(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 074 939 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
19.10.2022 Bulletin 2022/42

(21) Application number: **21168969.0**

(22) Date of filing: **16.04.2021**

(51) International Patent Classification (IPC):
E21B 33/127 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E21B 33/1277

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(71) Applicant: **Welltec Oilfield Solutions AG**
6300 Zug (CH)

(72) Inventor: **VASQUES, Ricardo Reves**
6300 Zug (CH)

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

(54) **ANNULAR BARRIER AND DOWNHOLE SYSTEM**

(57) The present invention relates to an annular barrier for providing isolation of a zone in a well having an isolation layer of less than 5 metres, comprising a tubular metal part configured to be mounted as part of a well tubular metal structure, the tubular metal part having an outer face, an opening and an axial extension along the well tubular metal structure, a first expandable metal sleeve surrounding the tubular metal part, the first expandable metal sleeve having a first thickness, a first end and a second end, the first end of the expandable metal sleeve being connected with the outer face of the tubular metal part, a second expandable metal sleeve surrounding the tubular metal part, the second expandable metal sleeve having the same thickness as the first expandable metal sleeve, the second expandable metal sleeve having a first end connected with the outer face of the tubular metal part and a second end, and wherein the annular barrier comprises a first connecting sleeve having a second thickness being greater than the first thickness, the first connecting sleeve comprises a first sleeve end connected to the second end of the first expandable metal sleeve and a second sleeve end connected with the second end of the second expandable metal sleeve, and the annular barrier comprises an annular space defined between the tubular metal part, the first connecting sleeve and the expandable metal sleeves. The invention also relates to a downhole system comprising a plurality of the annular barriers and the well tubular metal structure.

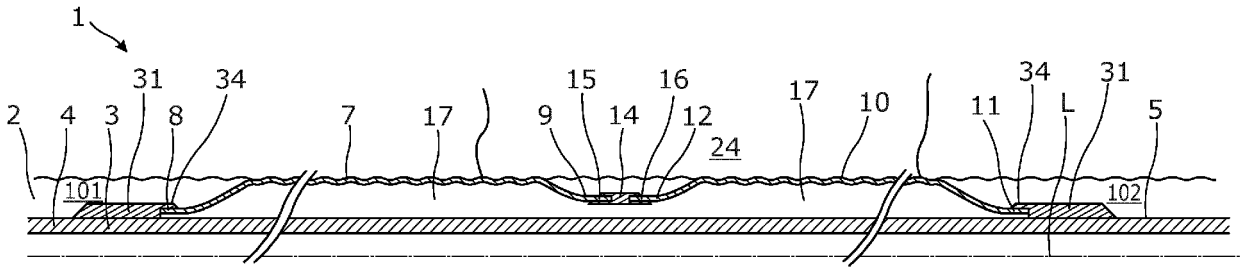

Fig. 2

EP 4 074 939 A1

Description

[0001] The present invention relates to an annular barrier for providing isolation of a zone in a well having an isolation layer of less than 5 metres. The invention also relates to a downhole system comprising a plurality of such annular barriers and a well tubular metal structure.

[0002] Annular barriers are used downhole for providing isolation of one zone from another in an annulus in a borehole of a well between a well tubular metal structure and the borehole wall or another well tubular metal structure. When expanding annular barriers, it is important that the annular barriers are expanded to abut the inner face of the borehole or another well tubular metal structure to provide proper zonal isolation. Furthermore, the annular barrier needs to be expanded opposite the isolation layer between two zones in order to provide proper isolation of one zone from the other zone. In some boreholes, the isolation layer between two zones is very thin, e.g. only a few metres. In these wells, there is a need for a longer annular barrier so that the annular barrier is able to overlap the isolation layer since, when running the completion in hole, the precision may be up to 5-10 metres.

[0003] Annular barriers may have an expandable metal sleeve to be expanded opposite the isolation layer, and expandable metal sleeves having a length of more than 2 metres are difficult and expensive to make.

[0004] It is an object of the present invention to wholly or partly overcome the above disadvantages and drawbacks of the prior art. More specifically, it is an object to provide an improved annular barrier which is long enough to be set in wells with thin isolation layers while still being relatively easy to make without substantially increasing manufacturing costs as compared to annular barriers having 1-2 metre long expandable metal sleeves.

[0005] The above objects, together with numerous other objects, advantages and features, which will become evident from the below description, are accomplished by a solution in accordance with the present invention by an annular barrier for providing isolation of a zone in a well having an isolation layer of less than 5 metres, comprising:

- a tubular metal part configured to be mounted as part of a well tubular metal structure, the tubular metal part having an outer face, an opening and an axial extension along the well tubular metal structure,
- a first expandable metal sleeve surrounding the tubular metal part, the first expandable metal sleeve having a first thickness, a first end and a second end, the first end of the expandable metal sleeve being connected with the outer face of the tubular metal part,
- a second expandable metal sleeve surrounding the tubular metal part, the second expandable metal sleeve having the same thickness as the first expandable metal sleeve, the second expandable metal sleeve having a first end connected with the outer face of the tubular metal part and a second end, and wherein the annular barrier comprises a first connecting sleeve having a second thickness being greater than the first thickness, the first connecting sleeve comprises a first sleeve end connected to the second end of the first expandable metal sleeve and a second sleeve end connected with the second end of the second expandable metal sleeve, and the annular barrier comprises an annular space defined between the tubular metal part, the first connecting sleeve and the expandable metal sleeves.

[0006] By having an annular barrier with two expandable metal sleeves and a thicker connecting sleeve, the expandable metal sleeves can be made having a length of 1-2 metres, which means that the annular barrier is easier and less costly to make than an annular barrier having one expandable metal sleeve with a length of 4 metres. The connecting sleeve is welded to the end of each expandable metal sleeve and in this way forms a common expandable metal sleeve. When expanding the expandable metal sleeves, the first and second expandable metal sleeves expand more than the connecting sleeve, and in this way the welded connections between the connecting sleeve and the expandable metal sleeves are only slightly expanded, and the welded connections are less likely to break compared to a solution where the expandable metal sleeves are directly connected by welding. The connecting sleeve is thicker than the expandable metal sleeves, ensuring that the welded connections between the connecting sleeve and the expandable metal sleeves are not expanded to the same extent as a middle part of the expandable metal sleeves. Thus, the modular sleeve of the annular barrier can be made as long as required, and even though the isolation layer is merely 2 metres thick and the precision of the completion procedure only results in a positioning of the annular barrier within 6 metres, part of the annular barrier is still overlapping the isolation layer, and sufficient isolation of the zone is obtained.

[0007] Moreover, the first sleeve end may be welded to the second end of the first expandable metal sleeve, and the second sleeve end may be welded to the second end of the second expandable metal sleeve.

[0008] Furthermore, the annular barrier may also comprise a third expandable metal sleeve surrounding the tubular metal part, the third expandable metal sleeve having the same thickness as the first expandable metal sleeve, the third expandable metal sleeve having a first end connected with the second sleeve end of the first connecting sleeve and a second end, and the annular barrier further comprising a second connecting sleeve having the second thickness, the second connecting sleeve comprising a first sleeve end connected with the second end of the third expandable metal sleeve and a second sleeve end connected with the second end of the second expandable metal sleeve so that the second

sleeve end is connected with the second end of the second expandable metal sleeve by means of the third expandable metal sleeve and the second connecting sleeve, and the annular space being defined between the tubular metal part, the first and second connecting sleeve and the expandable metal sleeves.

[0009] Also, the annular barrier may further comprise a fourth expandable metal sleeve surrounding the tubular metal part, the fourth expandable metal sleeve having the same thickness as the first expandable metal sleeve, the fourth expandable metal sleeve having a first end connected with the second sleeve end of the second connecting sleeve and a second end, and a third connecting sleeve having the second thickness, the third connecting sleeve comprising a first sleeve end connected with the second end of the third expandable metal sleeve and a second sleeve end connected with the second end of the second expandable metal sleeve so that the second sleeve end is connected with the second end of the second expandable metal sleeve by means of the third and fourth expandable metal sleeves and the second and third connecting sleeves, and the annular space being defined between the tubular metal part, the connecting sleeves and the expandable metal sleeves.

[0010] In addition, the annular barrier may further comprise a tube extending through the annular space, through the connection of the first end of the first expandable metal sleeve to the tubular metal part and through the connection of the second end of the second expandable metal sleeve to the tubular metal part, providing a flow channel through the annular barrier in an expanded condition.

[0011] Further, the annular barrier may also comprise at least one tubular connection part for connecting the end of the expandable metal sleeve to the outer face of the tubular metal part.

[0012] Moreover, the tubular connection part may comprise a projecting flange overlapping the end of the expandable metal sleeve.

[0013] Furthermore, the annular barrier may also comprise a valve assembly fluidly connected to the opening and the annular space.

[0014] Also the first and second sleeve ends of the connecting sleeve may comprise a projecting sleeve flange, each projecting sleeve flange overlapping one of the ends of the expandable metal sleeve.

[0015] In addition, the first ends of the first and second expandable metal sleeves may have an increased thickness for connecting to the tubular metal part. In that way, there is no need for separate connection parts.

[0016] Further, the second thickness may be at least 5% thicker than the first thickness, preferably at least 10% thicker than the first thickness, and more preferably at least 15% thicker than the first thickness.

[0017] Moreover, the first expandable metal sleeve and the second expandable metal sleeve may have a length along the axial extension being at least 50% longer than a length of the connecting sleeve, preferably at least 60% longer than a length of the connecting sleeve, and more preferably 75% longer than a length of the connecting sleeve.

[0018] Furthermore, the annular barrier may also comprise at least one sealing element arranged on an outer face of the expandable metal sleeves.

[0019] Also, one of the first ends of the first and/or second expandable metal sleeves may be welded to the outer face of the tubular metal part.

[0020] In addition, the invention relates to a downhole system comprising a plurality of the annular barriers and the well tubular metal structure.

[0021] Finally, the downhole system may further comprise at least one inflow valve between two annular barriers.

[0022] The invention and its many advantages will be described in more detail below with reference to the accompanying schematic drawings, which for the purpose of illustration show some non-limiting embodiments and in which:

Fig. 1 shows a cross-sectional view of an annular barrier having two expandable metal sleeves and one connecting sleeve in its unexpanded condition,

Fig. 2 shows a cross-sectional view of another annular barrier having two expandable metal sleeves and one connecting sleeve in its expanded condition,

Fig. 3 shows a cross-sectional view of another annular barrier having three expandable metal sleeves and two connecting sleeves in their unexpanded condition,

Fig. 4 shows a cross-sectional view of another annular barrier having four expandable metal sleeves and three connecting sleeves in their unexpanded condition,

Fig. 5 shows a cross-sectional view of another annular barrier having three expandable metal sleeves and two connecting sleeves in their unexpanded condition, and

Fig. 6 shows a cross-sectional view of a downhole system having two annular barriers.

[0023] All the figures are highly schematic and not necessarily to scale, and they show only those parts which are necessary in order to elucidate the invention, other parts being omitted or merely suggested.

[0024] Fig. 1 shows an annular barrier 1 for providing isolation of a zone in a well 2 having a thin isolation layer 24 of less than 5 metres. The annular barrier comprises a tubular metal part 3 mounted as part of a well tubular metal structure 4. The tubular metal part 3 has an outer face 5, an opening 6 and an axial extension L along the well tubular metal structure 4. The annular barrier 1 com-

prises a first expandable metal sleeve 7 surrounding the tubular metal part 3. The first expandable metal sleeve 7 has a first thickness t_1, a first end 8 and a second end 9. The first end 8 of the expandable metal sleeve 7 is connected with the outer face 5 of the tubular metal part 3. The annular barrier 1 further comprises a second expandable metal sleeve 10 surrounding the tubular metal part 3. The second expandable metal sleeve 10 has the same thickness as the first expandable metal sleeve 7. The second expandable metal sleeve 10 has a first end 11 connected with the outer face 5 of the tubular metal part 3 and a second end 12. The annular barrier 1 comprises a first connecting sleeve 14 having a second thickness t_2 being greater than the first thickness ti. The first connecting sleeve 14 comprises a first sleeve end 15 connected to the second end 9 of the first expandable metal sleeve 7 and a second sleeve end 16 connected with the second end 12 of the second expandable metal sleeve 10. The annular barrier 1 further comprises an annular space 17 defined between the tubular metal part 3, the first connecting sleeve 14 and the expandable metal sleeves 7, 10.

[0025] By having an annular barrier with two expandable metal sleeves 7, 10 and a thicker connecting sleeve 14, the expandable metal sleeves 7, 10 can be made having a length of 1-2 metres, which means that the annular barrier is easier and less costly to make than an annular barrier having one expandable metal sleeve with a length of 4 metres. The connecting sleeve 14 is welded to the ends of each expandable metal sleeve 7, 10 and in this way forms a common expandable metal sleeve. As can be seen in Fig. 2, the first and second expandable metal sleeves 7, 10 expand more than the connecting sleeve 14, and in this way the welded connections between the connecting sleeve 14 and the expandable metal sleeves 7, 10 are only slightly expanded and are less likely to break than if the connecting sleeve was expanded as much as the expandable metal sleeves. The connecting sleeve 14 is thicker than the expandable metal sleeves, ensuring that the welded connections between the connecting sleeve 14 and the expandable metal sleeves 7, 10 are not expanded as much as a middle part of the expandable metal sleeves 7, 10. Thus, the modular sleeve of the annular barrier 1 can be made as long as required, and even though the isolation layer 24 is merely 2 metres thick and the precision of the completion procedure only results in a positioning of the annular barrier 1 within 6 metres, part of the annular barrier 1 is still overlapping the isolation layer 24, and sufficient isolation of the zone is obtained.

[0026] The first sleeve end 15 of the first connecting sleeve 14 is welded to the second end 9 of the first expandable metal sleeve 7, and the second sleeve end 16 of the first connecting sleeve 14 is welded to the second end 12 of the second expandable metal sleeve 10 so as to form one common sleeve. The first ends of the expandable metal sleeves 7, 10 may have an increased thickness and may be crimped onto the tubular metal part 3 or welded to the tubular metal part 3. The opening in the tubular metal part 3 is arranged opposite the annular space 17. The first expandable metal sleeve 7 and the second expandable metal sleeve 10 have the same length along the axial extension, and the first connecting sleeve 14 is arranged in between the expandable metal sleeves 7, 10 and welded to their ends.

[0027] In Fig. 2, the expandable metal sleeves 7, 10 are expanded so that a middle part thereof abuts the wall of the borehole and conforms to its shape. The expanded annular barrier 1 isolates a first zone 101 from a second zone 102. The first ends 8, 11 of the expandable metal sleeves 7, 10 are connected to the outer face 5 of the tubular metal part 3 by means of a tubular connection part 31. Each tubular connection part 31 comprises a projecting flange 34 overlapping the first ends 8, 11 of the expandable metal sleeves 7, 10 so as to limit the free expansion of the ends of the expandable metal sleeves 7, 10 and thereby the connection between the ends of the expandable metal sleeves 7, 10, and the tubular connection parts 31 is not jeopardised, nor is the welded connection broken if welding is used. In Fig. 2, the ends of the expandable metal sleeves engage grooves in the connecting sleeve besides being welded together.

[0028] In Fig. 3, the annular barrier 1 comprises a third expandable metal sleeve 18 surrounding the tubular metal part 3 and arranged between the first expandable metal sleeve 7 and the second expandable metal sleeve 10. The third expandable metal sleeve 18 has the same thickness as the first expandable metal sleeve 7. The third expandable metal sleeve 18 has a first end 19 connected with the second sleeve end 16 of the first connecting sleeve 14 and a second end 20 connected to a second connecting sleeve 21. The second connecting sleeve 21 has the same second thickness as the first connecting sleeve 14. The second connecting sleeve 21 comprises a first sleeve end 22 connected with the second end 20 of the third expandable metal sleeve 18 and a second sleeve end 23 connected with the second end 12 of the second expandable metal sleeve 10 so that the second sleeve end 16 is connected with the second end 12 of the second expandable metal sleeve 10 by means of the third expandable metal sleeve 18 and the second connecting sleeve 21. In this aspect, the annular space 17 is defined between the tubular metal part 3, the first and second connecting sleeves 14, 21 and the expandable metal sleeves 7, 10, 18. By having three expandable metal sleeves 7, 10, 18 of 2 metres connected by means of thicker connecting sleeves, the annular barrier 1 can be made at least 6 metres long in an easy and modularised design only requiring short expandable metal sleeves which are easy to manufacture.

[0029] As can be seen in Fig. 3, the connecting sleeves provide a distance from an inner face 51 of the expandable metal sleeves and the outer face of the tubular metal part since the connecting sleeves have a greater thickness than that of the expandable metal sleeves. In that way, the connecting sleeves support the expandable

metal sleeves so that they do not collapse during submerging the well tubular metal structure into the borehole as the pressure increases down the hole.

[0030] The annular barrier 1 shown in Fig. 3 further comprises a valve assembly 33 fluidly connected to the opening 6 and the annular space 17. The opening 6 is positioned offset from the annular space 17 so as to enter the valve assembly 33 before entering the annular space 17. The valve assembly 33 may have a variety of designs. One aspect of a valve assembly has a first position providing fluid communication between the opening and the annular space and a second position after expansion of the annular barrier where this fluid communication is closed. In another aspect of the valve assembly, the first position is the same, but in the second position fluid communication from the opening is closed and there is fluid communication to the outside of the expanded annular barrier, i.e. to the first zone 101 or the second zone 102. By providing fluid communication between the annular space 17 and one of the zones after expansion, the pressure in the annular space 17 can be equalised with the pressure in the zone so as to avoid collapsing of the annular barrier 1 if the outside pressure increases, and in this way the collapse rating of the annular barrier 1 is increased.

[0031] In Fig. 4, the annular barrier 1 further comprises a fourth expandable metal sleeve 25 surrounding the tubular metal part 3. The fourth expandable metal sleeve 25 has the same first thickness as the first expandable metal sleeve 7. The fourth expandable metal sleeve 25 has a first end 26 connected with the second sleeve end 23 of the second connecting sleeve 21 and a second end 27. The annular barrier 1 also comprises a third connecting sleeve 28 having the same second thickness as the first and second connecting sleeves 14, 21. The third connecting sleeve 28 comprises a first sleeve end 29 connected with the second end 20 of the third expandable metal sleeve 18 and a second sleeve end 30 connected with the second end 12 of the second expandable metal sleeve 10 so that the second sleeve end 16 is connected with the second end 12 of the second expandable metal sleeve 10 by means of the third and fourth expandable metal sleeves 18, 25 and the second and third connecting sleeves 21, 28. The annular space 17 is defined between the tubular metal part 3, the connecting sleeves 14, 21, 28 and the expandable metal sleeves 7, 10, 18, 25. By having four expandable metal sleeves of 2 metres connected by means of three thicker connecting sleeves 14, 21 ,28, the annular barrier 1 can be made at least 8 metres long in an easy and modularised design only requiring short expandable metal sleeves which are easy to manufacture. If the connecting sleeves 14, 21 ,28 are made having a length of 0.5 metres, the length of the annular barrier 1 will be 10 metres, and in this way the annular barrier 1 can be made having the required length to ensure that the isolation layer is sufficiently overlapped.

[0032] Such long annular barriers can also be used to support a porous wall/formation so that the expanded annular barrier supports the wall of the borehole to prevent it from deteriorating, collapsing and interfering with the production as fluid from the zones would then be mixed as the zone isolation is destroyed.

[0033] The connecting sleeves 14, 21, 28 are thicker than the expandable metal sleeves 7, 10, 18, 25, i.e. the second thickness may be at least 5% thicker than the first thickness, preferably at least 10% thicker than the first thickness, and more preferably at least 15% thicker than the first thickness. Furthermore, the expandable metal sleeves 7, 10, 18, 25 are longer than the connecting sleeves 14, 21, 28, and thus the first expandable metal sleeve 7 and the second expandable metal sleeve 10 have a length along the axial extension L being at least 50% longer than a length of the connecting sleeve, preferably at least 60% longer than a length of the connecting sleeve, and more preferably 75% longer than a length of the connecting sleeve.

[0034] In Fig. 4, the annular barrier 1 further comprises a tube 32 extending underneath the common sleeve provided by the expandable metal sleeves 7, 10, 18, 25 welded together with the connecting sleeves 14, 21, 28. The tube 32 extends through the annular space 17, through the connection of the first end 8 of the first expandable metal sleeve 7 to the tubular metal part 3 and through the connection of the second end 12 of the second expandable metal sleeve 10 to the tubular metal part 3. The tube 32 thus provides a flow channel through the annular barrier 1 in an expanded condition. In Fig. 4, the annular barrier 1 has two connection parts 31 connecting the first ends 8, 11 of the first and second expandable metal sleeves 7, 10 to the outer face 5 of the tubular metal part 3, and the tube 32 extends through both connection parts 31. In another aspect of the invention (not shown), the flow through the annular barrier is provided by a thin sleeve arranged between the expandable metal sleeves and the tubular metal part so that the fluid channel is annular as the thin sleeve extends all the way around the tubular metal part, and the fluid channel through the annular barrier is the annular channel between the thin sleeve and the outer face of the tubular metal part.

[0035] The annular barrier 1 of Fig. 5 comprises three expandable metal sleeves 7, 10, 18 connected by welding by means of intermediate connecting sleeves 14, 21. The first and second sleeve ends 15, 16 of each connecting sleeve 14, 21 comprise a projecting sleeve flange 35 overlapping one of the ends of the expandable metal sleeve. Thereby, the expandable metal sleeves 7, 10, 18 are prevented from expanding freely in the same way as the projecting flange 34 of the connection parts 31, and in this way the welded connections are protected during the expansion of the expandable metal sleeves 7, 10, 18 so that the welded connections do not break during expansion. The annular barrier 1 further comprises some sealing elements 45 arranged on the outer face 46 of the expandable metal sleeves 7, 10, 18 in order to increase the isolation ability of the annular barrier 1.

[0036] In Fig. 6, a downhole system 100 comprising a plurality of the annular barriers 1 and the well tubular metal structure 4 is shown. In order to isolate a zone, two annular barriers 1 are needed. The downhole system 100 further comprises at least one inflow valve between two annular barriers 1 in order to let formation fluid into the well tubular metal structure 4 in a controlled manner.

[0037] The annular barrier 1 is expanded by means of pressurised fluid let into the opening and further into the annular space in order to expand the expandable metal sleeve 7, 10, 18, 25 to abut the wall of the borehole. The pressurised fluid is generated either by a pump at the surface pumping fluid down some tubing/well tubular metal structure 4 or by a pump in a tool which isolates a part of the well tubular metal structure 4 opposite the opening.

[0038] By "fluid" or "well fluid" is meant any kind of fluid that may be present in oil or gas wells downhole, such as natural gas, oil, oil mud, crude oil, water, etc. By "gas" is meant any kind of gas composition present in a well, completion or open hole, and by "oil" is meant any kind of oil composition, such as crude oil, an oil-containing fluid, etc. Gas, oil and water fluids may thus all comprise other elements or substances than gas, oil and/or water, respectively.

[0039] By "casing" or "well tubular metal structure" is meant any kind of pipe, tubing, tubular, liner, string, etc., used downhole in relation to oil or natural gas production.

[0040] In the event that the tool is not submergible all the way into the casing, a downhole tractor can be used to push the tool all the way into position in the well. The downhole tractor may have projectable arms having wheels, wherein the wheels contact the inner surface of the casing for propelling the tractor and the tool forward in the casing. A downhole tractor is any kind of driving tool capable of pushing or pulling tools in a well downhole, such as a Well Tractor®.

[0041] Although the invention has been described above in connection with preferred embodiments of the invention, it will be evident to a person skilled in the art that several modifications are conceivable without departing from the invention as defined by the following claims.

Claims

1. An annular barrier (1) for providing isolation of a zone in a well (2) having an isolation layer (24) of less than 5 metres, comprising:

   - a tubular metal part (3) configured to be mounted as part of a well tubular metal structure (4), the tubular metal part having an outer face (5), an opening (6) and an axial extension (L) along the well tubular metal structure,
   - a first expandable metal sleeve (7) surrounding the tubular metal part, the first expandable metal sleeve having a first thickness (ti), a first end (8) and a second end (9), the first end of the expandable metal sleeve being connected with the outer face of the tubular metal part,
   - a second expandable metal sleeve (10) surrounding the tubular metal part, the second expandable metal sleeve having the same thickness as the first expandable metal sleeve, the second expandable metal sleeve having a first end (11) connected with the outer face of the tubular metal part and a second end (12), and wherein the annular barrier comprises a first connecting sleeve (14) having a second thickness (t_2) being greater than the first thickness, the first connecting sleeve comprises a first sleeve end (15) connected to the second end of the first expandable metal sleeve and a second sleeve end (16) connected with the second end (12) of the second expandable metal sleeve, and the annular barrier comprises an annular space (17) defined between the tubular metal part, the first connecting sleeve and the expandable metal sleeves.

2. An annular barrier according to claim 1, wherein the first sleeve end is welded to the second end of the first expandable metal sleeve, and the second sleeve end is welded to the second end of the second expandable metal sleeve.

3. An annular barrier according to claim 1 or 2, further comprising a third expandable metal sleeve (18) surrounding the tubular metal part, the third expandable metal sleeve having the same thickness as the first expandable metal sleeve, the third expandable metal sleeve having a first end (19) connected with the second sleeve end (16) of the first connecting sleeve and a second end (20), and the annular barrier further comprising a second connecting sleeve (21) having the second thickness, the second connecting sleeve comprising a first sleeve end (22) connected with the second end of the third expandable metal sleeve and a second sleeve end (23) connected with the second end of the second expandable metal sleeve so that the second sleeve end (16) is connected with the second end (12) of the second expandable metal sleeve by means of the third expandable metal sleeve and the second connecting sleeve, and the annular space (17) being defined between the tubular metal part, the first and second connecting sleeve and the expandable metal sleeves.

4. An annular barrier according to any of the preceding claims, further comprising a fourth expandable metal sleeve (25) surrounding the tubular metal part, the fourth expandable metal sleeve having the same thickness as the first expandable metal sleeve, the fourth expandable metal sleeve having a first end

(26) connected with the second sleeve end (23) of the second connecting sleeve and a second end (27), and a third connecting sleeve (28) having the second thickness, the third connecting sleeve comprising a first sleeve end (29) connected with the second end of the third expandable metal sleeve and a second sleeve end (30) connected with the second end of the second expandable metal sleeve so that the second sleeve end (16) is connected with the second end (12) of the second expandable metal sleeve by means of the third and fourth expandable metal sleeves and the second and third connecting sleeves, and the annular space (17) being defined between the tubular metal part, the connecting sleeves and the expandable metal sleeves.

5. An annular barrier according to any of the preceding claims, further comprising a tube (32) extending through the annular space, through the connection of the first end of the first expandable metal sleeve to the tubular metal part and through the connection of the second end of the second expandable metal sleeve to the tubular metal part, providing a flow channel through the annular barrier in an expanded condition.

6. An annular barrier according to any of the preceding claims, further comprising at least one tubular connection part (31) for connecting the end of the expandable metal sleeve to the outer face of the tubular metal part.

7. An annular barrier according to claim 6, wherein the tubular connection part comprises a projecting flange (34) overlapping the end of the expandable metal sleeve.

8. An annular barrier according to any of the preceding claims, further comprising a valve assembly (33) fluidly connected to the opening and the annular space (17).

9. An annular barrier according to any of the preceding claims, wherein the first and second sleeve ends of the connecting sleeve comprise a projecting sleeve flange (35), each projecting sleeve flange overlapping one of the ends of the expandable metal sleeve.

10. An annular barrier according to any of the preceding claims, wherein the first ends of the first and second expandable metal sleeves have an increased thickness for connecting to the tubular metal part.

11. An annular barrier according to any of the preceding claims, wherein the second thickness is at least 5% thicker than the first thickness, preferably at least 10% thicker than the first thickness, and more preferably at least 15% thicker than the first thickness.

12. An annular barrier according to any of the preceding claims, wherein the first expandable metal sleeve and the second expandable metal sleeve have a length along the axial extension (L) being at least 50% longer than a length of the connecting sleeve, preferably at least 60% longer than a length of the connecting sleeve, and more preferably 75% longer than a length of the connecting sleeve.

13. An annular barrier according to any of the preceding claims, further comprising at least one sealing element (45) arranged on an outer face (46) of the expandable metal sleeves.

14. Downhole system comprising a plurality of the annular barriers according to any of claims 1-13 and the well tubular metal structure.

15. Downhole system according to claim 14, further comprising at least one inflow valve between two annular barriers.

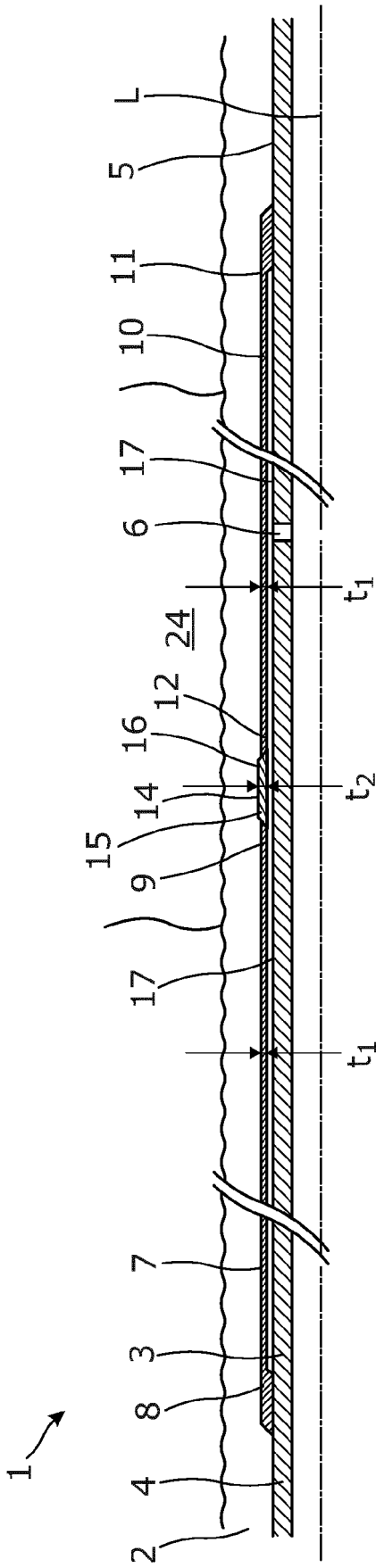

Fig. 1

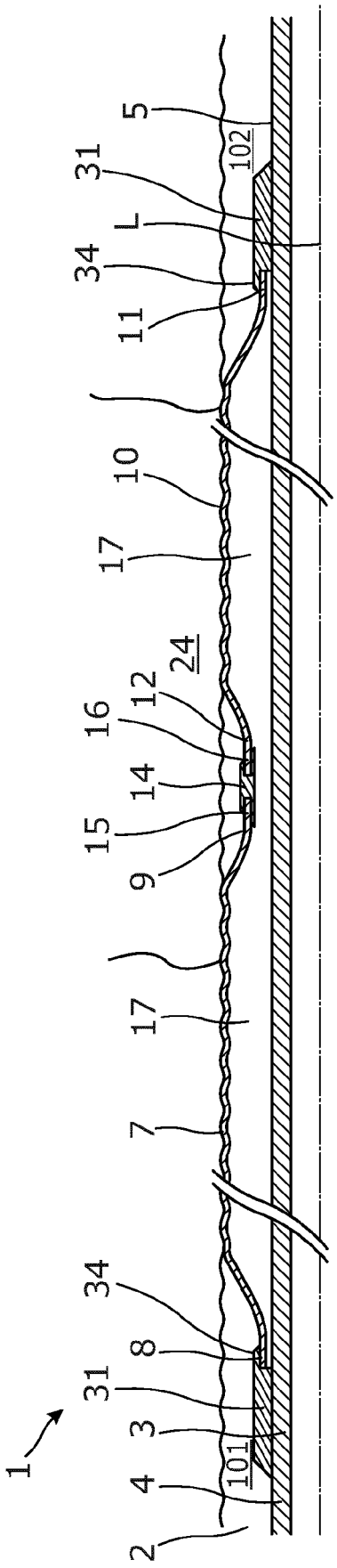

Fig. 2

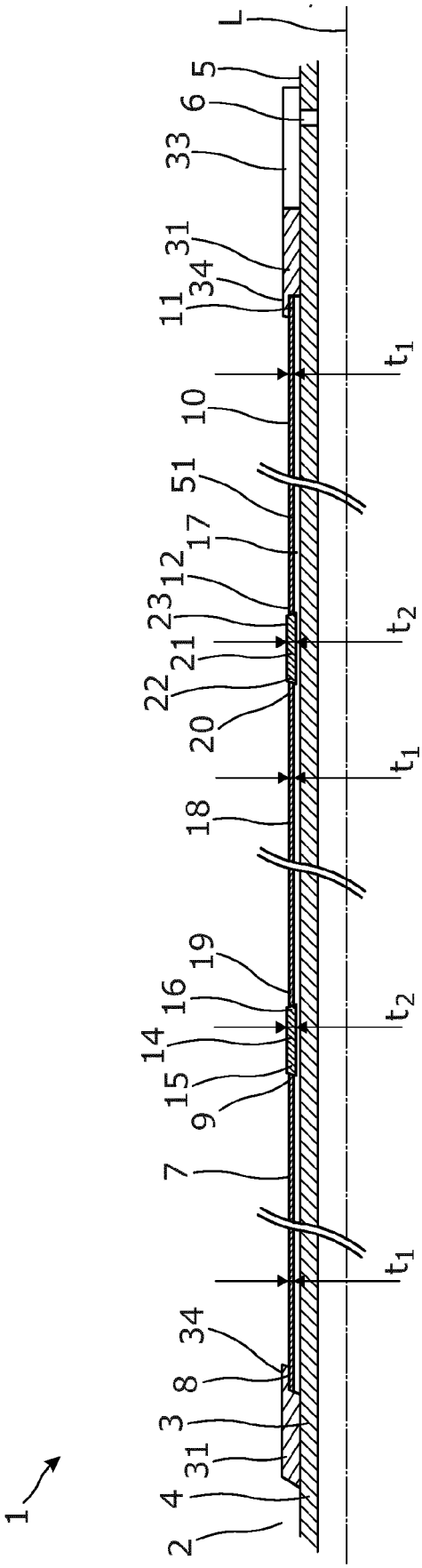
L
5
6
33
31
34
11
t_1
10
51
17
12
23
t_2
21
22
20
t_1
18
19
16
t_2
14
15
9
7
t_1
34
8
3
31
4
2
1

Fig. 3

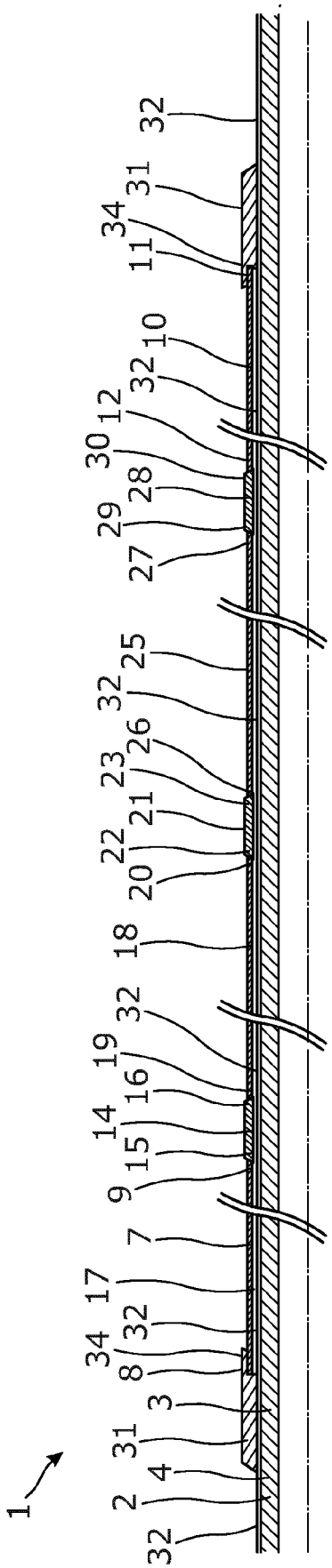
1
2
4
31
3
34
8
32
17
7
9
15
14
16
19
32
18
20
22
21
23
26
32
25
27
29
28
30
12
32
10
34
11
31
32

Fig. 4

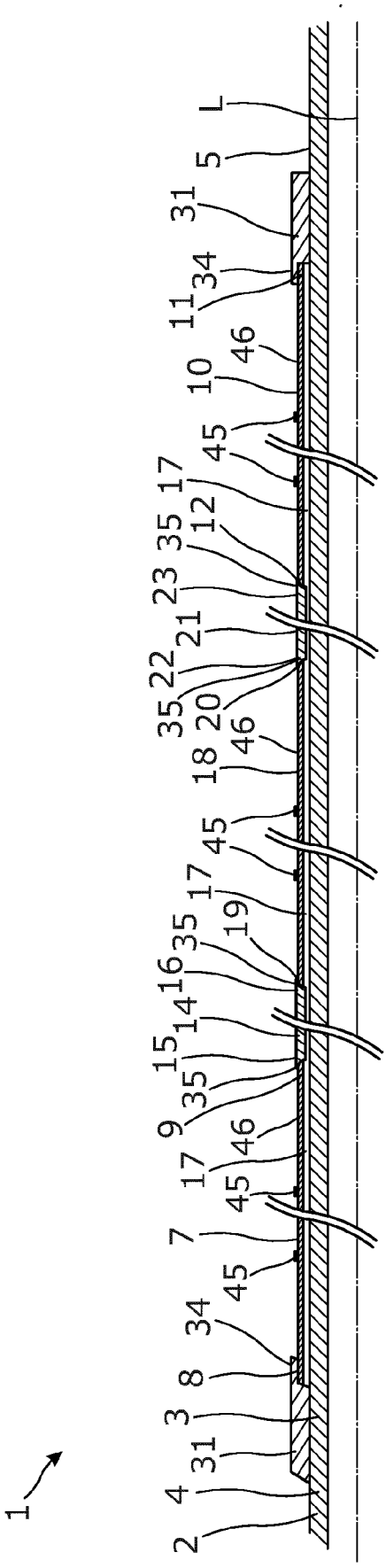
1
2
4
31
3
8
34
45
7
17
45
46
9
35
15
14
16
35
19
17
45
18
46
20
35
22
21
23
35
12
17
45
10
46
11
34
31
5
L

Fig. 5

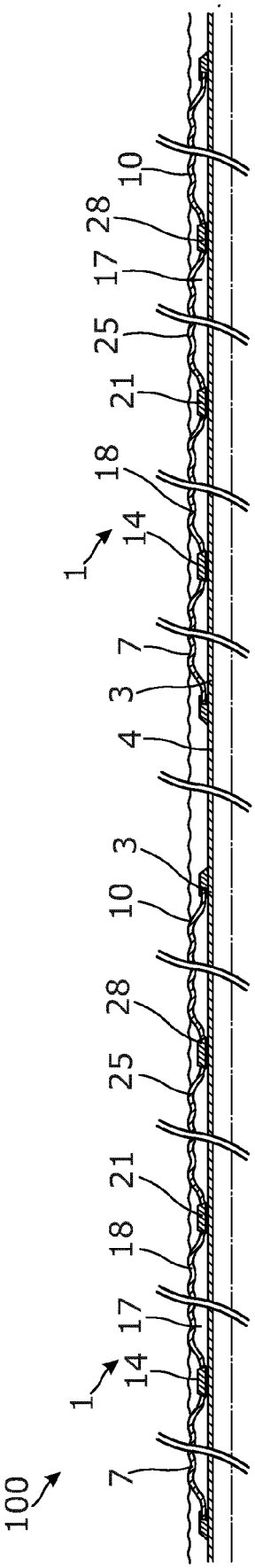

Fig. 6

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 21 16 8969

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2019/383114 A1 (VASQUES RICARDO REVES [CH]) 19 December 2019 (2019-12-19) * paragraphs [0052] - [0075] * * figures 1-8 *	1-15	INV. E21B33/127
A	US 5 101 908 A (MODY RUSTOM K [US]) 7 April 1992 (1992-04-07) * the whole document *	1-15	
A	US 2011/297400 A1 (PESSIN JEAN-LOUIS [FR] ET AL) 8 December 2011 (2011-12-08) * the whole document *	1-15	
A	EP 3 327 246 A1 (WELLTEC AS [DK]) 30 May 2018 (2018-05-30) * the whole document *	1-15	
A	EP 2 876 252 A1 (WELLTEC AS [DK]) 27 May 2015 (2015-05-27) * the whole document *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC) E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	29 September 2021	Kecman, Ivan

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 21 16 8969

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

29-09-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2019383114 A1	19-12-2019	BR 112020024913 A2	09-03-2021
		CA 3102446 A1	26-12-2019
		CN 112219011 A	12-01-2021
		EP 3584403 A1	25-12-2019
		US 2019383114 A1	19-12-2019
		WO 2019243308 A1	26-12-2019
US 5101908 A	07-04-1992	CA 2049686 A1	24-02-1992
		DE 4127923 A1	26-03-1992
		GB 2247263 A	26-02-1992
		NL 9101426 A	16-03-1992
		NO 305918 B1	16-08-1999
		US 5101908 A	07-04-1992
US 2011297400 A1	08-12-2011	FR 2935455 A1	05-03-2010
		US 2010051259 A1	04-03-2010
		US 2011297400 A1	08-12-2011
		US 2016047200 A1	18-02-2016
EP 3327246 A1	30-05-2018	AU 2017364219 A1	04-07-2019
		BR 112019009067 A2	16-07-2019
		CA 3043520 A1	31-05-2018
		CN 109952412 A	28-06-2019
		EP 3327246 A1	30-05-2018
		EP 3545165 A1	02-10-2019
		RU 2019118113 A	25-12-2020
		US 2018148992 A1	31-05-2018
		WO 2018096079 A1	31-05-2018
EP 2876252 A1	27-05-2015	AU 2014351826 A1	30-06-2016
		CA 2930289 A1	28-05-2015
		CN 105765159 A	13-07-2016
		DK 3074590 T3	13-11-2017
		EP 2876252 A1	27-05-2015
		EP 3074590 A1	05-10-2016
		EP 3284902 A1	21-02-2018
		NO 3074590 T3	30-12-2017
		RU 2016122686 A	29-12-2017
		US 2016298414 A1	13-10-2016
		WO 2015075224 A1	28-05-2015

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82