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(54) **A METHOD AND APPARATUS FOR SHRINKING TUBULAR SECTIONS**

VERFAHREN UND VORRICHTUNG ZUM SCHRUMPFEN VON ROHRABSCHNITTEN

PROCÉDÉ ET APPAREIL POUR LE RÉTRÉCISSEMENT DE SECTIONS TUBULAIRES

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Description

Technical Field

5 [0001] The invention relates to a complete system for reducing diameter of tubular pipes more precisely it relates to a drill string system for plug and abandoning of wells, the present invention relates to devices and methods of such a system.

Background Art

10 [0002] The invention relates to a complete system for reducing diameter of tubular pipes.
 [0003] For plug and abandonment of oil wells, the casing of the well has to be fully or partly removed before plugging. Removal of casing is a demanding task as the casing is normally bonded to concrete in between the underground formation and the casing. WO 2008118697 discloses a system of common use for recovering casing from the abandoned wells.
 15 [0004] The present invention enables casing section removal with milling only parts of a tubular/casing.
 [0005] Also for other purposes such as within water and sewerage it is often of interest to shrink and remove sections of piping's.

20 **Disclosure of Invention**

[0006] According to the present invention it is provided a shrinkage tool assembly for shrinkage and recovery of a wellbore tubular according to claim 1, a shrinkage forming die according to claim 6 and a method for shrinkage and recovery of a wellbore tubular according to claim 8.
 25 [0007] According to the invention, the forming die may consist of at least one mechanical mean for guiding the tubular into the die, where the mechanical mean will be activated by mean of an actuating system.
 [0008] According to another aspect of the invention, the recovered tubular section may have at least one helical or straight groove along the longitudinal axis of the tubular.
 [0009] According to the present invention, it is also provided a shrinking tool, which may utilize the method s indicated above and where the shrinking tool is adjacent to a milling tool, where the milling tool is adapted to mill at least one radial groove and at least one axial or helical groove along the longitudinal axis of the tubular.
 30 [0010] The shrinking tool may be pulled by mean of a moving tractor or other means like as wireline or drillstring from inside the tubular.
 [0011] It is also disclosed a shrinking tool where the tool comprises at least one anchoring mean for pulling one section of the tubular, where the separated section consist of at least on helical or axial groove along the longitudinal axis of the tubular.
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Brief description of drawings

40 [0012] To make the following description more readily understandable the following discussion will make reference to the accompanying drawings in which,

Figure 1 shows a perspective view of a system according to the present invention;
 FIG. 2 shows a view of the system according to the present invention;
 45 FIG. 3 shows a cross sectional view of the system according to the present invention ;
 FIG. 4 shows a tractor according to the present invention;
 FIG. 5a shows an example of a milling tool/milling section in accordance with the present invention;
 Fig 5b shows an example of a milling tool with expand able rotary side mill in neutral and working position
 Fig 5c shows a schematics view of one driving system according to one aspect of the invention using hydraulic mud motor and bevel gears,
 50 FIG. 6 shows a forming die according to the present invention;
 Fig. 7a shows a cross sectional view of the forming die outlet view with retracted or non-activated guiding arm;
 Fig. 7b shows a cross sectional view of the forming die outlet view with activated guiding arm;
 FIG. 8 shows the forming die and a casing section with a premade axial groove;
 55 Fig. 9 shows the forming die seen in figure 2;
 Fig. 10 shows the forming die, a casing with a premade axial grove and a shrunked casing;
 Fig. 11 shows a casing with helical grooves and the same in shrunked version according to one embodiment of the present invention, and

Fig. 12 shows a casing with helical grooves and the same in shrunk version according to one embodiment of the present invention.

Detailed description of the present invention

[0013] The invention will now be described with reference to the accompanying drawings, which are not to scale, however it shall be understood that the drawings are only meant to facilitate the understanding of the invention and they are in no way limiting the scope of the claimed invention.

[0014] The invention relates to a system 1, i.e. a shrinkage tool assembly for shrinkage and recovery of a wellbore tubular, for abandoning and plugging of oil wells as well as a system made for shrinking sections of tubular. The system comprises a forming die 15, which can be used in oil, gas and deep-water wells, mining and underground operations. The tools enable to shrink a section of a tubular 91 and reduce the diameter. In particular, it is disclosed a forming tool integrated in a shrinkage tool assembly 1 for shrinkage and recovery of a wellbore tubular. The shrinkage tool assembly 1 for shrinkage and recovery of a wellbore tubular comprises the mentioned forming die 15, a milling section 13 including means for milling out helical or axial grooves in tubulars 92 and at least a tractor 10 or pulling means 10.

[0015] The forming die 15 according to the present invention can be used to shrink a casing while the shrinkage tool assembly 1 for shrinkage and recovery of a wellbore tubular moves axially inside the tubular. This enables to pull out and recover a section of the tubular/casing through the rest of the tubular/casing that remains in the well. In addition, the forming die 15 reduces the de-bonding force for the tubular from the cement/formation.

Description of the system according to the present invention

[0016] In the following the wording system 1 shall be understood as the shrinkage tool assembly 1 for shrinkage and recovery of a wellbore tubular except if nothing else is explicitly mentioned.

[0017] As indicated above the present invention relates to a system, which is adapted to take out sections of casings or sections of pipes. The system 1 will now be described with reference to figure 1. The system 1 which is the shrinkage tool assembly 1 for shrinkage and recovery of a wellbore tubular comprises a tractor 10, a milling section 13 and a forming die section 15.

[0018] The tractor 15 is the front end of the system with reference to the active travel direction that is, when the system 1 is actively milling and shrinking tubulars or casings. Following the tractor is the milling section 13, the milling section includes at least one cutting tool 14.

[0019] Further, up the shrinkage tool assembly 1 for shrinkage and recovery of a wellbore tubular is the forming die 15, the forming die 15 is adapted to shrink casings or tubulars, which already has been prepared by the milling, section 13 so that the tubulars or casing has premade axial or helical grooves.

Description of the tractor

[0020] The tractor 10 is the propulsion unit of the drill string, it is shown in detail in figure 4. The tractor comprises two pistons 42, 43 connected with a push pull piston rod 12 there between. The push pull piston rod can move the end piston 42 relative to the near piston 43 and the rest of the shrinkage tool assembly (1) for shrinkage and recovery of a wellbore tubular in an axial direction.

[0021] Moving forward, that is in the X-direction in figure 4 starts with the near piston 43 and the end piston 42 in a retracted position, that is the distance between them are minimal, the near end piston 43 expands its anchor pads 11 to get into a fixed grip with its surrounding such as the casing. The anchor pads 13 of the end piston 42 is in a retracted position. The next step is that the end piston is moved in the x-direction by the piston rod 12. When the end piston 42 is in a maximum distance from the near piston 43, the end piston anchor itself to the surrounding walls or casings by expanding its anchor pads 13 radially. Following this step, the near piston 43 retracts its anchor pads 11 and the end piston 42 can pull the near piston 43 with its drillstring in the x-direction thereby causing the whole drillstring including the milling section and the die form 15 to move in the x-direction.

The milling section

[0022] The milling section 13 follows the tractor and is in between the forming die 15 and the tractor 10.

[0023] The milling section according to a first embodiment shall provide axial grooves in piping-sections or casing sections. As the groove shall be axial the shrinkage tool assembly 1 for shrinkage and recovery of a wellbore tubular will not rotate around its axis A - A (fig 2). As the tractor 10 provides movement of the shrinkage tool assembly 1 for shrinkage and recovery of a wellbore tubular the milling section provides axial grooves. One or more side cutters 14 are integrated in the milling section 13. The one or more side cutters rotate around its axis of rotation, where the axis of

rotation is substantially normal to the axis A-A and the surrounding walls.

[0024] The cutter 14 or cutters 14 can be retractable and expandable. In its expandable position with one or more rotating cutters, an axial groove will be made in the casing / surrounding tube.

5 **[0025]** The cutter 14 or cutters 14 can be rotated by using hydraulic driven/mud motor system placed inside the main housing. However many other means of driving systems can be utilised, it is the individualisation of powering the cutters 14 that is important. An internal hydraulic driving system can be placed, axial to the side cutters or axial to the direction of the milling tool and to rotate the side cutters 14 by using a gear/transmission system or by direct drive. The driving means can be electric motors with gear transmission drive or by direct drive.

10 **[0026]** Side cutters 14 can be rotated by internal mud motors and thereby use the hydraulic energy of circulating mud. However, drill string mechanical energy or electric motors can also be used for driving the side cutters. FIGS. 5c shows an example of use of internal mud motor(s) including a proper gear transmission system 67 for driving the side cutters 14. Any suitable gear type can be utilised. Different gear types such as worm or bevel can be used depending on the tool design. In addition, high torque hydro-motors can also be employed without gear system, the same applies to electric motors.

15 **[0027]** Each side cutter has individual driving system and can be operated independent of the other side cutters.

The die form

20 **[0028]** A shrinkage tool assembly 1 for shrinkage and recovery of a wellbore tubular is shown in figure 1, 2 and 3. The figures 6 - 10 shows a forming die 15 in detail.

[0029] According to one embodiment, the forming die has a c-shape entrance opening (fig. 7a, 7b) which has similar diameter D1 as a grooved tubular 72 in an entrance end and a smaller diameter DB at the exit end. According to this embodiment, while the shrinkage tool assembly 1 for shrinkage and recovery of a wellbore tubular moves axially within the grooved wellbore tubular, the tubular is pushed into the C shaped die entrance opening 83 and inside the C-outer sleeve 75 of the forming die 15. While the die 15 moves relative to the grooved tubular the grooved tubular is consequently fed into the c-shaped opening 83 (fig 7) and through the die and is shrunk into a reduced diameter when exited from the exit end of the forming die 15. It shall be noted that the part 63 of the die 15 where the grooved tubular or a grooved casing enters into the c-shaped opening (fig 7) of the die 15 is tapered with an input diameter approximately similar to the tubing D1, and an exit diameter DB, where $DB < D1$. According to this embodiment, the forming die consists of a mechanical means 16 for guiding the grooved tubular 72 or grooved casing into the opening entrance of the die. This mechanical means is an expandable guiding arm 16, which radially expands out of the tool body 15 when needed.

30 **[0030]** The following dimension restrictions applies:

35 $Z1 > Z2$
 $Z3$ and $Z1$ are approximately of the same width.
 $D1 > D2$

Another embodiment of pulling means

40 **[0031]** The forming die 15 and the milling tool 13 are adapted to be pulled by a moving tractor 10 or any other means through the wellbore longitude axis. Another mean for pulling the die 15 can be by wire, cable or drillstring. According to this embodiment, the milling tool 13 with actively driven side rotational cutters 14 can drill hole and mill axial, helical or radial grooves inside the tubular sidewalls.

Another embodiment of the invention

45 **[0032]** The invention has been described with reference to figure 1 - 10, this system 1 includes components, which together facilitates abandonment and plugging of oil wells and dismantling in sewerage systems. In another embodiment of the invention (fig 11 and 12), the milling tool 13 can create at least one helical groove and at least two radial grooves inside the casing downhole in the well. One way of achieving this is to use a rotational milling tool with one or more rotational side cutters 14. This enables to create a separated casing section from the tubular. According to this embodiment, the separated casing section with at least one helical groove can be pulled in an axial direction, which causes casing shrinkage and de-bonding from the formation cement. According to this embodiment, the separated casing can then be pulled out through the remaining casing inside the well. The moving tractor or other means, for example the drillstring or wire line, can pull the separated casing section.

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Reference numbers

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1	Shrinkage tool assembly
10	Moving tractor
11	Anchor pad
12	Push pull cylinder, push pull piston rod
13	Active milling tool
14	Side rotational cutter
15	Forming die
16	Expandable guiding arm
42	Piston, end piston
43	Piston, near piston
61	Die inlet
62	Die outlet-rear
63	Die body
66	
67	Gear transmission system, individual driving means
71	
72	Grooved tubular
73	
75	C-outer sleeve
81	First element
82	Second element
83	C shaped die entrance opening; inlet; c-shaped lofted cut
91	Tubular
92	Tubulars
DA	
DB	Diameter, exit diameter, $DB < D1$
D1	Diameter, $D1 > DB$; $D1 > D2$
D2	Diameter, $D2 < D1$
Z1	$Z1 > Z2, Z3$ and $Z1$ are approximately of the same width
Z2	Width of first element 81, $Z2 < Z3$
Z3	Width of second element, $Z3 > Z2, Z3$ and $Z1$ are approximately of the same width

Claims

1. A shrinkage tool assembly (1) for shrinkage and recovery of a wellbore tubular, where the shrinkage tool assembly (1) comprises at least:
 - a. one forming die (15) arranged along the axis of said wellbore tubular the forming die (15) is adapted to shrink casings or tubulars, which already has been prepared by one milling tool (13) so that the wellbore tubulars has premade axial or helical grooves,
 - b. one pulling means (10), for pulling the shrinkage tool assembly (1), and
 - c. one active milling tool (13), the milling tool (13) comprises one or more actively driven side rotational cutters

(14) that can drill hole and mill axial, helical or radial grooves inside tubular sidewall, where th

e forming die is configured to be pulled by the pulling means from inside the tubular and where the forming die consist of a c-shape lofted cut inside the tool body with a bigger profile diameter at the inlet and a smaller profile diameter at the outlet.

2. A shrinkage tool assembly (1) according to claim 1, where the forming die (15) consist of at least one mechanical mean (16) for guiding the tubular into the die, where the mechanical mean is configured to be activated by mean of an actuating system.

3. A shrinkage tool assembly (1) according to claim 1 where a recovered tubular section may have at least one helical or straight groove along the longitudinal axis of the tubular made by the active milling tool (13).

4. A shrinkage tool assembly (1) according to claim 1, 2 and 3, where the milling tool is adapted to mill at least one radial groove and at least one axial or helical groove along the longitudinal axis of the tubular.

5. A shrinkage tool assembly according to claim 1, where the tool (1) comprises at least one anchoring mean for pulling one section of the tubular, where the separated section consist of at least one helical or axial groove along the longitudinal axis of the tubular.

6. A shrinkage forming die (15) comprising:

a die inlet end (61),

a tapered cylindrical die body (63) with a first end adjacent to the die inlet end (61) where the first end has the widest diameter next to the die inlet end (61) and the tapered cylindrical die body (63) has a second end opposite of the first end;

a c-shape entrance opening (83) with a diameter D1 at a front end next to the second end of the tapered cylindrical die body (63) and smaller diameter D2 at the die outlet rear (62);

an extended radially expandable guiding arm (16) arranged on the perimeter of the shrinkage forming die (15) and with its longitudinal direction axially oriented with reference to the shrinkage forming die (15) and being configured to guide casings or tubulars having one or more grooves.

7. A shrinkage forming die (15) according to claim 6 where the extended radially expandable guiding arm (16) comprises a first element (81) with a width of Z2 and second element (82) with a width of Z3, where $Z3 > Z2$, the first element (81) is arranged next to the die inlet end (61) and the second element is arranged radially outside of the first element (81) and axially closer to the die outlet rear (62).

8. A method for shrinkage and recovery of a wellbore tubular comprising the steps of:

a. providing a shrinkage tool assembly (1), where the shrinkage tool assembly comprises:

i. one forming die (15) arranged along the axis of said wellbore tubular the forming die (15) is adapted to shrink casings or tubulars, which already has been prepared by one milling tool (13) so that the wellbore tubulars has premade axial or helical grooves,

ii. one pulling means (10) for pulling the shrinkage tool assembly (1), and

iii. one active milling tool (13), where the milling tool (13) comprises one or more actively driven side rotational cutters (14) that can drill hole and mill axial, helical or radial grooves inside tubular sidewall,

b. pulling the forming die (15) by the pulling means from inside the tubular and where the forming die consist of a c-shape lofted cut inside the tool body with a bigger profile diameter at the inlet and a smaller profile diameter at the outlet.

9. A method according to claim 8, further comprising the steps of:

c. entering a grooved tubular (72) with the die inlet (61) being inside the outer walls of the grooved tubular (72),

d. continuing pulling the forming die inlet (61) further into the grooved tubular (72),

e. an extended radially expandable guiding arm (16) arranged on the perimeter of the shrinkage forming die (15) and with its longitudinal direction axially oriented with reference to the shrinkage forming die (15) enters

the groove of the grooved tubular (72);

f. the grooved tubular (72) is pushed into the c-shaped lofted cut inside the tool body (15) with a bigger profile diameter at the inlet (83) and a smaller profile diameter at the outlet (62), and

g. a first end of the grooved tubular (72) is exiting the die outlet rear (62) with a diameter that is smaller than its diameter when entering the c-shaped lofted cut (83) inside the tool body (15).

10. A method according to claim 9, further comprising the step of: providing a first element (81) with a width of Z2 and a second element (82) with a width of Z3, where $Z3 > Z2$, arranging the first element (81) next to the die inlet end (61) and arranging the second element radially outside of the first element (81) and axially closer to the die outlet rear (62).

Patentansprüche

1. Schrumpfwerkzeuganordnung (1) zum Schrumpfen und Rückverformen eines Bohrlochförderrohrs, wobei die Schrumpfwerkzeuganordnung (1) mindestens umfasst:

a. ein Umformwerkzeug (15), das entlang der Achse des Bohrlochförderrohrs angeordnet ist, wobei das Umformwerkzeug (15) zum Schrumpfen von Futterrohren oder Förderrohren ausgelegt ist, die bereits mit einem Fräswerkzeug (13) vorbereitet wurden, so dass die Bohrlochförderrohre vorgefertigte axiale oder spiralförmige Nuten aufweisen,

b. ein Zugmittel (10) zum Ziehen der Schrumpfwerkzeuganordnung (1) und

c. ein aktives Fräswerkzeug (13), wobei das Fräswerkzeug (13) einen oder mehrere aktiv angetriebene seitliche Rotationsschneider (14) umfasst, die Löcher bohren und axiale, spiralförmige oder radiale Nuten innerhalb der Förderrohrseitenwand fräsen können, wobei das Umformwerkzeug konfiguriert ist, um von dem Zugmittel aus dem Inneren des Förderrohrs gezogen zu werden, und wobei das Umformwerkzeug aus einem C-förmigen hochgezogenen Schnitt im Inneren des Werkzeugkörpers mit einem größeren Profildurchmesser am Einlass und einem kleineren Profildurchmesser am Auslass besteht.

2. Schrumpfwerkzeuganordnung (1) nach Anspruch 1, wobei das Umformwerkzeug (15) aus mindestens einem mechanischen Mittel (16) zum Führen des Förderrohrs in das Umformwerkzeug besteht, wobei das mechanische Mittel konfiguriert ist, um mittels eines Betätigungssystems aktiviert zu werden.

3. Schrumpfwerkzeuganordnung (1) nach Anspruch 1, wobei ein rückverformter Förderrohrabschnitt mindestens eine spiralförmige oder gerade Nut entlang der Längsachse des Förderrohrs aufweisen kann, die durch das aktive Fräswerkzeug (13) hergestellt wurde.

4. Schrumpfwerkzeuganordnung (1) nach Anspruch 1, 2 und 3, wobei das Fräswerkzeug ausgelegt ist, um mindestens eine radiale Nut und mindestens eine axiale oder spiralförmige Nut entlang der Längsachse des Förderrohrs zu fräsen.

5. Schrumpfwerkzeuganordnung nach Anspruch 1, wobei das Werkzeug (1) mindestens ein Verankerungsmittel zum Ziehen eines Abschnitts des Förderrohrs umfasst, wobei der getrennte Abschnitt aus mindestens einer spiralförmigen oder axialen Nut entlang der Längsachse des Förderrohrs besteht.

6. Schrumpfumformwerkzeug (15), umfassend:

ein Werkzeugeinlassende (61), einen sich verjüngenden zylindrischen Umformwerkzeugkörper (63) mit einem ersten Ende neben dem Werkzeugeinlassende (61), wobei das erste Ende neben dem Werkzeugeinlassende (61) den breitesten Durchmesser aufweist und der sich verjüngende zylindrische Umformwerkzeugkörper (63) ein zweites Ende gegenüber dem ersten Ende aufweist;

eine C-förmige Eintrittsöffnung (83) mit einem Durchmesser D1 an einem vorderen Ende neben dem zweiten Ende des sich verjüngenden zylindrischen Umformwerkzeugkörpers (63) und einem kleineren Durchmesser D2 an der Werkzeugauslassrückseite (62);

einen verlängerten radial ausfahrbaren Führungsarm (16), der am Umfang des Schrumpfumformwerkzeugs (15) angeordnet ist und dessen Längsrichtung in Bezug auf das Schrumpfumformwerkzeug (15) axial ausgerichtet ist und der konfiguriert ist, um Futterrohre oder Förderrohre mit einer oder mehreren Nuten zu führen.

7. Schrumpfformwerkzeug (15) nach Anspruch 6, wobei der verlängerte radial ausfahrbare Führungsarm (16) ein erstes Element (81) mit einer Breite Z2 und ein zweites Element (82) mit einer Breite Z3 umfasst, wobei $Z3 > Z2$, das erste Element (81) neben dem Werkzeugeinlassende (61) angeordnet ist und das zweite Element radial außerhalb des ersten Elements (81) und axial näher an der Werkzeugauslassrückseite (62) angeordnet ist.

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8. Verfahren zum Schrumpfen und Rückverformen eines Bohrlochförderrohrs, umfassend die Schritte:

a. Bereitstellen einer Schrumpfwerkzeuganordnung (1), wobei die Schrumpfwerkzeuganordnung umfasst:

10 i. ein Umformwerkzeug (15), das entlang der Achse des Bohrlochförderrohrs angeordnet ist, wobei das Umformwerkzeug (15) zum Schrumpfen von Futterrohren oder Förderrohren ausgelegt ist, die bereits mit einem Fräswerkzeug (13) vorbereitet wurden, so dass die Bohrlochförderrohre vorgefertigte axiale oder spiralförmige Nuten aufweisen,

15 ii. ein Zugmittel (10) zum Ziehen der Schrumpfwerkzeuganordnung (1) und

15 iii. ein aktives Fräswerkzeug (13), wobei das Fräswerkzeug (13) einen oder mehrere aktiv angetriebene seitliche Rotationsschneider (14) umfasst, die Löcher bohren und axiale, spiralförmige oder radiale Nuten innerhalb der Förderrohrseitenwand fräsen können,

20 b. Ziehen des Umformwerkzeugs (15) durch das Zugmittel aus dem Inneren des Förderrohrs, wobei das Umformwerkzeug aus einem C-förmigen hochgezogenen Schnitt im Inneren des Werkzeugkörpers mit einem größeren Profildurchmesser am Einlass und einem kleineren Profildurchmesser am Auslass besteht.

9. Verfahren nach Anspruch 8, ferner umfassend die Schritte:

25 c. Eindringen in ein genutetes Förderrohr (72), wobei sich der Werkzeugeinlass (61) innerhalb der Außenwände des genuteten Förderrohrs (72) befindet;

d. Weiterziehen des Umformwerkzeugeinlasses (61) weiter in das genutete Förderrohr (72),

30 e. Eindringen eines verlängerten radial ausfahrbaren Führungsarms (16), der am Umfang des Schrumpfformwerkzeugs (15) angeordnet ist und dessen Längsrichtung in Bezug auf das Schrumpfformwerkzeug (15) axial ausgerichtet ist, in die Nut des genuteten Förderrohrs (72);

f. Gedrücktwerden des genuteten Förderrohrs (72) in den C-förmigen hochgezogenen Schnitt im Inneren des Werkzeugkörpers (15) mit einem größeren Profildurchmesser am Einlass (83) und einem kleineren Profildurchmesser am Auslass (62), und

35 g. Austreten eines ersten Endes des genuteten Förderrohrs (72) aus der Werkzeugauslassrückseite (62) mit einem Durchmesser, der kleiner als sein Durchmesser ist, wenn es in den C-förmigen hochgezogenen Schnitt (83) im Inneren des Werkzeugkörpers (15) eindringt.

10. Verfahren nach Anspruch 9, ferner umfassend den Schritt:

40 Bereitstellen eines ersten Elements (81) mit einer Breite Z2 und eines zweiten Elements (82) mit einer Breite Z3, wobei $Z3 > Z2$ ist, Anordnen des ersten Elements (81) neben dem Werkzeugeinlassende (61) und Anordnen des zweiten Elements radial außerhalb des ersten Elements (81) und axial näher an der Werkzeugauslassrückseite (62).

Revendications

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1. Ensemble d'outil de rétrécissement (1) pour le rétrécissement et la récupération d'un élément tubulaire de puits de forage, l'ensemble d'outil de rétrécissement (1) comprenant au moins :

50 a. une matrice de formage (15) disposée le long de l'axe dudit élément tubulaire de puits de forage, la matrice de formage (15) est adaptée pour rétrécir des tubages ou des éléments tubulaires, qui a déjà été préparée par un outil de fraisage (13) de sorte que les éléments tubulaires de puits de forage présentent des rainures axiales ou hélicoïdales préfabriquées,

b. un moyen de traction (10) pour tirer l'ensemble d'outil de rétrécissement (1), et

55 c. un outil de fraisage actif (13), l'outil de fraisage (13) comprend une ou plusieurs fraises rotatives latérales à entraînement actif (14) qui peuvent percer et fraiser des rainures axiales, hélicoïdales ou radiales à l'intérieur d'une paroi latérale de l'élément tubulaire, la matrice de formage étant conçue pour être tirée par le moyen de traction depuis l'intérieur de l'élément tubulaire et la matrice de formage étant constituée d'une découpe en forme de C à l'intérieur du corps d'outil, présentant un plus grand diamètre de profil à l'entrée et un plus petit

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diamètre de profil à la sortie.

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2. Ensemble d'outil de rétrécissement (1) selon la revendication 1, dans lequel la matrice de formage (15) est constituée d'au moins un moyen mécanique (16) pour guider l'élément tubulaire dans la matrice, le moyen mécanique étant conçu pour être activé au moyen d'un système d'actionnement.
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3. Ensemble d'outil de rétrécissement (1) selon la revendication 1, où une section tubulaire récupérée peut avoir au moins une rainure hélicoïdale ou droite le long de l'axe longitudinal de l'élément tubulaire réalisée par l'outil de fraisage actif (13).
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4. Ensemble d'outil de rétrécissement (1) selon les revendications 1, 2 et 3, où l'outil de fraisage est adapté pour fraiser au moins une rainure radiale et au moins une rainure axiale ou hélicoïdale le long de l'axe longitudinal de l'élément tubulaire.
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5. Ensemble d'outil de rétrécissement selon la revendication 1, où l'outil (1) comprend au moins un moyen d'ancrage pour tirer une section de l'élément tubulaire, la section séparée étant constituée d'au moins une rainure hélicoïdale ou axiale le long de l'axe longitudinal de l'élément tubulaire.
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6. Matrice de formage de rétrécissement (15) comprenant :
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- une extrémité d'entrée de matrice (61), un corps de matrice cylindrique conique (63) avec une première extrémité adjacente à l'extrémité d'entrée de matrice (61) où la première extrémité a le diamètre le plus large à côté de l'extrémité d'entrée de matrice (61) et le corps de matrice cylindrique conique (63) a une seconde extrémité opposée à la première extrémité ;
- 35
- une ouverture d'entrée en forme de C (83) avec un diamètre D1 à l'extrémité avant à côté de la seconde extrémité du corps de matrice cylindrique conique (63) et un diamètre D2 plus petit à l'arrière de sortie de matrice (62) ;
- 40
- un bras de guidage étendu radialement extensible (16) disposé sur le périmètre de la matrice de formage de rétrécissement (15) et dont la direction longitudinale est orientée axialement par rapport à la matrice de formage de rétrécissement (15) et qui est conçu pour guider des tubages ou des éléments tubulaires présentant une ou plusieurs rainures.
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7. Matrice de formage de rétrécissement (15) selon la revendication 6, où le bras de guidage étendu radialement extensible (16) comprend un premier élément (81) avec une largeur de Z2 et un second élément (82) avec une largeur de Z3, où $Z3 > Z2$, le premier élément (81) est disposé à côté de l'extrémité d'entrée de matrice (61) et le second élément est disposé radialement à l'extérieur du premier élément (81) et axialement plus près de l'arrière de sortie de matrice (62).
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8. Procédé de rétrécissement et de récupération d'un élément tubulaire de puits de forage comprenant les étapes consistant à :
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- a. fournir un ensemble d'outil de rétrécissement (1), l'ensemble d'outil de rétrécissement comprenant :
- i. une matrice de formage (15) disposée le long de l'axe dudit élément tubulaire de puits de forage, la matrice de formage (15) est adaptée pour rétrécir des tubages ou des éléments tubulaires, qui a déjà été préparée par un outil de fraisage (13) de sorte que les éléments tubulaires de puits de forage présentent des rainures axiales ou hélicoïdales préfabriquées,
- ii. un moyen de traction (10) pour tirer l'ensemble d'outil de rétrécissement (1), et
- iii. un outil de fraisage actif (13), où l'outil de fraisage (13) comprend une ou plusieurs fraises rotatives latérales à entraînement actif (14) qui peuvent percer et fraiser des rainures axiales, hélicoïdales ou radiales à l'intérieur d'une paroi latérale de l'élément tubulaire,
- b. tirer la matrice de formage (15) par le moyen de traction depuis l'intérieur de l'élément tubulaire et où la matrice de formage est constituée d'une découpe en forme de C à l'intérieur du corps d'outil, présentant un plus grand diamètre de profil à l'entrée et un plus petit diamètre de profil à la sortie.
9. Procédé selon la revendication 8, comprenant en outre les étapes consistant à :

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c. entrer dans un élément tubulaire rainuré (72), l'entrée de matrice de formage (61) étant à l'intérieur des parois extérieures de l'élément tubulaire rainuré (72),

d. continuer à tirer l'entrée de matrice de formage (61) davantage dans l'élément tubulaire rainuré (72),

5 e. un bras de guidage étendu radialement extensible (16) disposé sur le périmètre de la matrice de formage de rétrécissement (15) et dont la direction longitudinale est orientée axialement par rapport à la matrice de formage de rétrécissement (15) entre dans la rainure de l'élément tubulaire rainuré (72) ;

f. l'élément tubulaire rainuré (72) est poussé dans la découpe en forme de C à l'intérieur du corps d'outil (15) avec un plus grand diamètre de profil à l'entrée (83) et un plus petit diamètre de profil à la sortie (62), et

10 g. une première extrémité de l'élément tubulaire rainuré (72) sort de l'arrière de sortie de matrice (62) avec un diamètre qui est plus petit que son diamètre lors de l'entrée dans la découpe en forme de C (83) à l'intérieur du corps d'outil (15).

10. Procédé selon la revendication 9, comprenant en outre l'étape consistant à :

15 fournir un premier élément (81) d'une largeur de Z2 et un second élément (82) d'une largeur de Z3, où $Z3 > Z2$, disposer le premier élément (81) à côté de l'extrémité d'entrée de matrice (61) et disposer le second élément radialement à l'extérieur du premier élément (81) et axialement plus près de l'arrière de sortie de matrice (62).

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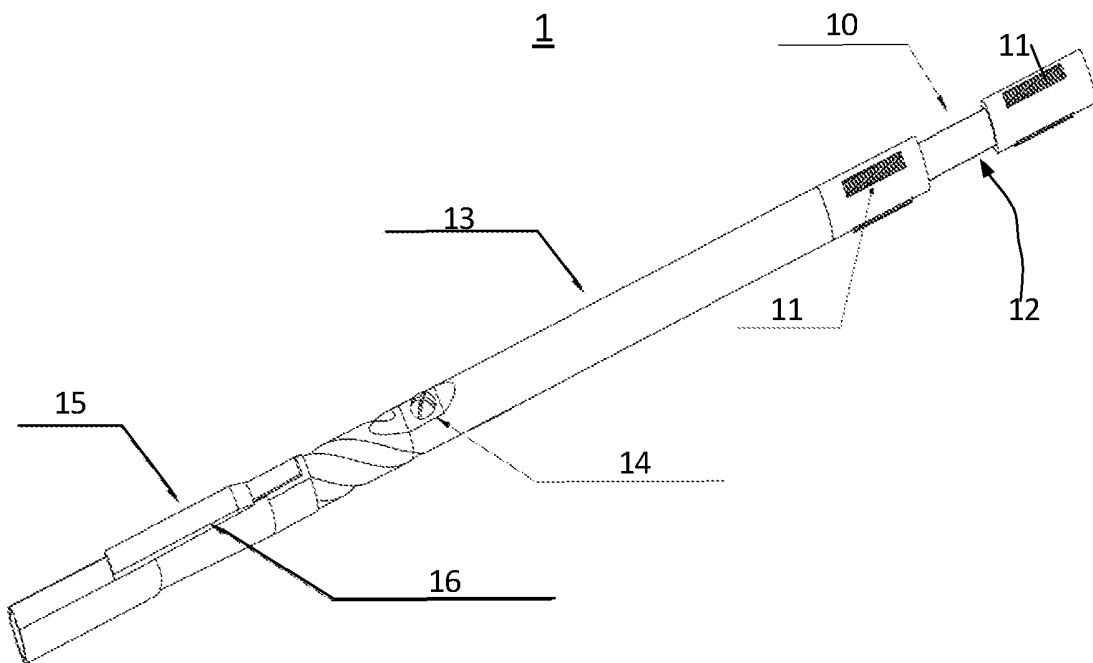


Fig. 1

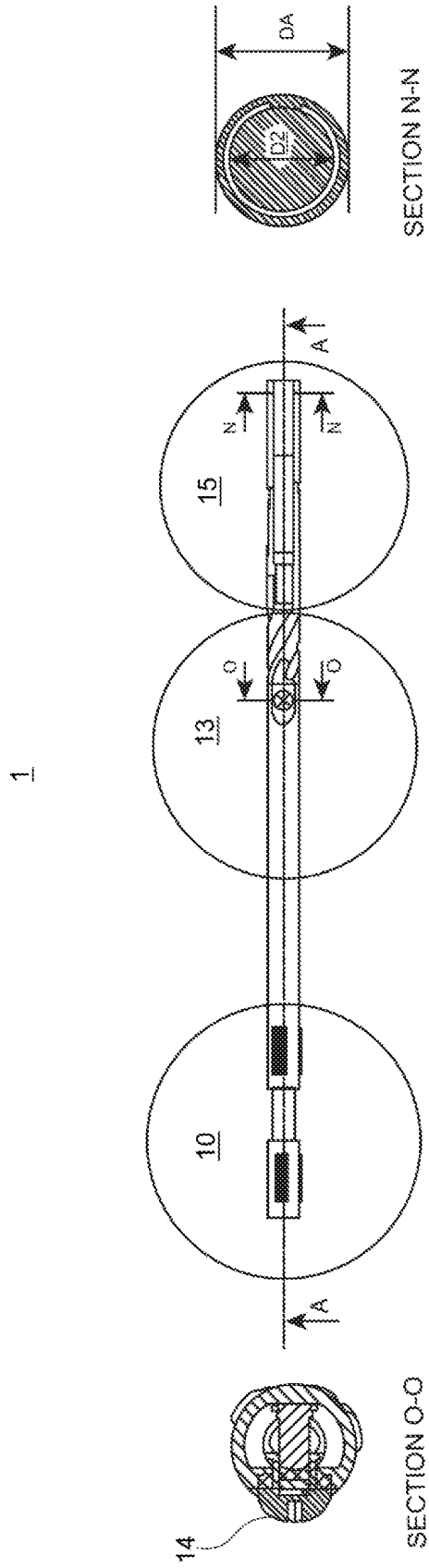


Fig. 2

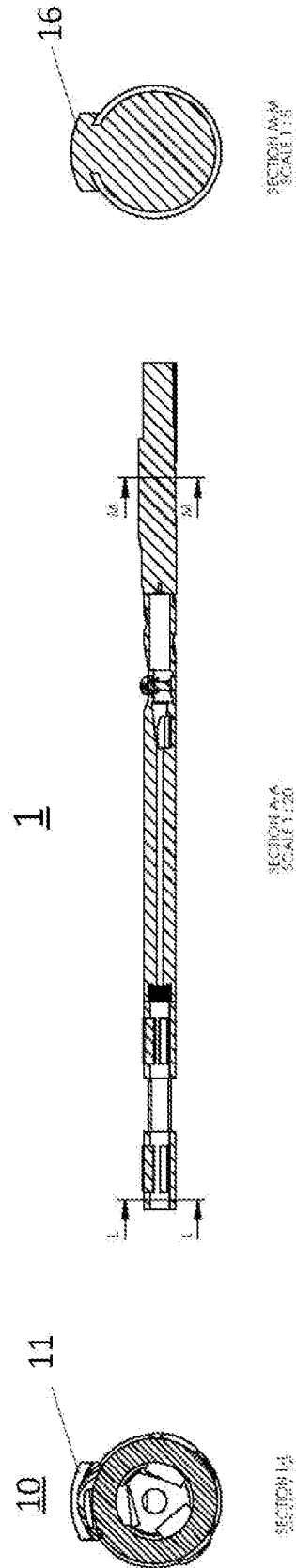


Fig. 3

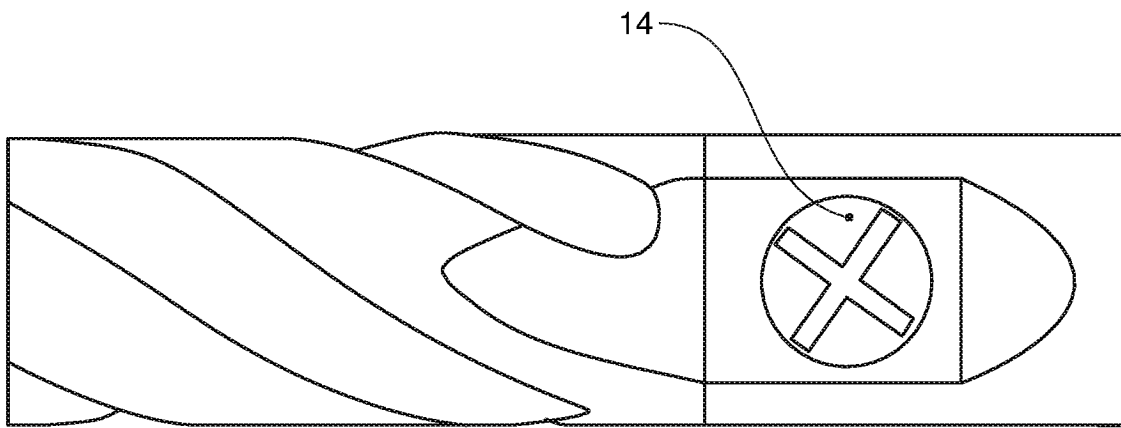
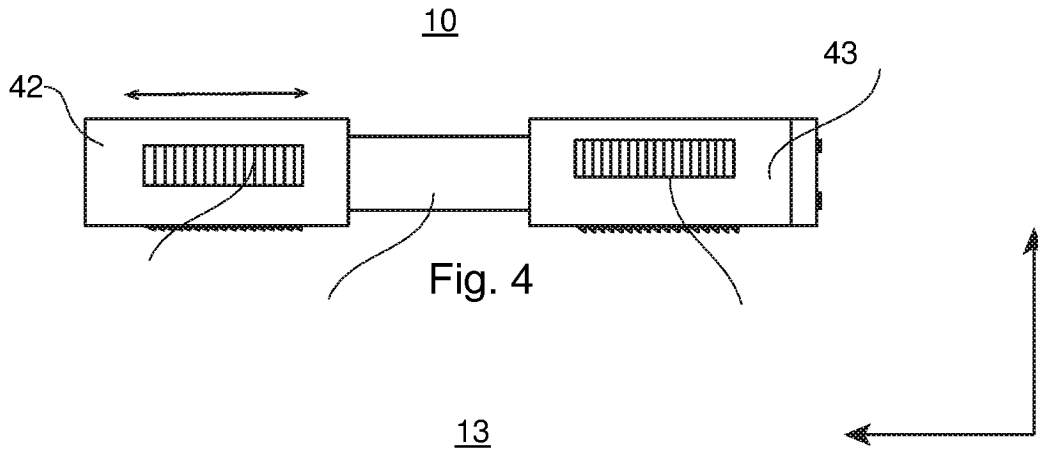


FIG. 5a

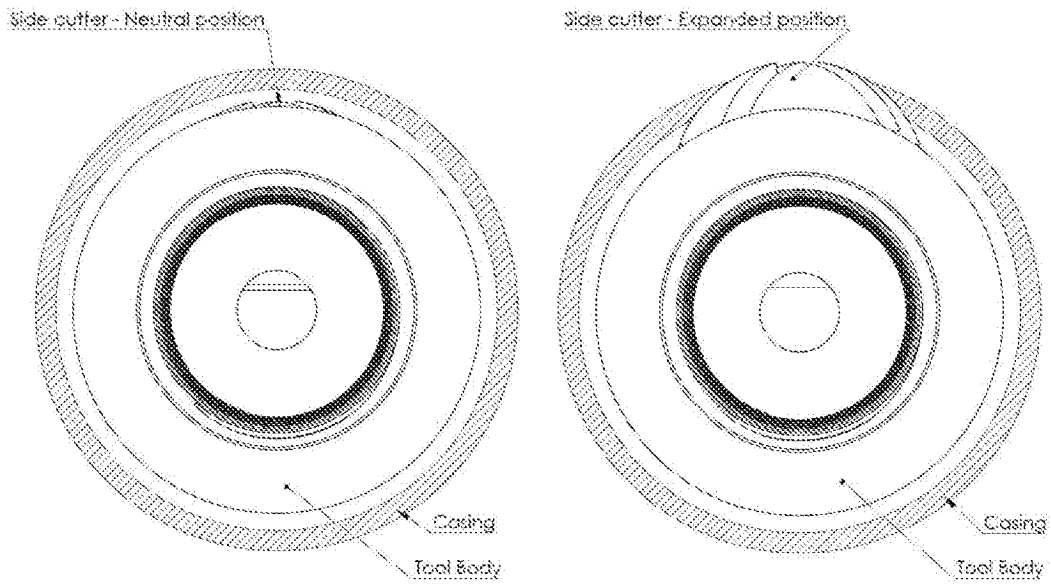


Fig. 5b

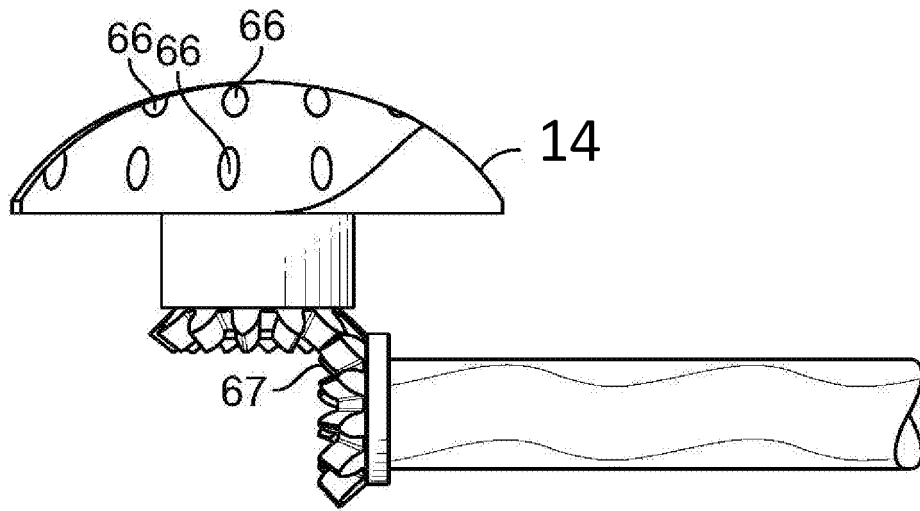


Fig. 5c

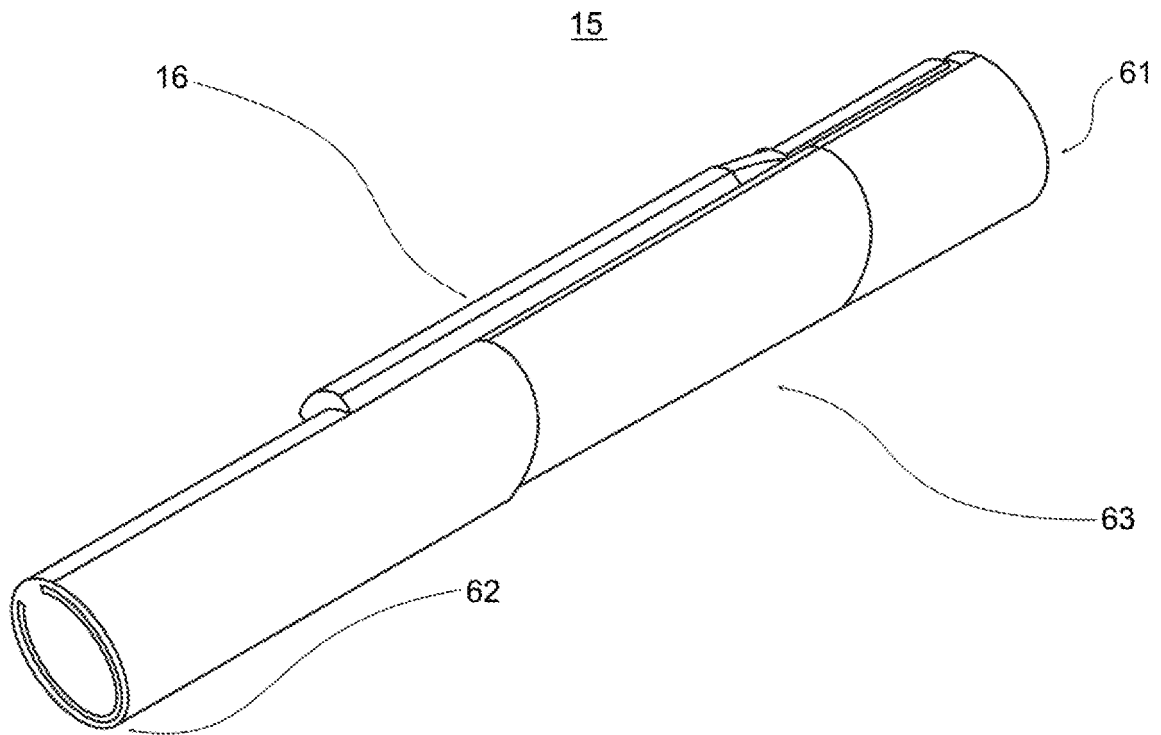


Fig. 6

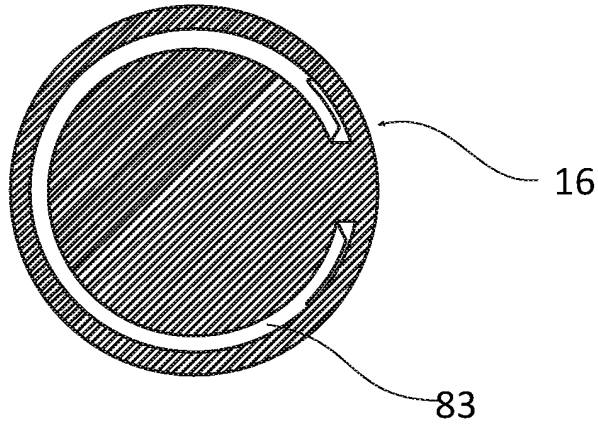


Fig 7a

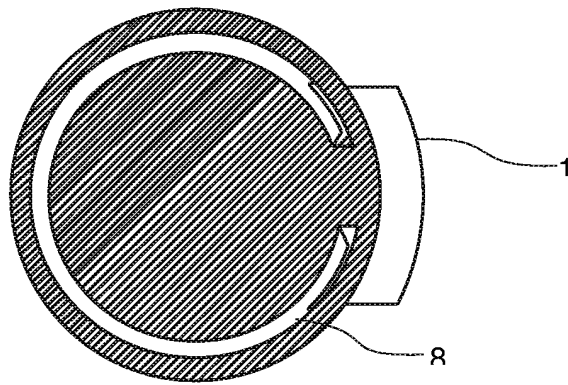


Fig. 7b

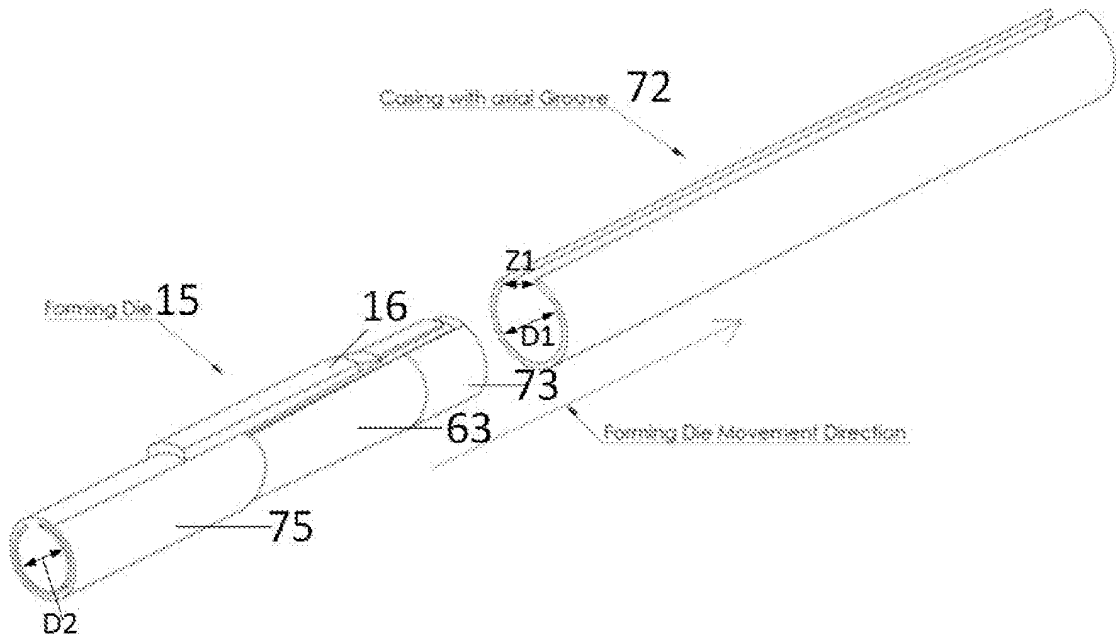


Fig. 8

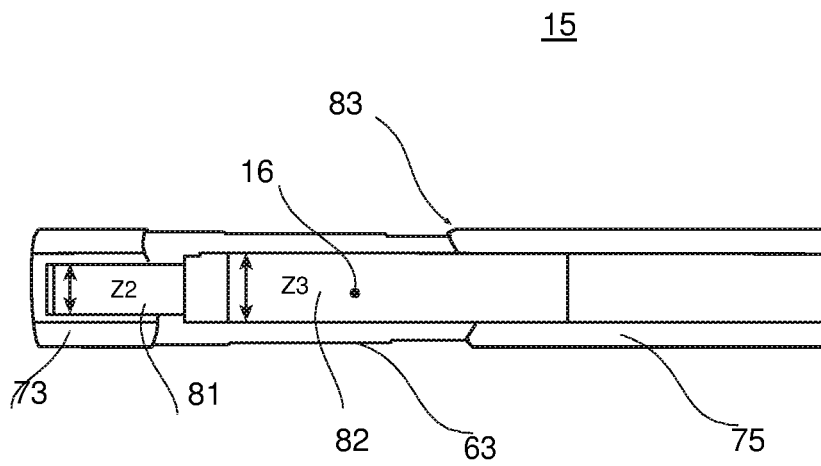


Fig. 9

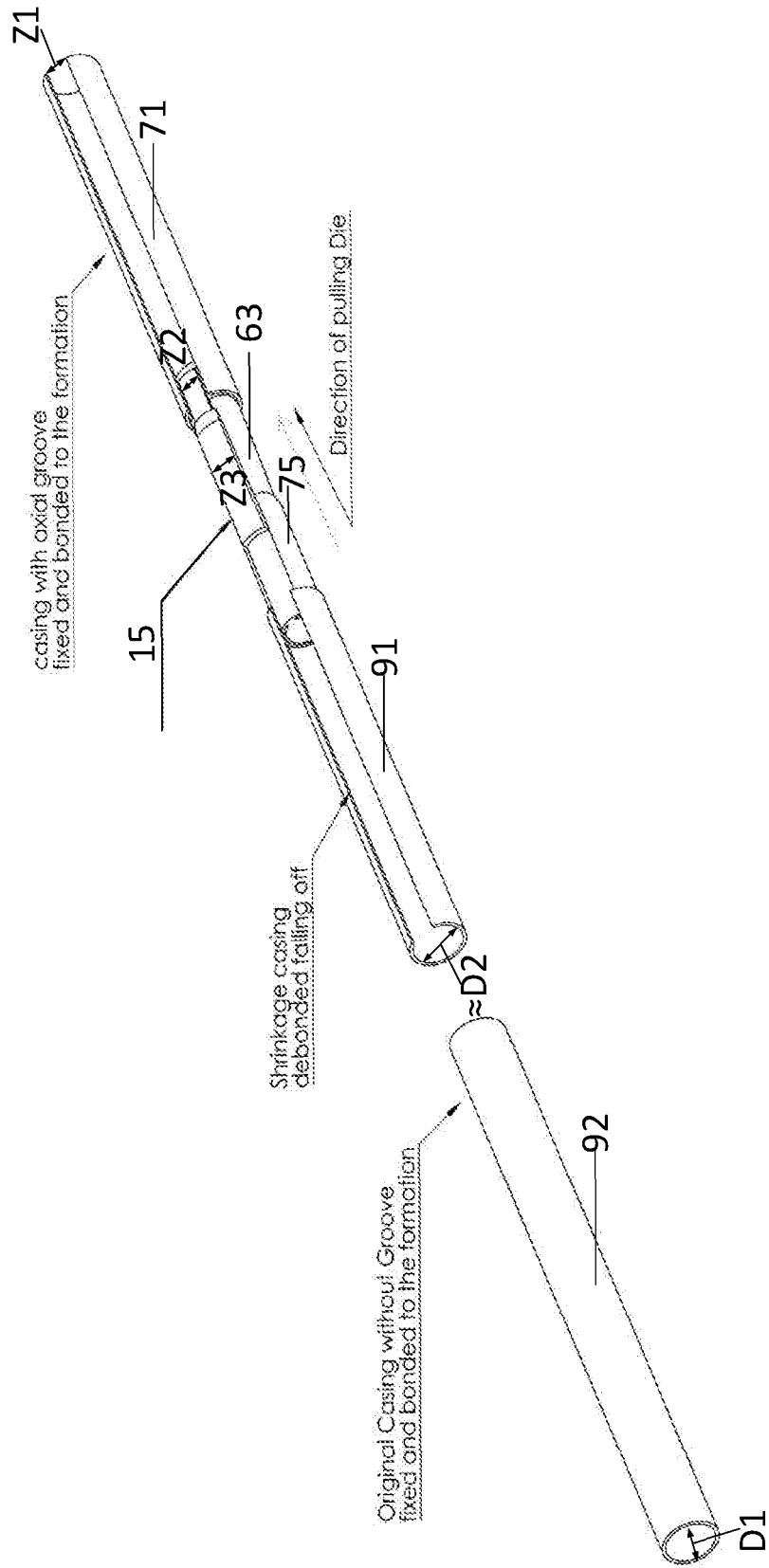


Fig. 10

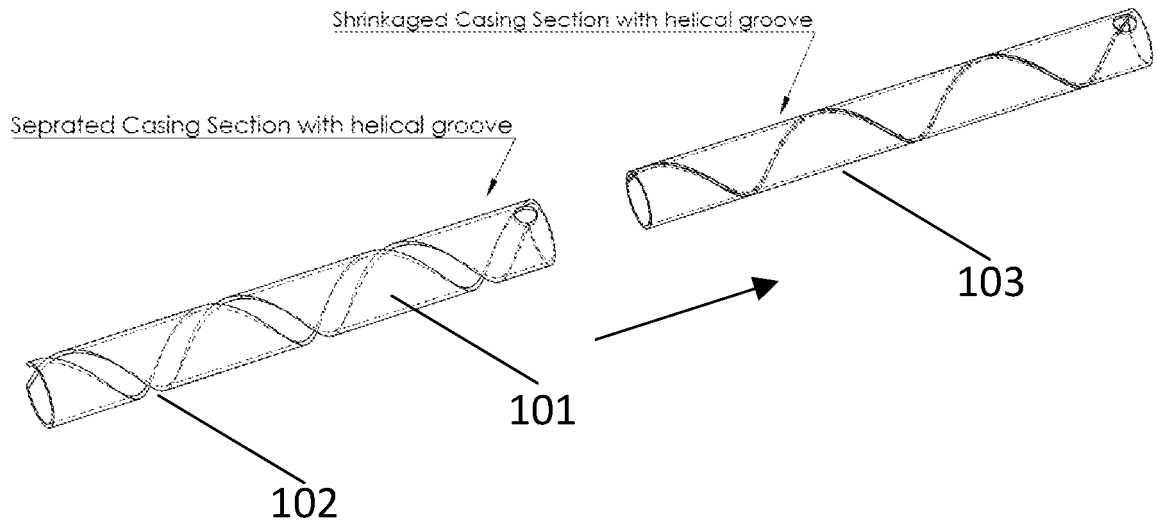


Fig. 11

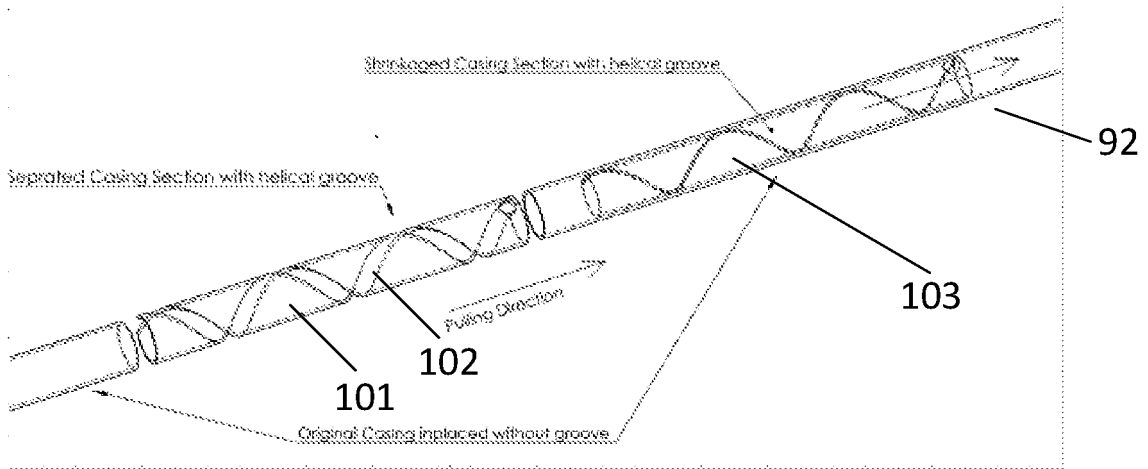


Fig. 12

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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