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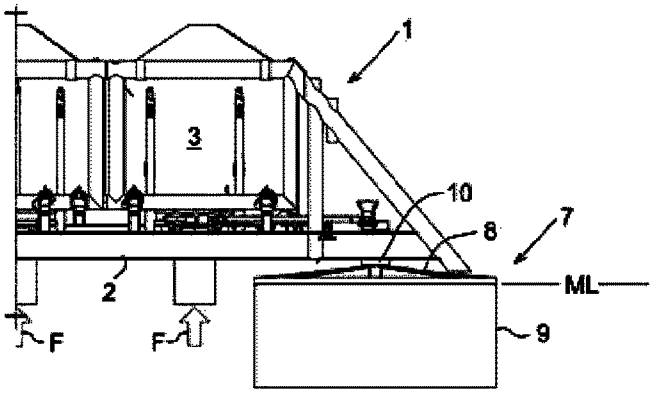
(54) Title **Subsea well template**

(57) Abstract

A subsea well template is shown comprising a template structure (1) resting on a seabed foundation (7). The template structure and the seabed foundation are mutually connected through a connection (10; 11) that permits movable engagement between the template structure (1) and the seabed foundation (7), at least in vertical directions.



Subsea well template

TECHNICAL FIELD OF THE INVENTION

The present invention relates to a well template to be located subsea for supporting equipment used in the production of oil and gas from subsea wells.

BACKGROUND AND PRIOR ART

Templates are welded structures designed to provide support and guidance for equipment used in subsea oil and gas production, such as drilling or well completion equipment, wellheads, manifolds and risers, pipeline connection equipment, valve trees etc. A well template is a template designed to group a number of closely positioned subsea wells at a single seabed location.

The templates must be designed to withstand loads applied from pipelines or risers or from drilling and maintenance equipment etc. To this purpose the templates need to be installed on the seabed by means of a foundation which must be sufficiently strong to transfer the applied loads into the seabed. One typical template foundation includes a set of suction anchors that are lowered into the mud to provide frictional anchorage of the template.

A well template must further be designed to withstand loads that are caused by thermal expansion in structural elements which are heated by the produced oil or gas stream, which typically can reach temperatures in the order of 100 °C and above. For this reason some flexibility or expansion capacity needs to be built into the design. For example, thermally induced axial expansion of the well structure and components demands for an ability of relative motion between the template and the components of the well system.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a subsea well template that is able to absorb thermal expansion in subsea wells or well components while still permitting a solid foundation in the seabed as well as a fixed connection between the template and a well system.

The object is met by a subsea well template arranged as defined in accompanying claims.

In a general aspect the object of the invention is met by a subsea well template comprising a template structure that is resting on a seabed foundation, wherein the template structure and seabed foundation are mutually connected through a connection that permits movable engagement between the template structure and the seabed foundation, at least in vertical directions.

By the solution defined above the previous demand for flexibility in the seabed foundation can be avoided. In other words the seabed foundation can be made stiffer and in this way provide a more solid base for the equipment that is to be installed and supported on the well template.

Other advantages that are achieved by the present solution include, e.g.:

- reduction of any consequences resulting from settlements in the seabed and seabed foundation;
- flexible pipe connections between wellheads and a manifold system can be made shorter;
- the conductor casing receptacle can be locked to the well insert since the well expansion is absorbed by the movable connection between the template structure and the seabed foundation.

In preferred embodiments the seabed foundation is realized in the form of a group of mud mats having skirts depending from their peripheries, or as a set of suction anchors/suction piles in dependence on the soil structure. Since full penetration into the seabed is critical to minimize the effects of horizontal loads on the well template, e.g., the aspect ratio (length/diameter) of suction anchors/piles can be in the order of 2:1 for stiff clay whereas very soft clay may require aspect ratios in the order of 7:1.

In preferred embodiments the template structure is a welded design comprising a base frame carrying parallel rows of well slots. The well slots are arranged for accommodation of a well system with a valve tree respectively that can be installed in the well slot once the drilling equipment has been removed and the well bore has been completed. The rows of well slots are separated by a central pipeline connection bay housing manifold header and valves of a manifold system connectable to the valve trees. The template structure may have a four-sided shape when seen in a top view.

The template structure is seated on the seabed foundation and connected thereto through the movable connection that allows relative movement between the structure and the foundation, at least in the vertical direction as previously explained. For example, the template structure may be resting on suction anchors arranged in each end of the template structure.

The movable connection between the template structure and the seabed foundation can be realized in the form of a barrel or column that rises vertically from the upper end of each suction anchor to be slidingly received in a guiding tube that is formed on the structure base frame. The vertical sliding mechanism can also be a part of a levelling jack system where a drive screw is implemented to actively level the template after installation The column and guiding tube are preferably circular in section with mating diameters and a small annular play between, concentric surfaces. The column and guiding tube may however alternatively be square in section. The column may be hollow or solid.

It is advantageous and preferred if the connection between the template structure and the seabed foundation can be temporarily fixed or locked to provide a stiff engagement between the template structure and the seabed foundation, such as during template installation or drilling, e.g. In one embodiment a locking bolt is arranged for insertion into the column via a hole formed in the wall of the guiding tube so as to arrest, in inserted position, the column relative to the guiding tube. The nearby locking bolt can be removed by an ROV once the well system has been secured in the template structure.

In one embodiment the movable connection between the template structure and the seabed foundation is part of a levelling jack system.

SHORT DESCRIPTION OF THE DRAWINGS

Details of the subsea well template will now be discussed and illustrated below with reference made to the accompanying drawings, wherein

Fig. 1 is a broken away side view showing an end portion of the well template,

Fig. 2 is a top view showing the end portion of Fig. 1 from above,

Fig. 3 is a broken away perspective showing the connection between the template structure and the seabed foundation, and

Fig. 4 is a partially broken away sectional view showing a detail of a telescopic guide assembly in the connection between the template structure and the seabed foundation.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

With reference to the Figs. 1-3 a subsea well template is shown comprising a template structure generally denoted 1. The template structure 1 is a welded steel design comprising a base frame 2 which defines a number of well slots 3. The well slots 3 are arranged in parallel rows on each side of a pipeline connection bay 4. Each row may contain 1, 2 or more well slots, e.g. The well slots may be conventionally arranged and designed for accommodation of a well system as known to a person skilled in the art.

Structural members 5 of the base frame extend in opposite ends of the template structure to rest on the upper ends of suction anchors 6, the suction anchors together forming a seabed foundation generally denoted 7. The suction anchors 6 are composed of a mud mat 8 having a skirt 9 depending from its periphery. The suction anchors with skirts are dimensioned with respect to the soil conditions to be completely lowered into the soil until the mud mat 8 is about level with the mudline ML.

A column 10 respectively rises vertically from the mud mats 8 in the upper ends of the suction anchors 6. The columns 10 are slidingly/telescopically received in guiding tubes 11 which are formed and secured in the base frame 2 of the template structure, and more particularly supported in the structural members 5 that extend from the base frame. The columns 10 are formed with a length l that exceeds the height of the guiding tubes 11 by an amount which is at least equal to the maximum axial growth and elongation to be expected from the well completion and well components in thermal expansion, caused by the temperature in the fluid produced by the subsea wells.

In this connection it should be noted that Figs. 1 and 3 illustrate the template structure in a lifted position which is a result of the lifting force (see arrows F) that is applied from the well(s).

The column 10 is formed with a hole (not shown) in its periphery for insertion of a locking bolt 12 via a hole 13 arranged through the wall of the guiding tube 11. The locking bolt may be removed as illustrated by the broken line in Fig. 3, such as by

means of an ROV, or a pull line or hydraulic device, in order to release the connection between the template structure 1 and the subject suction anchor of the seabed foundation 7.

Installation and operation of the well template will typically include the following procedure: The locking bolt is installed during template installation to secure the template structure to the seabed foundation. The locking bolt is removed as the nearby well system is installed and secured in the template structure. The template structure will be lifted up by the well as soon as it starts to produce, due to the heat from the produced flow. The seabed foundation will however stay fixed in the mud due to the friction developed between skirts and mud, the columns and guiding tubes allowing the template structure with manifold to follow up with the well expansion and leave the seabed foundation as is, the foundation will continue to take any horizontal load through the vertical column and guiding tube. The vertical release between the template structure 1 and the seabed foundation 7, the latter fixed to the seabed due to friction, will avoid any stress/deflection of the template structure during well expansion.

Fig. 4 shows in closer detail an embodiment of the connection between the template structure and the subsea foundation. In this embodiment a column 10, circular in section, rises from the suction anchor 6 to be slidingly/telescopically received in a guiding tube 11, likewise circular in section, arranged on the structure. The column 10 carries a plate 14 which rests loosely on the top of the column, the plate 14 having a central threaded through hole in which a drive screw 15 is received in threaded engagement. The drive screw 15 depends from an end wall 16 arranged in the upper end of the guiding tube 11. Turning the drive screw in one direction results in lifting the template structure, whereas turning the drive screw in opposite direction results in lowering of the template structure.

The invention has here been explained and disclosed through a few advantageous embodiments from which modifications can be derived, directly or indirectly, without departing from the scope of the invention as defined in the appended claims.

CLAIMS

1. A well template comprising a template structure (1) resting on a seabed foundation (7), wherein the template structure and the seabed foundation are mutually connected through a connection (10; 11) that permits movable engagement between the template structure (1) and the seabed foundation (7), at least in vertical directions.

2. The well template of claim 1, wherein the movable connection between the template structure (1) and the seabed foundation (7) comprises a column (10) that is slidingly received in a guiding tube (11).

3. The well template of claim 2, wherein the column (10) rises vertically from an upper end of a suction anchor (6).

4. The well template of claim 3, wherein the guiding tube (11) is formed on a structural member (5) extending from a base frame (2) included in the template structure (1).

5. The well template of any of claims 2-4, wherein the movable connection (10; 11) between the templates structure (1) and the seabed foundation (7) can be temporarily fixed by means of a locking bolt (12) that is insertable into the column (10) via a hole in the wall of the guiding tube (11).

6. The well template of any previous claim, wherein the seabed foundation (7) comprises a set of suction anchors (6) each comprising a skirt (9) depending from the periphery of a mud mat (8).

7. The well template of any previous claim, wherein the template structure (1) comprises parallel rows of well slots (3) separated through a pipeline connection bay (4).

8. The well template of any previous claim, wherein the movable connection (10; 11) between the template structure (1) and the seabed foundation (7) is part of a levelling jack system.

Fig. 1

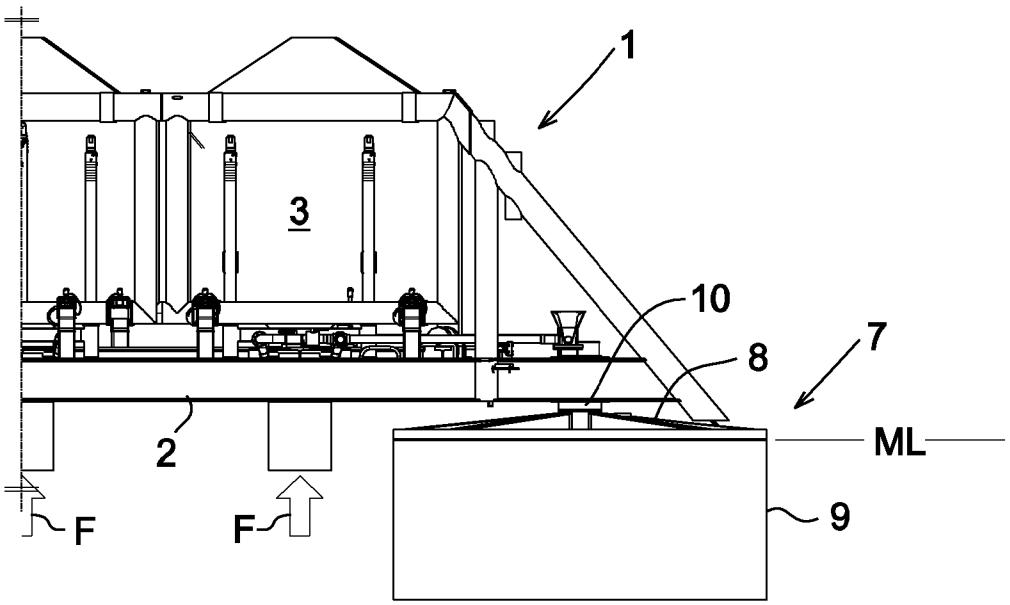


Fig. 2

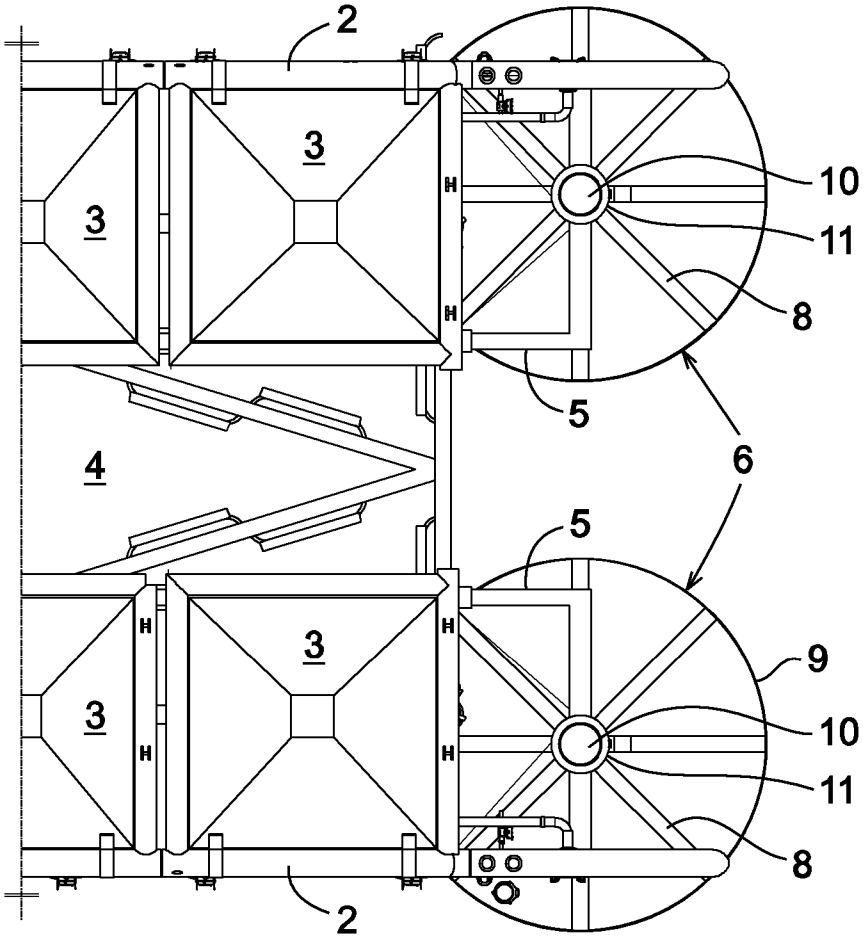


Fig. 3

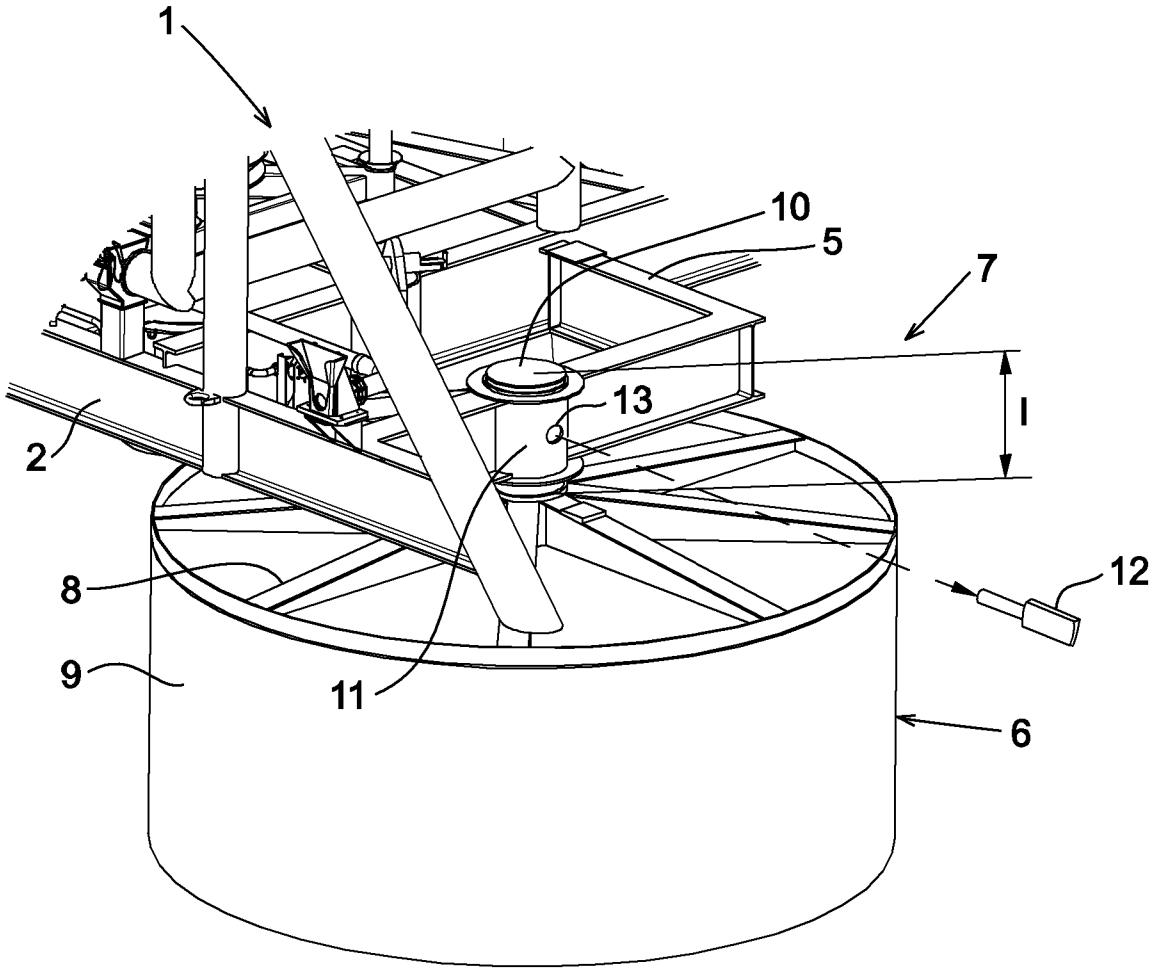


Fig. 4