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The present invention relates to a flexible pipe according to the preamble of claim 1.

The pipe is in particular a flexible pipe of the unbonded type for transporting hydrocarbons through a body of water, such as an ocean, a sea, a lake or a river.

Such a flexible pipe is, for example, produced in accordance with normative documents API 17J (Specification for Unbonded Flexible Pipe) and API RP 17B (Recommended Practice for Flexible Pipe) drawn up by the American Petroleum Institute.

The pipe is generally formed of an assembly of concentric superposed layers. It is considered to be "unbonded" within the meaning of the present invention since at least one of the layers of the pipe is capable of moving longitudinally relative to the adjacent layers as the pipe bends. In particular, an unbonded pipe is a pipe that does not have binding materials connecting layers forming the pipe.

The pipe is generally disposed through a body of water, between a bottom assembly, which is to collect the fluid extracted at the bottom of the body of water, and a floating or fixed surface assembly, which is to collect and distribute the fluid. The surface assembly may be a semi-submersible platform, an FPSO or another floating assembly.

In some cases, for the extraction of fluids in deep water, the flexible pipe has a length greater than 800 m. The ends of the pipe have end-pieces for connection to the bottom assembly and to the surface assembly, as well as for intermediate connections.

Such pipes are subject to very high axial tensile forces, especially when the body of water in which the pipe is disposed is very deep.

In this case, the upper end-piece connecting the pipe to the surface assembly must absorb very considerable axial tension, which can reach several hundred tonnes. These forces are transmitted to the end-piece by way of the tensile armour layers extending along the pipe.

The axial tension not only has a high mean value; it also exhibits permanent variations in dependence on the vertical movements of the surface assembly and of the pipe under the effect of the agitation of the body of water caused by the swell or by the waves.

The variations in axial tension can reach several tens of tonnes and be repeated continually during the service life of the pipe. In 20 years, the number of cycles can thus reach more than 20 million.

It is therefore necessary to ensure a particularly robust fixing between the tensile armour layers and the body of the end-piece.

To that end, in the known end-pieces, anchoring of the armours is generally provided by friction between the armour wires and the epoxy resin poured into the chamber delimited by the vault and the cap.

Moreover, the capstan effect associated with the helical path of the armour wires also contributes to the anchoring of the armours, it being possible to enhance this effect by changing the diameter of the helix described by the wires in the end-piece relative to the diameter of that helix along its main length, for example by gradually increasing the diameter according to an ascending cone and then decreasing it along a descending cone.

Furthermore, hook-, wave- or twist-shaped deformations can be formed at the end of each armour wire and engaged in the epoxy resin in order to effect mechanical blocking against the applied tension. These deformations provide the force necessary to establish the capstan effect.

WO 2007/144553 describes an end-piece of the above-mentioned type in which the armour wires move in a helical manner away from the axis of the pipe and then come closer in a helical manner to the axis of pipe in the chamber delimited by the end vault and by the cap of the end-piece.

The end of each armour wire is additionally deformed in a wave shape and then the armour wires are embedded in a thermosetting resin, in order to be immobilised in the chamber defined by the end vault and the cap of the end-piece.

Such an end-piece is not wholly satisfactory. Sometimes, over time, the anchoring of the tensile armours fails due to fatigue.

In particular, such failure occurs in the region of the wave-shaped deformations, where the wires forming the armours have been greatly deformed.

The failure is liable to occur also in the rear portion, in the region of the zone of separation of the armours relative to the diameter of the main length, this part additionally being weakened during assembly because of the folding and unfolding of the armours which is necessary to fit the end-piece.

JPH05231576 and FR2963817 describe terminal end-pieces for flexible pipes in which end portions of armour elements are interposed between an inner part and an outer part.

An object of the invention is, therefore, to obtain an end-piece of a flexible pipe which effectively absorbs axial tension, in which the risk of fatigue failure, especially in the end portions of the armours, is greatly reduced.

To that end, the invention relates to a flexible pipe according to claim 1.

The pipe according to the invention can comprise one or more of the features of claims 2 to 9 or the following feature, taken in isolation or in any technically possible combination:

- the crimping assembly is embedded in the filling material.

The invention relates also to a fitting method according to claim 10.

The invention will be better understood from reading the following description, which is given solely by way of example and with reference to the accompanying drawings, in which:

- Figure 1 is a perspective view, partially cut away, of a first flexible pipe according to the invention;
- Figure 2 is a partial view, in section along an axial mid-plane, of the end-piece of the first flexible pipe according to the invention;

- Figure 3 is a view analogous to Figure 2 of the end-piece of a second flexible pipe which does not form part of the subject-matter of the claims;
- Figure 4 is a view analogous to Figure 2 of the end-piece of a third flexible pipe according to the invention.

In the following, the terms "outside" and "inside" are understood generally radially relative to an axis A-A' of the pipe, the term "outside" being understood as being radially relatively further away from the axis A-A' and the term "inside" being understood as being radially relatively closer to the axis A-A' of the pipe.

The terms "front" and "rear" are understood axially relative to an axis A-A' of the pipe, the term "front" being understood as being relatively further away from the middle of the pipe and closer to one of its ends, and the term "rear" being understood as being relatively closer to the middle of the pipe and further away from one of its ends. The middle of the pipe is the point of the pipe situated at equal distance from the two ends of the pipe.

A first flexible pipe 10 according to the invention is shown in part in Figure 1.

The flexible pipe 10 comprises a central portion 12 shown in part in Figure 1. It comprises, at each of the axial ends of the central portion 12, a terminal end-piece 14 (not visible in Figure 1), the relevant parts of which are shown in Figure 2.

With reference to Figure 1, the pipe 10 delimits a central passage 16 for circulation of a fluid, advantageously a petroleum fluid. The central passage 16 extends according to an axis A-A', between the upstream end and the downstream end of the pipe 10. It opens through the end-pieces 14.

The flexible pipe 10 is to be disposed through a body of water (not shown) in an installation for extracting fluid, especially hydrocarbons.

The body of water is, for example, a sea, a lake or an ocean. The depth of the body of water in line with the installation for extracting fluid is, for example, between 500 m and 3000 m.

The installation for extracting fluid comprises a surface assembly, especially a floating surface assembly, and a bottom assembly (which are not shown), which are generally connected together by the flexible pipe 10.

The flexible pipe 10 is preferably an unbonded flexible pipe.

At least two adjacent layers of the flexible pipe 10 are free to move longitudinally relative to one another as the pipe bends.

Advantageously, all the layers of the flexible pipe are free to move relative to one another. Such a pipe is, for example, described in the normative documents published by the American Petroleum Institute (API), API 17J and API RP17B.

As is shown in Figure 1, the pipe 10 delimits a plurality of concentric layers around the axis A-A', which extend continuously along the central portion 12 to the end-pieces 14 situated at the ends of the pipe.

According to the invention, the pipe 10 comprises at least a first tubular sheath 20 based on polymer material, which advantageously constitutes a pressure sheath.

The pipe 10 further comprises at least one tensile armour layer 24, 25 arranged on the outside relative to the first sheath 20.

Advantageously, and according to the desired use, the pipe 10 further comprises an inner carcass 26 arranged on the inside of the pressure sheath 20, a pressure vault 28 interposed between the pressure sheath 20 and the tensile armour layer or layers 24, 25, and an outer sheath 30, which is to protect the pipe 10.

In known manner, the pressure sheath 20 is to confine in a sealed manner the fluid transported in the passage 16. It is formed of polymer material, for example based on a polyolefin such as polyethylene, based on a polyamide such as PA11 or PA12, or based on a fluorinated polymer such as polyvinylidene fluoride (PVDF).

The thickness of the pressure sheath is, for example, between 5 mm and 20 mm.

The carcass 26, when present, is formed, for example, of a profiled metal strip wound in a spiral. The turns of the strip are advantageously interlocked with one another, which allows the radial crushing forces to be absorbed.

In this example, the carcass 26 is arranged on the inside of the pressure sheath 20. The pipe is then designated "rough bore" because of the geometry of the carcass 26.

In a variant (not shown), the flexible pipe 10 does not have an inner carcass 26, and it is then designated "smooth bore".

The helical winding of the profiled metal strip forming the carcass 26 is of short pitch, that is to say it has a helix angle having an absolute value close to 90°, typically between 75° and 90°.

In this example, the pressure vault 28 is to absorb the forces associated with the pressure prevailing inside the pressure sheath 20. It is formed, for example, of a profiled metal wire wound in a helix around the sheath 20. The profiled wire generally has a complex geometry, especially in a Z, T, U, K, X or I shape.

The pressure vault 28 is wound in a helix with short pitch around the pressure sheath 20, that is to say with a helix angle having an absolute value close to 90°, typically between 75° and 90°.

The flexible pipe 10 according to the invention comprises at least one armour layer 24, 25 formed of a helical winding of at least one elongate armour element 29.

In the example shown in Figure 1, the flexible pipe 10 comprises a plurality of armour layers 24, 25, especially an inside armour layer 24, applied to the pressure vault 28 (or to the sheath 20 when the vault 28 is absent), and an outside armour layer 25 around which the outside sheath 30 is arranged.

Each armour layer 24, 25 comprises longitudinal armour elements 29 wound with a long pitch around the axis A-A' of the pipe.

"Wound with a long pitch" is understood as meaning that the absolute value of the helix angle is less than 60° and is typically between 25° and 55°.

The armour elements 29 of a first layer 24 are wound generally at an opposite angle relative to the armour elements 29 of a second layer 25. Accordingly, if the winding angle of the armour elements 29 of the first layer 24 is equal to $+\alpha$, α being between 25° and 55°, the winding angle of the armour elements 29 of the second armour layer 25 arranged in contact with the first armour layer 24 is, for example, equal to $-\alpha°$.

The armour elements 29 are, for example, formed by metal wires, especially steel wires, or by tapes of composite material, for example carbon-fibre-reinforced tapes.

As will be seen below, the armour elements 29 each have en end portion 34 introduced into the end-piece 14. The end portion 34 extends to a free end arranged in the end-piece 14. It advantageously has a helical or pseudo-helical path of axis A-A' in the end-piece 14.

The outer sheath 30 is to prevent the permeation of fluid from the outside of the flexible pipe 10 to the inside. It is advantageously made of polymer material, especially based on a polyolefin, such as polyethylene, based on a polyamide, such as PA11 or PA12, or based on a fluorinated polymer such as polyvinylidene fluoride (PVDF).

The thickness of the outer sheath 30 is, for example, between 5 mm and 15 mm.

As is shown in Figure 2, each end-piece 14 comprises an end vault 50 and an outside connecting cap 51 which projects axially towards the rear starting from the vault 50. The cap 51, with the end vault 50, delimits a chamber 52 for receiving the end portions 34 of the armour elements 29.

The end-piece 14 further comprises a front sealing assembly 54 around the tubular sheath 20, shown schematically in Figure 2, and a rear sealing assembly 56 around the outside sheath 30.

According to the invention, the end-piece 14 further comprises a front assembly 62 for crimping each end portion 34 of the armour elements 29, capable of forming a radial deformation 64 on each end portion 34.

The end-piece 14 additionally advantageously comprises a rear member 66 for holding the armour layers 24, 25, situated in the rear zone of the end-piece 14, and a solid filling material 68 disposed in the chamber 52 for embedding the end portions 34, in particular in the region of each radial deformation 64.

The front crimping assembly 62 is separate from the filling material 68. It is advantageously received in the filling material 68.

In this example, the end vault 50 is to connect the pipe 10 to another connection end-piece 14 or to terminal equipment, advantageously by way of an end flange (not shown).

The end vault 50 has a central bore for receiving the end of the first sheath 20 and allowing the fluid circulating through the central passage 16 to flow to the outside of the pipe 10.

The cap 51 comprises a tubular peripheral wall 70 extending around the axis A-A'. The peripheral wall 70 has a front edge 71 fixed to the end vault 50, radially spaced apart from the armour layers 24, 25, and a rear edge 72 extending axially towards the rear beyond the end vault 50.

The cap 51 delimits the chamber 52 radially towards the outside. A rear face 73 of the end vault 50 delimits the chamber 52 axially towards the front.

The front sealing assembly 54 is advantageously situated in front of the end-piece 14, in contact with the vault 50. In the embodiment of Figure 2, the front sealing assembly 54 is offset axially towards the front relative to the front crimping assembly 62.

In known manner, it comprises a front crimping ring 74, which is to come into engagement on the pressure sheath 20, and a clamping collar 76.

In the example shown in Figure 2, in which the pipe 10 comprises a pressure vault 28, the front assembly 54 further comprises an intermediate stop ring 78 for the pressure vault 28. The intermediate stop ball 78 is interposed between the front crimping ring 74 and the clamping collar 76.

The rear sealing assembly 56 is arranged to the rear of the rear holding member 66, and to the rear of the front crimping assembly 62.

It comprises at least one rear crimping ring 80, which crimps the outer sheath 30, and a rear collar 82 for clamping the rear ring 80, fixed to the cap 51, advantageously in the region of the rear edge 72 of the peripheral wall 70.

In the example shown in Figure 2, the front crimping assembly 62 comprises, from the outside to the inside, an outside crimping ring 90, applied to the outside of the end portions 34 of the armour layers 24, 25, an intermediate deformation ring 92, interposed between the end portions 34 of the armour layers 24, 25, and advantageously a support vault 94.

In this example, the support vault 94 is applied to the pressure vault 28. It comprises a bevelled front portion 96 and a rear portion 98 in the form of a collar fixed to the end vault 50.

The support vault 94 further comprises a cylindrical intermediate support portion 100 arranged facing the outside ring 90 and the intermediate ring 92.

The thickness of the intermediate portion 100 of the support vault 94 is advantageously between 5 mm and 50 mm, preferably between 10 mm and 20 mm.

The intermediate portion 100 defines a first radial relief 102 for deforming a facing end portion 34, formed in this example by an annular hollow.

The intermediate ring 92 comprises a rear circlip 104 defining an inner radial relief 106 directed towards the axis A-A' and an outside radial relief 108 directed in the opposite direction to the inner relief 106, away from the axis A-A'.

The intermediate ring 92 further advantageously comprises a front wall 110 having a thickness less than that of the circlip 104, projecting towards the front starting from the circlip 104.

The inner relief 106 projects radially towards the support vault 94, facing the first relief 102. It advantageously extends continuously over a circumference around the axis A-A'.

The outside relief 108 projects towards the outside ring 90. It advantageously extends continuously over a circumference around the axis A-A'.

After crimping, the outside ring 90 is clamped on an end portion 34, facing the outside relief 108. It then defines a second hollow radial relief 112, opposite the outside radial relief 108.

At least one end portion 34 of the inner armour layer 24 is interposed between the support vault 94 and the intermediate ring 92.

The inner relief 106 and/or the first relief 102 impart a radial deformation 64 in the shape of a wave to the end portion 34. The radial deformation 64 is here directed towards the axis A-A'.

In the embodiment of Figure 2, to the rear of the radial deformation 64, the end portion 34 is applied to the bevelled front portion 96, which moves the end portion 34 radially away from the axis A-A'.

Moreover, at least one end portion 34 of the outside armour layer 25 is interposed between the intermediate ring 92 and the outside ring 90.

The outside relief 108 and/or the second relief 112 impart a radial deformation 64 in the shape of a wave to the end portion 34. The radial deformation 64 is here directed away from the axis A-A'.

Moreover, to the rear of the radial deformation 64, the end portion 34 is applied to an end portion 34 of the inside armour layer 24, which itself rests on the bevelled front portion 96.

Because the radial deformations 64 are produced directly *in situ* at the time of crimping of the outside ring 90, it is not necessary to form hooks or undulations on each armour element 29 beforehand, which enhances the mechanical properties of the armour element 29 and its fatigue strength.

At the location of the rear holding member 66, the armour elements 29 of the armour layers 24, 25 are wound helically with the same helix radius as they have in the region of the central portion 12. The zone in which the armour layers 24, 25 move in a helical manner away from the axis A-A' of the pipe is situated in front of the annular holding member 66, to the rear of the end vault 50, on the bevelled front portion 96 of the support vault 94.

Accordingly, the end portions 34 of the armour elements 29 are maintained in a state similar to that of the main length, by virtue of the slight separation caused by the support vault 94.

This advantageously makes it possible to omit the folding/unfolding of the armour elements 29 when the end-piece 14 is fitted.

Advantageously, the length of each wave-shaped radial deformation 64, taken along the axis A-A', is between 10 mm and 150 mm.

The crimping performed on the end portions 34 produces radial deformations 64 which are very successful in terms of retention, which makes it possible to reduce the anchoring length, and therefore the lengthening in the critical portion of change of radii of the armour elements 29.

Furthermore, uniform clamping is obtained at the end of the each armour element 29, and the assembly time is reduced, since all the end portions 34 are crimped in a single operation. The reproducibility of the operation is furthermore increased.

With reference to Figure 2, the rear holding member 66 is arranged around the armour elements 29 of the armour layer 25, in the region of the rear portion of the end-piece 14.

At the location of the rear holding member 66, the armour elements 29 of the armour layers 24, 25 are wound helically with the same helix radius as they have in the region of the central portion 12.

The rear holding member 66 is in the form of an annular collar and does not contribute significantly to the absorption of tensile forces. Its function is especially to prevent the disarrangement of the armour layers 24, 25 during fitting of the end-piece 14, as will be explained hereinbelow.

The solid filling material 68, such as an epoxy-type thermosetting polymer resin, is disposed in the chamber 52 around the rear holding member 66, the vault 50, and the end portions 34 of the armour elements 29. It especially embeds the radial deformations 64.

The material 68 fills the chamber 52 substantially completely. It is preferably injected in fluid manner into the chamber 52 and solidifies therein, joining the end portions 34 of the armour elements 29 to the vault 50 and/or to the cap 51.

Assembly of the end-piece 14 according to the invention is carried out as follows.

Initially, the different layers of the pipe 10 are cut to the correct length to reveal, on the vault 28, a free end portion 34 of each armour element 29 of the armour layers 24, 25.

Each free end portion 34 is initially without radial deformation, especially deformation in the shape of a wave or hook.

The rear holding member 66 in an expanded configuration is then mounted around the armour layer 25 before being clamped around that armour layer. Once this has been done, the outside ring 90 in an expanded configuration is engaged around the end portions 34, on the outside thereof.

The end portions 34 of the outside armour layer 25 are then lifted slightly away from the axis A-A', advantageously without being folded backwards, in order to introduce the intermediate ring 82 between the end portions 34 of the inside armour layer 24 and the end portions 34 of the outside armour layer 25.

The end portions 34 are then lifted slightly away from the axis A-A', advantageously without being folded backwards, in order to introduce the support vault 94 beneath the end portions 34.

The first relief 102 present on the support vault 94, the reliefs 106, 108 on the intermediate ring 92 and the outside ring 90 are then placed facing one another.

A crimping device of known type is then arranged around the outside ring 90. An example of a crimping device comprises jaws which can be deployed radially towards the axis A-A'.

The outside ring 90 is then crimped by the crimping device by being compressed radially towards the axis A-A' against the end portions 34 of the outside armour layer 25, against the circlip 104 of the intermediate ring 92 and against the radial relief 102 of the intermediate portion 100 of the support vault 94.

The radial deformation of the outside ring 90, and the cooperation between the respective reliefs 108, 112 and 102, 106 create wave-shaped radial deformations 64 at the free end of the end portions 34.

In the example shown in Figure 2, the radial deformation 64 formed on the end portions 34 of the outside armour layer 25 is directed away from the axis A-A', in the opposite direction to the radial deformation formed on the end portions 34 of the inside armour layer 24.

The vault 50 and the front sealing assembly 54 are then put in place. The clamping collar 76 is then tightened, in order to achieve tightness around the sheath 20.

The cap 51 is then fitted and is fixed to the vault 50.

The rear sealing assembly 56 is then put in place and is fixed to the cap 51.

Finally, the filling material 68 is introduced into the chamber 52, advantageously in fluid form. The material 68 fills the chamber 52 and solidifies between the vault 50 and the cap 51 around the end portions 34 of the armour elements 29, in particular

on the radial deformations 64. The end portions 34 are thus embedded in the filling material 68.

In operation, when the end-piece 14 is connected to another end-piece or to a surface assembly, the axial tension transmitted by the armour layers 24, 25 resulting from the weight of the pipe 10 is absorbed by the portions 34 embedded in the filling material 68, especially by virtue of the presence of the wave-shaped radial deformations 64 produced when the outside ring 90 was crimped.

The end-piece 14 of a second flexible pipe 120 is shown in Figure 3.

In contrast to the end-piece 14 shown in Figure 2, the front crimping assembly 62 does not have a support vault 94.

The outside ring 90 comprises a wave-shaped inside radial relief 122 which projects radially towards the axis A-A'. It comprises, in front of the inside relief 122, a housing 124 for insertion of the intermediate ring 92.

The inside relief 122 is applied to the end portion 34 of the outside armour layer 25 in order to create a wave-shaped radial deformation 64.

In contrast to the end-piece 14 shown in Figure 2, the intermediate ring 92 is not interposed between the end portions 34 of the armour layers 24, 25.

The intermediate ring 92 is arranged in front of the front end of the outside armour layer 25, in the insertion housing 124.

The intermediate ring 92 comprises a wave-shaped inside radial relief 126 which projects radially towards the axis A-A'.

The inside relief 126 is applied to the end portion 34 of the inside armour layer 24, in front of the end portion 34 of the outside armour layer 25, to create a wave-shaped radial deformation 64.

Advantageously, in this embodiment, the end portions 34 extend substantially in a cylindrical envelope, without moving away from the axis A-A', retaining the helix radius which they have in the region of the central portion 12 of the pipe 120.

Thus, the end-piece 14 of the pipe 120 has particularly high fatigue strength, since no folding or lifting of the end portions 34 is necessary to effect anchoring of the armour elements 29.

For the transmission of the forces, the outside ring 90 is applied to the cap 51. The intermediate ring 92 rests on the outside ring 90 in the housing 124, on the projection 122.

The intermediate ring 92 also rests partially on the clamping collar 76.

Owing to the absence of a support vault interposed between the pressure vault 28 and the end portion 34 of the outside armour layer 24, the radial crimping pressures exerted by the outside ring 90 and by the intermediate ring 92 are absorbed by the inner layers of the flexible pipe 10. Consequently, in this embodiment, those inner layers, and especially the pressure vault 28 and the carcass 26, must be sufficiently strong to withstand all the crimping forces.

The assembly of the end-piece 14 described in Figure 3 differs from the assembly of the end-piece 14 described in Figure 2 in that separation of the end portions 34 is not carried out during the assembly.

The intermediate ring 92 is first put in place, and the outside ring 90 is crimped around the intermediate ring 92 and facing the end portion 34 of the outside armour layer 25, in order to form the radial deformations 64 facing the reliefs 122, 126.

The end-piece 14 of a third pipe 130 according to the invention is shown in Figure 4.

In contrast to the end-pieces shown in Figures 2 and 3, the front crimping assembly 62 is not situated in line with the inner layers of the flexible pipe 10, and especially with its pressure vault 28. In this embodiment, the front crimping assembly 62 is here situated in line with the outside vault 50 of the end-piece 14. The crimping

pressure is therefore absorbed by the outside vault, which avoids especially stress on the pressure vault 28.

The outside vault 50 comprises a bearing surface 132, which is advantageously conical, for supporting the end portions 34 of the armour elements 29 and the front crimping assembly 62.

The conical bearing surface 132 diverges away from the axis A-A' from the front to the rear. It advantageously defines a first radial relief 102, which in this example is hollow.

The intermediate ring 92 is arranged facing the conical bearing surface 132, advantageously in the region of the first relief 102. It is interposed between the end portions 34 of the inner armour layer 24 and of the outside armour layer 25. As above, it comprises an inner radial relief 106 and an outside radial relief 108.

Analogously to the end-piece 14 of Figure 2, the outside ring 90 is crimped around the end portion 34 of the outside armour layer 25, the intermediate ring 92 and the end portion 34 of the inside armour layer 24.

The outside ring 90, the inner ring 92 and the relief 102 on the conical bearing surface 132 thus create, on each end portion 34, a wave-shaped radial deformation 64.

In contrast to the end-piece 14 shown in Figure 2, each end portion 34 has a rear portion 134 which moves away from the axis A-A' from the rear member 66 towards the conical bearing surface 132, and a front portion 136 which comes closer to the axis A-A' on the conical bearing surface 132.

In this example, the front sealing assembly 54 is situated beneath the end portions 34 to the rear of the end vault 50 and to the rear of the radial deformations 64.

Patentkrav

1. Fleksibelt rør (10 ; 120 ; 130) til transport af fluid, omfattende mindst ét rørformet hylster (20) og mindst ét lag (24, 25) af trækarmering, der er anbragt udvendigt i forhold til det rørformede hylster (20), hvor armeringslaget (24, 25) omfatter en flerhed af trådformede armeringselementer (29), hvor det fleksible rør (10) omfatter et forbindelsesendestykke (14), der er monteret ved enden af det rørformede hylster (20),
hvor endestykket (14) omfatter:
- mindst ét endeafsnit (34) af hvert armeringselement (29),
- en endebue (50) og en kappe (51), der er fastgjort på endebuen (50), hvor endebuen (50) og kappen (51) mellem dem afgrænser et kammer (52) til modtagelse af endeafsnittet;
- et fyldningsmateriale (68) af modtagelseskammeret (52), i hvilket endeafsnittet (34) er nedsænket;
- mindst én enhed (62) til falsning af endeafsnittet (34), som definerer mindst ét radialt fremspring (102, 106, 108, 112 ; 122, 126) til falsning af endeafsnittet (34), hvor endeafsnittet (34) har en radial deformering (64) over for falsningsfremspringet (102, 106, 108, 112 ; 122, 126),
hvor falsningsenheden (62) omfatter en udvendig falsningsring (90), en støttebue (94), der er anbragt radialt modsat den udvendige falsningsring (90), hvor mindst ét endeafsnit (34) er anbragt mellem støttebuen (94) og den udvendige ring (90), **kendetegnet ved, at** støttebuen (94) definerer et første radial falsningsfremspring (102), der er anbragt over for den udvendige ring (90), hvor det radiale falsningsfremspring (102) omfatter en radial fordybning og eller en radial afsats.

2. Rør ifølge krav 1, **kendetegnet ved, at** den radiale deformering (64) er bølgeformet.

3. Rør ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** støttebuen (94) er fastgjort på endebuen (50).

4. Rør ifølge et hvilket som helst af de foregående krav, omfattende mindst ét lag med trækarmering (24) og mindst ét andet lag med trækarmering (25), hvor endestykket (14) omfatter en mellemliggende falsningsring (92), der er anbragt mellem et første endeafsnit (34) af det første trækarmeringslag (24) og et andet endeafsnit (34) af det andet trækarmeringslag (25).

5. Rør ifølge krav 4, **kendetegnet ved, at** den mellemliggende falsningsring (92) har et første mellemfremspring (106), som radialt deformerer det første endeafsnit (34) og/eller et andet mellemfremspring (108), som radialt deformerer det andet endeafsnit (34).

6. Rør ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** den del af endeafsnittet (34), som indfalses af falsningsenheden (62), anbringes direkte på et andet endeafsnit (34) af et andet armeringslag (24).

7. Rør ifølge krav 6, **kendetegnet ved, at** endeafsnittet (34) i det væsentlige strækker sig parallelt med det rørformede hylster (20) over hele længden af endestykket til bagsiden af den radiale deformering (64).

8. Rør ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** det omfatter en frontenhed (54) til tætning omkring det rørformede hylster (20), hvor fronttætningsenheden (54) forskydes aksialt foran og bagved falsningsindretningen (62) af endeafsnittet (34).

9. Rør ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** det omfatter et bagelement (66) til radial fastholdelse af endeafsnittet (34), aksial forskudt bagud i forhold til falsningsenheden (62) af endeafsnittet (34).

10. Fremgangsmåde til montering af et endestykke (14) af et fleksibelt rør (10 ; 120 ; 130), omfattende de følgende trin:

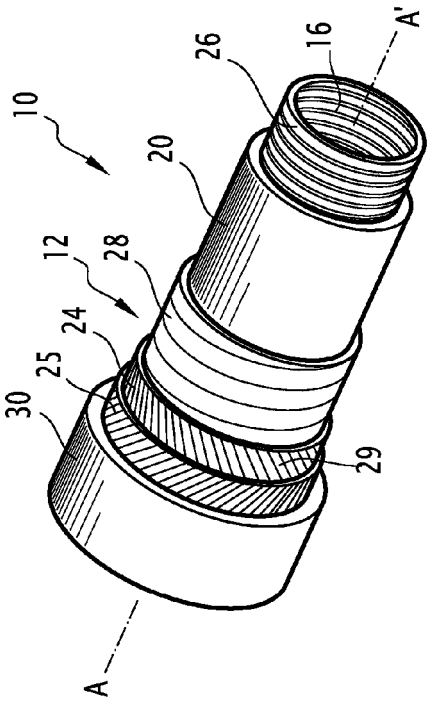
- tilvejebringelse af et rørformet hylster (20);
- anbringelse af mindst ét lag (24, 25) af trækarmering udvendigt af det rørformede hylster (20), hvor trækarmeringslaget (24, 25) omfatter en flerhed af trådformede armeringselementer (29), hvor armeringselement (29) omfatter et endeafsnit (34);
- placering af en endebue (50) og en kappe (51), der er fastgjort på endebuen (50), hvor endebuen (50) og kappen (51) mellem dem afgrænser et kammer (52) til modtagelse af endeafsnittet (34);
- indføring af et fyldningsmateriale (68) i modtagelseskammeret (52) for at nedsænke endeafsnittet (34);

kendetegnet ved, at den omfatter følgende trin:

- placering af en enhed (62) til falsning af endeafsnittet (34), som definerer mindst ét radialt fremspring (102, 106, 108, 112 ; 122, 126) til falsning af endeafsnittet (34) for at danne en radial deformering (64) på endeafsnittet (34) over for falsningsfremspringet (102, 106, 108, 112 ; 122, 126),

hvor falsningsenheden (62) omfatter en udvendig falsningsring (90), en støttebue (94), der er anbragt radialt modsat den udvendige falsningsring (90), hvor mindst ét endeafsnit (34) er anbragt mellem støttebuen (94) og den udvendige ring (90),

hvor støttebuen (94) definerer et første radial falsningsfremspring (102), der er anbragt over for den udvendige ring (90), hvor det radiale falsningsfremspring (102) omfatter en radial fordybning og eller en radial afsats.


10
12
16
20
24
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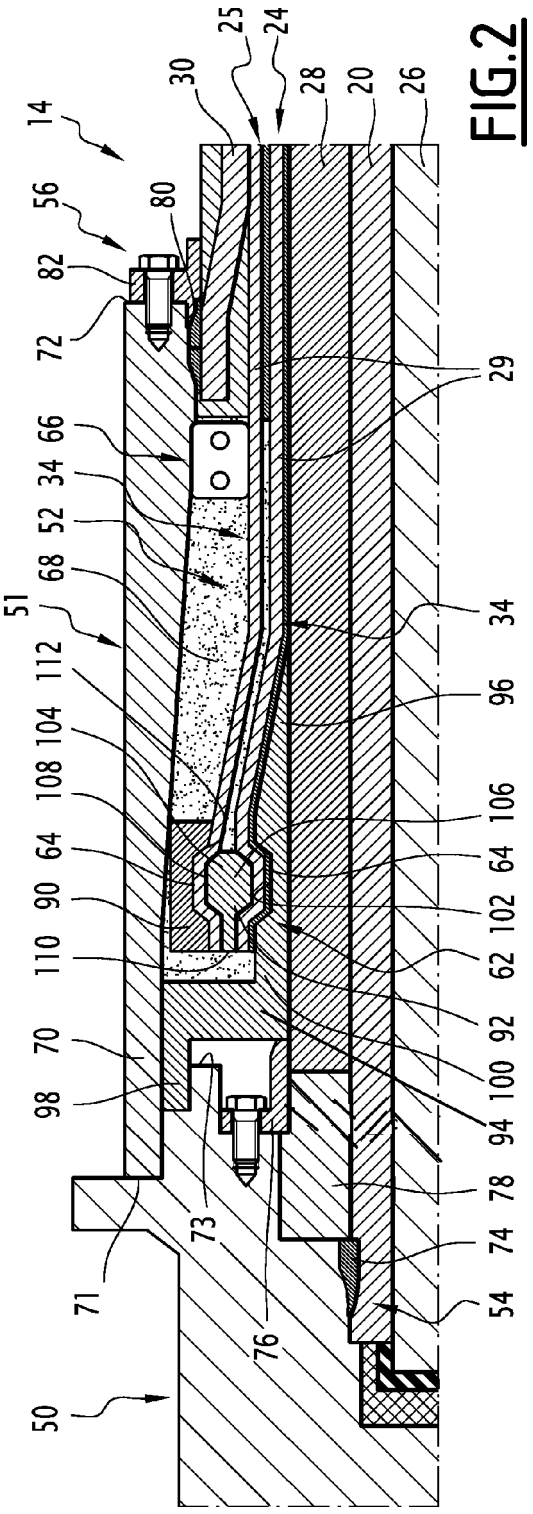
26
28
29
30
A
A'

FIG.1


14
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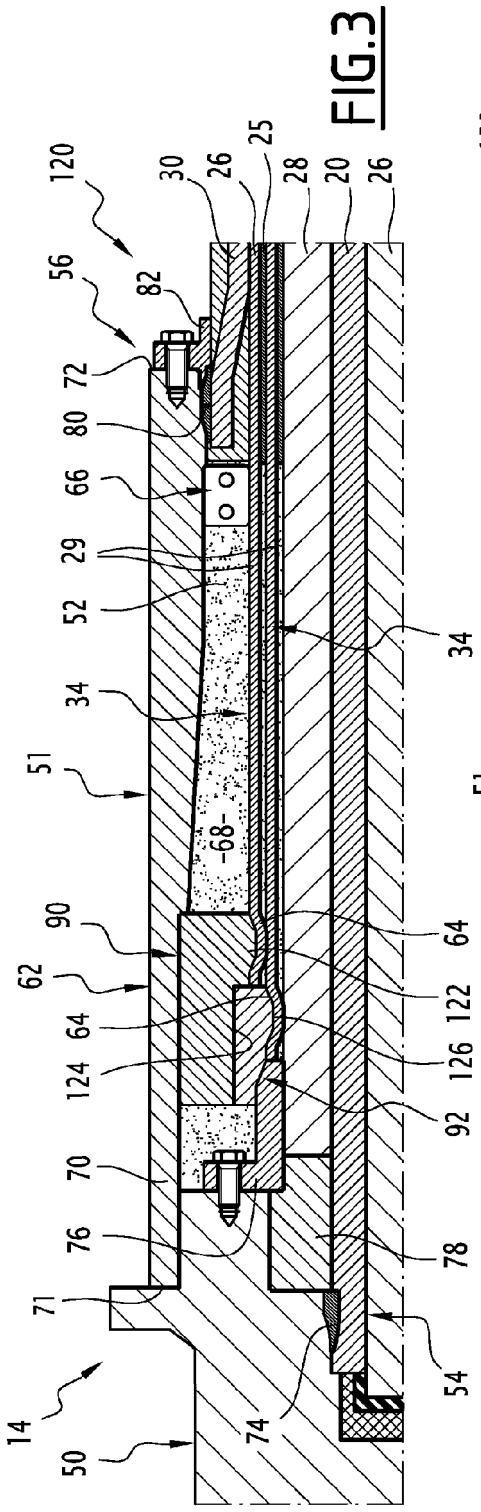
110
112

FIG.2


120
56
82
72
80
66
29
52
34
51
-68-
90
62
64
124
70
76
71
14
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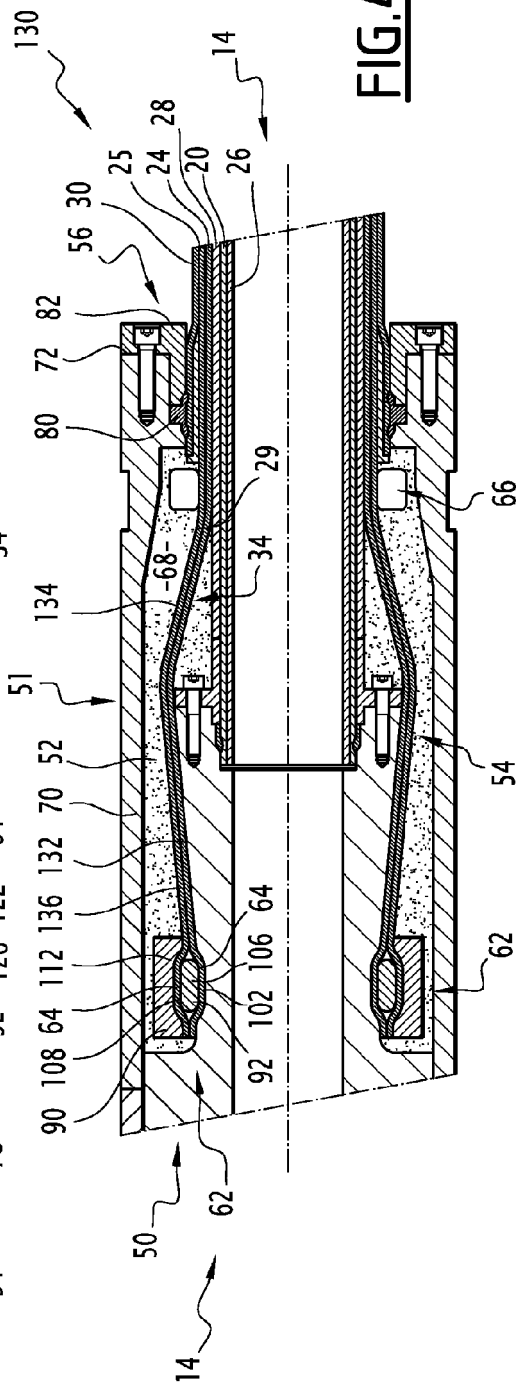
30
26
25
28
20
26
34
64
122
126
92
78
54
74

FIG.3


130
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34
-68-
134
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132
136
112
64
108
90
106
102
92
54
62
50
14

FIG.4