(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
17 February 2011 (17.02.2011)

PCT

(10) International Publication Number
WO 2011/018120 A1

(51) International Patent Classification: *E21B 33/043* (2006.01)

(21) International Application Number: PCT/EP2009/060564

(22) International Filing Date: 14 August 2009 (14.08.2009)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: **STATOIL ASA** [NO/NO]; Forusbeen 50, Forus, N-4035 Stavanger (NO).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: **WASA TVERLID, Steinar** [NO/NO]; Geitavegen 4, N-5177 BjØrØyhamn (NO).

(74) Agent: **MARKS & CLERK LLP**; 4220 Nash Court, Oxford Business Park South, Oxford OX4 2RU (GB).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) **Title**: SUBSEA WELL HEAD STRUCTURE

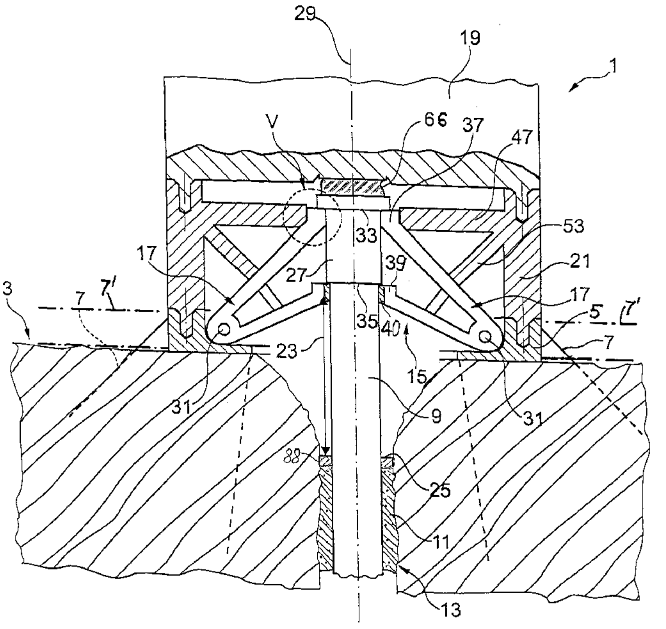

Fig. 1

(57) Abstract: The subsea well head structure (1) comprises a foundation ring (5) adapted to be supported on a seabed (3), a tubular casing portion (9) to be positioned uppermost in a borehole (13) coaxially with the foundation ring (5), a hanger structure (15) mounted on the foundation ring (5) for supporting the casing portion (9) on the foundation ring (5) through a first load supporting path, and a blow-out preventer (19) which is mounted to the foundation ring (5) through a supporting structure (21) supporting the blow-out preventer (19) on the foundation ring (5) through a second load supporting path in parallel to the first load supporting path of the hanger structure (15).

WO 2011/018120 A1

Subsea Well Head Structure

The invention relates to a subsea well head structure.

The surface termination of an oil or natural gas wellbore incorporates facilities for installing a casing during the well construction phase and also may incorporate flow control equipment like a Christmas tree or a blow-out preventer during the production phase. The well head structure is founded on the seabed with a foundation structure that rigidly holds an upper end of a tubular casing and ties it firmly to the blow-out preventer.

Common subsea well head structures, for example as known from US patents 2 207 471, 3 137 348 and 3 330 339 or US 2009/0 032 241 A1 or NL 282 753 and NL 70 001 comprise a foundation ring provided with a hanger structure for supporting the casing and/or other tubing on the foundation ring. The well head equipment, in particular a blow-out preventer is mounted to and supported by the hanger structure. The load of the blow-out preventer and of a riser leading up to the sea level is taken up through the hanger structure. The well head therefore is exposed to fatigue failure. This may lead to stricter operational constraints, higher costs and potential serious environmental problems due to loss of the well integrity.

It is an object of the invention to provide for a simple subsea well head structure capable of an improved handling of operational stresses and loads acting on the well head structure.

The subsea well head structure according to the invention comprises:

- a foundation ring adapted to be supported on a seabed,

- a tubular casing portion to be positioned uppermost in a borehole coaxially with the foundation ring,
- a hanger structure mounted on the foundation ring for supporting the casing portion on the foundation ring through a first load supporting path, and
- a blow-out preventer.

The improvement according to the invention is characterized in that the blow-out preventer is mounted on the foundation ring through a supporting structure supporting the blow-out preventer on the foundation ring through a second load supporting path in parallel to the first load supporting path of the hanger structure.

Through the hanger structure and the support structure the foundation ring rigidly holds the casing portion and the blow-out preventer and firmly ties them together, while any operational loads are directly transferred into the seabed. Even in case of larger blow-out preventers and significant off-center riser tension an overload of the well head and its sensitive components can be avoided. The potential risk of fatigue failure and a loss of well integrity can largely be reduced. Due to the improved load distribution a conductor which is used as a foundation of known well head structures may be omitted. The well head structure according to the invention can be connected directly to a surface casing. Of course a traditional conductor may also be used.

Preferably, the foundation ring is fixed to the seabed, for example through a plurality of anchors or piles or the like jarred into the seabed. As may be easily understood the foundation ring can also be a part of a larger subsea structure, like a template arrangement. Fixing the foundation ring to said larger subsea structure will eliminate any significant momentum taken up by the connection between the blow-out preventer and the well head, i.e. the casing portion.

In a preferred embodiment, the hanger structure comprises a plurality of supporting elements which are movably guided on the foundation ring and are distributed around the casing portion to be individually seated on the casing portion. The hanger structure relies on a truss work load carrying principle which allows to keep momentums at a minimum. The load carrying stresses on the well head are transferred as hoop-stresses symmetrically distributed around the axis of the well head, thus providing for a very efficient manner of load transfer.

Preferably, the supporting elements are supporting arms pivotably mounted on the foundation ring so as to extend upwardly and towards a center of the foundation ring and are adapted to be seated against a shoulder of the casing portion. Stresses exerted onto the supporting arms and/or the casing portion tend to close any tolerance gaps between the casing portion and the supporting arms seated thereon and will make the grip of the supporting arms tighter.

In a preferred embodiment, the casing portion has a shoulder extending in circumferential direction around the casing portion and each supporting arm has two end sections at an axial distance from one another, a first end section of which is adapted to be seated on the shoulder. Seated on the downwardly facing shoulder, the first end section takes up vertical and horizontal loads of the casing portion. The second end section faces the outer circumference of the casing portion and at least is loaded in horizontal direction. Preferably, the casing portion has two shoulders extending in circumferential direction around the casing portion at an axial distance from one another so that each of the two end sections of each supporting arm can be seated on a different one of the two downwardly facing shoulders. This double belt supporting structure allows transfer of major well head load stresses to the seabed.

The two end sections of each supporting arm form two load carrying interfaces with respect to corresponding counterfaces on the casing portion. To provide for a defined load distribution at both end section even in case of dimensional tolerances in a preferred embodiment the second one of the two end sections radially resiliently engages the casing portion. It is reasonable to make the upper end section of each supporting arm, i.e. the first end section, the master support with both horizontal and vertical support capacity. The main function of the lower end section, i.e. the second end section, is to accommodate for any momentum in the casing portion caused by horizontal forces. Preferably, the second end sections or the surface of the casing portion associated to the second end sections is equipped with a lining of elastic material, for example rubber. The elastic liner may be in the form of an elastic tenter ring prepositioning the supporting arms such that during instalment of the casing portion an opening is left within the end sections for introducing the casing portion.

Another option to eliminate any significant momentum to be taken up by the connection between the blow-out preventer and the well head is to fix the foundation ring to a larger subsea structure, like a template.

Since the supporting arms are pivotably mounted on the foundation ring, the well head installation procedure is simplified. After inserting the casing portion through the foundation ring the supporting arms will be seated on the casing portion through gravity. Preferably, the supporting structure of the blow-out preventer comprises locking means adapted to lock the supporting arms in a position seated on the casing portion. Thus, locking forces are also directed to the foundation ring through the second load supporting path. Preferably, the locking means are in the form of a disk-like locking ring enclosing the supporting arms coaxially to the foundation ring. In a preferred embodiment, the locking means and the arms have corrugated structured mutual abutment surfaces adapted to prevent pivotal movement of the arms in their seating position at least in a pivotal movement direction away from the casing portion.

The locking means can be adapted to prevent pivotal movement of the supporting arms both towards the casing portion and away from the casing portion, but preferably the locking system blocks only the pivotal movement of the supporting arms away from the casing portion, but allows approach of the supporting arms towards the casing portion. On additional loading of the system, for example when another casing is installed inside of already installed tubulars, the lock will tighten around the outermost casing and will improve the clamping action. However, the locking means prevents the system to release the clamping in a reverse situation of off-loading. In a preferred embodiment, ratchet means are associated to the locking means and the supporting arms adapted to allow pivotal movement of the supporting arms in the direction towards the casing portion and to prevent pivotal movement of the supporting arms in the direction away from the casing portion. The corrugated structure mentioned above may be dimensioned to form said ratchet means. Of course, the ratchet means may comprise a plurality of pawls of the like associated to a corrugated structured surface provided on the locking means or the supporting arms.

The at least one shoulder provided on the casing portion for seating the supporting arms preferably is in the form of a cranked section of the casing portion and provide an oppositely directed inner shoulder adapted to support a casing tube portion inserted into the casing portion. The casing tube portion has a complementary shoulder to be seated on the inner shoulder of the casing portion to axially support the casing tube within the casing portion. Since the supporting arms exert radial pressure onto the casing portion also gaps between the casing portion and the casing tube can be leveled out. The radial pressure can be engineered by designing the length of the supporting arms, and therefore also the positioning angle of the supporting arms, and in this way the horizontal component of the clamping force, which controls the casing hanger assembly squeeze.

To improve the stiffness of the well head structure, the supporting structure of the blow-out preventer preferably is a support ring co-axially surrounding the hanger structure. The supporting structure and/or the blow-out preventer may comprise a plurality of plug-in positioning elements to be seated at complementary mating plug-in positioning elements of the foundation ring and/or the supporting structure, respectively. The positioning elements allow easy positioning of the supporting structure and the blow-out preventer relatively to each other and to the foundation ring fixed on the seabed.

When installed to the seabed, the casing portion of the well head structure is cemented into the wellbore. In a preferred embodiment, an upper portion of the borehole is left free of cement to provide a predetermined length of the casing portion freely extending between a cemented section of the casing portion below the foundation ring and an upper section of the casing portion coupled to the hanger structure. Any movement in the well head structure due to for example a flexible seabed will move the entire structure keeping the upper section of the casing portion and the blow-out preventer at minimal relative movement. This movement will be taken up by the casing portion over the predetermined freely extending length between the cemented section and the hanger structure, i.e. the supporting arms thereof. Providing a freely flexible length of the casing portion extending downwards of the foundation ring significantly lowers fatigue failure problems.

A second aspect of the invention is directed to a method for installing a subsea well head structure, comprising the steps of

a) anchoring a foundation ring on a seabed, the foundation ring carrying a hanger structure for supporting a casing portion on the foundation ring through a first load supporting path,

b) drilling through the foundation ring a borehole into the seabed,

c) inserting the casing portion through the foundation ring into the borehole and coupling the casing portion with the hanger structure,

d) cementing the casing portion within the borehole,

e) mounting to the foundation ring a supporting structure adapted to support a blow-out preventer on the foundation ring through a second load supporting path in parallel to the first load supporting path of the hanger structure, and

f) mounting the blow-out preventer to the supporting structure.

The method allows installing of the subsea well head structure in a simple installation procedure. The well head structure facilitates post-installation interventions by providing easy access and de-installation of the components of the well head structure.

As explained above, the step of cementing the casing portion preferably includes the step of providing a predetermined length of the casing portion freely extending between a cemented section below the foundation ring and the hanger structure. The correct level of the cement can easily be assured by pre-installing a ring around the outside of the casing to be cemented. The ring acts as a restriction to free flow. The resistance would be low when water passes, but will increase as the cement front passes the restriction. The pump pressure will increase, and the operator will have a positive confirmation of the cement level and will stop the pumps.

In a preferred embodiment, the foundation ring in step a) is lowered and anchored to the seabed while a plurality of supporting arms which are pivotably mounted to the foundation ring to form the hanger structure engage a tenter ring device which locks the supporting arms in a radially outer position. In step c) the casing portion partially is inserted into the borehole through the tenter ring device whereupon the tenter ring device is simply lifted to free the supporting arms for seating against a shoulder of the casing portion.

Of course, other installation methods can be used. For example a traditional conductor tube can be pre-installed in the well head before the foundation ring is anchored on the seabed. The conductor can be made so short that it does not come in conflict with the seabed. Thereafter, the rest of the well head preparation operation can be performed as it is usual with a traditional well. The conductor will be used as a guide for inserting the casing so that the tenter ring device is not necessary.

Below a preferred embodiment of the invention will be described with reference to the accompanying drawings in which

Fig. 1 is a sectional view of a subsea well head structure installed on the seabed;

Fig. 2 is an exploded view of the well head structure;

Fig. 3 is a sectional view of the well head structure seen along a line III-III in Fig. 2;

Fig. 4 is a sectional view of the well head structure seen at a line V-V in Fig. 2;

Fig. 5 is a detail of the well head structure shown at V in Fig. 1;

Fig. 6 is a sectional view of a foundation ring of the well head structure in a position prior to installment on the seabed and

Figs. 7a to 7k show a well head structure shown in a sequence of steps during installment on the seabed.

Fig. 1 shows a subsea well head structure 1 of an oil and/or natural gas well. The well head structure 1 is installed on a seabed 3. As shown also in more detail in Figs. 3 to 5, the well head structure 1 comprises a foundation ring 5 which is fixed to the soil of the seabed 3 through a plurality of anchor plates 7 or piles or the like distributed around the foundation ring 5 and extending downwardly into the soil of the seabed 3 or fixed to a larger subsea structure, e.g. a template structure indicated at 7'.

The foundation ring 5 encloses an upper portion of a tubular casing 9 which is cemented at 11 into a wellbore 13 drilled into the seabed 3. An upper end of the casing 9 is engaged and coupled to the foundation ring 5 through a hanger structure 15. As explained in more detail below, the hanger structure 15 comprises a plurality of supporting arms 17 which transmit load and tension forces between the foundation ring 5 and the casing 9 through a first load supporting path.

The well head structure 1 comprises other well head equipment, in particular a blow-out preventer which schematically is shown at 19. The blow-out preventer 19 is supported on the foundation ring 5 through a tubular or ring-like supporting structure 21, which encloses the hanger structure 15 and supports the load of the blow-out preventer 19 on the foundation ring 5 through a second load supporting path which is independent but in parallel to the first load supporting path. Loads introduced from the blow-out preventer 19 and/or tensions and loads introduced for example from a raiser tube coupled to the blow-out preventer 19 or other equipment mounted to the blow-out preventer 19 therefore are transferred to the foundation ring 5 and thus the seabed 3 directly and without significantly influencing the hanger structure 15 and the casing 9 or other tubular components of the well head.

As shown in Fig. 1, an upper portion of the borehole 13 is left free of cement 11 to provide a predetermined length 23 of the casing 9 freely extending between an upper end 25 of the cemented section of the casing 9 below the foundation ring 5 and an upper section 27 of the casing 9 coupled to the hanger structure 15. The free length 23 of the casing 9 allows the upper end 27 to follow any movement of the foundation ring and the blow-out preventer 19 relatively to the seabed 3. This further minimizes fatigue failure problems.

As shown in more details also in Figs. 2 to 4, the supporting arms 17 radially extend upwardly towards a center 29 of the foundation ring

5 and are pivotably mounted for an up and down movement each at a pivot axis 31. The upper section 27 of the casing 9 is provided with two ring shoulders 33, 35 at an axial distance from each other. The ring shoulders 33, 35 are facing downwards and form seats for engaging with end portions 37, 39 provided on each of the supporting arms 17. In the process of installing the casing 9, the load exerted on the supporting arms 17 will tend to pivot the supporting arms 17 toward the center 29 and to close any tolerance gaps between the casing 9 and the end sections 37, 39 of the supporting arms 17. Stresses exerted onto the supporting arms 17 and/or the casing 9 tend to make the grip of the supporting arms 17 tighter through dimensioning the length and/or positioning angle of the supporting arms 17.

The upper end section 37 takes up both vertical and horizontal loads when seated under the downwardly facing shoulder 33. The lower end sections 39 are provided with a resilient liner 40, for example a rubber liner, to take up dimensional tolerances while accommodating for a momentum in the casing. In the embodiment shown in the figures also the end sections 39 take up both vertical and horizontal forces. If it is sufficient to take up only horizontal forces, the lower shoulder 39 is unnecessary.

As indicated at 40' in Fig. 3, the liners 40 can be combined to a ring which is wide enough to allow the casing portion 9 to pass through during installation of the well head. The ring 40' will be compressed while the upper end sections 37 are seated on the shoulder 33. During installation of the well head the ring 40' acts as a resilient tenter ring as it is explained below with respect to Figs. 7a to 7f.

As can be seen best from Fig. 2, the ring shoulders 33, 35 are in the form of a cranked section of the casing 9 and provide an oppositely directed inner shoulder 41 and 43 respectively. The inner shoulders 41, 43 are adapted to support at least one further casing tube 45 which is inserted into the casing 9. The casing tube 45 has complementary shoulders to be seated on the inner shoulders 41, 43 of the casing 9. By tightening the grip of the supporting arms 17 also the grip holding the casing tube 45 is enhanced and tolerances can be eliminated. As mentioned above the horizontal component of the clamping forces exerted by the supporting arms 17 onto the casing can be engineered by dimensioning the supporting arms 17.

The supporting structure 21 comprises locking means in the form of a locking ring 47 which engages with its inner circumference 49 a radially outward directed shoulder 51 of the upper one 37 of the end sections to prevent disengagement of the ring shoulders 33, 35. The locking means further comprise a conical abutment ring 53 engaging on an upper surface of each supporting arm 17 to prevent disengagement of the shoulders 33, 35.

As shown in Fig. 5, due to tolerances a gap 55 may remain between the abutment surfaces 49, 51 of the locking ring 47 and the end section 37, respectively. To nevertheless lock the supporting arms 17 the mating surfaces of the locking ring 47 and the supporting arm 17 have a corrugated structure as indicated at 57. The corrugated structure 57 forms ratchet means which allows pivotal movement of the supporting arms 17 towards the casing 9, but prevent pivotal movement of the supporting arms 17 away from the casing 9. If the support structure is further loaded, for example when another casing is installed inside the already installed tubulars, the lock will tighten around the outermost casing and enhance the clamping forces while the corrugated surfaces of the locking ring 47 and the supporting arms 17 will move relatively to each other. However, the lock prevents the clamp to release in a reverse situation of off-loading the inner casing. Other types of ratchet means can be used including rack and pawl arrangements.

To make the installment of the well head structure 1 more easy, the mating surfaces of the foundation ring 5 and the supporting structure 21 are provided with a plurality of plug-in positioning elements 59 which are to be seated at complementary mating plug-in positioning elements 61. Simply by lowering of the supporting structure 21 onto the foundation ring 5 and engaging of the plug-in positioning elements the supporting structure 21 can be centered relatively to the foundation ring 5 and the hanger structure 15 mounted thereon. Similar pairs of complementary plug-in positioning elements 63, 65 can be provided at mating surfaces between the blow-out preventer 19 and the supporting structure 21. Additional fixture can be provided to axially rigidly lock the blow-out preventer 19 to the supporting structure 21 and the foundation ring 5.

The blow-out preventer 19 can be connected to the upper end of the casing 9 through a common coupling. Preferably, the coupling is in the form of a solid steel joint, but could be a flexible joint 66 (Fig. 1) to allow for some movement between the blow-out preventer 19 and the upper end of the casing 9.

Figs. 7a to 7k show a possible sequence of operation steps, amongst many, for installing the subsea well head structure on the seabed 3 from above sea level which is indicated at 67. In a first step (Fig. 7a) the foundation ring 5 hanging on cables 69 at a bark or another vessel or the like is lowered to the seabed 3. The supporting arms 17 engage a tenter ring device 71 also shown in more detail in Fig. 6. The tenter ring device 71 holds the supporting arms 17 in an open position which allows the casing 9 to be inserted along the center of the foundation ring 5 without being engaged by the supporting arms 17. As shown in Fig. 7a, the tenter ring device provides for a support attachment of a lowermost drill pipe section 73 including a drill bit 75.

After having reached the seabed 3 (Fig. 7b), the cables 69 are detached from the foundation ring 5 and upper sections 77 of a drill pipe string are connected to the lowermost section 73 including a hammer mechanism 79 which jars the anchor plates 7 into the soil of the seabed 3 (Fig. 7c). The supporting arms 17 are positioned such that loads are directly transferred onto the anchors 7 via the foundation ring 5. Instead of anchor plates also suction anchors can be used.

Thereafter, a first section of the borehole 13 is drilled into the seabed 3 using the drill pipe string 73, 77 (Fig. 7d). As shown in Fig. 6, the tenter ring device 71 comprises two ring elements 81, 83 which are detachably connected to each other into one unit. After having drilled the borehole, the drill bit including one of the ring elements, here the lower ring element 81, is raised through the opening of the upper ring element 83 while the other ring element 83 remains in a tentering position (Fig. 7e).

Thereafter, hanging on a drill pipe string 85, the uppermost section of the casing 9, which can be several hundred meters long, is inserted into the borehole 13 through the ring element 83 and the foundation ring 5 (Fig. 7f).

Through lifting the ring element 83 including the uppermost of the casing 9 section the supporting arms 17 will disengage from their seats at the ring element 83 (Fig. 7g) and become engaged with the casing 9 while the ring element 83 is removed towards the surface level 67 (Fig. 7h).

Fig. 7i shows the step of cementing the casing 9 within the borehole 17 through a tubing 87 leaving the predetermined length 23 of the casing 9 uncemented. In order to define the predetermined length 23 a restriction ring 88 surrounding the casing 9 is attached to the casing 9 at a position defining the predetermined uncemented length 23. The ring 88 acts as a restriction to free flow and allows water to pass at a low resistance while pumping cement into the borehole 13. The resistance and thus the pump pressure will increase as the cement front passes the restriction ring 88. The increase of the pump pressure informs the operator of the cementing pump that the cement level has reached the ring 88. and prompts the operator to stop the pump.

Fig. 7j shows the step of lowering the supporting structure 21 onto the foundation ring 5 from the sea level 67 by cables 89. Fig. 7k shows the well head structure 1 with the supporting structure 21 mounted on the foundation ring 5. In a next step of the assembly sequence (not shown) the blow-out preventer 19 is lowered down to the supporting structure 21 and is assembled therewith as shown in Fig. 1.

Claims

1. Subsea well head structure comprising
- a foundation ring (5) adapted to be supported on a seabed (3),
- a tubular casing portion (9) to be positioned uppermost in a borehole (13) coaxially with the foundation ring (5),
- a hanger structure (15) mounted on the foundation ring (5) for supporting the casing portion (9) on the foundation ring (5) through a first load supporting path, and
- a blow-out preventer (19),

characterized in that

the blow-out preventer (19) is mounted to the foundation ring (5) through a supporting structure (21) supporting the blow-out preventer (19) on the foundation ring (5) through a second load supporting path in parallel to the first load supporting path of the hanger structure (17).

2. Subsea well head structure according to claim 1, wherein the hanger structure (15) comprises a plurality of supporting elements (17) which are movably guided on the foundation ring (5) and are distributed around the casing portion (9) to be individually seated on the casing portion (9).

3. Subsea well head structure according to claim 2, wherein the supporting elements (17) are supporting arms (17) pivotably mounted on the foundation ring (5) so as to extend upwardly and towards a center of the foundation ring (5) and are adapted to be seated against a shoulder (33, 35) of the casing portion (9).

4. Subsea well head structure according to claim 3, wherein the casing portion (9) has a shoulder (33, 35) extending in circumferential direction around the casing portion (9) and each supporting arm (17) has two end sections (37, 39) at an axial distance from one another, wherein a

first end section (37) of the two end sections (37, 39) is adapted to be seated on the shoulder (33, 35).

5. Subsea well head structure according to claim 4, wherein a second (3) of the two end sections (37, 39) radially resiliently engages the casing portion (9).

6. Subsea well head structure according to one of claims 4 or 5, wherein the casing has two shoulders (33, 35) extending around the casing portion (9) at an axial distance from one another and each of the two end sections (37, 39) is adapted to be seated on a different one of the two shoulders (33, 35).

7. Subsea well head structure according to one of claims 3 to 6, wherein the supporting structure (21) comprises locking means (47, 53) in particular in the form of a disk-like locking ring adapted to engage and lock the supporting arms (17) in a position seated on the casing portion (9).

8. Subsea well head structure according to claim 7, wherein ratchet means (57) are associated to the locking means (47, 53) and the supporting arms (17) adapted to allow pivotal movement of the supporting arms (17) in a direction towards the casing portion (9) and to prevent pivotal movement of the supporting arms (17) in a direction away from the casing portion (9).

9. Subsea well head structure according to one of claims 7 or 8, wherein the locking means (47, 53) and the supporting arms (17) have corrugated structured mutual abutment surfaces (57) adapted to prevented pivotal movement of the supporting arms (17) in their seating position at least in a pivotal movement direction away from the casing portion (9).

10. Subsea well head structure according to any one of claims 3 to 9, wherein the shoulder (33, 35) is in the form of a cranked section of the casing portion (9) to provide an oppositely directed inner shoulder (41, 43) adapted to support a casing tube portion (45) inserted into the casing portion (9), wherein the casing tube portion (45) has a complementary shoulder to be seated on the inner shoulder (41, 43) of the casing portion (9).

11. Subsea well head structure according to any one of claims 1 to 10, wherein the supporting structure (21) is a supporting ring coaxially surrounding the hanger structure (15).

12. Subsea well head structure according to any one claims 1 to 11, wherein the supporting structure (219 and/or the blow-out preventer (19) comprises a plurality of plug-in positioning elements (59, 63) to be seated at complementary mating plug-in positioning elements (61, 65) at the foundation ring (5) and/or the supporting structure (21) respectively.

13. Subsea well head structure according to any one of claims 1 to 12, wherein the blow-out preventer (19) is connected to an upper end of the casing portion (9) through a flexible joint (67).

14. Subsea well head structure according to any one of claims 1 to 13, wherein the foundation ring (5) is provided with a plurality of downwardly extending anchors (7) to be joined into the seabed (3).

15. Method for providing a subsea well head structure, comprising the steps of

(a) anchoring a foundation ring (5) on a seabed (3), the foundation ring (5) carrying a hanger structure (15) for supporting a casing portion (9) on the foundation ring (5) through a first load supporting path,

(b) drilling through the foundation ring (5) a borehole (13) into the seabed (3),

(c) inserting the casing portion (9) through the foundation ring (5) into the borehole (13) and coupling the casing portion (9) with the hanger structure (15),

(d) cementing the casing portion (9) within the borehole (13),

(e) mounting to the foundation ring (5) a supporting structure (21) adapted to support a blow-out preventer (19) on the foundation ring (5) through a second load supporting path in parallel to the first load supporting path of the hanger structure (15) and

(f) mounting the blow-out preventer (19) to the supporting structure (21).

16. Method according to claim 15, wherein an upper portion of the borehole (13) is left free of cement to provide a predetermined length (23) of the casing portion (9) freely extending between a cemented section of the casing portion (9) below the foundation ring (5) and an upper section of the casing portion (9) coupled to the hanger structure (15).

17. Method according to claim 16, wherein a restriction ring (88) surrounding the casing portion (9) at a position defining the predetermined length (23) is inserted into the borehole (13) before cementing the borehole (13).

18. Method according to any one of claims 15 to 17, wherein in step (a) the foundation ring (5) is lowered and anchored to the seabed (3) while a plurality of supporting arms (17) which are pivotably mounted to the foundation ring (5) to form the hanger structure (15) engage a tenter ring device (71) which locks the supporting arms (17) in a radially outer position and

wherein in step (c) the casing portion (9) partially is inserted into the borehole (13) through the tenter ring (71) whereupon the tenter ring device (71) is lifted to free the supporting arms (17) for seating against a shoulder (33, 35) of the casing portion (9).

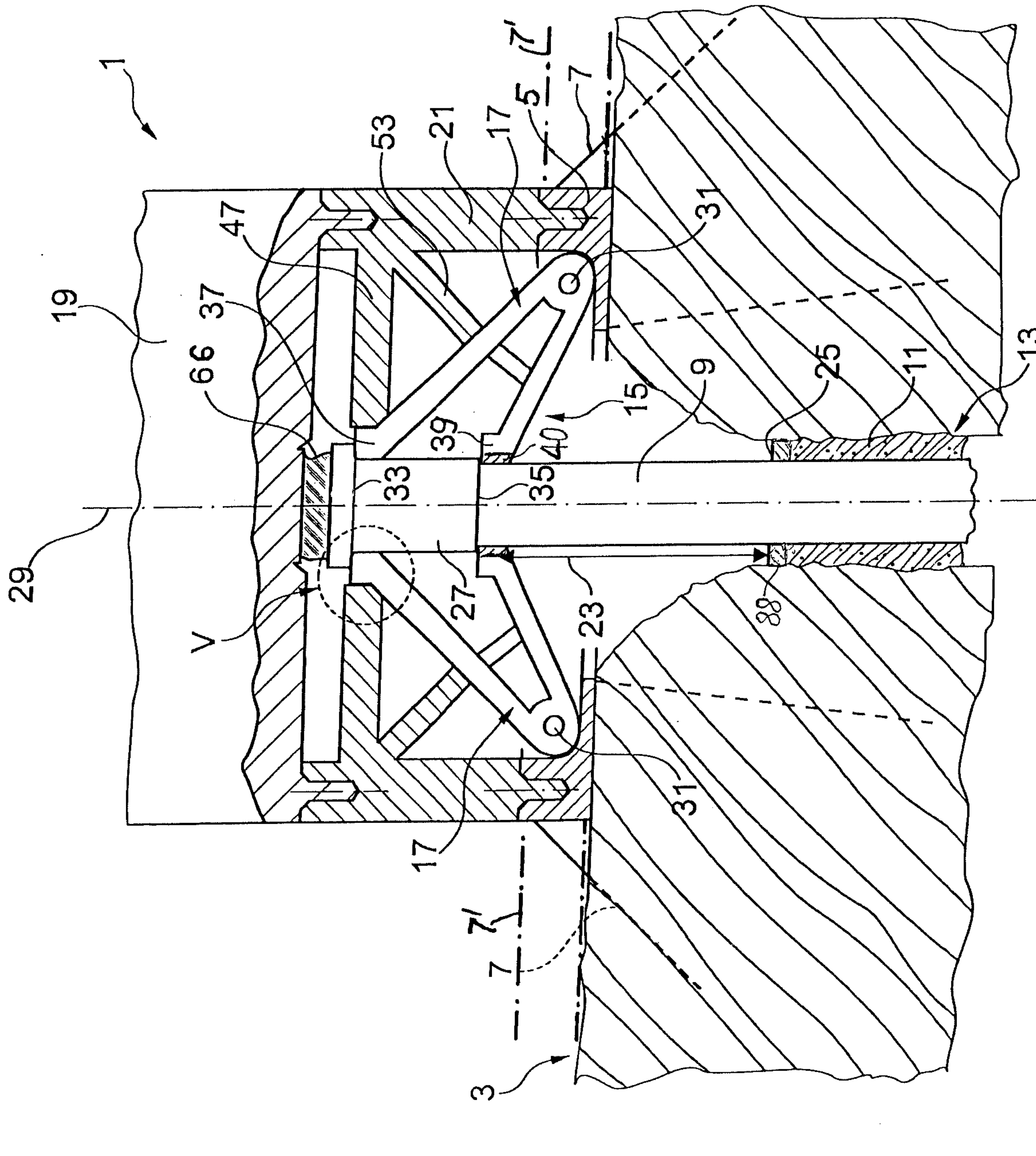

Fig. 1

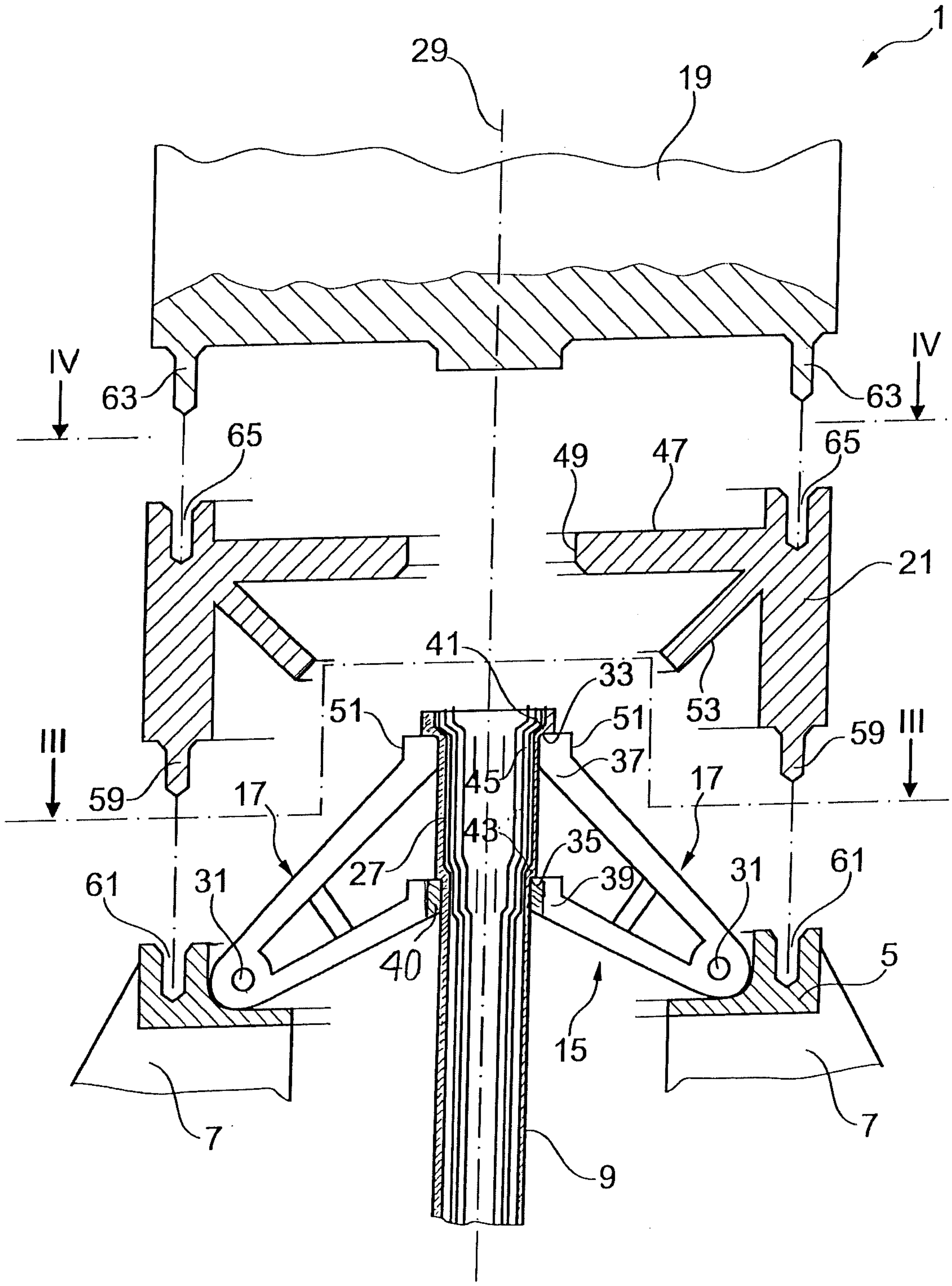
1
29
19
IV
63
63
IV
65
49
47
65
21
41
33
53
51
51
III
59
37
59
III
59
17
45
17
43
35
61
31
27
39
31
61
40
5
15
7
7
9

Fig. 2

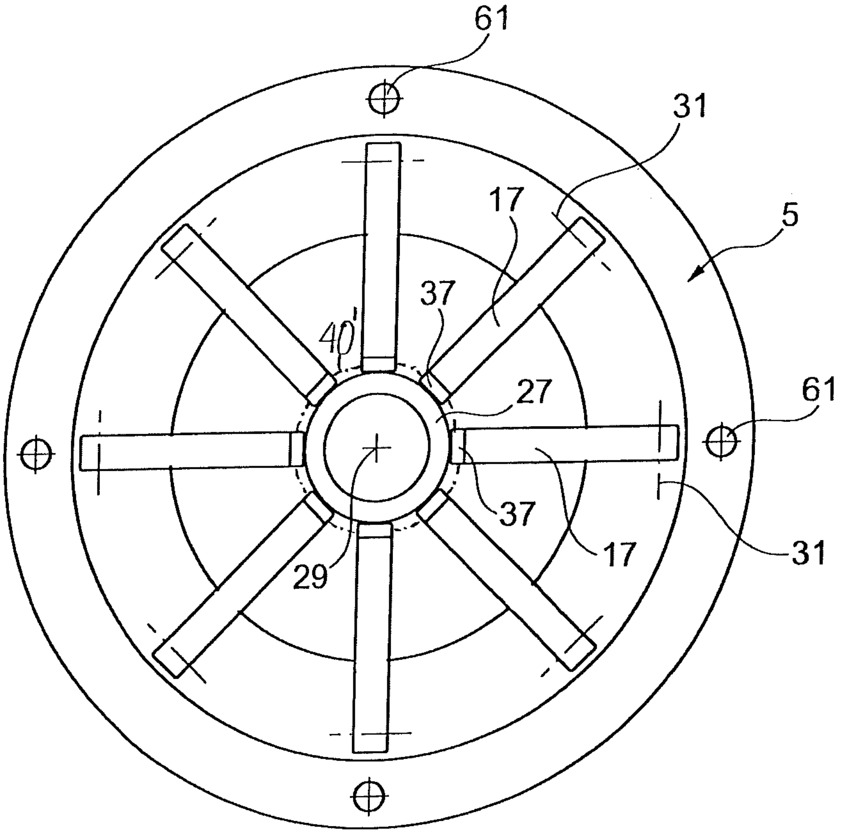

Fig. 3

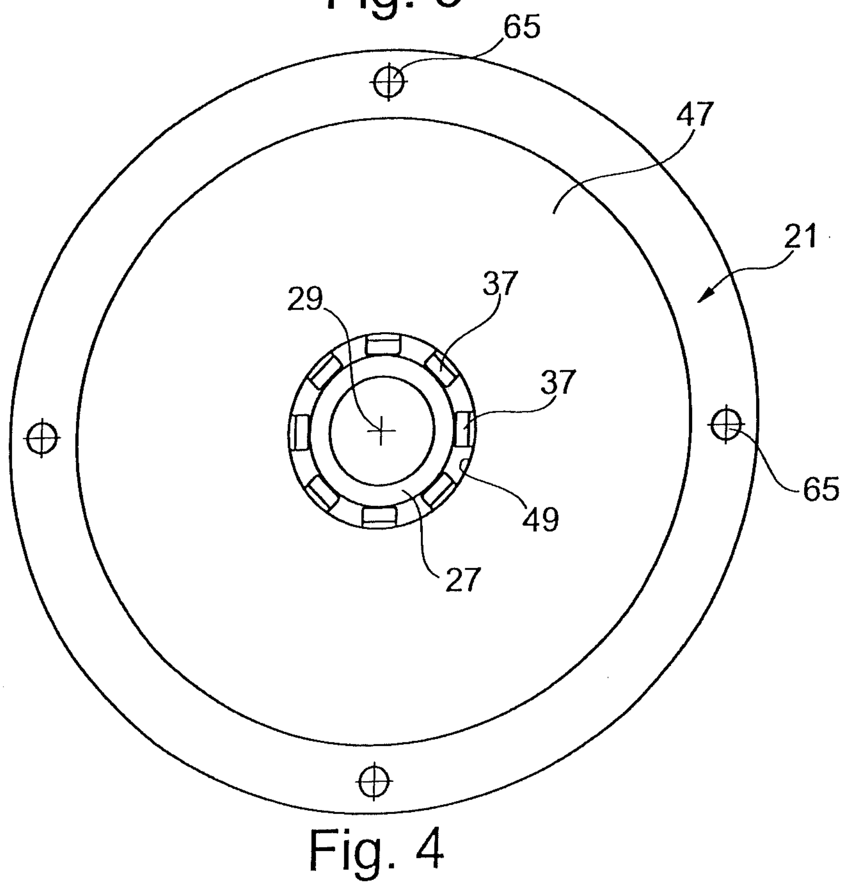

Fig. 4

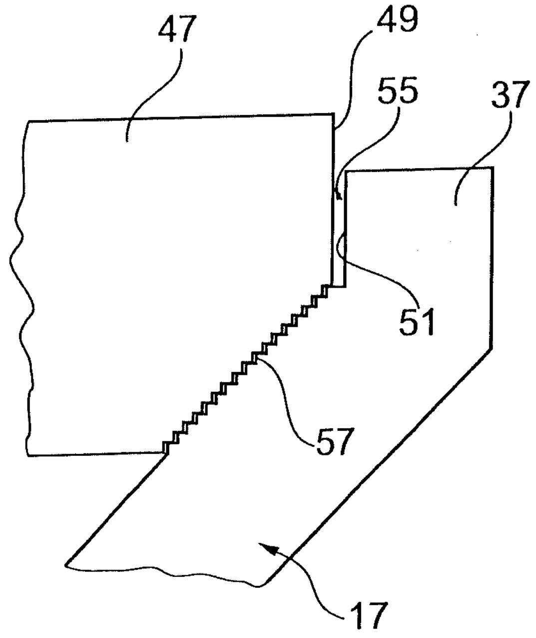

Fig. 5

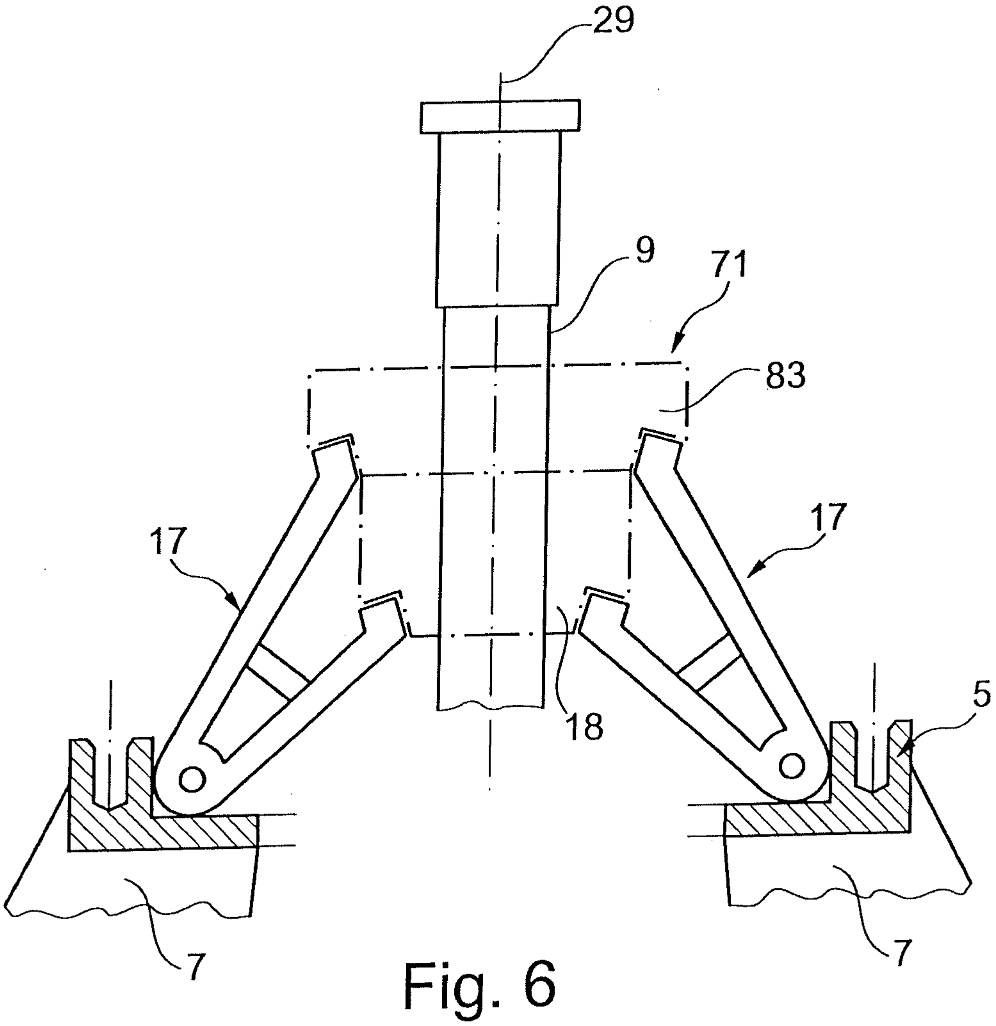

Fig. 6

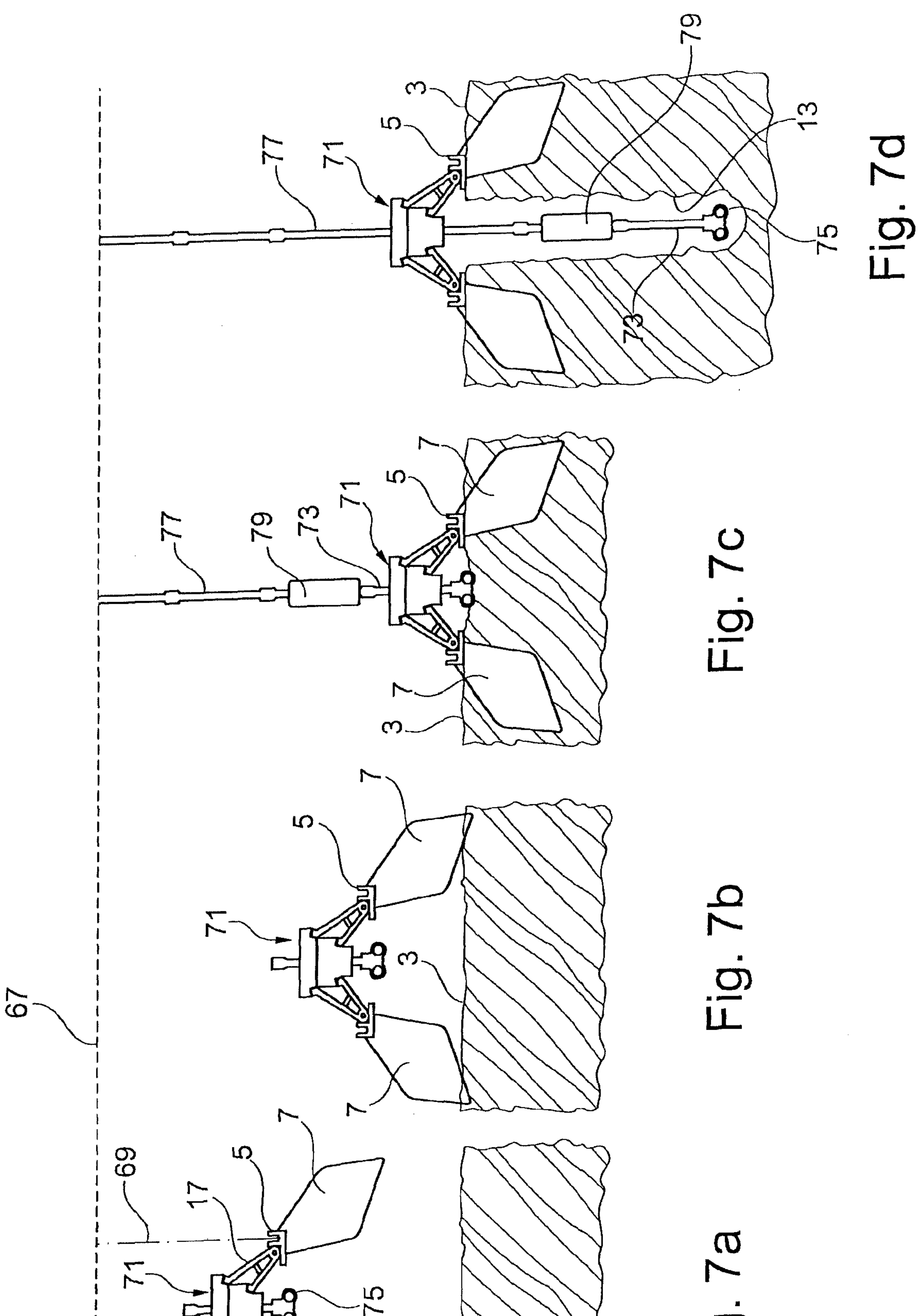

Fig. 7a

Fig. 7b

Fig. 7c

Fig. 7d

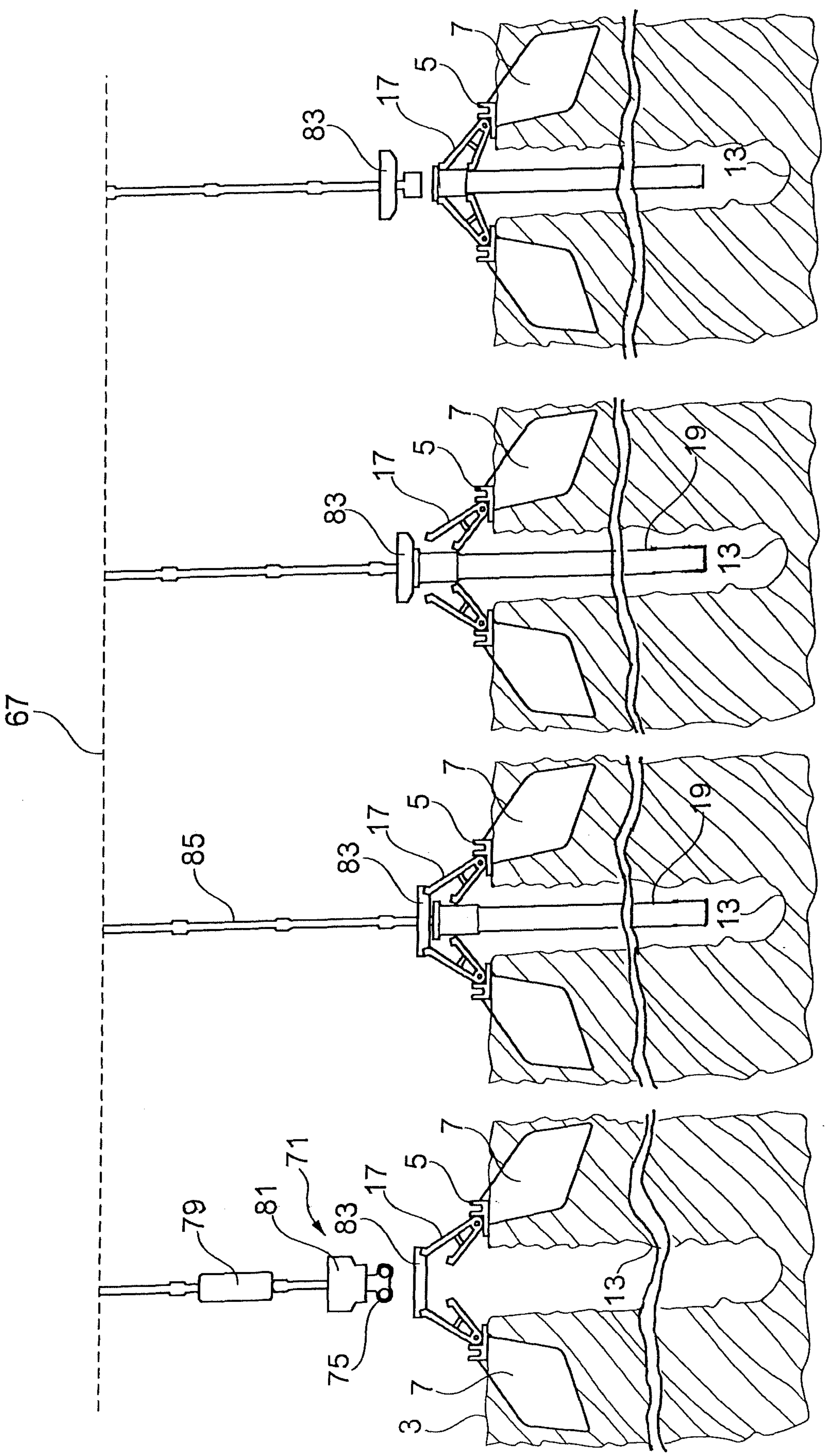

Fig. 7e

Fig. 7f

Fig. 7g

Fig. 7h

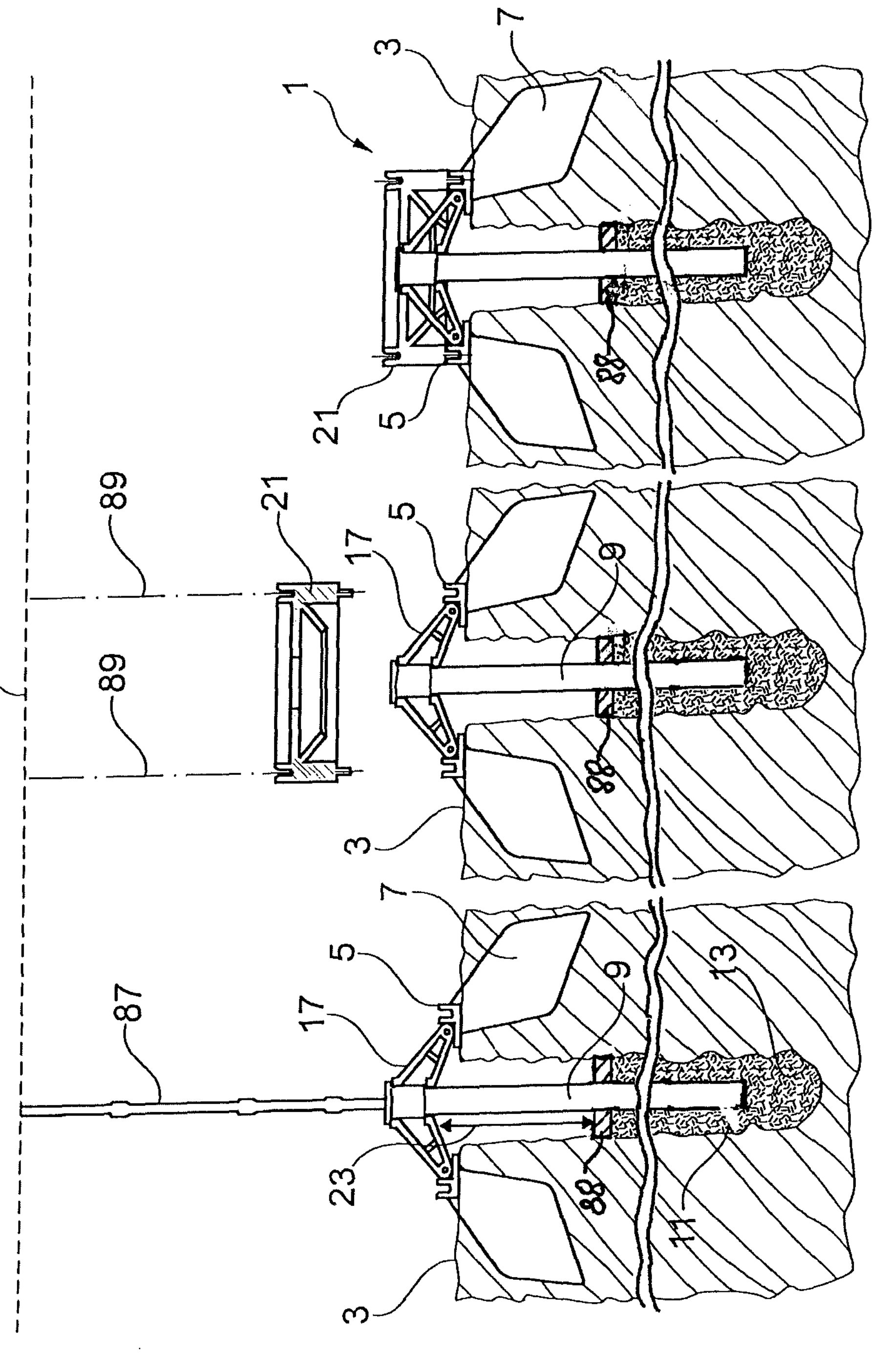

Fig. 7i

Fig. 7j

Fig. 7k

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2009/060564

A. CLASSIFICATION OF SUBJECT MATTER
INV. E21B33/043
ADD.

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

B. FIELDS SEARCHED

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

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 874 178 A (CALIFORNIA RESEARCH CORP) 2 August 1961 (1961-08-02) page 2, lines 109-112; figure 2	1-18
A	US 3 256 937 A (HAEBER JOHN A ET AL) 21 June 1966 (1966-06-21) column 4, lines 23-40; figures 10-27 column 12, lines 25-56	1-18
A	US 3 885 625 A (AHLSTONE ARTHUR G) 27 May 1975 (1975-05-27) the whole document	1-18
A	US 6 179 053 B1 (DALLAS L MURRAY [US]) 30 January 2001 (2001-01-30) the whole document	1-18

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

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 March 2010	14/04/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Fax: (+31–70) 340–3016	Manolache, Iustin

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2009/060564

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
GB 874178	A	02-08-1961	NONE		
US 3256937	A	21-06-1966	GB	948330 A	29-01-1964
			GB	948331 A	29-01-1964
			GB	948322 A	29-01-1964
			OA	1049 A	07-08-1968
US 3885625	A	27-05-1975	NONE		
US 6179053	B1	30-01-2001	CA	2299762 A1	12-02-2001