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(54) **STRING OF EXPANDABLE SLOTTED TUBULARS AND METHOD OF EXPANDING A STRING OF SLOTTED TUBULARS**

(57) A string of expandable slotted tubulars is made of at least two tubular lengths. Each of the tubular lengths has a first longitudinal end, a second longitudinal end, and an expandable middle section connecting the longitudinal ends. The expandable middle section is provided with a pattern of slotted perforations and can be expanded. The first and second longitudinal ends are respec-

tively provided with first and second connectors which are not expandable. The string may be expanded by moving a flexible expansion device through the string of expandable slotted tubulars in a longitudinal direction, thereby expanding the respective middle sections while leaving the connectors unexpanded.

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Description

Field of the Invention

[0001] In one aspect, the present invention relates to a string of expandable slotted tubulars. In another aspect, the present invention relates to a method of expanding a string of slotted tubulars.

Background of the Invention

[0002] Expandable slotted tubing (EST) has become a widely used technique in the industry of oil and gas exploration and production, as a means to complete an uncased section of a borehole in an earth formation. Traditionally, the tubing consists lengths of pipe made up into a string. The lengths of pipe have been provided with specific patterns of a large number of slots. These slots are typically machined in the pipe walls in longitudinal direction in staggered rows. Pipes with such slots are relatively easy to expand radially outwardly by running a mandrel or the like through the pipes.

[0003] Various proposals have been made in the past to provide connectors for EST pipes that permit expansion of the connectors in a corresponding manner to the pipes. US Patent 5,924,745, for example, discloses a connector assembly for connecting expandable slotted tubing which has mating parts which are themselves slotted. Generally, such special connectors are relatively costly.

Summary of the invention

[0004] The invention provides a string of expandable slotted tubulars comprising at least two tubular lengths each comprising a first longitudinal end, a second longitudinal end, and an expandable middle section connecting the first longitudinal end and the second longitudinal end, wherein the expandable middle section is provided with a pattern of slotted perforations; and wherein the first and second longitudinal ends are respectively provided with first and second connectors which are not expandable, and wherein the first connector of one of the at least two tubular lengths is connected to the second connector of adjacent one of the at least two tubular lengths thereby forming part of a string of expandable slotted tubulars.

[0005] In another aspect, the invention provides a method of expanding a string of slotted tubulars, comprising:

- providing a string of expandable slotted tubulars as defined above; and
- moving a flexible expansion device in a longitudinal direction through the string of expandable slotted tubulars, thereby expanding the respective middle sections while leaving the connectors unexpanded.

Brief description of the drawing

[0006] The appended drawing, which is non-limiting, comprises the following figures:

Fig. 1 schematically shows a string of expandable slotted tubulars having unexpandable connectors after running into a borehole;

Fig. 2 schematically shows the string of Fig. 1 after expanding.

Detailed description of the invention

[0007] The invention will be further illustrated herein-after by way of example only, and with reference to the non-limiting drawing. The person skilled in the art will readily understand that, while the invention is illustrated making reference to one or more specific combinations of features and measures, many of those features and measures are functionally independent from other features and measures such that they can be equally or similarly applied independently in other embodiments or combinations.

[0008] A string of expandable slotted tubulars is made of at least two tubular lengths. Each of the tubular lengths has a first longitudinal end, a second longitudinal end, and an expandable middle section connecting the longitudinal ends. The expandable middle section is provided with a pattern of slotted perforations, and can be expanded. The first and second longitudinal ends are respectively provided with first and second connectors, which, in contrast to previously employed expandable slotted tubular strings, are non-expandable connectors.

[0009] Non-expandable connectors, in this context means that, while an original diametrical size of the non-expandable connectors is preserved when expanding the string of expandable slotted connectors. After installation of the string, the expandable middle sections of the slotted tubulars have been expanded to a larger diameter as compared to an original diameter, while the original diametrical size of the non-expandable connectors is preserved.

[0010] It is expected that the presently proposed string of expandable slotted tubulars can be made from lower quality (hence lower cost) materials than the EST having premium connectors.

[0011] Preferably, wherein the first and second connectors are unslotted or at least unperforated. Herewith it is achieved that the connectors are blocking flow of production fluids, and thus the lack of physical contact between the EST and the borehole wall at the connectors is not adversely affecting the borehole stability.

[0012] Figure 1 schematically shows a string 10 of expandable slotted tubulars run in a borehole 8 in the earth. The string 10 comprises at least two tubular lengths 12 joined together. Each of the tubular lengths 12 comprise a first longitudinal end 14, a second longitudinal end, and an expandable middle section 18 which connects the first

longitudinal end 14 and the second longitudinal end 16. The expandable middle section is provided with a pattern of slotted perforations 20 (for reasons of clarity, not all perforations are individually identified in the drawing). The first and second longitudinal ends (14,16) are respectively provided with first and second connectors which are not expandable. Such connectors may be standard treaded pipe or casing joints commonly used in the oil field industry. The first and second connectors (14,16) may be unslotted and/or unperforated, such as standard joints are. The first and second connectors (14,16) are preferably threaded connectors, but alternatively the first and second connectors may be welded connectors.

[0013] In an assembled configuration, the first connector 14 of one of the at least two tubular lengths is connected to the second connector 16 of an adjacent one of the at least two tubular lengths. Herewith, the string 10 of expandable slotted tubulars. In the assembled configuration, the expandable middle sections 18 of respective adjacent tubular lengths 12 are separated from each other by said connectors (14,16).

[0014] After providing the string 10 of expandable slotted tubulars as described thus far, the string 10 of slotted tubulars may be expanded. An expansion operation may include moving a flexible expansion device in a longitudinal direction through the string 10 of expandable slotted tubulars, thereby expanding the respective middle sections 18 while leaving the connectors (14,16) unexpanded. The end result is schematically illustrated in Fig. 2. The slotted perforations 20 from Fig. 1 have dilated into deformed slots 20', as described in for example US patent 5,366,012. (Again, for clarity reasons, not all deformed slots 20' have been marked in the figure).

[0015] The moving of the flexible expansion device through the string 10 of expandable slotted tubulars may be accomplished by exerting a translation force to the expansion device, which results in the expansion device applying a stress on the string of slotted tubulars in a contact area between the expansion device and the string of slotted tubulars. The flexible expansion device may be a force-limited collapsible cone, sometimes referred to as a compliant cone. Non-limiting examples are shown in US patents 7,360,604 7,681,636; 8,561,690; and US pre-grant publication US 2016/0362968. Suitably, the stress is limited to a predetermined maximum stress, by (partly) collapsing of the flexible expansion device when the predetermined maximum stress is reached. Suitably, the predetermined maximum stress is higher than a first yield stress in the middle sections of the string of slotted tubulars and lower than a second yield stress in the connectors. The yield stress is a material property which defines the stress at which a material begins to deform plastically. Once the material is exposed to its yield stress, some fraction of deformation will be permanent and non-reversible.

[0016] As shown in Fig. 1, the string of slotted tubulars may be run into a borehole in the earth prior to expanding.

At least part of the string of slotted tubulars may be located in an uncased part of the borehole, in order to provide mechanical support to the exposed formation layers. If desired, the slotted tubulars may be provided with expandable well screens, such as those disclosed in US patents 5,901,789 and 6,315,040 or similar.

[0017] The person skilled in the art will understand that the present invention can be carried out in many various ways without departing from the scope of the appended claims.

Claims

1. A string of expandable slotted tubulars comprising at least two tubular lengths each comprising a first longitudinal end, a second longitudinal end, and an expandable middle section connecting the first longitudinal end and the second longitudinal end, wherein the expandable middle section is provided with a pattern of slotted perforations; and wherein the first and second longitudinal ends are respectively provided with first and second connectors which are not expandable, and wherein the first connector of one of the at least two tubular lengths is connected to the second connector of an adjacent one of the at least two tubular lengths thereby forming part of a string of expandable slotted tubulars.
2. The string of claim 1, wherein the first and second connectors are unslotted and/or unperforated.
3. The string of claim 1 or 2, wherein middle sections of respective adjacent tubular lengths are separated from each other by said connectors.
4. The string of any one of claims claim 1 to 3, wherein the first and second connectors are threaded connectors.
5. The string of any one of claims claim 1 to 3, wherein the first and second connectors are welded connectors.
6. Method of expanding a string of slotted tubulars, comprising:
 - providing a string of expandable slotted tubulars in accordance with any one of claims 1 to 5;
 - moving a flexible expansion device in a longitudinal direction through the string of expandable slotted tubulars, thereby expanding the respective middle sections while leaving the connectors unexpanded.
7. The method of claim 6, wherein moving the flexible expansion device in said longitudinal comprises exerting a translation force to the expansion device

which results in the expansion device applying a stress on the string of slotted tubulars in a contact area between the expansion device and the string of slotted tubulars, which stress is limited to a predetermined maximum stress by collapsing of the flexible expansion device. 5

8. The method of claim 7, wherein the predetermined maximum stress is higher than a first yield stress in the middle sections of the string of slotted tubulars and lower than a second yield stress in the connectors. 10
9. The method of any one of claims 6 to 8, wherein prior to expanding the respective middle sections the string of slotted tubulars is run into a borehole in the earth. 15
10. The method of claim 9, wherein at least part of the string of slotted tubulars is located in an uncased part of the borehole. 20

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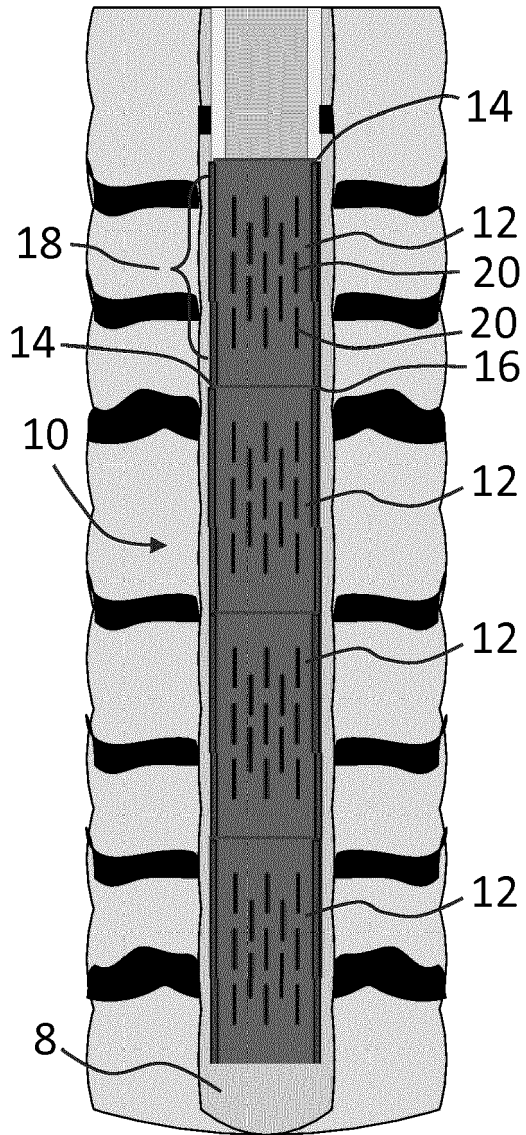


Fig. 1

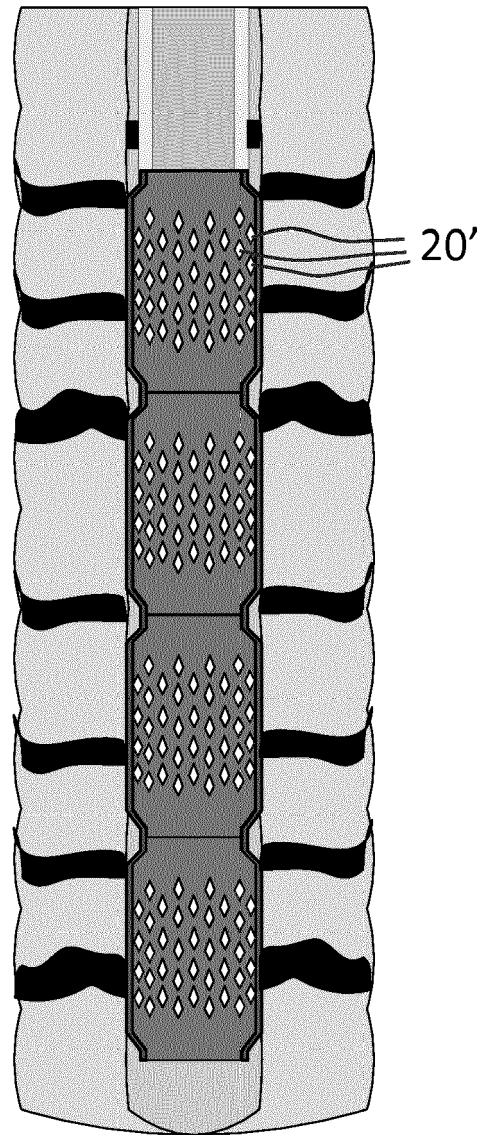


Fig. 2



EUROPEAN SEARCH REPORT

 Application Number
 EP 18 16 3873

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			TECHNICAL FIELDS SEARCHED (IPC)
			E21B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 31 August 2018	Examiner 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			

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 EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 18 16 3873

5 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
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31-08-2018

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