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(54) Title: METHOD FOR SEALING OFF A WATER ZONE IN A PRODUCTION WELL DOWNHOLE AND A SEALING ARRANGEMENT

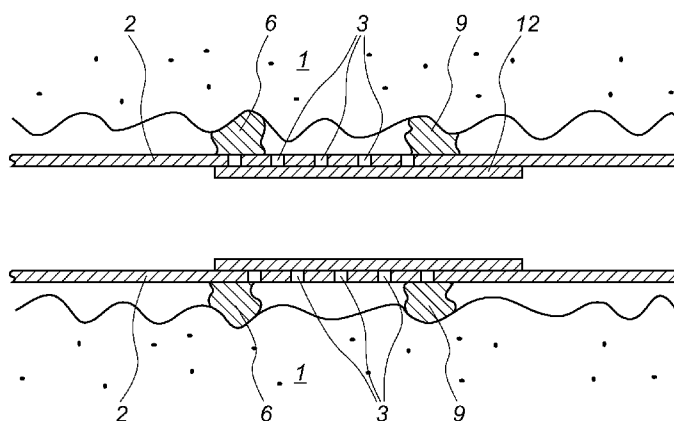


Fig. 8

(57) Abstract: The invention relates to a sealing method for sealing off a leak in a casing (2) or for sealing of a production zone (1) where the casing (2) having a circumference and perforations (3) is situated in a borehole downhole, but with a distance to the inner wall of the borehole, creating an intervening space (4) there between. The sealing method comprises the steps of injecting a composition (5) for making a first circumferential seal (6) in the intervening space (4) at a first position (7) of the casing in one end of the production zone through holes situated along a first intersecting line (8) where a first plane intersects the circumference of the casing; filling the intervening space at a first position in a radial direction of the casing; injecting a composition (5) for making a second circumferential seal (9) in the intervening space (4) at a second position (10) of the casing in another end of the production zone through holes situated along a second intersecting line (11) where a second plane intersects the circumference of the casing; filling the intervening space at a second position in a radial direction of the casing; inserting a liner (12) into the casing (2) opposite the perforations (3) and extending between and at least partly covering both the first and the second circumferential seal; and expanding the liner until the liner is pressing against the casing whereby the liner together with the first and the second circumferential seal isolate the production zone. The composition is able to harden once injected into the intervening space.

Title: Method for sealing off a water zone in a production well downhole and a sealing arrangement

Technical Field

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The present invention relates to a sealing method for sealing off a production zone where a casing having a circumference and perforations is situated in a borehole downhole, but with a distance to an inner wall of the borehole, creating an intervening space there between. Furthermore, the invention relates to a sealing arrangement.

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Background

Casings are placed in boreholes in the formation mainly for preventing a collapse of the boreholes. The borehole may have a number of casings situated within one another so that a production casing is situated within an intermediate casing which again is situated within a surface casing and a conductor pipe.

15

When the production casing is placed in the borehole, it is subsequently perforated in a certain zone where oil is present. The oil fluid is then able to enter the production casing, and oil production is initiated. During the oil production phase, the oil fluid may be mixed with water as the zone with oil may shift when emptying the oil reservoir for oil.

20

In the event that the zone with oil has shifted, it is necessary to make new perforations in the production casing and to seal off the previous perforations. In order to seal off the previous perforations, a new production casing is inserted within the first production casing, and packers are placed on both sides of the zone. Subsequently, new perforations are made in the new production casing.

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By inserting a new production casing into the previous production casing, the production rate is substantially diminished due to the increase in friction and the velocity is likewise decreased causing a variety of related problems.

Another way to seal off the zone with water is to insert a cement plug above the zone for plugging the underlying casing. Subsequently, the production casing is perforated in a new area above the cement plug where oil is present. Hereby, the underlying casing is shut off more permanently and it is very difficult, if not impos-

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sible, to resume the production in the production casing beneath the plug without having to insert a new production casing.

Description of the Invention

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An aspect of the present invention is, at least partly, to overcome the disadvantages of the known solutions to sealing off a production zone mentioned by providing a method for sealing off a production zone which does not entail plugging part of the production casing or inserting a new production casing diminishing the production rate substantially.

10

This aspect and the advantages becoming evident from the description below are obtained by a sealing method for sealing off a leak in a casing or a production zone where the casing having a circumference and perforations is situated in a borehole downhole, but with a distance to the inner wall of the borehole, creating an intervening space there between, comprising the steps of:

15

- injecting a composition for making a first circumferential seal in the intervening space at a first position of the casing in one end of the production zone through holes situated along a first circular or oval line around the casing,

20

- filling the intervening space at a first position in a radial direction of the casing,

- injecting a composition for making a second circumferential seal in the intervening space at a second position of the casing in another end of the production zone through holes situated along a second circular or oval line around the casing,

25

- filling the intervening space at a second position in a radial direction of the casing,

- inserting a liner into the casing opposite the perforations and extending within both the first and the second circumferential seal, and

- expanding the liner until the liner is pressing against the casing whereby the liner together with the first and the second circumferential seal isolate the production zone.

30

Injecting a composition for making two separate circumferential seals in the intervening space in a predetermined distance from one another and subsequently expanding a liner between the two seals makes it possible to seal off a production zone without having to block the lowest part of the casing or seal every perforation hole one by one.

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In one embodiment, the composition may comprise a compound which is able to harden, expand, swell or paste once injected into the intervening space.

In another embodiment, the holes through which the composition is injected may
5 be positioned directly opposite each other in the casing.

Moreover, the holes may be some of the perforations.

In addition, the method may also comprise the step of making the holes prior to at
10 least one of the injection steps.

In one embodiment, the sealing method may moreover comprise a third injection
step where composition is injected for making a third circumferential seal in the in-
tervening space through holes made at a distance from the perforations.
15

Furthermore, the sealing method may comprise the step of making new perfora-
tions in the casing for letting oil fluid flow into the casing from a new and second
production zone.

20 In some embodiments, the composition may be expanded for making the circum-
ferential seals.

In addition, the sealing method may comprise a further step of injecting an inter-
mediate circumferential seal between the first and the second circumferential seal.
25

Finally, the invention also relates to a sealing arrangement for sealing off a leak in
a casing or a production zone where the casing having a circumference and perfora-
tions is situated in a borehole downhole, but with a distance to the inner wall of
borehole, creating an intervening space between casing and the borehole, compris-
30 ing:

- a first circumferential seal of composition in the intervening space at a first
position of the casing in a first end of the production zone,
- a second circumferential seal of composition in the intervening space at a
second position of the casing in a second end of the production zone, and
35 - an expanded liner in between the first and the second circumferential seal,
for isolation of the production zone.

Brief Description of the Drawings

The invention is explained in detail below with reference to the drawings, in which

5 Fig. 1 shows a sectional view of a casing within a borehole,

Fig. 2 shows a sectional view of the casing of Fig. 1 during a first injection step,

10 Fig. 3 shows a sectional view of the casing of Fig. 1 with a first circumferentially seal,

Fig. 4 shows a sectional view of the casing of Fig. 1 during a second injecting step,

15 Fig. 5 shows a sectional view of the casing of Fig. 1 with a second circumferentially seal,

Fig. 6 shows a cross-sectional view the casing of Fig. 5,

20 Fig. 7 shows the cross-sectional view the casing of Fig. 5 during the performance of an expansion step of the present method,

Fig. 8 shows a cross-sectional view of the casing of Fig. 5 with a fully expanded liner,

25 Fig. 9 shows a sectional view into the borehole with a plurality of circumferentially seals and a new production zone, and

30 Fig. 10 shows a sectional view into the borehole with a production casing, intermediate casings, a surface casing, and a conductor pipe.

The drawings are merely schematic and shown for an illustrative purpose.

Detailed description of the invention

35 The present invention finds it use in a situation where a perforated casing is used in a borehole and where an oil production zone 1 for some reason has shifted or become emptied of oil. Perforations 3 are situated facing the production zone 1, enabling oil to flow into the casing 2 and in this way be brought up from downhole.

When the oil has become too emulsified with water or the reservoir has been emptied for oil, the perforations 3 of the casing 2 must be sealed so that a new production zone 14 can be made in another place along the extension of the casing 2.

- 5 The borehole can be made in a formation of limestone or in sand. The oil fluid seeps from the formation or sand into the casing 2 through the perforations 3 in the casing. The seepage of oil fluid is illustrated by arrows in Fig. 1. Due to the fact that the casing 2 is not cemented in order to fixate the casing in relation to the borehole, a space occurs between the outside wall of the casing 2 and the inside wall of the borehole. Thus, the oil fluid is able to flow along the longitudinal extension of the casing 2 and into the perforations 3 of the casing. When the amount of oil present in a production zone 1 is no longer sufficient and/or oil fluid has become too diluted, the production zone 1 needs to be sealed off. Subsequently, new perforations are made at a certain distance from the previous production zone so that a new production zone 14 can be created. The distance depends on how far the water is able to flow within the formation or the sand towards the casing 2 and along the casing so that the diluted fluid from the previous production zone is not mixed with the oil fluid from the new production zone 14.
- 10
- 15
- 20 In Fig. 1 a casing 2 situated in a borehole is shown. The casing 2 has perforations 3 in the area facing the production zone 1 in order for the oil fluid to flow into the casing. As can be seen, the diameter of the borehole may vary, and the intervening space 4 between the casing 3 and the inside of the borehole thus vary accordingly. When sealing off the production zone 1, the intervening space 4 is locally filled with a composition 5 that is able to harden upon injection into the space for making a circumferential seal 6, 9 around the outside wall of the casing 2.
- 25

A circumferential seal 6, 9 in the intervening space 4 around the outside wall of the casing 2 is made by injecting a composition 5 through holes situated along a first circular line 8 as shown with a broken line in Fig. 1. The intersecting line 8 is shown as a first plane perpendicular to the longitudinal extension of the casing and intersecting with the circumference of the casing. Thus, the circumferential seal 6, 9 has an extension around the outside of the casing 2 substantially perpendicular to the longitudinal extension of the casing.

35

In another embodiment, the intersecting line 8 occurs when a plane intersects with the circumference of the casing and has an angle of 60°-85° to the longitudinal ex-

tension of the casing 2. Thus, the circumferential seal 6, 9 will also have an angle of 60°-85° to the longitudinal extension of the casing 2.

5 The injection of composition 5 is performed in some of the perforations by an injection tool 13 as shown in Fig. 2. The injection tool 13 is submerged into the casing 2 and an injection tip 16 is subsequently moved outwards and out of some of the perforations 3 in a radial direction of the casing.

10 To seal off a production zone 1, at least two seals 6, 9 must to be made, one in each end of the production zone 1, and a liner 12 must be inserted covering the perforations 3 from inside the casing and overlapping the first 6 and the second 9 seal. In this way, fluid seeping from the formation is not able to flow along the casing 2 and into other perforations of the casing.

15 Firstly, a first circumferential seal 6 is made at a first position 7 of the casing in one end of the production zone 1 as shown in Figs. 2 and 3. Secondly, a second circumferential seal 9 is made at a second position of the casing in a second opposing end of the production zone 1 as shown in Figs. 4 and 5. As can be seen, the intervening space 4 is filled with composition 5 until a circumferential seal 6, 9 has been created.
20

Fig. 6 shows a cross-section of a casing with a surrounding first 6 and second 9 seal and perforations 3. Subsequent to the injection steps, a liner 12 must be expanded so as to cover the perforations 3 from within the casing 2 and to overlap both the first and the second seal. As shown in Fig. 7, a liner 12 is submerged into the casing 2 and placed outside the perforations 3 by an expansion tool. Then, the liner 12 is expanded until it abuts and is sealed against the inside wall of the casing 2 as shown in Fig. 8. The expanded liner 12 at least partly overlaps each seal 6, 9 so that the sealing arrangement – i.e. the first 6 and the second 9 seal, the expanded
25 liner 12, and the intermediate casing wall – hinders a fluid connection between the production zone 1 and the inside of the casing 2.
30

The perforations 3 through which the composition 5 has been injected may be filled with composition 5 during the expansion process of the composition 5. However,
35 due to the fluid pressure from the production zone 1, it is sometimes recommendable that the liner 12 also overlaps the perforations through which the composition 5 has been injected, as shown in Fig. 8.

The liner 12 may be expanded in many ways using a variety of expansion tools in addition to the one shown in Fig. 7. Furthermore, the liner 12 may be a tube of an expandable material such as metal. In another embodiment, the liner 12 may in have circumferential grooves with a sealing ring, such as an O-ring.

5

Occasionally, the production zone 1 extends beyond the extension of the perforations 3. In this case, new holes have to be made before injecting the composition 5. Alternatively, a third seal 15 can be placed at a distance between the sealing arrangement and the new perforations facing the new production zone 14 in order to
10 hinder fluid seeping from the former production zone 1 along the outside of the casing 2 and to the new production zone 14 as shown in Fig. 9.

Additionally, the casing 2 may have several perforation sections within the range of the same production zone 1. In that case each perforation section has to be sealed
15 off by a first 6 and a second 9 seal followed by an expanded liner 12 within the casing 2.

In some events, it may not be possible for one liner 12 to overlap both the first 6 and the second 9 seal since it may not be possible to expand a sufficiently long
20 liner 12 or the casing may bend, demanding a use of several liners in order to fit the bend of the casing. In these events, intermediate seals can be made between the first 6 and the second 9 seal, and liners 12 can be expanded so that each liner at least partly covers two adjacent seals.

25 Furthermore, the perforations 3 may be too small for the injection tip 16 to inject the composition 5 into the intervening space 4. In this event, the perforations 3 need to be widened before the injections step can take place.

As shown in Fig. 10, the sealing method may also be used for sealing a leak 21 in a
30 production casing 2 which is partly surrounded by an intermediate casing 20. The intermediate casing 20 is partly surrounded by a surface casing 17, which again is partly surrounded by a conductor pipe 18. The production casing 2 is fixated in the intermediate casing 20 by means of packers 19, and the intermediate casing 20 is fixated within the surface casing 17 by means of cement as is the surface casing 17
35 to the conductor pipe 18.

The first 6 and second 9 circumferential seals are made in the same manner as mentioned above followed by insertion of a liner 12. The first 6 and the second 9

seals are placed on each side of the leak 21 in the casing 2, and the liner 12 overlaps both of the seals 6, 9 and the leak 21 as shown in Fig. 10.

5 The injection tool 13 has at least one chamber comprising the composition 5 to be injected. In one embodiment, the tool 13 has one chamber with composition 5 and, in another embodiment, the tool may have two chambers, each comprising enough composition to make one circumferential seal. Due to the fact that the composition 5 expands subsequent to being injected into the intervening space 4, the chamber does not need to be of the same volume as the final seal or seals.

10

In one embodiment, the injection tool may be part of a system which also comprises a drilling tool able to drill holes in the casing 2 prior to the injection steps. The drilling tool may also be a separate tool which is submerged into the casing 2 prior to the injection tool 13 so that the drilling operation and the injection operation is performed in two separate runs. Following the injection step, the injection tool 13 is retracted from the casing 2 and, subsequently, an expansion tool for expanding the liner 12 is submerged into the casing.

20 The composition 5 to be injected may be any kind of expandable composition. In one embodiment, the composition is thus a two-part glue where the parts when mixed expand and harden. In another embodiment, the composition 5 expands when subjected to the water in the emulsified fluid seeping from the formation and/or when subjected to the heat of the fluid. Additionally, the composition 5 may be of the type which does not expand, but only hardens when subjected to the water in the emulsified fluid or the heat of the fluid seeping from the formation. Thus, 25 the composition 5 may be a two-component polyurethane glue or another suitable polymer able to harden in one of the mentioned ways.

30 In one embodiment, a network is comprised in the composition after injection. The composition can be in the form of a compound or in the form of separate units.

When the composition is in form of a compound, the compound is injected in its liquid phase, and while the compound hardens it needs to be held in place in a certain position, which is accomplished by a network.

35 In one embodiment, the composition 5 is melted before being injected and hardens/stiffens when injected. In another embodiment, the composition 5 consists of one base part in its liquid form, or at least in a partly liquid form, which is mixed with another part such as a hardener prior to being injected in order to make the

compound harden. By a partly liquid form is meant an injectable base part which is partly liquid and partly solid.

In another embodiment, the composition 5 expands or swells while hardening. The
5 composition 5 may be any kind of expandable or swellable composition. Thus, the composition 5 may be a two-part polyurethane glue, or another suitable polymer able to harden in one of the ways mentioned above.

Furthermore, the composition 5 may comprise a resin and a catalyst reacting under
10 pressure whereby the composition hardens. Thus, the composition 5 reacts when exposed to a certain pressure which may be applied by the injection tool 13 just before injecting the composition. Alternatively, the reaction may come from the high pressure within the borehole 22 when the composition has been injected.

15 In another embodiment, the composition comprises separate units in the form of balls, beads, or the like objects. Each unit has an external layer of a compound enabling the units to paste together after injection and thereby form a network.

The sealing arrangement 100 comprises a composition 5 which is in its liquid or
20 partially liquid phase when injected. In this embodiment, the network 30 is a plurality of interlacing lines 29 in the form of a woven wire, a wire netting, a web, a grid, a lattice 27, a grating, or the like networks. The network 30 is compressed during storage in the injection tool 13 and is discharged either before the composition 5 or simultaneously with the composition.

25

The network 30 can be made of coiled metal wires 28 or threads which are compressed in the tool 13 by stacking the windings of each coiled wire 28 onto each other forming a coil or a helically spring. The network 30 can also be made of wire, core, polymer thread, glass fibre threads, or a like elongated component being tangled up into a network during injection.
30

In another embodiment, the network 30 is an expandable lattice 27 in which first interlacing lines 29 cross second interlacing lines 29, the interlacing lines being twisted so that each first interlacing lines abut other adjacent first interlacing lines
35 and each second interlacing lines abut other adjacent second interlacing lines. Thus, the compressed lattice 27 has the form of an elongated member and the expanded lattice has the form of a sheet. In yet another embodiment, the network 30 is in the form of a grid made of a slit plate which, when expanded, forms a perfo-

rated plate. Such networks 30 can be discharged prior to the injection of the composition 5 in order to retain the composition and form the sealing arrangement 100.

- The network 30 can also be comprised in the composition 5 and be formed during
5 hardening of the composition. In this case, the network 30 is formed from elements pasting together during hardening of the injected composition 5. The elements may be in the form of beads or small balls 25 or in the form of fibres 36 or threads. The elements may be made from ceramics, polymer, glass fibre, cellulose, or pulpwood.
- 10 The composition 5 may be injected so that it hits the inside wall of the borehole 22. In order to hold the composition 5 in position outside the leak 21 in the casing 2, a network 30 is discharged together with the composition. As mentioned above, the network 30 can also be discharged prior to the injection of the composition 5. The network 30 helps the composition bridge the gap between the outside of the leak in
15 the casing 2 and the inside wall of the borehole 22.

- In some embodiments, the composition 5 is a compound comprising cement, polymer, synthetic rubber, natural rubber, and/or silicone. When using rubber or silicone, the compound is typically melted prior to the injection. The melting process is
20 performed in the injection tool 13 or prior to loading the compound into the tool.

- The polymer may be any suitable elastomer or a thermoplastic polymer. The elastomer may comprise nitrile rubber (NBR), hydrogenated nitrile rubber (HNBR), carboxyl nitrile rubber (XNBR), silicone rubber, ethylene-propylene-diene copolymer
25 (EPDM), fluoroelastomer (FKM, FEPM), and perfluoroelastomer (FFKM), or other suitable polymers. Thermoplastic polymer may comprise Teflon, polyetheretherketone, polypropylene, polystyrene, and polyphenylene sulphide, or other suitable polymers.

- 30 In order to absorb water from the emulsified fluid seeping from the formation, the polymer may comprise any water-soluble polymer able to absorb water, thus enabling a hardening of the compound. Such water-soluble polymer may be methylcellulose, cellulose acetate phthalate, and hydroxypropyl methylcellulose polymers, poly (ethylene oxide) polymers, guar and its derivatives, polyacrylamide, polyvinylpyrrolidone, polyacrylic acid, polyvinylpyrrolidone, oligo maleinate copolymers,
35 oligo maleinate oligomers, allyl maleate oligomers, silicon-based materials, and fluoro-silicone based materials.

As mentioned, the compound can comprise a hardener or a curing agent when the compound is stored in a two-part form and mixed just before injection of the compound. In order for the elements to paste together, the compound may comprise a binding agent. The binding agent can also be added to the composition 5 in order
5 for the compound to bind to the metal wire or other elongated components. The process of stiffening or hardening must take place immediately after the composition 5 has been injected so that the highly pressurised fluid in the well does not interfere with the forming of a sealing arrangement 100 in a predetermined position, and the compound may therefore be provided with an accelerator.

10

When using a network 30 of metal – such as coiled wire 28, threads, woven wire, wire netting, a web, a grid, a lattice 27, or a grating – the network can be used to provide heat to the compound thereby accelerating the hardening process. Electricity is led through the metal and transformed into heat, which again is ejected into
15 the compound from within the compound.

As mentioned, the composition 5 may comprise a plurality of separate units each having a core enclosed by a compound. The compound may be the same as mentioned above and enable the units to paste together after being ejected into the intervening space. Thus, the network is made from the separate units pasting together during hardening of the compound and thereby forming the network.
20

The composition may comprise a plurality of separate units. Each unit has a core 31 enclosed within an intermediate substance 32 which again is enclosed within an external layer 33 of compound. When ejecting the units into the intervening space to make a circumferential seal, the units paste together as a seal in that the compound layer of one unit pastes to the compound layer of another unit. In this embodiment, the compound becomes sticky when reacting with the water in the space.
25

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In one embodiment, the elements, the core, or the intermediate substance are made from ceramics, metal, polymer, glass fibre, cellulose, or pulpwood.

In another embodiment, the core of each separate unit is made of a magnetic material making the separate units paste together. Thus, the units will be drawn towards one another when injected and since the casing through which the composition is injected is of metal, the units will also stick to the casing. In this way, a leak is easily sealed without filling up the whole intervening space.
35

In the event that the system is not submergible all the way into the casing 2, a downhole tractor can be used to push the system all the way into position in the well. A downhole tool is any kind of driving tool capable of pushing or pulling tools in a well downhole, such as a Well Tractor®.

Claims

1. Sealing method for sealing off a leak in a casing (2) or for sealing off a production zone (1) where the casing (2) having a circumference and perforations (3) is
5 situated in a borehole downhole, but with a distance to an inner wall of the borehole, creating an intervening space (4) there between, comprising the steps of:
- injecting a composition (5) for making a first circumferential seal (6) in the intervening space (4) at a first position (7) of the casing in one end of the production zone through holes situated along a first intersecting line (8) where a first
10 plane intersects the circumference of the casing,
 - filling the intervening space at a first position in a radial direction of the casing,
 - injecting a composition (5) for making a second circumferential seal (9) in the intervening space (4) at a second position (10) of the casing in another end of
15 the production zone through holes situated along a second intersecting line (11) where a second plane intersects the circumference of the casing,
 - filling the intervening space at a second position in a radial direction of the casing,
 - inserting a liner (12) into the casing (2) covering the holes (3) and extending
20 between and at least partly covering both the first and the second circumferential seal, and
 - expanding the liner until the liner is pressing against the casing whereby the liner together with the first and the second circumferential seal isolate the production zone.
- 25
2. Sealing method according to claim 1, wherein the composition comprises a compound which is able to harden, expand, swell or paste once injected into the intervening space.
3. Sealing method according to claim 1 or 2, wherein the holes through which the
30 composition is injected are positioned directly opposite each other in the casing.
4. Sealing method according to any one of claims 1-3, wherein the holes are some of the perforations.
- 35 5. Sealing method according to any one of claims 1-4, further comprising the step of making the holes prior to at least one of the injection steps.

6. Sealing method according to claim 5, comprising a third injection step where composition is injected for making a third circumferential seal (15) in the intervening space (4) through holes made at a distance from the perforations.

5 7. Sealing method according to any of the preceding claims, further comprising the step of making new perforations in the casing for letting oil fluid flow into the casing from a new and second production zone (14).

8. Sealing method according to any of the preceding claims, wherein the composition is expanded for making the circumferential seals.

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9. Sealing method according to any of the preceding claims, comprising a further step of injecting an intermediate circumferential seal between the first and the second circumferential seal.

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10. Sealing arrangement for sealing off a leak in a casing or for sealing off a production zone where the casing having a circumference and perforations is situated in a borehole downhole, but with a distance to an inner wall of borehole, creating an intervening space between casing and the borehole, comprising:

20 - a first circumferential seal of composition in the intervening space at a first position of the casing in a first end of the production zone,

- a second circumferential seal of composition in the intervening space at a second position of the casing in a second end of the production zone, and

25 - an expanded liner in between the first and the second circumferential seal, for isolation of the production zone.

1/6

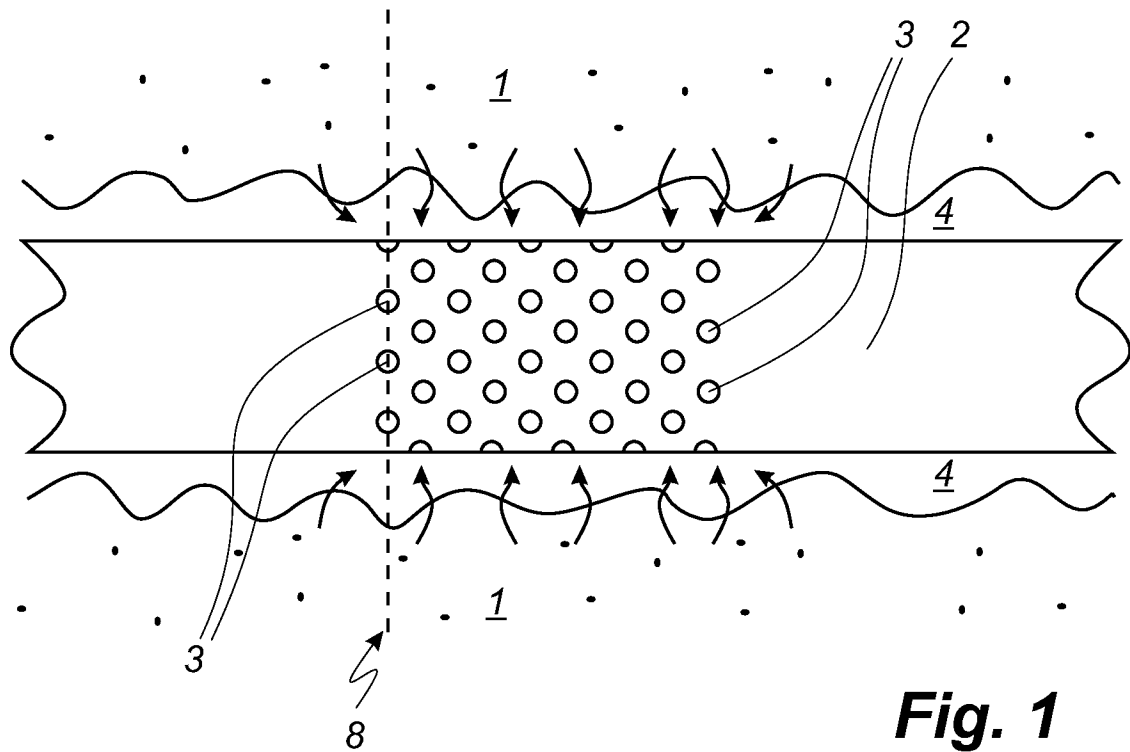


Fig. 1

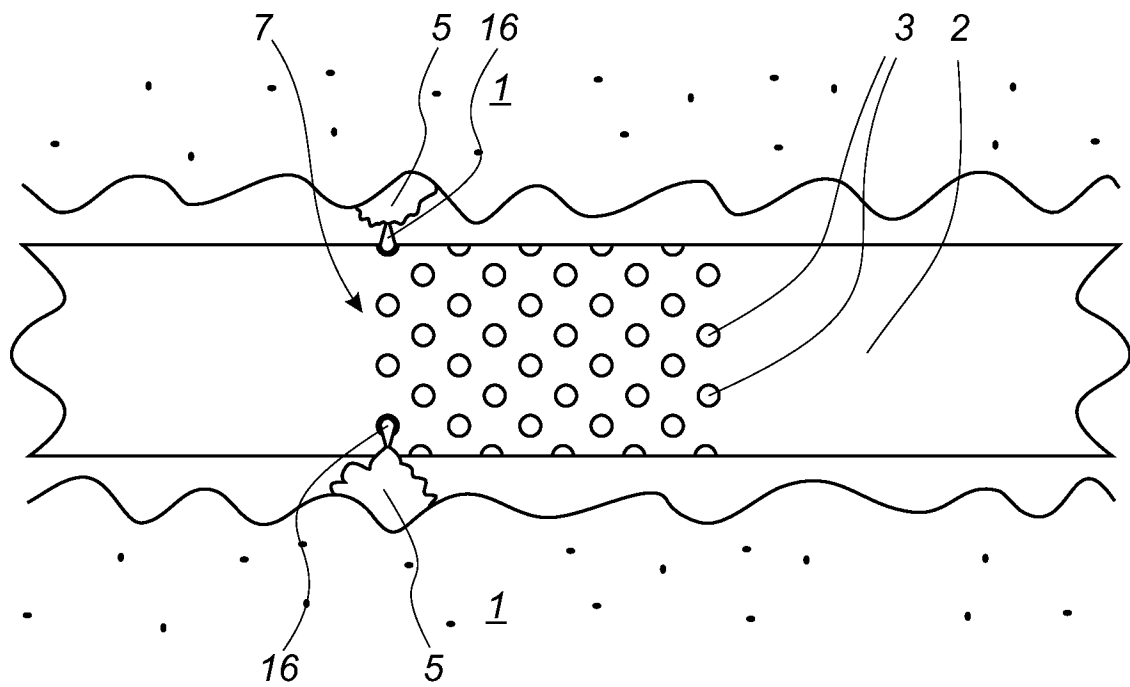


Fig. 2

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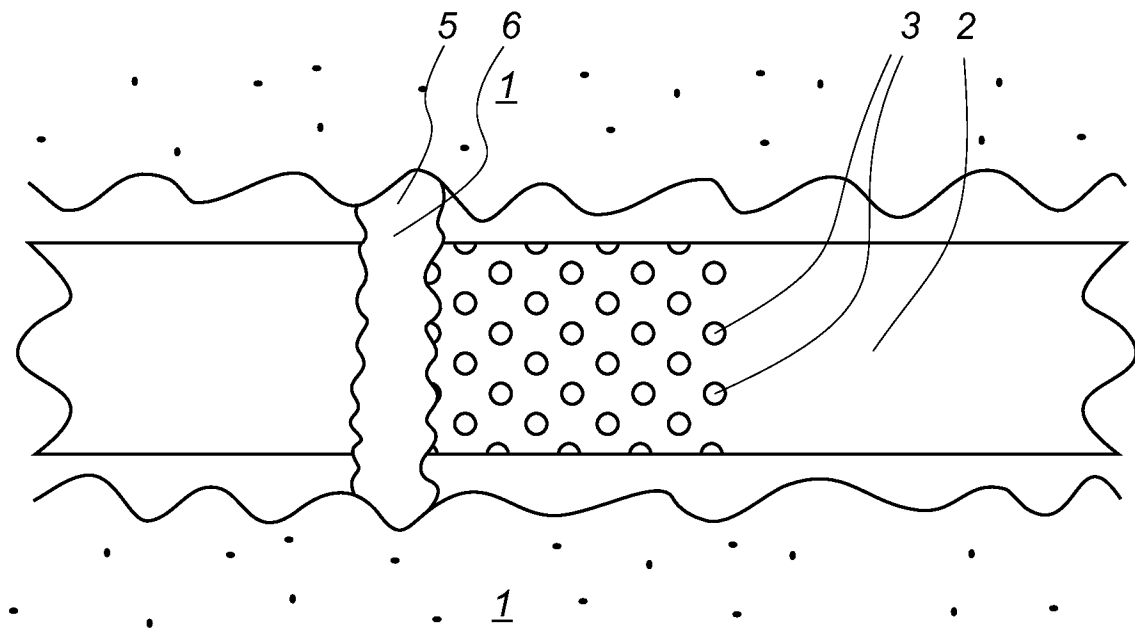


Fig. 3

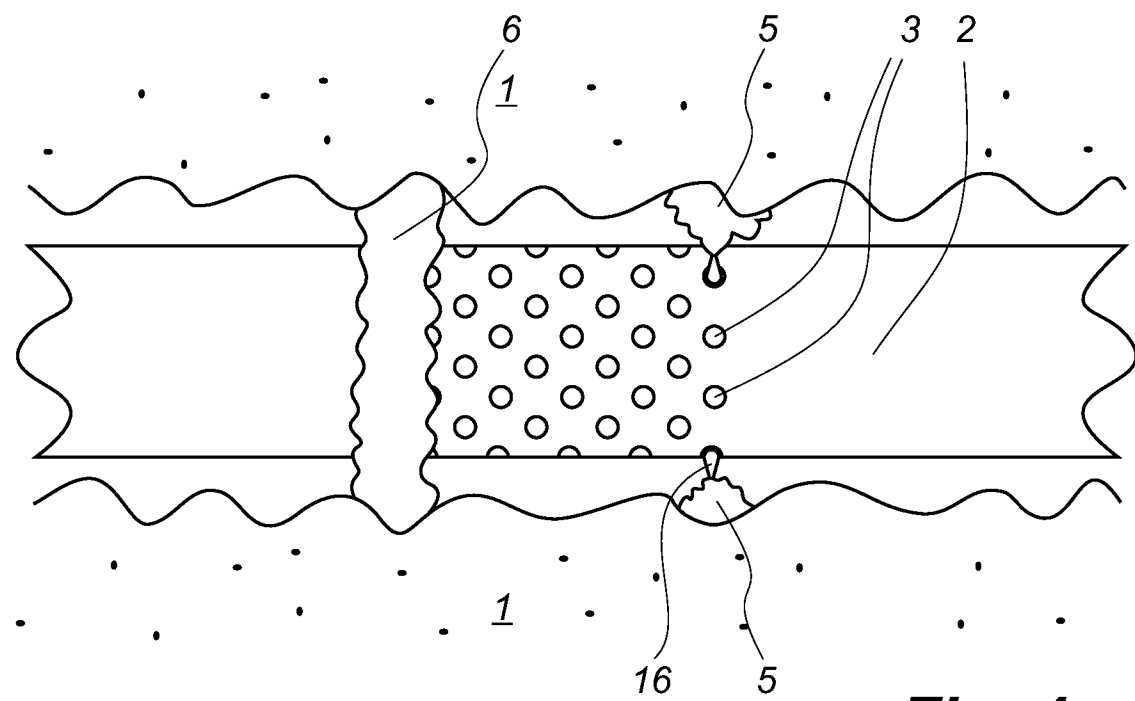


Fig. 4

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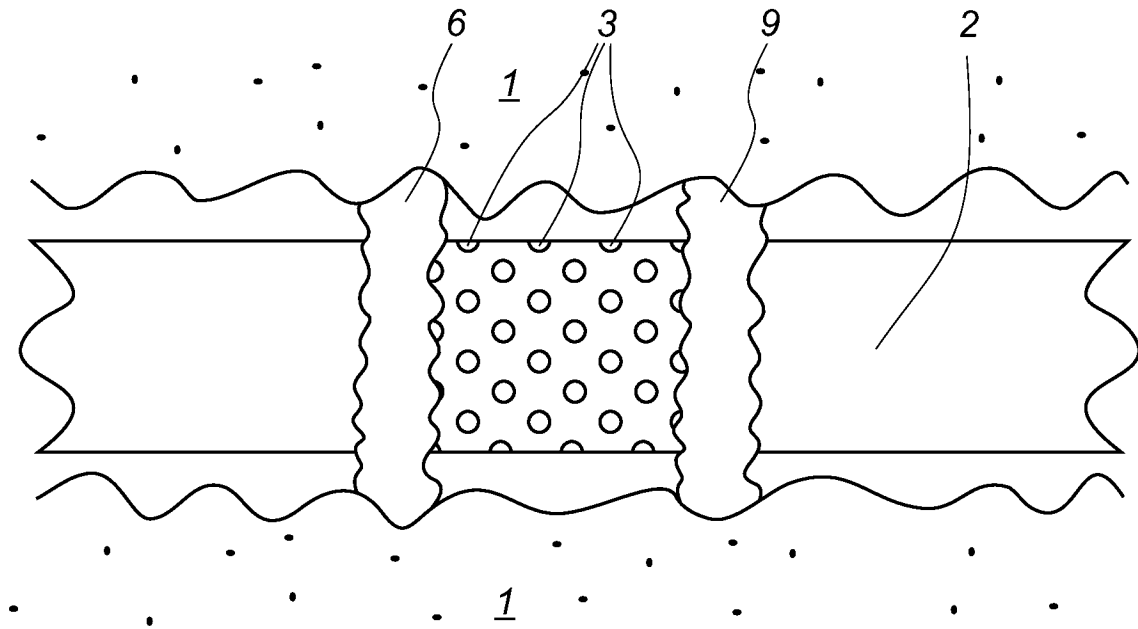


Fig. 5

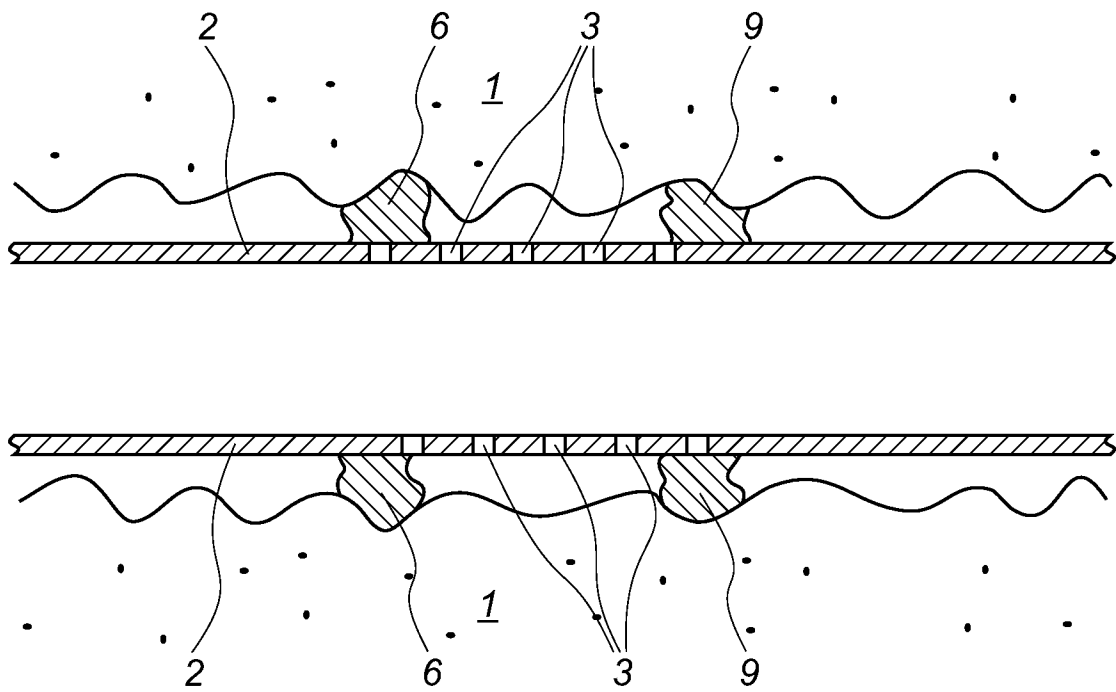


Fig. 6

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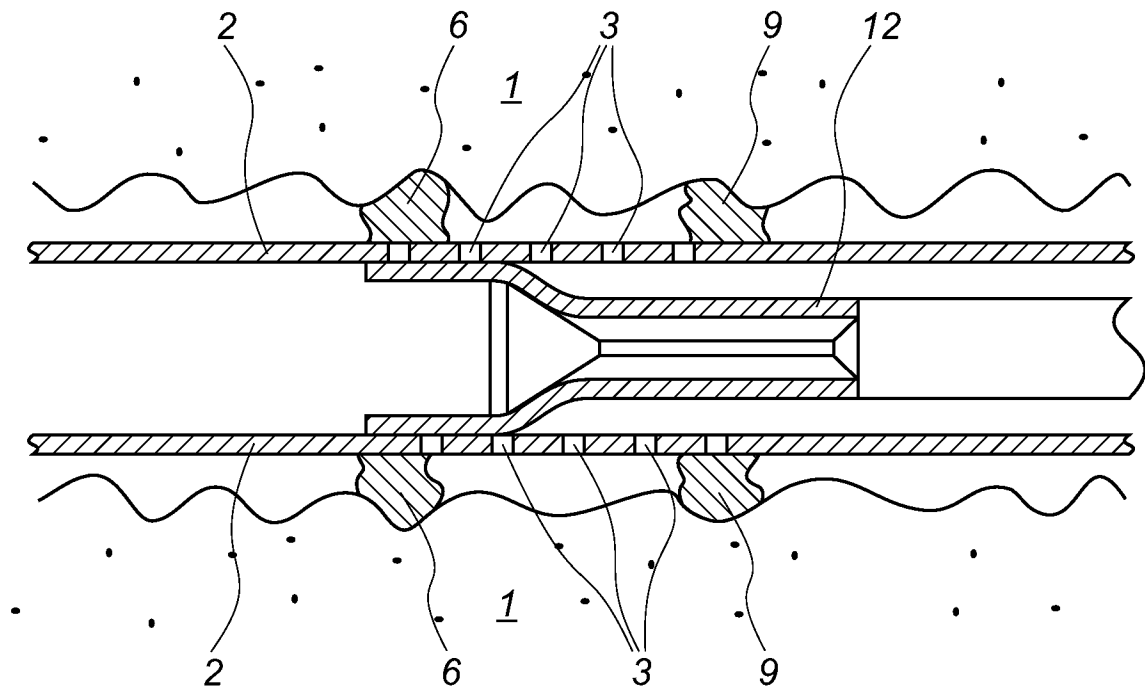


Fig. 7

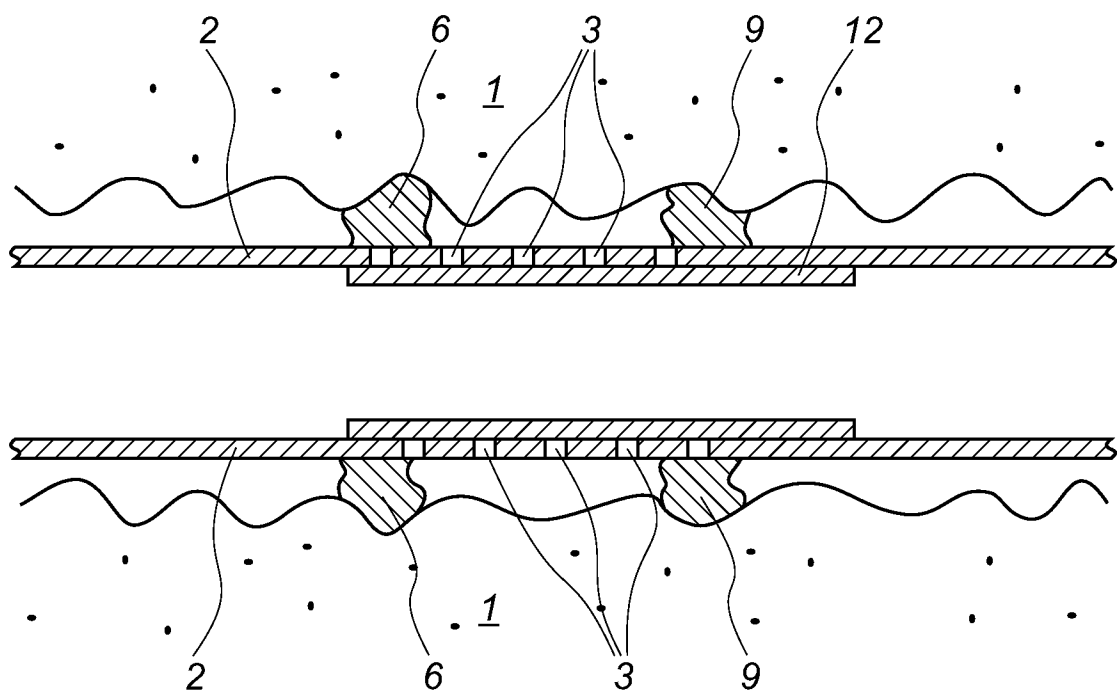


Fig. 8

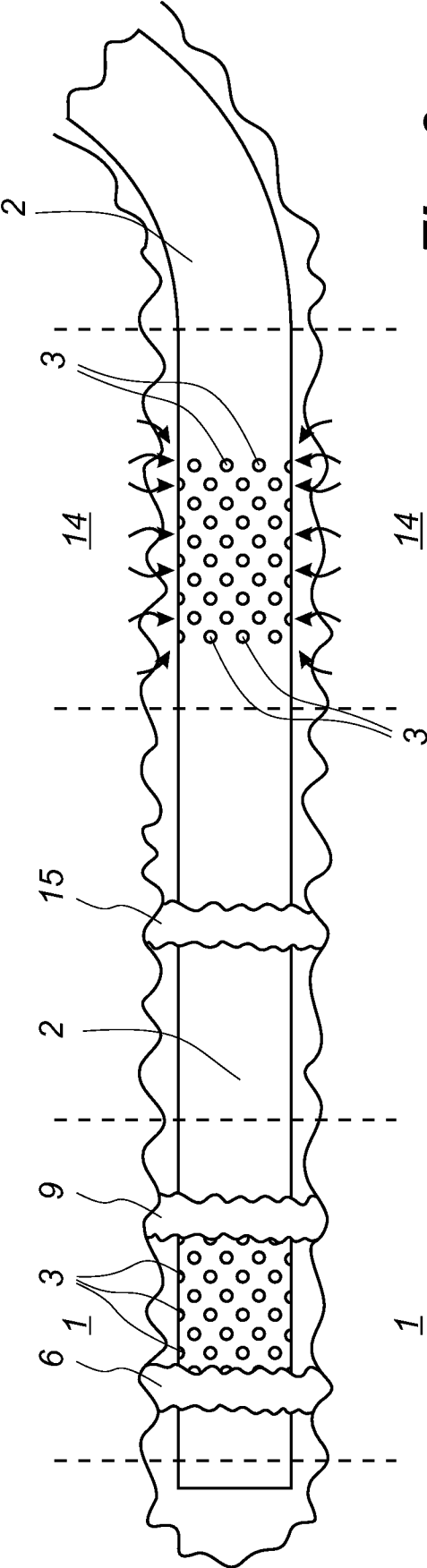


Fig. 9

6/6

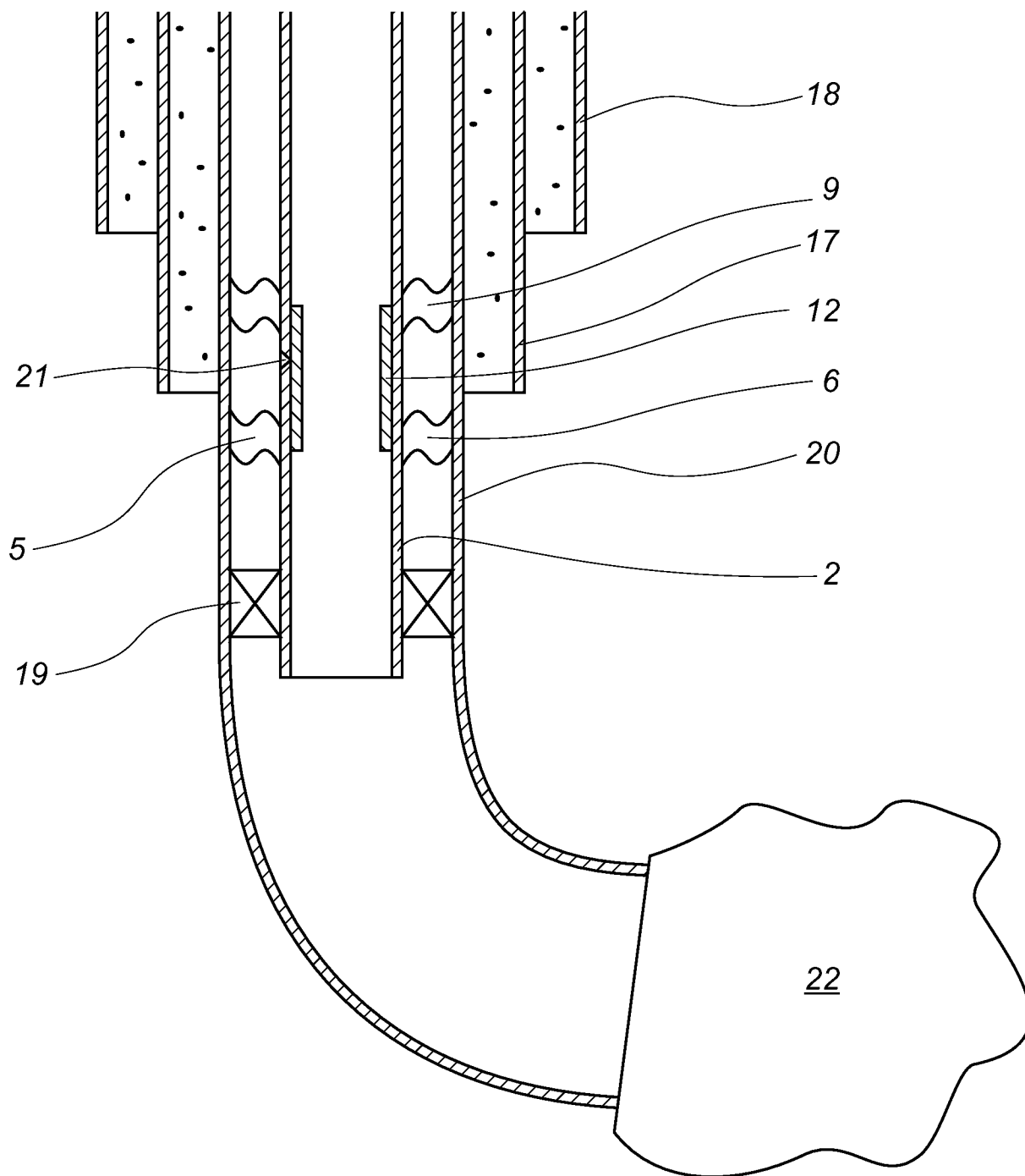


Fig. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2009/058847

A. CLASSIFICATION OF SUBJECT MATTER
INV. E21B43/10

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

B. FIELDS SEARCHED

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

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/183397 A1 (HOFFMAN COREY E [US]) 2 October 2003 (2003-10-02) paragraph [0055]; figures 11a,11b the whole document	10
X	US 3 354 955 A (BERRY WILLIAM B) 28 November 1967 (1967-11-28) the whole document	10
A	WO 2005/088064 A (HALLIBURTON ENERGY SERV INC [US]) 22 September 2005 (2005-09-22) fluids may be injected directly into the annulus between tubing and a borehole wall to form an annular isolator by itself paragraphs [0125], [0126], [0143]; figure 35	10

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

☒ See patent family annex.

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Date of the actual completion of the international search

12 August 2009

Date of mailing of the international search report

19/08/2009

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van Berlo, André

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2009/058847

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2003/234102 A1 (BROTHERS LANCE E [US] ET AL) 25 December 2003 (2003-12-25) the whole document -----	1, 10
A	US 2007/119597 A1 (MCHARDY COLIN [GB] ET AL) 31 May 2007 (2007-05-31) figures 15-22 -----	10

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2009/058847

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