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(54) Method and apparatus for sealing a bore with a line therethrough

Verfahren und Vorrichtung zur Abdichtung eines Loches mit einem durchquerenden Seil

Procédé et appareil pour étanchéifier un puits traversé par un câble

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Description

[0001] The present invention provides a method and apparatus for substantially sealing a throughbore of a tubular wherein the tubular has a line running therethrough, such that the sealed throughbore can withstand a pressure differential, preferably without any leakage of fluid. The invention also provides a method of substantially filling voids in a line. In particular, the method and apparatus is suitable for use in an oil and gas well in conjunction with a blow-out preventor or wireline valve to effectively seal off a wellbore by filling voids in a wireline in the throughbore.

[0002] In the oil and gas industry, a "blow-out" is a term used to describe an uncontrolled sudden escape of fluids such as gas, water or oil from a wellbore. A blow-out preventor or wireline valve (hereinafter BOP) is a device used to control formation pressures in a well by sealing the wellbore. BOPs can be provided with a centrally disposed aperture extending parallel to the throughbore of the wellbore to allow tubing or wireline running through the wellbore to remain in position when the wellbore is sealed. Thus, BOPs also allow remedial work to be performed on the tubing or wireline by sealing a wellbore under pressure.

[0003] In order to seal the wellbore having a wireline running therethrough, the BOP typically closes a pair of rams to seal around the wireline. However, the BOPs can be required to contain a large pressure differential that may be around 5000-15000 psi (34.5 - 103.4 MPa) or greater. The wireline usually comprises helically wound strands with voids therebetween. Due to the high pressures that the BOP can be expected to contain, it is desirable to ensure that voids in the wireline do not present potential leak paths for high pressure fluids, such as the produced liquids and gases.

[0004] US 4 938 290 discloses a method and apparatus for sealing a tubular, over which the present invention is characterised.

[0005] According to a first aspect of the invention, there is provided a method of substantially sealing a throughbore of a tubular, as claimed in claim 1.

[0006] The method can also include injecting a first fluid in the region of the line and substantially sealing a remaining portion of the throughbore using the first fluid and the solid particles. The method can include injecting the first fluid in the region of the line prior to step (b).

[0007] The method can include injecting a greater proportion of the first fluid than the fluid containing solid particles in the region of the line.

[0008] The method can include injecting the first fluid and the fluid containing solid particles in series. The method can include injecting the first fluid in the region of the line, followed by injecting the fluid containing solid particles in the region of the line. The method can include injecting between two to five times by volume of the first fluid relative to the second fluid. The method can include filling voids associated with the line using the first fluid and the solid particles. Preferably the throughbore is substantially sealed such that no leak path exists. The pressure differential that the sealed throughbore may be required to withstand can be up to 15000 psi (103.4 MPa) or greater. The pressure differential may be in the range 2000 - 15000 psi (13.8 -103.4 MPa). The pressure differential may be in the range 3000 - 10000 psi (20.7 - 68.9 MPa). The pressure differential that the sealed throughbore is arranged to withstand can be in the range 3000 - 6000 psi (20.7 - 41.4 MPa).

[0009] The method can include settling out solid particles to substantially plug one or more voids in the line. The method can include settling out solid particles from the fluid in response to a drop in pressure of the fluid.

[0010] The method can include substantially enclosing the line and sealing a portion of the throughbore around the line by moving a retractable enclosing means into the throughbore. Preferably, the retractable enclosing means are movable into a closed configuration in which the line is centrally disposed and fluids are substantially restricted from flowing through the throughbore. The method can include enclosing the line by moving the enclosing means in a direction perpendicular to an axis of the tubular. The enclosing means can guide the line to and retain the line in the closed configuration. The method can include substantially sealing around an outer profile of the line using a resilient portion provided on the enclosing means.

[0011] The method can include providing a pair of axially spaced enclosing means and substantially enclosing the line at two axially spaced locations thereby sealing a portion of the throughbore around the line arranged parallel to one another. The method can include injecting the fluid(s) between the two axially spaced enclosing means. The method can include providing at least one port in selective fluid communication with the throughbore of the tubular, wherein the or each port provides an opening through which the fluid(s) can be injected and wherein the port is located between the axially spaced enclosing means. The method can include injecting the first fluid and the fluid containing solid particles in the region of the line through separate ports and coupling each port to an injection apparatus.

[0012] The method can include injecting the fluid(s) at a higher pressure relative to the ambient pressure of the voids such that the fluid(s) are forced into the voids.

[0013] The method can include opening one or more apertures between outer elements of the line to allow the fluid(s) access to one or more voids within the line. This can be achieved by forcing the line into an alternative configuration in which the voids are more accessible to the fluids. The method can include twisting the line to open one or more apertures between the outer elements, prior to enclosing the line. The method can include bending the line to open one or more apertures between the outer elements. The method can include shaping a contact surface of the enclosing means to retain the line in a bent or twisted configuration when the enclosing means

are in the closed configuration. The method can include inserting one or more protrusions between the outer elements of the line and thereby opening one or more apertures in the outer elements.

[0014] According to a second aspect of the invention there is provided an apparatus for substantially sealing a throughbore of a tubular, as claimed in claim 13.

[0015] The apparatus can also comprise a first fluid, wherein the at least one injector is capable of injecting the first fluid in the region of the line such that the remaining portion of the throughbore is capable of being sealed using the first fluid and the solid particles.

[0016] The line can comprise one or more voids. The line can comprise at least one layer of helically wound elements. The line can comprise an outer layer of helically wound elements and an inner layer of helically wound elements. The elements of the outer layer and the elements of the inner layer can be helically wound in opposing directions. An inner protected portion of the line can comprise one or more cables selected from the group consisting of: hydraulic supply lines; power supply lines; and communications cables. The line be a wireline.

[0017] The first fluid can have a higher viscosity than the fluid containing solid particles. The first fluid can comprise a heavy hydrocarbon, such as grease or glycol.

[0018] The solid particles can be in suspension with the fluid. The solid particles in the fluid can be arranged to settle out of the fluid. The solid particles can be arranged to settle out of the fluid in response to a drop in pressure of the fluid. The fluid can comprise solid particles of barite.

[0019] The solid particles can have a median grain size between 10 and 250 microns. Preferably, the solid particles can have a median grain size between 25 and 150 microns. The larger median grain size of between 200 to 250 microns is typically suited to use with larger diameter lines.

[0020] The fluid(s) can be injected at a pressure higher than the ambient pressure in the region of the voids such that the fluid(s) are forced into the voids.

[0021] The enclosing means can be selectively movable into the throughbore to substantially enclose the line and seal a portion of throughbore surrounding the line. The enclosing means can be movable perpendicular to the axis of the tubular to a closed configuration in which the portion of the throughbore surrounding the line is substantially sealed.

[0022] A pair of enclosing means can be provided, spaced axially relative to the throughbore. The enclosing means can be a blow-out preventor.

[0023] The enclosing means can be provided with a resilient portion that is arranged to substantially seal around an outer profile of the line. The resilient portion can comprise an elastomeric material.

[0024] The enclosing means can have a contact surface with a recess therein for engaging the line. The recess in the contact surface of the enclosing means can be shaped so as to at least partially bend the line, or otherwise divert the line from a linear configuration, in order to disrupt the voids and make them more accessible to the fluids. After the line has been treated with the fluids, the bent configuration can optionally be relaxed so that the line assumes its normal configuration once more. The or each enclosing means can be provided in at least two parts and the recess in the contact surface of each part can be profiled to cause the line placed therein to at least partially bend. The contact surface of each part of the enclosing means can be provided with a corresponding substantially S-shaped recess for accommodating the line.

[0025] The enclosing means can be provided with one or more protrusions for protruding between one or more elements of an outer layer of the tubular to thereby open an aperture between adjacent elements of the outer armour. The recess in the contact surface of the enclosing means can be provided with one or more protrusions therein for opening adjacent elements of the outer armour.

[0026] The apparatus can comprise an opener wherein the opener is arranged to be selectively coupled to the line to grip and twist the outer armour so as to change the pitch of the helix and open apertures and voids between adjacent elements.

[0027] The fluid containing solid particles and optionally the first fluid can be injected such that the particles and the fluid(s) fill and thereby seal the one or more voids in the line.

[0028] Preferably the method and apparatus are suitable for use in a wellbore.

[0029] Embodiments of the present invention will now be described with reference to and as shown in the accompanying drawings, in which:-

Fig. 1 is a part-side, part-sectional view of a blow-out preventor;

Fig. 2 is a perspective view of a pair of rams of the blow-out preventor of Fig. 1; and

Fig. 3 is a sectional view of the wireline and part of the rams of Fig. 2.

[0030] A wireline BOP is shown generally at 1 in Fig. 1. The BOP 1 comprises a body 2 having a throughbore 3, a pair of upper hydraulic actuators 8, 9, and a pair of lower hydraulic actuators 10, 11. Each hydraulic actuator in a pair extends radially outwardly from the body 2 and in opposing relation to the other hydraulic actuator in the pair. Each hydraulic actuator 8-11 houses an actuator assembly 50, 51 and a ram 59,61. The actuator assembly 50, 51 is operable to retractably move the respective ram 59, 61 provided in the hydraulic actuators 9, 11. The rams 59, 61 are selectively moveable by the associated actuator assembly 54, 51 between an open configuration as shown for the upper pair of hydraulic actuators 8, 9 and a closed configuration as shown for the lower pair of hydraulic actuators 10, 11. In the open configuration at least part of the throughbore 3 is continuous between the op-

posing rams 58, 59. In the closed configuration, the ram 61 of the hydraulic actuator 11 and the opposing ram associated with the arm 10 engage one another thereby closing the throughbore 3 of the body 2 apart from a centrally disposed aperture. Each hydraulic actuator 8, 9 is provided with a mechanical backup 8b, 9b that can be screwed up behind the actuator assembly 59 to resist separation of the rams 59 once in the closed configuration.

[0031] A manifold 14 is provided on the body 2 with a series of inlets 15, 16 for selectively connecting to pumps (not shown) via conduits (not shown). The inlets 15, 16 are in fluid communication with the throughbore 3 via openings (not shown) located in the body 2 between the pair of upper hydraulic actuators 8, 9 and the pair of lower hydraulic actuators 10, 11. According to the present embodiment, a first pump suitable for pumping viscous fluid is coupled to a first reservoir (not shown) containing a grease. The first pump is in fluid communication with the inlet 16. A second pump suitable for use with particle fluids can pump fluid from a second reservoir (not shown) containing a drilling fluid or mud (such as Baracarb™, available from Baroid Drilling Fluids or Enviromul™, available from Hallibrton) having finely divided barite particles with a grain size of 25 to 150 microns that settle out of suspension with the fluid in response to a drop in pressure of the fluid. The second pump is in fluid communication with the inlet 15.

[0032] The ram 59 associated with the hydraulic actuator 9 and a ram 58 associated with the hydraulic actuator 8 is shown in the open configuration in Fig. 2. The rams 58, 59 are substantially cylindrical in shape with V-shaped guides 58V, 59V at a leading end thereof. The rams 58, 59 also have a contact surface 58F, 59F provided with corresponding apertures 5, 6 and recesses 55. The rams 58, 59 are complementary and in the closed configuration (not shown), the rams 58, 59 interlock with the V-shaped guides 58V, 59V overlaid to seal the throughbore 3. In the closed configuration, the apertures 5, 6 and recesses align in such a way that a continuous passage is formed for accommodating a wireline. The passage is thus provided in the contact surface 58F, 59F of the rams 58, 59 in order to allow a wireline extending through the bore 3 to remain in position.

[0033] A sectional plan view of the rams 58, 59 in a closed configuration is shown in Fig. 3. Each ram 58, 59 has an elastomeric collar 62, 63. The elastomeric collars 62, 63 conform with the outer profile of a wireline shown generally at 88 and therefore form a seal around the outer profile of the wireline 88 when brought into contact therewith.

[0034] The wireline 88 is representative of a typical braided wire, but the skilled person will appreciate that there are other configurations of braided wire having differing strand helix arrangements and varying numbers of armour layers.

[0035] The wireline 88 comprises an outer armour 82 consisting of a series of helically wound strands 83 and an inner armour 80 consisting of a series of strands 81 helically wound in an opposing direction to the strands 83 of the outer armour 82. The wireline 88 has a core 86 containing one or more cables 84. Since the strands 81, 83 of the inner armour 80 and outer armour 82 respectively are helically wound in opposing directions there is no nesting of the strands 81 in ridges between the strands 83 of the outer armour 82. As a result, a series of outer voids 90 exist between the inner armour 80 and the outer armour 82. A number of inner voids 92 also occur between the strands 81 of the inner armour 80 and the core 86 of the wireline 88.

[0036] Before use, the wireline BOP 1 is typically positioned at a wellhead (not shown) with the body 2 arranged such that the throughbore 3 is substantially vertical and co-axial with a throughbore of the wellhead. During normal operation of the wellbore, production fluids are recovered from the well (not shown) in a controlled manner and both pairs of hydraulic actuators 8-11 are in the open configuration.

[0037] Should the throughbore 3 require to be closed, for example, to resist a blow-out from the well or to conduct remedial work on a portion of wireline 88 downstream of the BOP 1, the rams 58, 59, associated with the hydraulic actuators 8,9 are hydraulically activated by the actuator assembly 50 to move into the closed configuration. As the opposing rams 58, 59 are moved towards one another, the V-shaped guides 58V, 59V contact the wireline 88 and guide it towards the centrally disposed passage created by the apertures 5, 6 and recesses 55. In this way the throughbore 3 is substantially sealed and the wireline 88 is captured within the passage. The elastomeric collars 62, 63 seal around the outer profile of the wireline 88. The mechanical backup 8b, 9b can be screwed into position behind the actuator assembly 60 to retain the rams 58, 59 in their closed configuration in the event of a failure of the hydraulic system. Similarly, the rams housed within the lower pair of hydraulic actuators 10, 11 are moved into the closed configuration.

[0038] The inner and outer voids 92, 90 remain unsealed within the wireline in the throughbore 3 and therefore pose a potential leak path. Accordingly, viscous grease is first pumped through the inlet 16 of the manifold 14 to the opening between the upper and lower hydraulic actuators 8-11. The grease is injected through the openings at a higher pressure than the well pressure and substantially fills the inner and outer voids 92, 90. The pumping continues until a steady leak of the grease is registered and the well pressure is controlled at an acceptable level that enabling the seal to withstand a certain predetermined pressure across the throughbore 3. The first pump is stroked until the sealed area between the hydraulic actuators 8-11 is packed with grease and the voids 90, 92 are filled with sufficient grease. At this stage, a drilling fluid containing solid barite particles is pumped through the opening located between the pairs of hydraulic actuators via the inlet 15 of the manifold in order to plug the voids 90, 92 in the wireline 88. The second pump

forces drilling fluid out of the openings at high pressure. However, the pressure of the fluid drops once pumped into the wireline 88 and the energy loss causes, the finely divided barite particles to settle out of suspension with the fluid and plug the voids 90, 92 thereby blocking the leak path and substantially sealing the voids 90, 92 within the wireline 88.

[0039] In order to avoid a situation where the outer voids 90 are bridged prior to plugging the inner voids 92 it may be necessary to open gaps between one or more strands 83 of the outer armour 82 to allow the fluids access to the inner voids 92 and avoid initial bridging of the outer armour 82 prior to sealing the inner voids 92. There are several alternative methods by which this can be achieved.

[0040] The contact surface 58F, 59F of the rams 58, 59 in the region of the apertures 5, 6 or recesses 55 can be provided with one or more small protrusions (not shown). These protrusions can have a pointed end and can be arranged such that the pointed end nests between outer strands 83 to thereby part two or more of the strands 83 and open gaps therebetween.

[0041] In an alternative embodiment, the contact surface 58F, 59F of the rams 58, 59 can be provided with corresponding S-shaped recesses such that the wireline 88 conforms to a bent shape when the wireline BOP 1 occupies the closed configuration. A bending of the wireline 88 has the effect of opening the outer strands 83 on outside edges of the S-bend.

[0042] Alternatively, prior to or simultaneous with sealing the BOP 1 an opener (not shown) can be provided to grip around the outer armour 82 and twist the strands 83 to thereby alter the pitch of the wireline 88 helix and open gaps between the strands 83.

[0043] Using the above described method, the throughbore 3 is sealed by the rams 58, 59 and the voids 90, 92 can be filled and sealed to eliminate potential leak paths and contain high pressures within the wellbore.

[0044] Modifications and improvements can be made without departing from the scope of the invention. In particular, the embodiment described above concerns sealing the wellbore using a wireline BOP 1. However, the general method of sealing voids within apparatus according to the present invention can be used in other applications. Although the above described embodiment utilises grease in addition to the drilling fluid for sealing the wireline 88, it will be appreciated that the drilling fluid can be used without the grease for the same purpose of sealing voids in a wireline 88. The fluid containing solid particles that is the drilling fluid or mud according to the described embodiment can be selected according to the specific application and the diameter of the wireline 88. For example, wireline 88 having a greater diameter may be used with drilling muds having a larger median grain size of around 200 to 250 microns.

Claims

1. A method of substantially sealing a throughbore (3) of a tubular (2), the tubular (2) having a line (88) running therethrough, such that the sealed throughbore (3) can withstand a pressure differential, the method comprising the steps of:

   (a) substantially enclosing the line (88) and sealing a portion of the throughbore (3) around a region of the line (88) using an enclosing means (58, 59);
   (b) injecting a fluid in the region of the line (88); and
   (c) substantially sealing a remaining portion of the throughbore (3), **characterised in that**:

   the fluid is a fluid suspension, containing solid particles in suspension in the fluid, and wherein the solid particles seal the remaining portion of the throughbore (3) such that the sealed throughbore (3) is capable of withstanding a pressure differential.

2. A method according to claim 1, including settling out the solid particles from the fluid suspension in response to a drop in pressure of the fluid during step (b).

3. A method according to claim 1 or claim 2, including injecting a first fluid in the region of the line (88) prior to step (b) and substantially sealing the remaining portion of the throughbore (3) according to step (c) using the solid particles in the fluid suspension and the first fluid.

4. A method according to claim 3, including injecting a greater proportion of the first fluid than the fluid suspension containing solid particles in the region of the line (88).

5. A method according to claim 3 or claim 4, including filling voids (90, 92) associated with the line (88) using the first fluid and the solid particles, such that the sealed throughbore (3) is arranged to withstand a pressure differential of up to 15000 psi (103.4 MPa).

6. A method according to any one of claims 3 to 5, including filling voids (90, 92) associated with the line (88) using the first fluid and the solid particles, such that the sealed throughbore (3) is arranged to withstand a pressure differential in the range of 3000 - 6000 psi (20.7 - 41.4 MPa).

7. A method according to any one of claims 3 to 6, including injecting the first fluid and the fluid suspension containing solid particles in the region of the line (88) through separate ports (15, 16) and coupling

each port (15, 16) to an injection apparatus.

8. A method according to any one of claims 1 to 7, including performing step (a) by moving the enclosing means (58, 59) into a closed configuration in which the line (88) is substantially centrally disposed and fluid(s) are substantially restricted from flowing through the throughbore (3).

9. A method according to claim 8, including providing a pair of axially spaced enclosing means (58, 59) and performing step (a) at two axially spaced locations, thereby sealing an annular portion of the throughbore 3 around the line (88) and further including injecting the fluid(s) between the two axially spaced enclosing means (58, 59).

10. A method according to any one of claims 1 to 9, including injecting the fluid(s) at a higher pressure relative to the ambient pressure of voids (90, 92) associated with the line (88) such that the fluid(s) are forced into the voids (90, 92).

11. A method according to any one of claims 1 to 10, including opening at least one aperture in an outer part of the line (88) to allow the fluid(s) access to voids (90, 92) associated with the line (88).

12. A method according to any one of claims 1 to 11, including shaping a contact surface (58F, 59F) of the enclosing means (58, 59) to retain the line (88) in a configuration in which voids (90, 92) associated with the line (88) are more accessible to fluids when the enclosing means (58, 59) are in contact with the line (88).

13. Apparatus for substantially sealing a throughbore (3) of a tubular (2), the tubular (2) having a line (88) running therethrough, such that the sealed throughbore (3) can withstand a pressure differential, the apparatus comprising:

an enclosing means (58, 59) to enclose a region of the line (88) and seal a portion of the throughbore (3) around the line (88) in use;
a fluid; and
at least one injector, wherein the or each injector is capable of injecting the fluid in the region of the line (88):

characterised in that:

the fluid is a fluid suspension containing solid particles in suspension in the fluid, and wherein the solid particles seal the remaining portion of the throughbore (3).

14. Apparatus according to claim 13, wherein the solid particles are arranged to settle out of the fluid in response to a drop in pressure of the fluid.

15. Apparatus according to claim 13 or claim 14, comprising at least one addition injector for a first fluid, wherein the at least one additional injector is capable of injecting the first fluid in the region of the line (88) such that the remaining portion of the throughbore (3) is capable of being sealed using the first fluid and the solid particles.

16. Apparatus according to any one of claims 13 to 15, wherein voids (90, 92) are associated with the line (88) and the fluid(s) can be injected at a pressure higher than the ambient pressure of the voids (90, 92) such that the fluid(s) are forced into the voids (90, 92) so that the fluid(s) fill and thereby seal the voids (90, 92) in the line (88).

17. Apparatus according to any one of claims 13 to 16, wherein a pair of enclosing means (58, 59) are provided, spaced axially relative to the throughbore (3) and wherein each enclosing means (58, 59) is provided with a resilient portion (62, 63) that is arranged to substantially seal around an outer profile of the line (88).

18. Apparatus according to any one of claims 13 to 17, wherein the enclosing means (58, 59) have a contact surface (58F, 59F) for engaging the line (88), wherein the contact surface (58F, 59F) is shaped so as to divert the line from a linear configuration in order to disrupt voids (90, 92) associated with the line (88) and make them more accessible to the fluids.

Patentansprüche

1. Ein Verfahren zum wesentlichen Abdichten einer Durchgangsbohrung (3) eines Rohres (2), wobei das Rohr (2) ein Seil (88) aufweist, das durch dieses verläuft, so dass die abgedichtete Durchgangsbohrung (3) einer Druckdifferenz standhalten kann, wobei das Verfahren die folgenden Schritte beinhaltet:

(a) wesentliches Umschließen des Seils (88) und Abdichten eines Abschnitts der Durchgangsbohrung (3) um eine Region des Seils (88) unter Verwendung eines Umschließungsmittels (58, 59);
(b) Injizieren eines Fluids in die Region des Seils (88) und
(c) wesentliches Abdichten eines verbleibenden Abschnitts der Durchgangsbohrung (3),

dadurch gekennzeichnet, dass:

das Fluid eine Fluidsuspension ist, die feste Par-

tikel in Suspension in dem Fluid enthält, und wobei die festen Partikel den verbleibenden Abschnitt der Durchgangsbohrung (3) abdichten, so dass die abgedichtete Durchgangsbohrung (3) fähig ist, einer Druckdifferenz standzuhalten.

2. Verfahren gemäß Anspruch 1, das das Absetzen der festen Partikel aus der Fluidsuspension als Reaktion auf einen Druckabfall des Fluids während Schritt (b) umfasst.

3. Verfahren gemäß Anspruch 1 oder Anspruch 2, das das Injizieren eines ersten Fluids in die Region des Seils (88) vor Schritt (b) und das wesentliche Abdichten des verbleibenden Abschnitts der Durchgangsbohrung (3) gemäß Schritt (c) unter Verwendung der festen Partikel in der Fluidsuspension und des ersten Fluids umfasst.

4. Verfahren gemäß Anspruch 3, das das Injizieren eines größeren Anteils des ersten Fluids als der Fluidsuspension, die feste Partikel enthält, in die Region des Seils (88) umfasst.

5. Verfahren gemäß Anspruch 3 oder Anspruch 4, das das Füllen von mit dem Seil (88) assoziierten Hohlräumen (90, 92) unter Verwendung des ersten Fluids und der festen Partikel umfasst, so dass die abgedichtete Durchgangsbohrung (3) eingerichtet ist, um einer Druckdifferenz von bis zu 15000 psi (103,4 MPa) standzuhalten.

6. Verfahren gemäß einem der Ansprüche 3 bis 5, das das Füllen von mit dem Seil (88) assoziierten Hohlräumen (90, 92) unter Verwendung des ersten Fluids und der festen Partikel umfasst, so dass die abgedichtete Durchgangsbohrung (3) eingerichtet ist, um einer Druckdifferenz in dem Bereich von 3000-6000 psi (20,7-41,4 MPa) standzuhalten.

7. Verfahren gemäß einem der Ansprüche 3 bis 6, das das Injizieren des ersten Fluids und der feste Partikel enthaltenden Fluidsuspension in die Region des Seils (88) durch separate Eingänge (15, 16) und das Koppeln jedes Eingangs (15, 16) an eine Injektionsvorrichtung umfasst.

8. Verfahren gemäß einem der Ansprüche 1 bis 7, das das Durchführen von Schritt (a) durch das Bewegen des Umschließungsmittels (58, 59) in eine geschlossene Konfiguration, in der das Seil (88) im Wesentlichen zentral angeordnet ist und das Fluid/die Fluide im Wesentlichen daran gehindert wird/werden, durch die Durchgangsbohrung (3) zu fließen, umfasst.

9. Verfahren gemäß Anspruch 8, das das Bereitstellen eines Paares axial mit Abstand angeordneter Umschließungsmittel (58, 59) und das Durchführen von Schritt (a) an zwei axial mit Abstand angeordneten Stellen umfasst, wodurch ein ringförmiger Abschnitt der Durchgangsbohrung 3 um das Seil (88) abgedichtet wird, und das ferner das Injizieren des Fluids/der Fluide zwischen die zwei axial mit Abstand angeordneten Umschließungsmittel (58, 59) umfasst.

10. Verfahren gemäß einem der Ansprüche 1 bis 9, das das Injizieren des Fluids/der Fluide mit einem relativ zu dem Umgebungsdruck von mit dem Seil (88) assoziierten Hohlräumen (90, 92) höheren Druck umfasst, so dass das Fluid/die Fluide in die Hohlräume (90, 92) gezwungen wird/werden.

11. Verfahren gemäß einem der Ansprüche 1 bis 10, das das Öffnen von mindestens einer Öffnung in einem äußeren Teil des Seils (88) umfasst, um zu ermöglichen, dass das Fluid/die Fluide Zugang zu mit dem Seil (88) assoziierten Hohlräumen (90, 92) erhält/erhalten.

12. Verfahren gemäß einem der Ansprüche 1 bis 11, das das Formen einer Kontaktoberfläche (58F, 59F) der Umschließungsmittel (58, 59) umfasst, um das Seil (88) in einer Konfiguration zu behalten, in der mit dem Seil (88) assoziierte Hohlräume (90, 92) für Fluide zugänglicher sind, wenn sich die Umschließungsmittel (58, 59) mit dem Seil (88) in Kontakt befinden.

13. Eine Vorrichtung zum wesentlichen Abdichten einer Durchgangsbohrung (3) eines Rohres (2), wobei das Rohr (2) ein Seil (88) aufweist, das durch dieses verläuft, so dass die abgedichtete Durchgangsbohrung (3) einer Druckdifferenz standhalten kann, wobei die Vorrichtung Folgendes beinhaltet:

ein Umschließungsmittel (58, 59), um bei Gebrauch eine Region des Seils (88) zu umschließen und einen Abschnitt der Durchgangsbohrung (3) um das Seil (88) abzudichten;
ein Fluid und
mindestens einen Injektor, wobei der oder jeder Injektor fähig ist, das Fluid in die Region des Seils (88) zu injizieren;
dadurch gekennzeichnet, dass:

das Fluid eine Fluidsuspension ist, die feste Partikel in Suspension in dem Fluid enthält, und wobei die festen Partikel den verbleibenden Abschnitt der Durchgangsbohrung (3) abdichten.

14. Vorrichtung gemäß Anspruch 13, wobei die festen Partikel eingerichtet sind, um sich als Reaktion auf einen Druckabfall des Fluids aus dem Fluid abzu-

setzen.

15. Vorrichtung gemäß Anspruch 13 oder Anspruch 14, das mindestens einen Zusatzinjektor für ein erstes Fluid beinhaltet, wobei der mindestens eine zusätzliche Injektor fähig ist, das erste Fluid in die Region des Seils (88) zu injizieren, so dass der verbleibende Abschnitt der Durchgangsbohrung (3) unter Verwendung des ersten Fluids und der festen Partikel abgedichtet werden kann.

16. Vorrichtung gemäß einem der Ansprüche 13 bis 15, wobei mit dem Seil (88) Hohlräume (90, 92) assoziiert sind und das Fluid/die Fluide mit einem höheren Druck als dem Umgebungsdruck der Hohlräume (90, 92) injiziert werden kann/können, so dass das Fluid/die Fluide in die Hohlräume (90, 92) gezwungen wird/werden, so dass das Fluid/die Fluide die Hohlräume (90, 92) in dem Seil (88) füllt/füllen und dadurch abdichtet/abdichten.

17. Vorrichtung gemäß einem der Ansprüche 13 bis 16, wobei ein Paar Umschließungsmittel (58, 59) bereitgestellt ist, die relativ zu der Durchgangsbohrung (3) axial mit Abstand angeordnet sind, und wobei jedes Umschließungsmittel (58, 59) mit einem elastischen Abschnitt (62, 63) versehen ist, der eingerichtet ist, um im Wesentlichen um ein äußeres Profil des Seils (88) abzudichten.

18. Vorrichtung gemäß einem der Ansprüche 13 bis 17, wobei die Umschließungsmittel (58, 59) eine Kontaktoberfläche (58F, 59F) zum Eingriff mit dem Seil (88) aufweisen, wobei die Kontaktoberfläche (58F, 59F) so geformt ist, dass sie das Seil aus einer linearen Konfiguration ablenkt, um mit dem Seil (88) assoziierte Hohlräume (90, 92) aufzubrechen und sie für die Fluide zugänglicher zu machen.

Revendications

1. Une méthode pour étanchéifier de façon substantielle un trou débouchant (3) d'un tubulaire (2), le tubulaire (2) ayant une conduite (88) le traversant, de sorte que le trou débouchant étanchéifié (3) peut supporter une différence de pression, la méthode comprenant les étapes consistant à :

(a) enfermer de façon substantielle la conduite (88) et étanchéifier une portion du trou débouchant (3) autour d'une région de la conduite (88) à l'aide d'un moyen d'enfermement (58, 59) ;
(b) injecter un fluide dans la région de la conduite (88) ; et
(c) étanchéifier de façon substantielle une portion restante du trou débouchant (3),

caractérisée en ce que :

le fluide est une suspension fluide, contenant des particules solides en suspension dans le fluide, et dans laquelle les particules solides étanchéifient la portion restante du trou débouchant (3) de sorte que le trou débouchant étanchéifié (3) soit capable de supporter une différence de pression.

2. Une méthode selon la revendication 1, incluant le fait de décanter les particules solides de la suspension fluide en réponse à une chute de pression du fluide au cours de l'étape (b).

3. Une méthode selon la revendication 1 ou la revendication 2, incluant le fait d'injecter un premier fluide dans la région de la conduite (88) avant l'étape (b) et d'étanchéifier de façon substantielle la portion restante du trou débouchant (3) selon l'étape (c) à l'aide des particules solides dans la suspension fluide et du premier fluide.

4. Une méthode selon la revendication 3, incluant le fait d'injecter une proportion plus grande du premier fluide que de la suspension fluide contenant des particules solides dans la région de la conduite (88).

5. Une méthode selon la revendication 3 ou la revendication 4, incluant le fait de remplir des vides (90, 92) associés à la conduite (88) à l'aide du premier fluide et des particules solides, de sorte que le trou débouchant étanchéifié (3) est arrangé pour supporter une différence de pression allant jusqu'à 15 000 psi (103,4 MPa).

6. Une méthode selon n'importe laquelle des revendications 3 à 5, incluant le fait de remplir des vides (90, 92) associés à la conduite (88) à l'aide du premier fluide et des particules solides, de sorte que le trou débouchant étanchéifié (3) est arrangé pour supporter une différence de pression comprise dans la gamme allant de 3 000 à 6 000 psi (20,7 à 41,4 MPa).

7. Une méthode selon n'importe laquelle des revendications 3 à 6, incluant le fait d'injecter le premier fluide et la suspension fluide contenant des particules solides dans la région de la conduite (88) à travers des orifices distincts (15, 16) et de coupler chaque orifice (15, 16) à un appareil pour injection.

8. Une méthode selon n'importe laquelle des revendications 1 à 7, incluant le fait de réaliser l'étape (a) en faisant prendre au moyen d'enfermement (58, 59) une configuration fermée dans laquelle la conduite (88) est disposée de façon substantiellement centrale et un (des) fluide(s) sont substantiellement em-

pêchés de s'écouler à travers le trou débouchant (3).

9. Une méthode selon la revendication 8, incluant le fait de fournir une paire de moyens d'enfermement espacés de façon axiale (58, 59) et de réaliser l'étape (a) au niveau de deux emplacements espacés de façon axiale, étanchéifiant de ce fait une portion annulaire du trou débouchant 3 autour de la conduite (88) et incluant en outre le fait d'injecter le(s) fluide (s) entre les deux moyens d'enfermement espacés de façon axiale (58, 59).

10. Une méthode selon n'importe laquelle des revendications 1 à 9, incluant le fait d'injecter le(s) fluide(s) à une pression plus élevée relativement à la pression ambiante de vides (90, 92) associés à la conduite (88) de sorte que le(s) fluide(s) soient forcés à pénétrer dans les vides (90, 92).

11. Une méthode selon n'importe laquelle des revendications 1 à 10, incluant le fait d'ouvrir au moins une ouverture dans une partie externe de la conduite (88) pour permettre au(x) fluide(s) d'avoir accès à des vides (90, 92) associés à la conduite (88).

12. Une méthode selon n'importe laquelle des revendications 1 à 11, incluant le fait de former une surface de contact (58F, 59F) des moyens d'enfermement (58, 59) pour retenir la conduite (88) dans une configuration dans laquelle des vides (90, 92) associés à la conduite (88) sont plus accessibles à des fluides lorsque les moyens d'enfermement (58, 59) sont en contact avec la conduite (88).

13. Appareil pour étanchéifier de façon substantielle un trou débouchant (3) d'un tubulaire (2), le tubulaire (2) ayant une conduite (88) le traversant, de sorte que le trou débouchant étanchéifié (3) peut supporter une différence de pression, l'appareil comprenant :

un moyen d'enfermement (58, 59) pour enfermer une région de la conduite (88) et étanchéifier une portion du trou débouchant (3) autour de la conduite (88) lors de l'utilisation ;
un fluide ; et
au moins un injecteur, dans lequel le ou chaque injecteur est capable d'injecter le fluide dans la région de la conduite (88) ;
caractérisé en ce que :

le fluide est une suspension fluide contenant des particules solides en suspension dans le fluide, et dans lequel les particules solides étanchéifient la portion restante du trou débouchant (3).

14. Appareil selon la revendication 13, dans lequel les particules solides sont arrangées pour se décanter du fluide en réponse à une chute de pression du fluide.

15. Appareil selon la revendication 13 ou la revendication 14, comprenant au moins un injecteur supplémentaire pour un premier fluide, dans lequel le au moins un injecteur supplémentaire est capable d'injecter le premier fluide dans la région de la conduite (88) de sorte que la portion restante du trou débouchant (3) soit capable d'être étanchéifiée à l'aide du premier fluide et des particules solides.

16. Appareil selon n'importe laquelle des revendications 13 à 15, dans lequel des vides (90, 92) sont associés à la conduite (88) et le(s) fluide(s) peuvent être injectés à une pression plus élevée que la pression ambiante des vides (90, 92) de sorte que le(s) fluide (s) soient forcés à pénétrer dans les vides (90, 92) de façon que le(s) fluide(s) remplissent et de ce fait étanchéifient les vides (90, 92) dans la conduite (88).

17. Appareil selon n'importe laquelle des revendications 13 à 16, dans lequel une paire de moyens d'enfermement (58, 59) sont prévus, espacés de façon axiale relativement au trou débouchant (3) et dans lequel chaque moyen d'enfermement (58, 59) est muni d'une portion résiliente (62, 63) qui est arrangée pour étanchéifier de façon substantielle le pourtour d'un profil externe de la conduite (88).

18. Appareil selon n'importe laquelle des revendications 13 à 17, dans lequel les moyens d'enfermement (58, 59) présentent une surface de contact (58F, 59F) destinée à se mettre en prise avec la conduite (88), dans lequel la surface de contact (58F, 59F) est formée de façon à faire dévier la conduite d'une configuration linéaire afin de disloquer des vides (90, 92) associés à la conduite (88) et les rendre plus accessibles aux fluides.

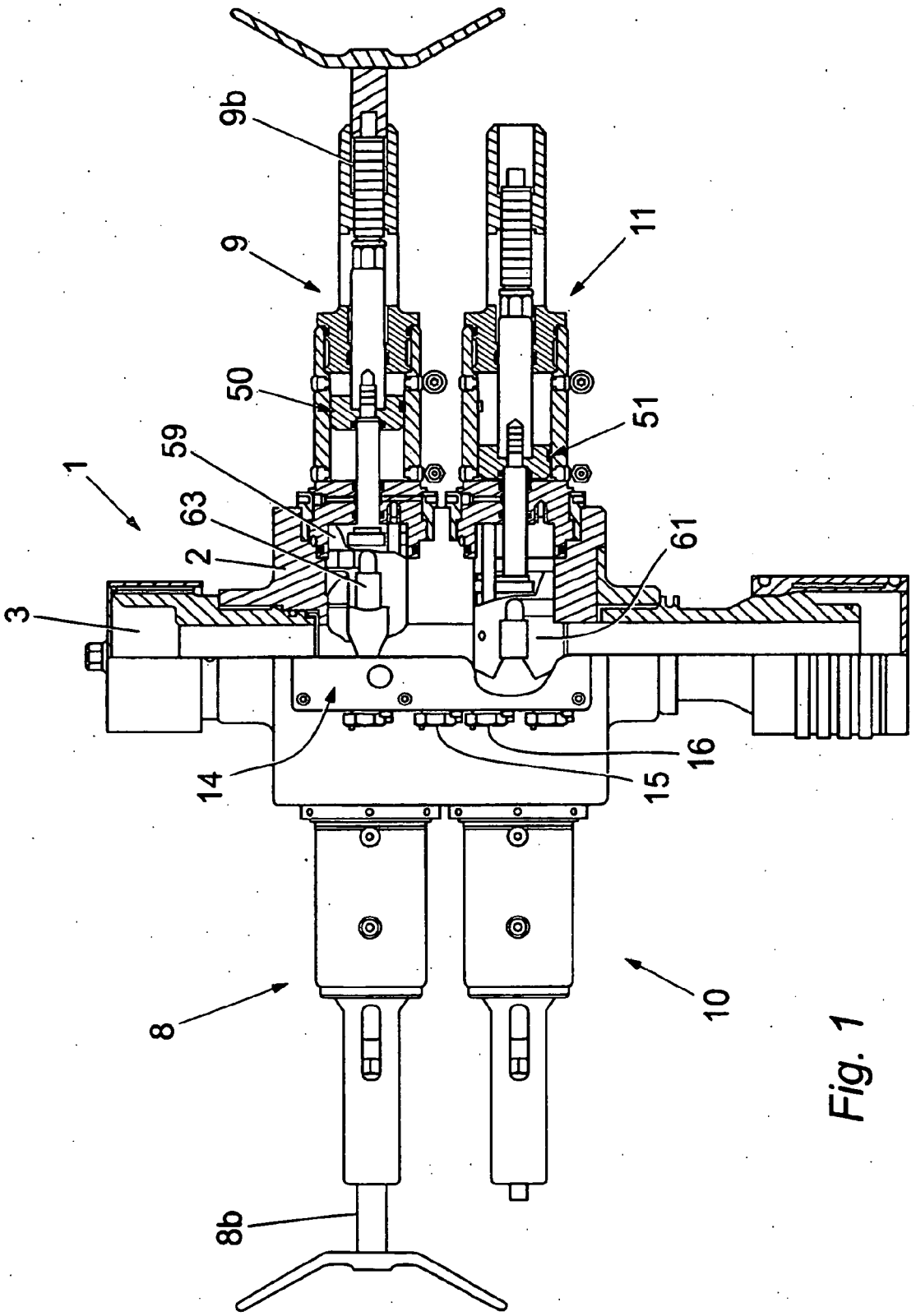

Fig. 1

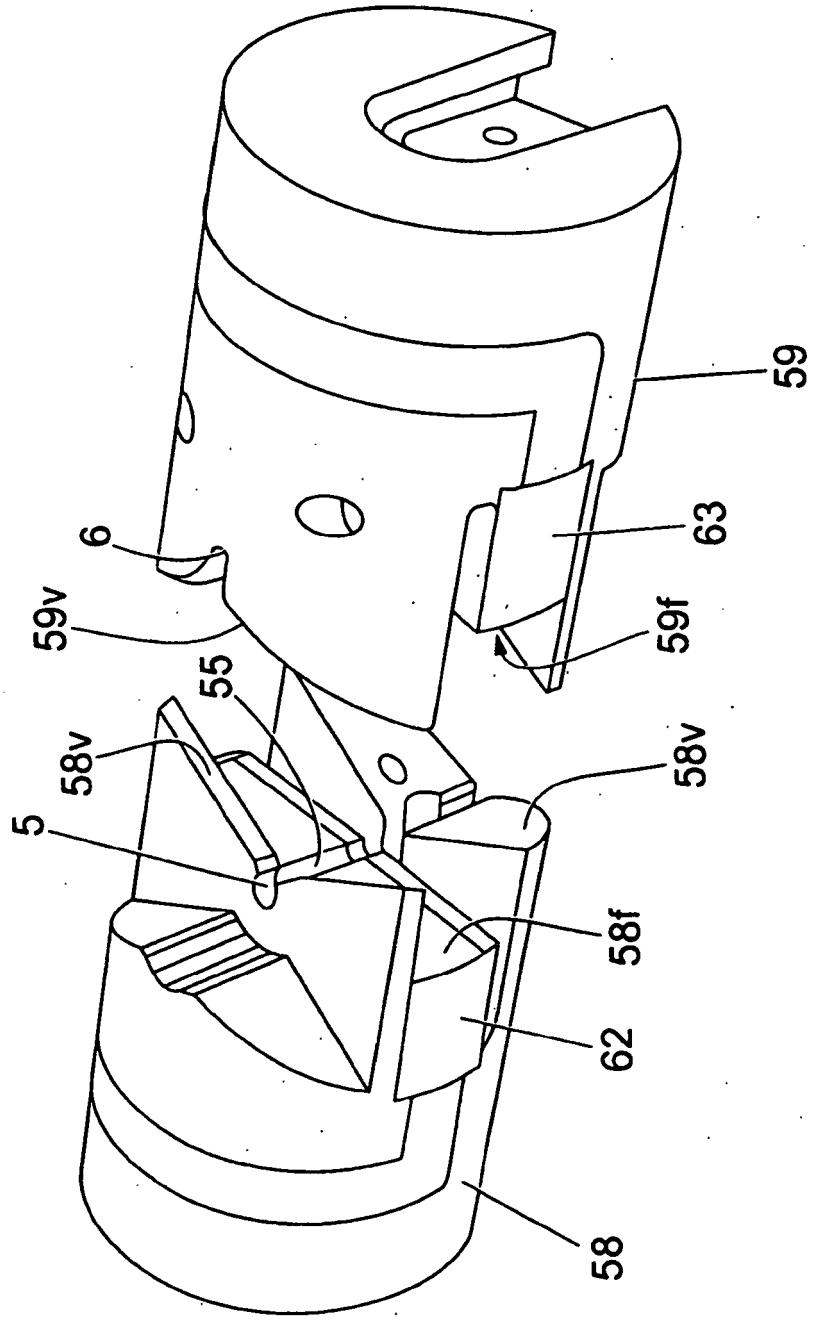

Fig. 2

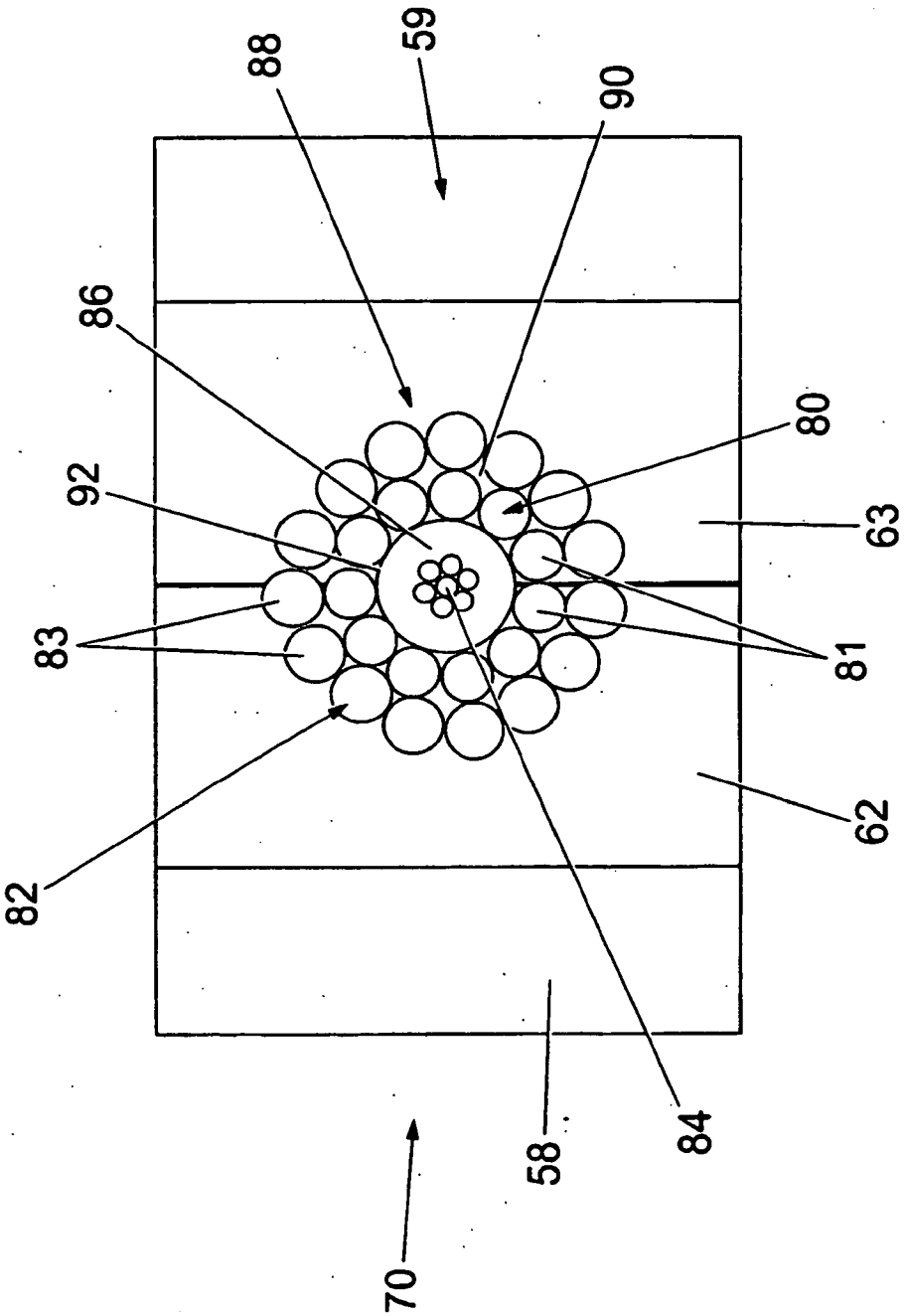

Fig. 3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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