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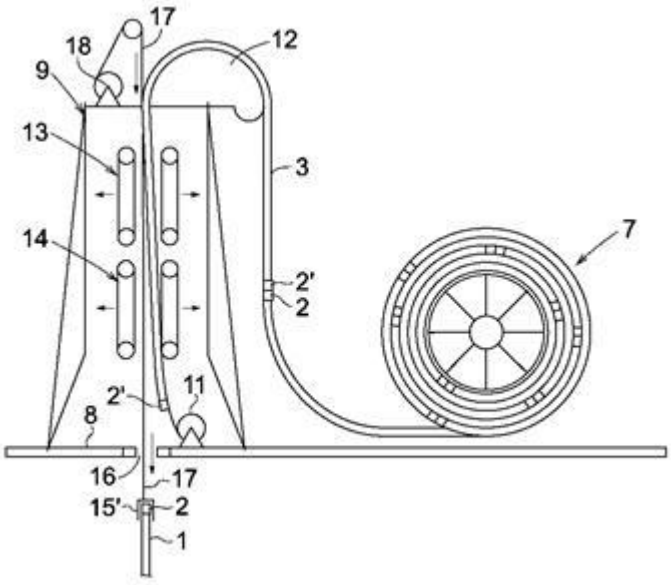
(54) Title **A method for subsea deployment of discrete lengths of flexible jumper pipes**

(57) Abstract

A method for deployment of discrete lengths of flexible jumper pipes (1,3) for installation subsea is disclosed, comprising coupling the jumper pipes together end- to-end thus forming a flexible train of jumper pipes, and winding the train of jumper pipes on a drum (7) suitable for transport to a deployment site by a pipelaying vessel. On site, the train of jumper pipes is unreeled from the drum until the first jumper pipe is lowered into the sea, then the drum is halted and the trailing end (2) of the first jumper pipe (1) is detached from the leading end (2') of the second jumper pipe (3) in the train of jumper pipes. The trailing end (2) of the first jumper pipe (1) is shifted to a lowering wire (17), and the first jumper pipe is lowered to the sea bottom. The process is repeated until the discrete lengths of flexible jumper pipes are individually lowered into the sea.



A method for subsea deployment of discrete lengths of flexible jumper pipes

TECHNICAL FIELD OF THE INVENTION

The present invention relates to subsea installation of flexible jumper pipes, and more specifically to a method for deployment of discrete lengths of flexible jumper pipes from a surface vessel or platform.

BACKGROUND AND PRIOR ART

Flexible jumper pipes or just flexible jumpers can be used to connect subsea structures such as valve trees, pipelines, manifolds and risers, etc. A flexible jumper typically consists of a flexible pipe between two end-fittings usually of a standardized design that permits a sealed lock with a mating connector of a subsea component. The flexible jumpers are typically multi-layered structures including at least one or more fluid barrier layers, pressure and tensile load resistant layers and wear resistant layers, e.g. The flexibility of the jumper provides a connection that permits some freedom of movement for at least one of the connected parts.

Since flexible jumpers are provided at discrete lengths for installation subsea they are usually individually stored on a vessel for transport to a deployment site. The jumpers are then fed through a laying system with tensioners and lowered one by one into the sea using crane wires attached to both ends of the jumper, in a time-consuming process that often involves both the transportation vessel and a laying-out vessel.

SUMMARY OF THE INVENTION

The object of the present invention is to provide an alternative method for deployment of discrete lengths of flexible jumper pipes for installation subsea.

The object is met in a method comprising

- coupling the jumper pipes together end-to-end thus forming a flexible train of jumper pipes,
- winding the train of jumper pipes on a drum suitable for transport to a deployment site by a pipe-laying vessel,
- unreeling the train of jumper pipes from the drum until the first jumper pipe is lowered into the sea, then halting the drum,
- hanging off/detaching the trailing end of the first jumper pipe from the leading end of the second jumper pipe in the train of jumper pipes,

- shifting the trailing end of the first jumper pipe to a lowering wire, and lowering the first jumper pipe to the sea bottom, and
- repeating the previous steps until the discrete lengths of flexible jumper pipes are individually lowered into the sea.

In one preferred embodiment the method includes feeding the train of jumper pipes in a vertical or near-vertical path towards a working platform, wherein the detached trailing end of the first jumper pipe is arrested above the platform while installing an end termination assembly thereto.

In one preferred embodiment the detached leading end of the second jumper pipe is momentarily parked at the side of the vertical or near-vertical feed path while an end termination assembly is installed in the trailing end of the first jumper pipe.

One preferred embodiment comprises halting the feed of the train of jumper pipes while installing end termination assemblies in the leading ends respectively of the discrete jumper pipes before lowering into the sea.

The method of the present invention is advantageously implemented using a working platform that is a structural part of a J-Lay ramp or a VLS (Vertical Landing System)-tower, wherein feeding the train of jumper pipes comprises intermittent drive of top and bottom tensioners arranged on this ramp or tower.

More specifically the top and bottom tensioners are alternatingly operated in feeding/closed and non-feeding/open modes to permit the feed of end-fittings through the tensioners.

In a preferred embodiment the step of parking the detached leading end of the second jumper pipe at the side of the vertical or near-vertical feed path includes shifting said leading end to the end of a wire of a pulling winch on the working platform. This winch may be the same winch that initially pulls the train of jumpers off the drum, until the first jumper is engaged by the tensioners of the ramp or the VLS tower.

For the purpose of forming the flexible train of jumper pipes the jumper pipes are coupled together end to end by fixation of end-fittings in a split clamp with a male/female adapter insert installed between the end-fittings.

The method of the present invention is advantageously implemented on a working platform comprising an adjustable opening which can be closed around the jumper pipe for arresting the trailing end of the jumper pipe above the platform.

SHORT DESCRIPTION OF THE DRAWINGS

The invention will be further explained below with reference made to the accompanying schematic drawings that illustrate embodiment examples of the invention. In the drawings,

Figs. 1A-1F	show successive steps in the process of deployment of discrete lengths of flexible jumper pipes from a surface vessel,
Figs. 2A-2B	show an end-to-end coupling of flexible jumper pipes in connected and disconnected modes respectively, and
Figs. 3A-3B	show end termination components installed on the leading and trailing ends respectively of a flexible jumper pipe.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

One key feature in the process of subsea deployment of flexible jumper pipes according to the present invention is the connection end-to-end of discrete lengths of jumper pipes. The jumper pipes can be of different lengths or may have the same length. Interconnected they form a flexible train of jumper pipes, wherein for the purpose of description a leading jumper pipe, as seen in a feed direction, will be named the first jumper pipe whereas the following jumper pipe will be named the second jumper pipe regardless of their location in the train of jumper pipes. In interconnected mode, obviously, the trailing end of the first jumper pipe is coupled to the leading end of the second jumper pipe.

The coupling together of the first and second jumper pipes is illustrated in Figs. 2A and 2B. The jumper pipe lengths comprise in each end an end-fitting which is adapted for connecting the flexible jumper to a subsea facility. Thus, with reference to the drawing of Fig. 2 A, the first jumper pipe 1 carries in its trailing end an end-fitting 2 which is coupled to a meeting end-fitting 2' in the leading end of the second jumper pipe 3. Coupling together the end-fittings 2 and 2' is accomplished by means of a split clamp 4 comprising two half-circular parts which are bolted together to form a grip behind flanges 5 that are formed in the ends of the end-fittings 2 and 2'. A male/female adapter insert 6 is installed to locate the end-fittings and to protect the end surfaces of the end-fittings 2 and 2' in coupled mode.

The coupling can be equipped with seals to allow pressure testing of the complete train of jumper pipes.

In coupled mode the jumper pipes form a flexible train which can be reeled up on a drum 7 as illustrated in Figs. 1A-1F. The drum or reel 7 is carried by a pipe-laying vessel to the site of deployment of the flexible jumpers. The vessel is not shown in the schematic drawings, but persons skilled in the art will realize that among suitable vessels are those that permit a vertical or near vertical lowering of the jumper pipes from a working platform 8, such as a J-lay or a Reel-lay vessel e.g. To this purpose the vessel would carry a J-ramp or a VLS (Vertical Landing System)-tower 9 that permits personnel to operate on the working platform 8.

In the following disclosure, the procedure of subsea deployment of flexible jumper pipes includes unreeling the train of jumper pipes from the drum, separation of the leading jumper pipe from the train of jumper pipes and lowering of the jumper pipes individually into the sea using the VLS-tower 9 illustrated in the drawings.

An initial step of the deployment procedure is shown in Fig. 1A, wherein a pulling wire 10 of a winch 11 is attached to the leading end of the first jumper pipe 1 and driven for pulling the first jumper into the gutter of a sheave 12 that is arranged in the top of the VLS-tower 9. During this pulling manoeuvre the upper set of endless-belt tensioners 13 is opened to allow passage of the end-fitting 2' in the leading end of the jumper pipe.

The winch 11 is operated until the end-fitting 2' has passed the upper set of tensioners 13, upon which these are tightened about the jumper pipe for feeding the same in a vertical or near vertical path towards the working platform 8 as illustrated in Fig. 1B. At this stage the lower set of endless-belt tensioners 14 is opened to allow passage of the end-fitting 2' in the leading end of the jumper pipe 1.

Once the end-fitting 2' in the leading end of jumper pipe 1 has passed the lower set of tensioners 14 these can be tightened about the jumper pipe to support the feed of the jumper pipe into the position illustrated in Fig. 1C. In the sequence shown in Fig. 1C the feed is stopped and the jumper pipe is halted with its leading end located on the working platform 8. In this position the jumper pipe is manually fitted with an end termination assembly 15 that is mounted over the end-fitting 2'.

The end termination 15 can be a standard type assembly as illustrated in Fig. 3A, comprising bend stiffeners and coupling interface for mating with a subsea facility such as a pipeline, a manifold, riser or tree, etc. In a later sequence of the deployment process a corresponding end termination assembly 15' as illustrated in Fig. 3B will be mounted over the end-fitting 2 in the trailing end of the jumper pipe.

In the next sequence, see Fig. 1D, the lower tensioner 14 is operated to feed the first jumper pipe 1 into the sea via an adjustable opening 16 arranged in the working platform. As the trailing end of the first jumper pipe 1 descends through the VLS-tower the upper and lower sets of tensioners 13 and 14 are operated intermittently and alternatingly opened in sequence to allow for passage of the interconnected end-fittings 2 and 2' between the jumper pipes 1 and 3, as illustrated in Figs. 1D and 1E respectively.

When the first jumper pipe 1 has been lowered to an extent wherein the trailing end reaches the working platform the feed is halted, and the adjustable opening 16 is closed about the jumper pipe. In this halted position the trailing end of the first jumper pipe 1 is detached from the leading end of the second jumper pipe 3, by opening the split clamp 4 and separating the subject end-fittings 2 and 2'. The winch wire 10 is attached to the leading end of the second jumper pipe 3 and the winch 11 is operated to move the second jumper pipe 3 away from the feed path. An end termination assembly 15' is then mounted over the end-fitting 2 in the trailing end of the first jumper pipe 1.

Now separated from the train of jumper pipes and properly terminated in both ends for connection between two subsea facilities, the first jumper pipe 1 can be lowered into the sea by means of a wire 17 that is operated from a winch 18 in the VLS tower (see Fig. 1F). The steps of Figs. 1C to 1F can then be repeated in sequence until the entire train of jumper pipes on the reel 7 is split into discrete lengths which are lowered individually into the sea at the site of deployment and installation.

The invention is of course not in any way restricted to the embodiments described above. On the contrary, many possibilities to modifications thereof will be apparent to a person with ordinary skill in the art without departing from the basic idea of the invention such as defined in the appended claims.

CLAIMS

1. A method for deployment of discrete lengths of flexible jumper pipes (1,3) for installation subsea comprising
   - coupling the jumper pipes together end-to-end thus forming a flexible train of jumper pipes,
   - winding the train of jumper pipes on a drum (7) suitable for transport to a deployment site by a pipe-laying vessel,
   - unreeling the train of jumper pipes from the drum until the first jumper pipe is lowered into the sea, then halting the drum,
   - hanging off/detaching the trailing end (2) of the first jumper pipe (1) from the leading end (2') of the second jumper pipe (3) in the train of jumper pipes,
   - shifting the trailing end (2) of the first jumper pipe (1) to a lowering wire (17), and lowering the first jumper pipe to the sea bottom,
   - repeating the previous steps until the discrete lengths of flexible jumper pipes are individually lowered into the sea.

2. The method of claim 1, wherein unreeling includes feeding the train of jumper pipes in a vertical or near-vertical path towards a working platform (8), the method further comprising
   - arresting the detached trailing end (2) of the first jumper pipe (1) above the platform (8) while installing an end termination assembly (15') thereto.

3. The method of claim 2, comprising
   - parking the detached leading end (2') of the second jumper pipe (3) at the side of the vertical or near-vertical feed path while installing an end termination assembly (15') in the trailing end (2) of the first jumper pipe (1).

4. The method of any previous claim, comprising halting the feed of the train of jumper pipes while installing end termination assemblies (15) in the leading ends (2') of the discrete jumper pipes before lowering into the sea.

5. The method of any of claims 2-4, wherein the working platform (8) is a structural part of a J-Lay ramp or a VLS (Vertical Landing System)-tower (9), and feeding the train of jumper pipes comprises intermittent drive of top and bottom tensioners (13,14) on the ramp or tower.

6. The method of claim 5, wherein the top and bottom tensioners (13,14) are alternatingly operated in feeding/closed and non-feeding/open modes to permit the feed of end-fittings (2,2') through the tensioners.

7. The method of any of claims 3-6, wherein parking the detached leading end (2') of the second jumper pipe (3) at the side of the vertical or near-vertical feed path comprises shifting said leading end to the end of a wire (10) of a pulling winch (11) on the working platform (8).

8. The method of any previous claim, wherein coupling the jumper pipes together end to end comprises fixation of end-fittings (2,2') in a split clamp (4) with a male/female adapter insert (6) installed between the end-fittings.

9. The method of any of claims 2-8, wherein arresting the trailing end of the jumper pipe above the platform comprises closing an adjustable opening (16) through the working platform around the jumper pipe.

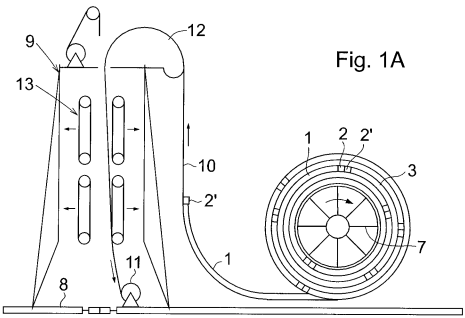


Fig. 1A

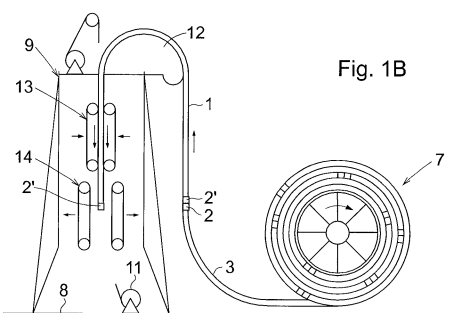


Fig. 1B

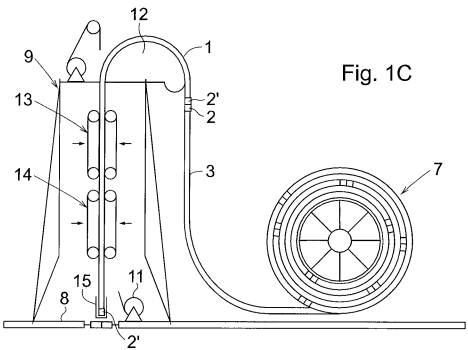


Fig. 1C

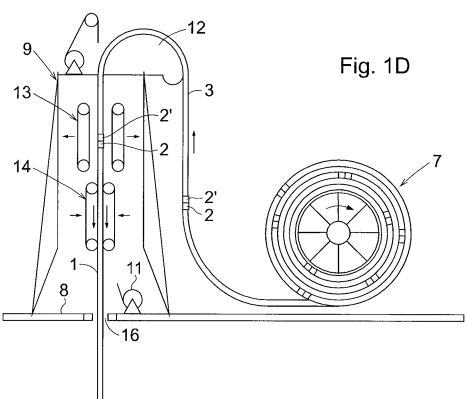


Fig. 1D

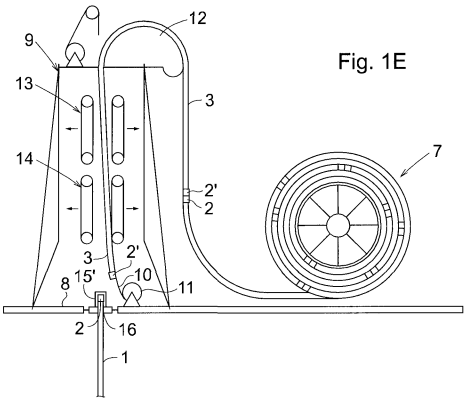

12
9
13
3
14
7
2'
2
3
2'
15'
10
8
11
2
16
1

Fig. 1E

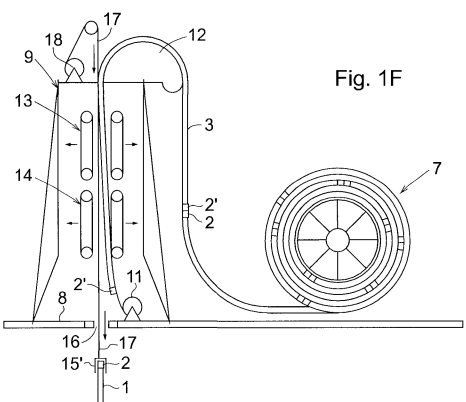

17
18
12
9
13
3
14
7
2'
2
11
2'
8
16
17
15'
2
1

Fig. 1F

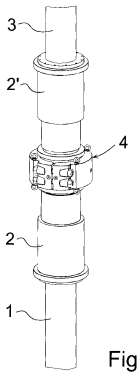


Fig. 2A

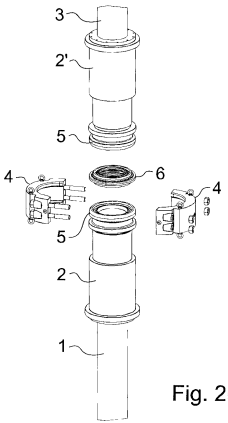


Fig. 2B

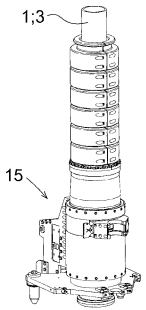


Fig. 3A

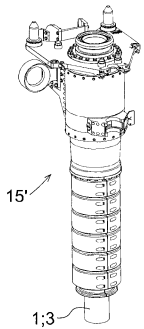


Fig. 3B