stop (16) for preventing the patch from moving axially in one direction,

wherein and the holding means further comprises a retractable retainer unit (17).

11. A patch setting tool (1) according to claim 10, wherein the retainer unit comprises a cylinder (18) and a piston (19) dividing the cylinder into a first chamber part (20) and a second chamber part (21), wherein the first chamber part is fluidly connected with the fluid channel and the piston has a projection part (22) engaging an indentation (23) in the patch.

12. A patch setting tool (1) according to claim 11, wherein the retainer unit comprises a breakable element (36) arranged in the second chamber part for maintaining the projection part in engagement with the indentation.

13. A patch setting tool (1) according to any of the preceding claims, further comprising a milling bit (33) and an anchoring section (34) having projectable anchors (35).

14. A downhole patch setting system (100) comprising a patch setting tool according to any of claims 6-13 and a casing (3) having an opening (2) or a weak part.

15. A patch setting method for setting a tubular patch (6) according to any of claims 1-5, using the patch setting tool (1) according to any of claims 6-13, the method comprising the steps of:

- inserting the patch setting tool into a casing in a well,
- positioning the intermediate part of the patch opposite the aperture to be sealed off or opposite a weak part,
- pressuring the fluid,
- letting the pressurised fluid through the aperture to expand the intermediate part by means of the pressurised fluid so that the intermediate part abuts the casing and seals off the opening (2) or weak part,
- moving the tool away from the patch, and
- removing the first and second end parts of the patch.

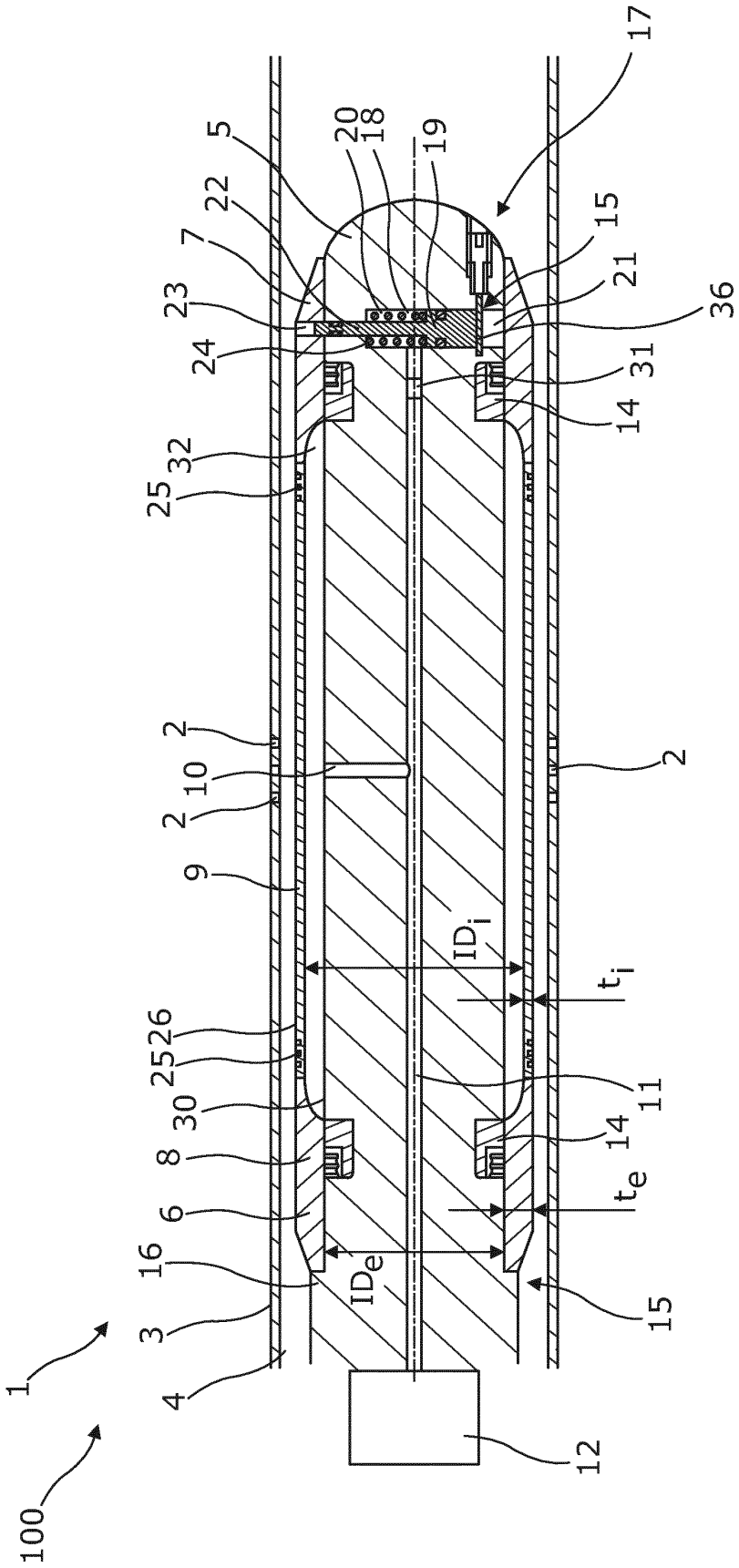
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Fig. 1

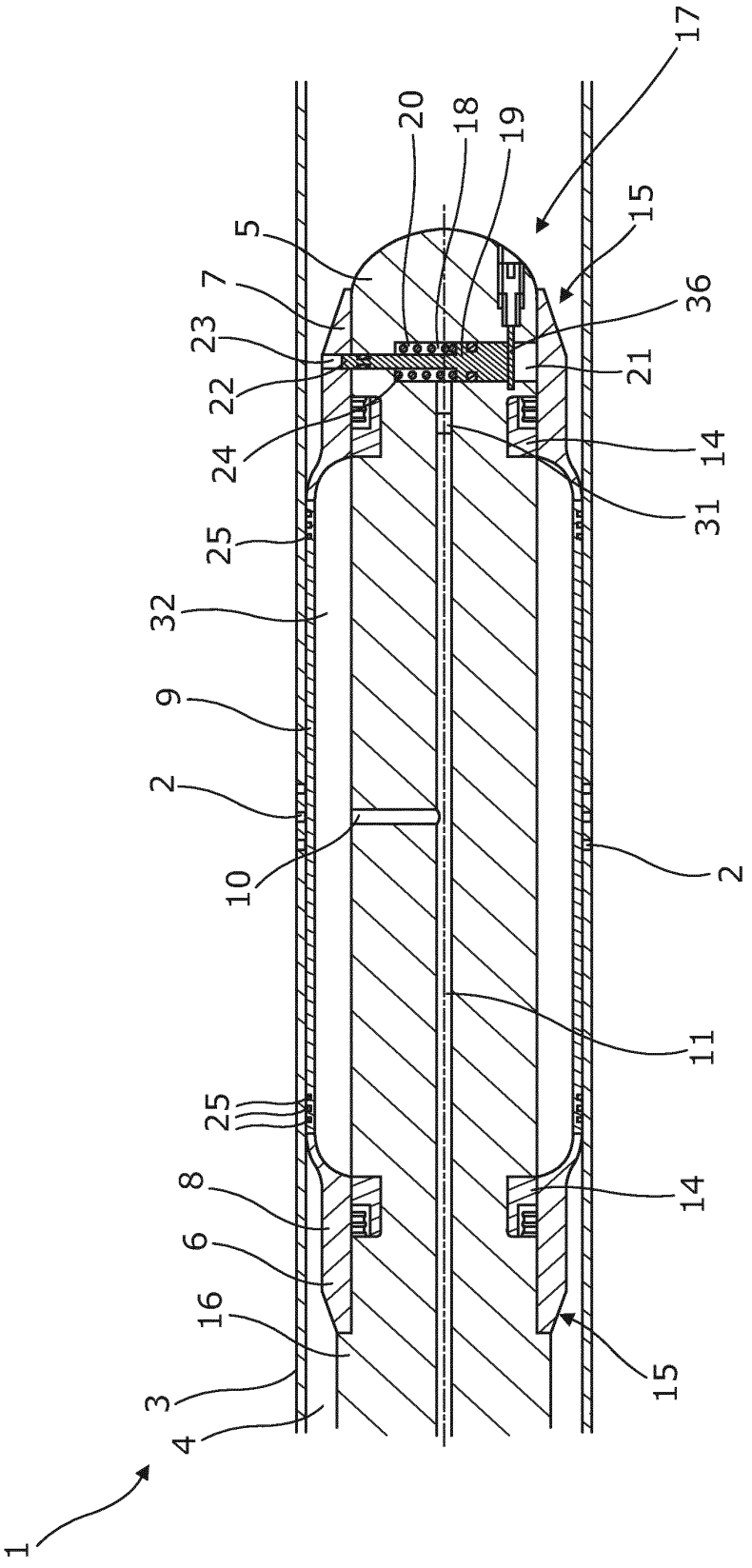
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Fig. 2

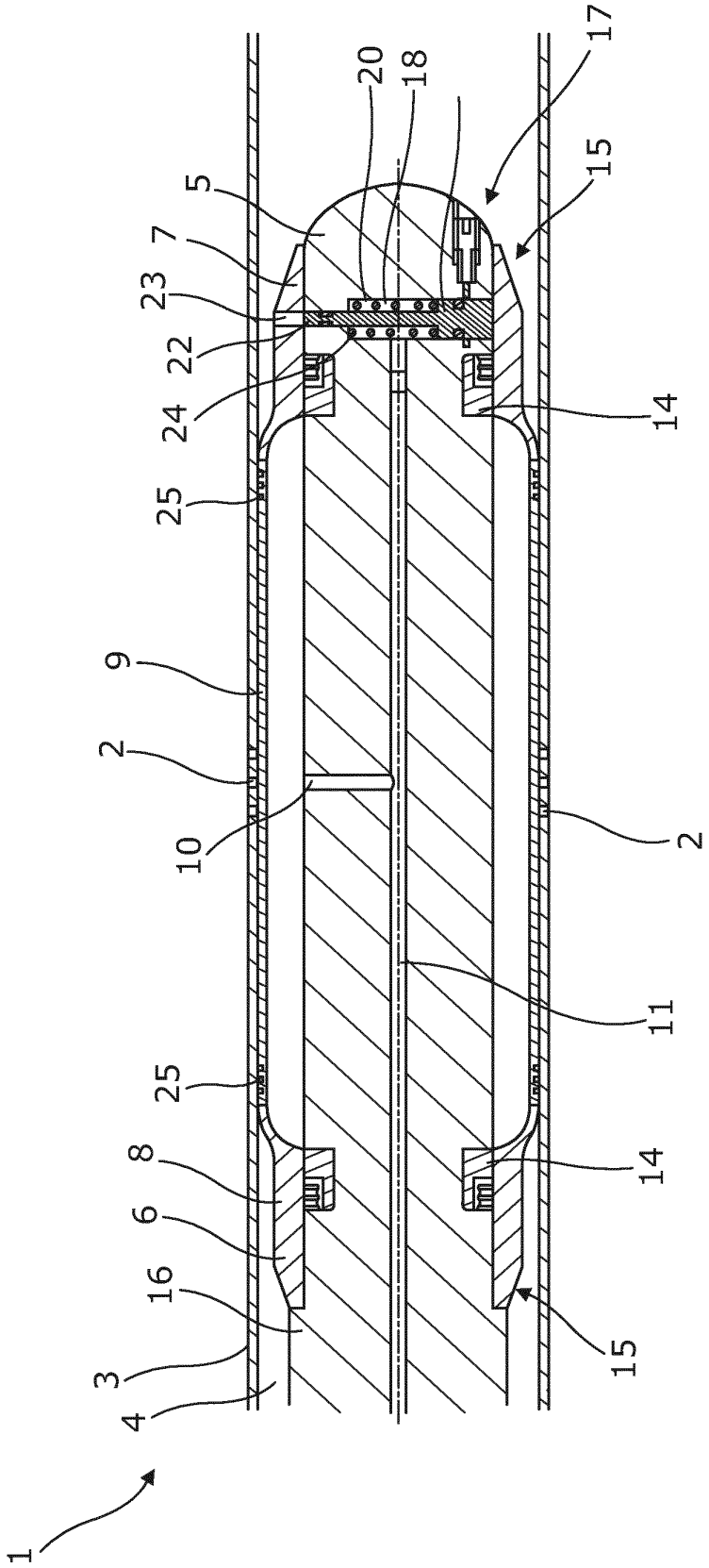

Fig. 3

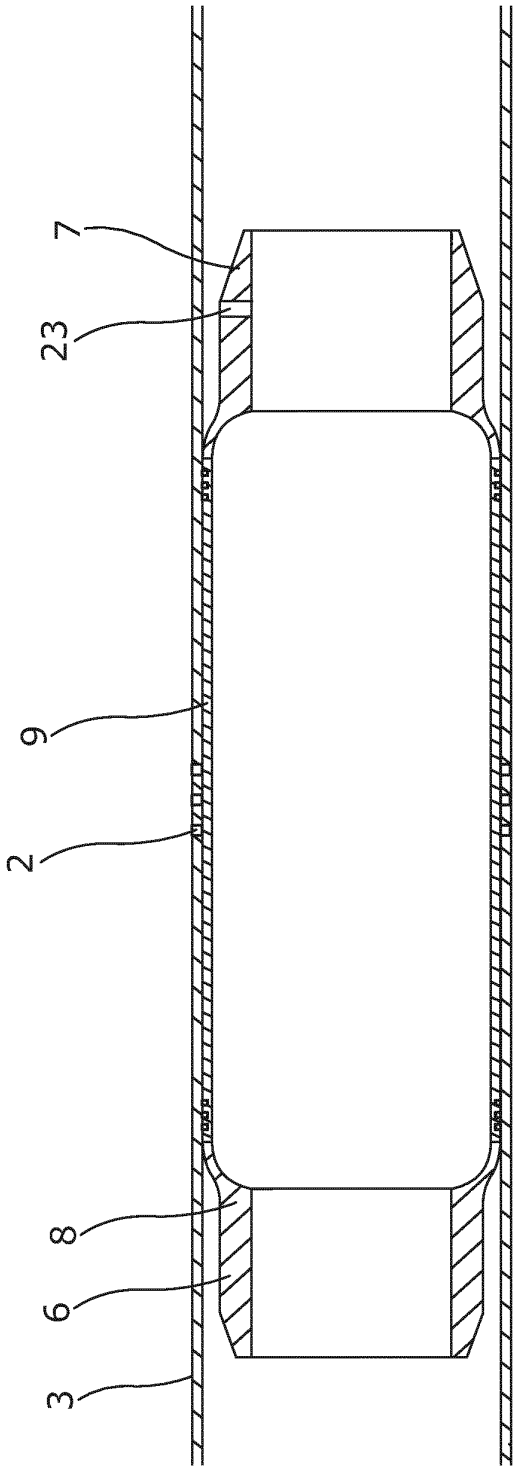

Fig. 4

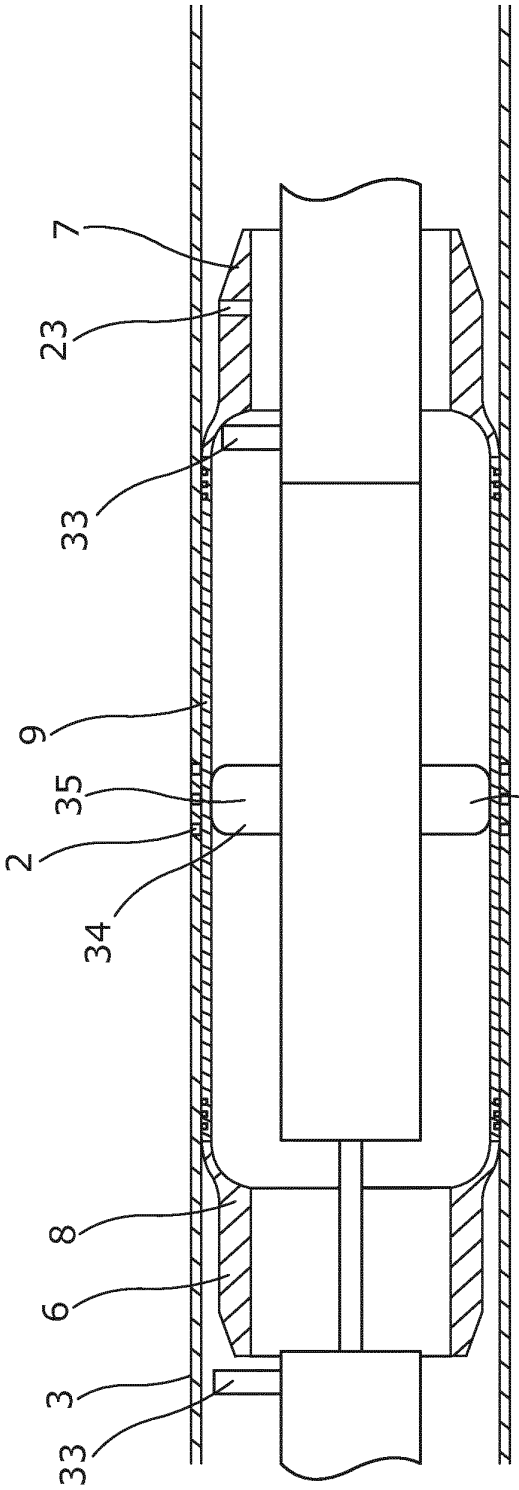

Fig. 5

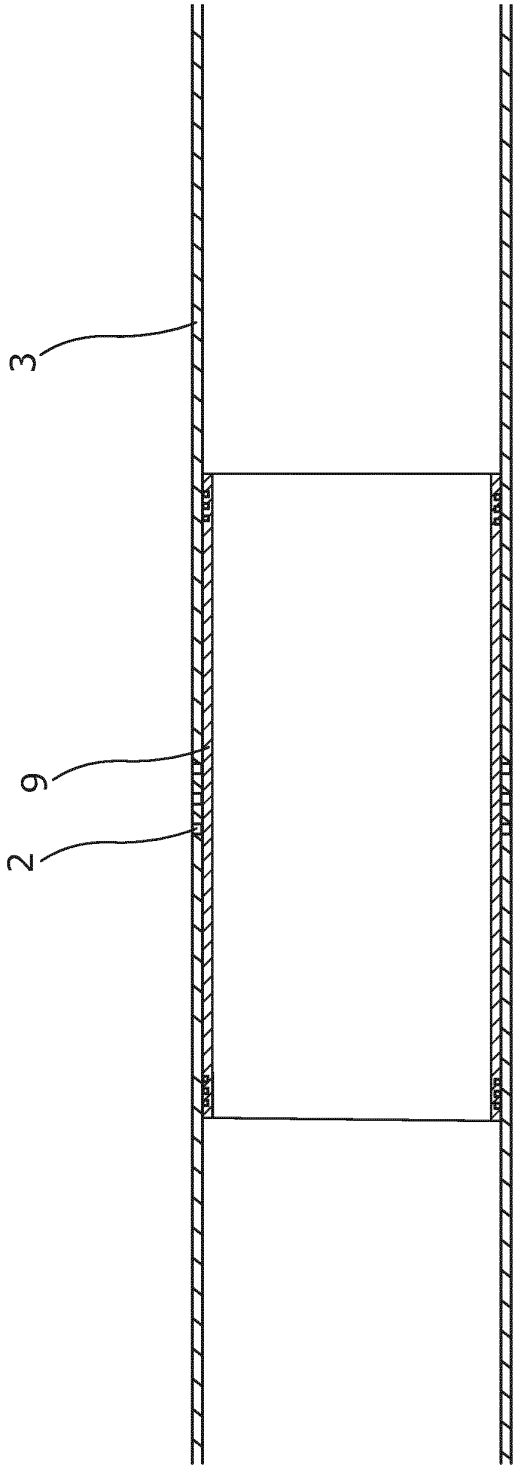

Fig. 6

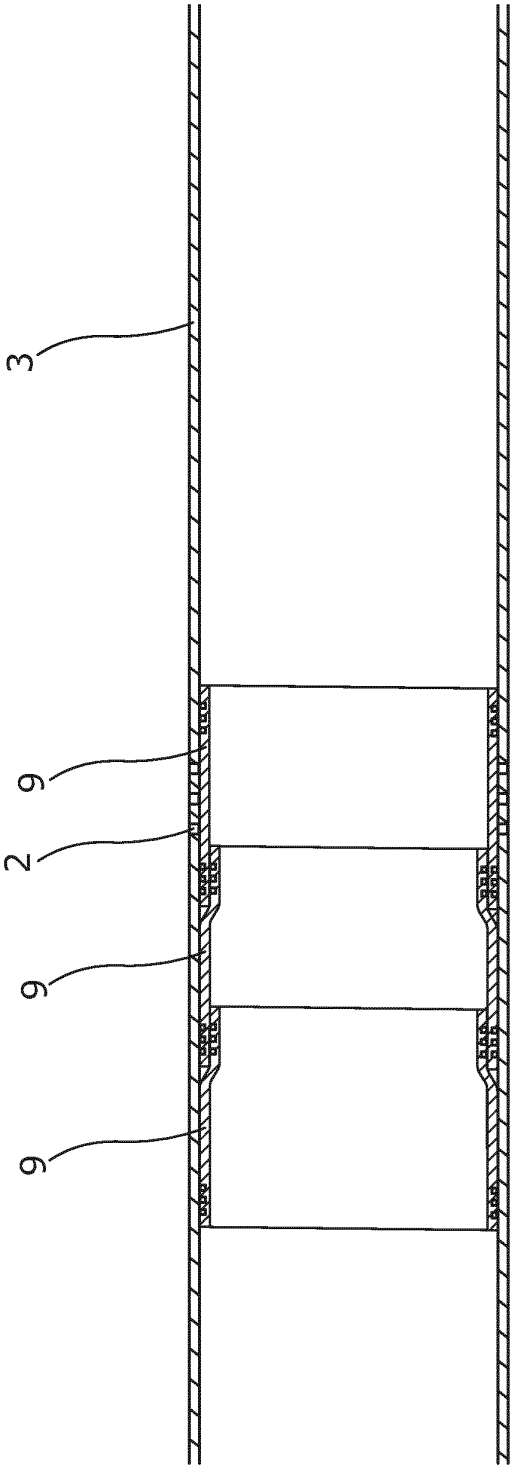

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 13 17 3981

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 Y	US 2012/205124 A1 (RING LEV [US] ET AL) 16 August 2012 (2012-08-16) * paragraphs [0042], [0044]; figures 3,4 * -----	1-4,6-9, 13-15 5,10-12	INV. E21B29/10
Y	WO 2012/127229 A2 (READ WELL SERVICES LTD [GB]; GORRARA ANDREW JOHN [GB]; WOOD PETER [GB]) 27 September 2012 (2012-09-27) * claims 1,5 * -----	5	
Y	US 2013/048308 A1 (LEHR JOERG [DE] ET AL) 28 February 2013 (2013-02-28) * paragraph [0046] * -----	10-12	

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
Munich	18 November 2013	Bellingacci, F

CATEGORY OF CITED DOCUMENTS

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18-11-2013

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