(12) UK Patent (19) GB (11) 2539818 (13) B

(45) Date of B Publication **17.02.2021**

(54) Title of the Invention: Well head stabilizing device and method

(51) INT CL: ***E21B 33/035*** (2006.01)

(21) Application No: **1613660.8**

(22) Date of Filing: **18.02.2015**

Date Lodged: **09.08.2016**

(30) Priority Data:
(31) **20140210** (32) **18.02.2014** (33) **NO**

(86) International Application Data:
PCT/NO2015/050034 No 18.02.2015

(87) International Publication Data:
WO2015/126259 En 27.08.2015

(43) Date of Reproduction by UK Office **28.12.2016**

(56) Documents Cited:

GB 2198768 A	**US 5927403 A**
US 4499950 A	**US 3561531 A**
US 3352357 A	**US 20030029620 A1**

(58) Field of Search:
As for published application 2539818 A viz:
INT CL **E21B**
Other: **EPODOC, WPI**
updated as appropriate

Additional Fields
Other: **None**

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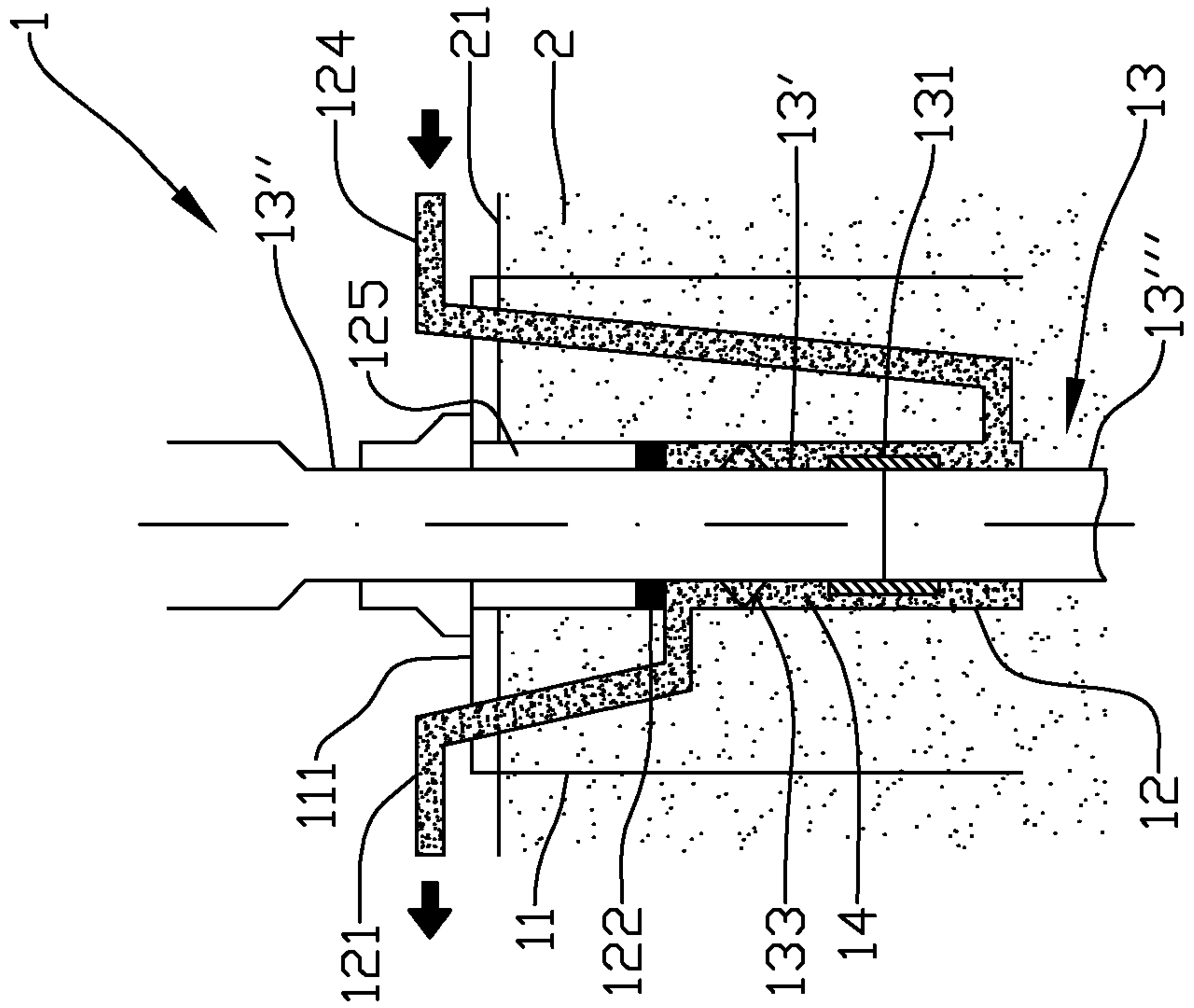
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21
2
13'
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13
13'''
125
111
121
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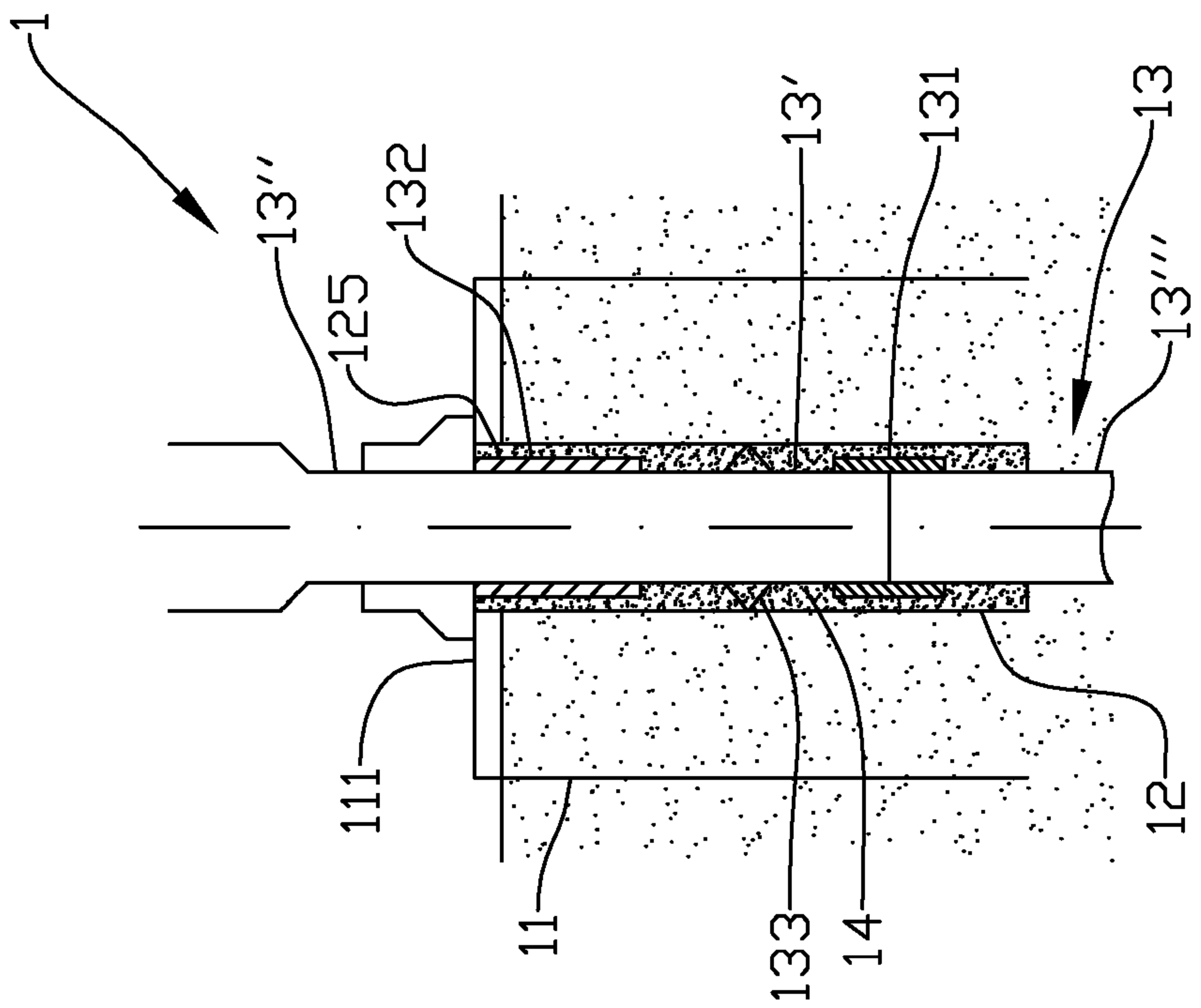
122
133
14
12

Fig. 1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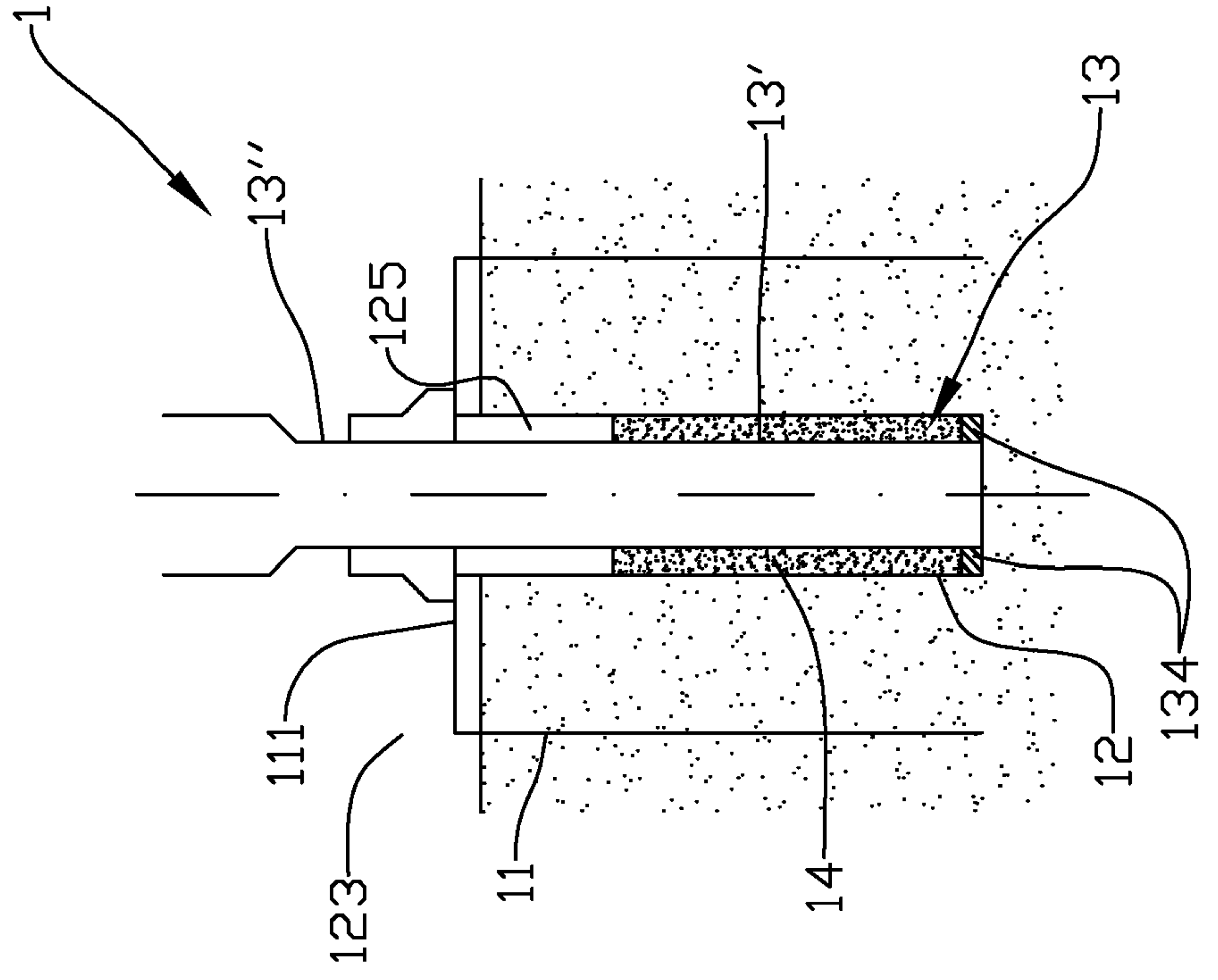
12

Fig. 2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13'
13
111
123
11
14
12
134

Fig. 4

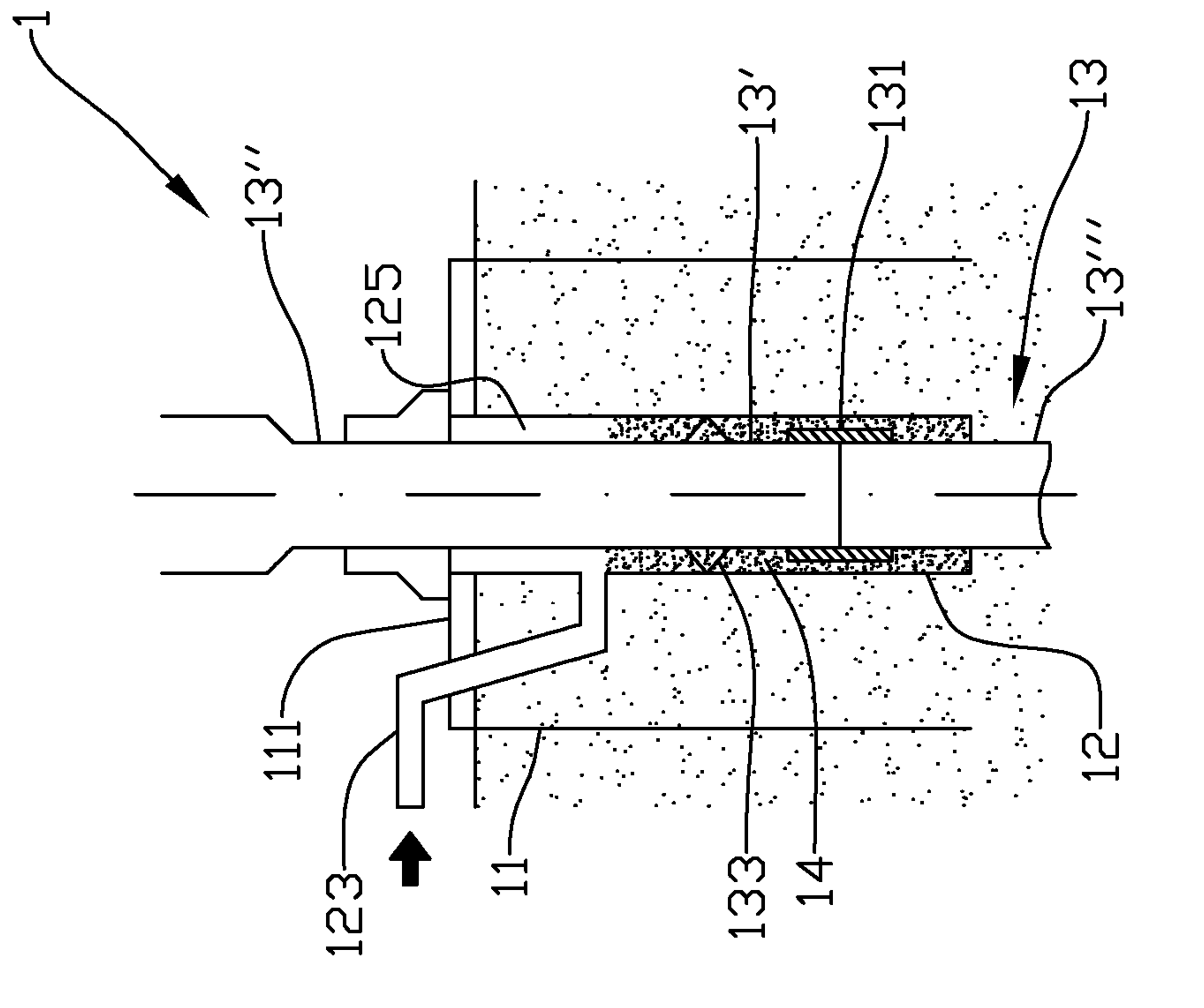
1
13''
125
13'
131
13
13'''
111
123
11
133
14
12

Fig. 3

WELL HEAD STABILIZING DEVICE AND METHOD

The invention relates to a device and a method for stabilizing a well head which includes a well base arranged on a seabed.

When a subsea well for extracting petroleum, for example, is established, a well-foundation system is installed on the seabed. A conventional base is usually established by a hole being drilled in the seabed (usually 36" or 42", equivalent to 914 mm or 1067 mm, respectively), in which a conductor casing (usually 30" or 36", equivalent to 762 mm or 914 mm, respectively) is lowered into and fixed in the unconsolidated masses by a cement slurry being pumped in for the purpose of completely filling the space between the conductor casing and the hole wall. Thereby it is sought to achieve two primary aims:

1) the cured cement is to give full lateral support to the conductor casing up to the seabed, and

2) the cured cement is to give enough cover and strength for the first coupling of the conductor casing to be fully embedded and protected from any movements transmitted from a connected riser system to the conductor casing.

It turns out in practice that loss of cement slurry into, above all, permeable layers of unconsolidated mass may occur, and the conductor casing may move during the curing of the cement. This leads to the cement having a reduced quality, and it leads to the stiffness of the conductor casing being reduced to such a degree that specific design requirements are not reached, with the consequence that the fatigue strength of the well will be too low or that the load capacity of the well will not be fulfilled.

The invention has for its object to remedy or reduce at least one of the drawbacks of the prior art or at least provide a useful alternative to the prior art.

The object is achieved through features, which are specified in the description below and in the claims that follow.

A well-foundation system for a subsea well for production of petroleum, for example, is provided. A support column is set into an unconsolidated mass below a sea floor and forms a reliable mounting for a conductor casing so that a structure, which is predictable and as reliable as possible with respect to the stability and load capacity of a well head is provided through a direct coupling between the unconsolidated mass, the support column and the conductor casing of the well. The support column is driven down into the unconsolidated mass with a jacket surface in direct contact with the unconsolidated mass without any predrilling of holes or use of cement or other fillers, for example by the use of a suction base, for example a so-called CAN (Conductor Anchor Node) according to the applicant's own NO patent No. 313340, or other methods. Then the conductor casing is installed through the support column in a manner known *per se*, for example by a hole being drilled into the unconsolidated mass into which the conductor casing is lowered. The conductor casing is fixed and supported in the support column. Thereby a predetermined and controlled hanging-off of the conductor casing, an accurate positioning of the attachment point of the conductor casing, that is to say the transition between a supported portion and a freely flexible portion of the conductor casing, and full cementing of the conductor casing in the support column below said attachment point are achieved.

The support column can be driven down into the unconsolidated mass, for example as an integral part of a suction base, that is to say a suction base with a closed top and an open bottom, in which an underpressure is worked up inside the well base by water mass enclosed by the well base and the seabed being pumped out, so that the downward resultant force arising on the well base through said underpressure is used to press the suction base and the support column down into the unconsolidated mass. Thereby the support column is positioned in good contact with the unconsolidated mass over its entire length and forms a reliable lateral and vertical support for the conductor casing during the subsequent installation of the conductor casing in the support column.

The support column may also be driven down into the unconsolidated mass by means other than the suction base as described above, for example by it being driven in by means of a hammer, and it may be part of a well frame or other supporting structure, which is anchored to the seabed with one or more suction anchors.

The task of the support column is to provide a continuous contact surface against the unconsolidated mass without the use of cement or other types of filler or grouting material between the unconsolidated mass and the jacket surface of the support column, so that a planned and checkable stability and a well-defined interface against the unconsolidated mass are achieved.

The support column may form a seat for the conductor casing, as the conductor casing is passed through the former and hung off by means of suitable means, for example a suspension clamp, with a prescribed length projecting freely above the seabed. The conductor casing may then be cemented into the support column and, in a manner known *per se*, against the unconsolidated mass below the support column up to a prescribed level in the support column, so that the conductor casing will have an optimum free top length (for example in the range of 2-5 metres) with respect to fatigue and allowed distance of deflection. Primarily, the upper cement level is governed by the vertical positioning of a cement-diversion system arranged in the support column, alternatively by cement being flushed out of the annulus between the support column and the conductor casing until a prescribed upper cement level has been provided. To achieve an even and continuous filling of the annulus, the support column may be provided with a system for separately introducing cement or other grouting material from a lower level in the support column up to the chosen level of attachment of the conductor casing.

Advantageously, one or more centring means may be arranged between the support column and the conductor casing optimally placed for an exact definition of the attachment of the conductor casing to the support column.

In an alternative embodiment, the planned free conductor-casing length in the support column may have a coating of a suitable elastomer material in a prescribed, optimized thickness applied to it. In this embodiment, the conductor casing is cemented with a full cement filling to the top of the support column. After the cement has cured, this elastomer material will give the conductor casing the free conductor-casing length chosen in advance. A further effect of the elastomer material may be a damping of any potential large single swings resulting from lateral forces imposed through the riser system.

The invention is defined by the independent claims. The dependent claims define advantageous embodiments of the invention.

In a first aspect, the invention relates more specifically to a device for stabilizing a well head on a seabed, the device comprising:
- a well base having a support column for being driven down into an unconsolidated mass below the seabed,

- a conductor casing having a first portion that is encircled by the support column, and a second portion that projects upwardly from the first conductor-casing portion in an elastically flexible manner,

wherein an annulus is defined between the support column and the conductor casing, the annulus having a lower portion that encircles the first portion of the conductor casing, wherein the lower portion of the annulus is fillable with cement up to a predetermined level.

At the transition between the first and second conductor-casing portions, the annulus may be provided with a packer downstream of a cement-diversion system, which is arranged to carry any excess of cement away from the annulus.

The jacket surface of the second conductor-casing portion may be provided with an elastomer coating extending from the transition to the first conductor-casing portion and at least to the upper edge of the upper portion of the well base, and at least a portion of the elastomer coating is surrounded by cement.

The support column may be provided with a flushing line which discharges into the annulus at the level of the transition between the first and second conductor-casing portions.

The support column may be provided with a cementing line, which discharges into a lower portion of the annulus between the support column and the conductor casing.

In a substantial part of its longitudinal extent, the support column may rest in a laterally supporting manner against an unconsolidated mass.

A third conductor-casing portion may extend downwards in an unconsolidated mass below the support column.

The conductor casing may extend upwards from a conductor-casing attachment, the conductor casing and a lower end portion of the support column being interconnected via the conductor-casing attachment.

In a second aspect, the invention relates more specifically to a method of stabilizing a well head on a seabed, the method including the following steps:

- providing a well base having a support column;
- driving the support column down into an unconsolidated mass below the seabed;
- providing a conductor casing having a first portion and a second portion, the

second portion projects upwardly from the first portion in an elastically flexible manner;

- lowering the conductor casing into the support column so that an annulus is defined between the support column and the conductor casing, the annulus having a lower portion that encircles the first portion of the conductor casing;
- filling the lower portion of the annulus with cement up to a predetermined level; and
- establishing the well head on the second conductor-casing portion projecting upwards.

The method may further include the step:

- limiting the annulus with a packer at the transition between the first and second conductor-casing portions.

The method may further include the step:

- filling the annulus by letting the cement enter a lower portion of the support column.

The method may further include the steps:

- limiting the annulus with a packer at the transition between the first and second conductor-casing portions;
- filling the annulus by letting the cement enter a lower portion of the support column; and
- carrying an excess amount of cement out of the annulus through a cement-diversion system arranged at the lower edge of the packer.

The method may further include:

- flushing an excess amount of cement out of the annulus by means of a flushing line discharging into the annulus at the level of the transition between the first and second conductor-casing portions.

In what follows, an example of a preferred embodiment is described, which is visualized in the accompanying drawings, in which:

Figure 1 shows, in an axial section, a principle drawing of the conductor casing of a petroleum well supported by a support column integrated in a suction base driven down into seabed sediments, the attachment point of the conductor casing being determined by the use of a packer and a diversion system for cement;

Figure 2 shows, in an axial section, a principle drawing of the conductor casing of a petroleum well supported by a support column integrated in a suction base driven down into seabed sediments, the attachment point of the conductor casing being determined by the use of an elastomer material over a length which gives the desired free mounting length of the conductor casing; and

Figure 3 shows, in an axial section, a principle drawing of the conductor casing of a petroleum well supported by a support column integrated in a suction base driven down into seabed sediments, the attachment point of the conductor casing being determined by the flushing-out of injected cement above a level which gives the prescribed free mounting length of the conductor casing;

Figure 4 shows, in an axial section, a principle drawing of a shorter conductor casing fixed in a lower portion of a support column integrated in a suction base driven down into seabed sediments, the upper attachment point of the conductor casing being determined by a controlled filling of cement to a level arranged to give the prescribed free mounting length of the conductor casing, the conductor casing being fixed to the support column before the base is put down on the seabed.

In the figures, the reference numeral 1 indicated a well head arranged on a seabed 21 over a layer of unconsolidated mass 2. In a well base 11, which, in its simplest embodiment, may be a support column 12 driven down into the unconsolidated mass, but which is shown in the figures as a suction base which is driven down, together with an integrated support column 12, into the unconsolidated mass 2, the support column 12 being arranged for the support and hanging-off of a conductor casing 13 extending downwards in the unconsolidated mass 2 in a manner known *per se*. The conductor casing 13 may be placed in the unconsolidated mass 2 in any known way. The conductor casing 13 may be sectioned and may thereby include several conductor-casing joints 131 in a manner known *per se*, only one shown in figures 1-3. Centring means 133 may provide for the conductor casing 13 to be centred in the support column 12.

In an annulus 125 between the support column 12 and a first portion 13' of the conductor casing 13, cement 14 has been introduced. The cement 14 may have been injected separately into the annulus 125 through a cementing line 124 as it is shown in figure 1. A third portion 13''' of the conductor casing 13 may extend downwards in the unconsolidated mass 2 under the support column 12 and may, if necessary, be surrounded by cement (not shown) filling up cavities between the third portion 13''' of the conductor casing 13 and the unconsolidated mass 2. In this embodiment, the cement 14 may be carried up the annulus in the support column 12 while the third conductor-casing portion 13''' is being cemented into the unconsolidated mass 2.

In figure 1, a packer 122 prevents the cement 14 from flowing up the annulus 125 between the support column 12 and a second conductor-casing portion 13" projecting freely up through an upper portion of the support column 12 and up above an upper portion 111 of the well base 11. The packer 122 is placed at a distance below the top surface 111 for the cement 14 to form a lateral support for the conductor casing 13 at a prescribed distance below the well head 1. In this embodiment, a sufficient filling of the annulus 125 will be ensured by excess cement being allowed to leave the annulus 125 through a cement-diversion system 121, which also functions as a diversion system for water *et cetera* which is driven up through the annulus 125 in front of the cement 14. The cement-diversion system 121 may include means, not shown, for regulating the level of the cement 14 in the annulus 125, for example a pump. The length of the second conductor-casing portion 13" and the positioning of the packer 122 are determined on the basis of the requirements for the length of deflection of the conductor casing 13, which is typically in the range of 2-6 metres.

Figure 2 shows a second exemplary embodiment, in which parts of the jacket surface of the second conductor-casing portion 13" is covered by an elastomer coating 132. The elastomer coating 132 extends from an upper edge of the upper portion 111 of the well base 11 to a prescribed distance below the upper portion 111. In this embodiment, cement 14 is filled to the top of the support column 12. The elastomer coating 132, which is yielding, will thereby allow the second conductor-casing portion 13" to deflect laterally corresponding to the exemplary embodiment shown in figure 1.

Figure 3 shows a third exemplary embodiment, in which a flushing line 123 discharges into the support column 12 at a distance below the upper portion 111 of the well base 11. Excess cement 14 is flushed out of the annulus 125 so that the second conductor-casing portion 13" stands freely in the support column 12 to be able to deflect sideways corresponding to the exemplary embodiment shown in figure 1.

Figure 4 shows a fourth exemplary embodiment, in which a short conductor casing 13 is attached to a lower portion of the support column 12 by means of a conductor-casing attachment 134, and in which cement 14 has been filled into the annulus 125 to a prescribed level based on the requirements for the length of deflection of the conductor casing 13. The advantage of this embodiment is that the joining of the conductor casing 13 and the support column 12 and the filling of cement 14 into the annulus 125 can be carried out before the assembly is placed on the seabed 21 and driven down into the unconsolidated mass 2, for example at an onshore facility, before the assembly is transported to the location where the well head 1 is to be established.

With its embodiments, the invention provides a system for a predetermined fixing of the conductor casing 13 of a subsea well head 1 into the surrounding unconsolidated masses 2, it being possible to give the conductor casing 13 a controllable attachment point, preferably placed below the seabed 21, so that the conductor casing 13 will be arranged with a predetermined free length of the second conductor-casing portion 13" for optimum utilization of the elastic properties of the conductor casing 13 in a calculated, reliable way.

The support column 12 is forced down into the unconsolidated mass 2 below the seabed 21 and given stable lateral support in the unconsolidated mass 2 as a well base 11 alone or part of a more complex well base 11.

By providing the conductor casing 13 with a suspension device, not shown, for vertical support in the support column 12 or the well base 11, the conductor casing 13 according to the exemplary embodiments of figures 1-3 may be disconnected from a pipe-landing string, not shown, while the cement is curing. Thereby the best possible conditions are provided for developing full cement strength without breaking cement bindings, by the conductor casing 13 not being subjected to movements during the setting and initial curing of the cement 14.

A further advantage of the invention is that the support column 12 forms a barrier between the cement 14 and the unconsolidated mass 2 during the introduction of the cement 14, so that the cementing of the first conductor-casing portion 13' may take place under near-ideal conditions and full cement strength be achieved after curing and planned stability be achieved for both the conductor casing 13 in general and the conductor-casing joint 131 in particular.

c l a i m s

1. A device for stabilizing a well head on a seabed, the device comprising
   - a well base having a support column for being driven down into an unconsolidated mass below the seabed;
   - a conductor casing having a first portion that is encircled by the support column, and a second portion that projects upwardly from the first portion in an elastically flexible manner,

   wherein an annulus is defined between the support column and the conductor casing, the annulus having a lower portion that encircles the first portion of the conductor casing,
   wherein the lower portion of the annulus is fillable with cement up to a predetermined level.

2. The device according to claim 1, wherein the well base further comprises a suction base.

3. The device according to claim 2, wherein the support column is formed integrally with the suction base.

4. The device according to any one of claims 1-3, wherein an upper portion of the annulus is free from cement.

5. The device according to any one of claims 1-4, further comprising a packer arranged at a transition between the first and second portions of the conductor-casing.

6. The device according to any one of the preceding claims, further comprising a cement-diversion system which is arranged to carry away an excess of cement from the annulus.

7. The device according to any one of claims 1-3, wherein the second conductor-casing portion is provided with an elastomer coating and an upper portion of the annulus is at least partly filled with cement.

8. The device according to any one of claims 1-4, wherein the support column is provided with a flushing line discharging into the annulus at the level of the transition between the first and second conductor-casing portions.

9. The device according to any one of the preceding claims, wherein the support column is provided with a cementing line discharging into a lower portion of the annulus between the support column and the conductor casing.

10. The device according to any one of the preceding claims, wherein the lower portion of the support column rests in a laterally supporting manner against the unconsolidated mass.

11. The device according to any one of the preceding claims, wherein a third conductor-casing portion extends downwards in the unconsolidated mass below the support column.

12. The device according to any one of claims 1-4, further comprising a conductor-casing attachment for joining the conductor casing and a lower end portion of the support column so that the annulus forming therebetween may be filled with cement before placing the device on the seabed.

13. A method of establishing a well head on a seabed, the method includes the following steps:

providing a well base having a support column;

driving the support column down into an unconsolidated mass below the seabed;

providing a conductor casing having a first portion and a second portion, the second portion projects upwardly from the first portion in an elastically flexible manner;

lowering the conductor casing into the support column so that an annulus is defined between the support column and the conductor casing, the annulus having a lower portion that encircles the first portion of the conductor casing;

filling the lower portion of the annulus with cement up to a predetermined level; and

establishing the well head on the second conductor-casing portion projecting upwards.

14. The method according to claim 13, wherein the method further includes the step:

installing a packer in the annulus at the transition between the first and second conductor-casing portions.

15. The method according to claims 13 or 14, wherein the step of filling the lower portion of the annulus with cement up to a predetermined level, includes:

letting the cement enter a lower portion of the support column.

16. The method according to claim 14 or 15 insofar as dependent on claim 14, wherein the method further includes the steps:

providing a cement-diversion system at a lower edge of the packer; and

diverting an excess amount of cement out of the annulus through the cement-diversion system.

17. The method according to claim 13, wherein the method further includes the steps:

providing a flushing line discharging into the annulus at the level of the transition between the first and second conductor-casing portions; and

flushing an excess amount of cement out of the annulus by means of the flushing line .