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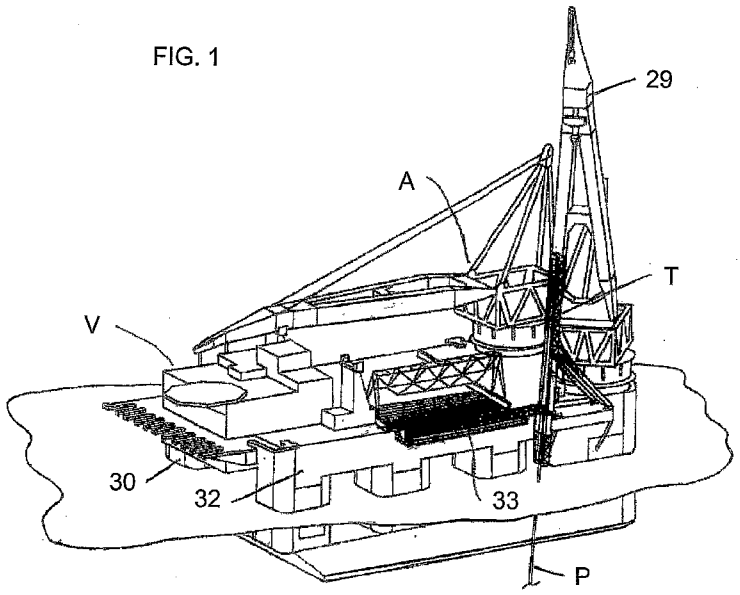
(54) Title: PIPELINE LAYING METHOD, SYSTEM AND VESSEL TO INSTALL A PIPELINE COMPRISING PIPELINE EQUIPMENT

FIG. 1



(57) Abstract: Pipeline laying system, method and vessel to install a pipeline comprising pipeline equipment. The pipe laying system having a tower constructed and arranged to join pipe sections and the pipe line equipment to the pipeline along a tower firing line. The tower is provided with a hoisting apparatus constructed and arranged to move the pipeline and the equipment with respect to the firing line of the tower so that the pipeline and the pipe line outside the firing line. The hoisting apparatus is further provided with a hoisting device constructed and arranged for lowering the pipeline with the pipeline equipment.

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Title: Pipeline laying method, system and vessel to install a pipeline comprising pipeline equipment

The invention relates to a pipeline laying method, system and vessel to install a pipeline comprising one or more pipeline equipment, the system comprising:

a tower constructed and arranged to join pipe sections and pipe line equipment to the pipeline along a tower firing line;.

The concept of near vertical pipe laying (called J-Lay) as a method for deep water pipe laying is used within the offshore pipeline industry. It has been proposed to conduct J-Lay pipe laying from a vessel with a pipeline laying system comprising a tower pivotally mounted to the vessel. A supply of pipe sections may be stored on the vessel deck. Individual pipe sections are successively upended from a horizontal position on the deck towards a vertical position near or within the tower by means of a loader. The loader hands over the pipe section to the tower, where it is firmly held for positioning the pipe section to be connected to the upper end of a pipeline. The upper end of the pipeline extends through a clamping mechanism located at the lower position of the tower which holds the pipeline. After welding is completed the pipeline and its newly-added pipe section are lowered through the clamping mechanism along the tower pipeline firing line. Simultaneously the vessel moves forward thereby installing the pipeline on a sea bed.

The underwater pipe laying system may be helpful in laying pipe sections of uniform diameter. However, if pipeline equipment must be inserted in the pipeline, the system does not permit insertions of such items in the pipeline easily. Examples of pipeline equipment are inline structures like riser buoys, pipe valves, tee assemblies, and pipeline termination assemblies with their supporting structures and mud-mats or a buoyancy module. Existing pipe lay systems in the tower do not allow convenient handling of pipeline equipment, since it is not practical to design a pipe clamping mechanism which will open up sufficiently wide as to permit downward passage of such equipment along the tower firing line.

US 2002/0159839 discloses a pipe laying vessel V, shown in FIG. 1, which is provided with a first preferred form of apparatus A for the underwater laying of a pipeline P on a seabed (not shown). Vessel V is of the semi-submersible type, however, other types of vessels may be utilized for operation with a pipe laying system. Vessel V is provided with two large rotatable cranes 28 and 29 mounted at the rear end portions of the semi-submersible hulls 30 and 32. Vessel V carries a supply of pipe sections 33 on its deck to be added to pipeline P. With further reference to FIG. 1 the pipe laying apparatus A includes a J-Lay

tower T pivotally connected to vessel V for tilting in a vertical plane by hydraulic cylinders in a conventional manner, with the angle of such tower being defined by adjustable struts having their upper end pivotally attached to the intermediate portion of the tower and its lower end pivotally attached to the vessel. The tower T may be stowed in a lowered position (not shown) during rough seas or during travel of the vessel V.

For installing pipeline equipment to the pipeline, one of the large rotatable cranes 28, 29 may be used to:

lift the pipeline equipment to a position above the pipeline,

hold the pipeline equipment when it is joined to the pipeline,

move the pipeline equipment with the pipeline joined thereto away from the tower,

lower the pipeline until the pipeline equipment is below the pipelay tower,

and,

move the pipeline back into the tower firing line.

The use of the large rotatable crane close to the tower gives a risk of collisions between the tower and the crane. This risk may be increased by bad weather conditions. The need of a crane also may make the vessel more heavy. Finally large rotatable cranes are expensive to build and maintain.

The object of the invention is to provide an improved or at least an alternative method and system for installing pipeline equipment to a pipeline.

The object is achieved by a method to install a pipeline comprising pipeline equipment on a seabed, the method comprising:

providing a pipe laying system comprising a tower;

installing the pipeline along a pipe departure trajectory that coincides with the tower firing line in the direction of the seabed;

engaging the pipeline with a hang-off device provided to a base of the tower to support the weight of the pipeline;

loading a pipe section including pipeline equipment in the firing line above the hang-off device;

connecting the pipe section with the pipeline equipment to the pipeline clamped by the hang-off device;

clamping the top of the pipeline to a hoisting device provided to a hoisting apparatus provided to the tower;

disengaging the pipeline from the hang-off device;

moving the tower and/or the hoisting device such that the tower firing line does no longer coincide with the pipe departure trajectory; and

lowering the pipeline and the connected pipeline equipment with the hoisting device along the pipe departure trajectory that differs from the firing line of the tower.

According to a further embodiment of the invention there is provided a pipeline laying system to install a pipeline comprising pipeline equipment, the system comprising:

a tower constructed and arranged to join pipe sections and pipe line equipment to the pipeline along a tower firing line; wherein the tower is provided with a hoisting apparatus constructed and arranged to move the pipeline and the equipment to a trajectory that differs form the firing line of the tower.

By providing a hoisting apparatus to the tower that can lower the pipeline when the tower is rotated away from the natural departure angle of the pipeline no separate crane mounted on the vessel is necessary to install the pipeline equipment in the pipeline. A more compact and light weight design of the system is thus possible. There is no risk of a collision of a crane with the tower anymore thereby improving the workability of the pipelay vessel.

According to a further embodiment of the invention there is provided a pipeline laying vessel to install a pipeline comprising pipeline equipment, the vessel comprising a tower constructed and arranged to join pipe sections and pipe line equipment to the pipeline along a firing line; wherein the angle between the tower and the vessel is adjustable so as to move the pipeline and the equipment along a trajectory that differs from the firing line of the tower.

Embodiments of the invention will be described by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts, and in which:

- figure 1 depicts a pipe laying vessel according to the prior art;
- figures 2a-2c depict a pipeline laying system and method to install a pipeline comprising pipeline equipments according to a first embodiment of the invention;
- figures 3a-3c depict a pipe laying system and method to install a pipeline comprising pipeline equipments according to a second embodiment of the invention; and,
- figures 4a-4c depict a pipe laying system and method to install a pipeline comprising pipeline equipments according to a third embodiment of the invention.

Figure 2a depicts a pipeline laying system 2 mounted on the bow 9 of a ship (only partially depicted) for installing a pipeline 13 comprising pipeline equipments 3 according to a first embodiment of the invention. The pipeline laying system 2 comprises a tower 1 which is mounted on a tower base via a tower tilting axis 11. The pipe laying system 2 comprises a

hoisting device 4 in the top of the tower 1 and the hoisting device 4 may be used for moving a moveable pipe clamp 5 along the tower 1. During operation of the system 2 a new pipe section will be moved into the tower 1 and lowered with the moveable pipe clamp 5 until it is above the top of the already installed pipeline 13 which is held by a hang off device on the lower side of the tower 1 in a work station 30. The new pipe section will than be aligned and welded on the already installed pipeline 13 along the firing line 7 of the tower 1. The new pipe section welded to the already installed pipeline 13 will be moved to the seabed by releasing it from the hang off device and lowering it with the moveable pipe clamp 5 through the hang off device and the pipe laying system will move further to install a next pipe section on the pipe line 13.

When pipeline equipment 3 which has a larger size than the diameter of the pipe needs to be installed on the already installed pipeline 13 a different method may be used. Examples of pipeline equipments 3 may be riser buoys, initiation fittings, pipeline end terminations (PLET), branches, inline SLED assemblies, inline manifolds, pipe valves, tee assemblies with their supporting structures and mud-mats. For the installation the pipeline equipment will be moved above the already installed pipeline 13 and aligned and welded to the installed pipeline. During movement of the pipeline equipment 3 to the seabed along the firing line 7 the pipeline equipment 3 may not be able to move through the hang off device because it may be too big. The tower and the firing line 7 may be rotated around the tower tilting axis 11 such that the bottom of the tower moves away from the edge of the vessel, leaving the installed pipe line 13 and the pipeline equipment 3 suspended along the natural departure angle. Pipe clamp 5 is equipped and arranged to support the pipeline in the event that the tower is rotated away from the natural pipe departure angle. The installed pipeline and the pipeline equipment can be lowered towards the seabed by lowering the pipe clamp 5 with the hoisting device 4 down along the tower 1. Since the tower angle is different from the pipe departure angle room is created between the vessel bow 9 and the tower 1 for the pipeline equipment to pass the hang off device and work station 30 (see figure 2b). Sufficient room needs to be provided to allow the structure 3 to pass the vessel hull. Section A-A of figure 2b shows a cross section of the tower just above hinge point 11. For instance via a recess 31 in the deck 32 of the vessel sufficient space can be created for the pipeline equipment to pass. After the pipeline equipment passed the base of the tower 1, the tower can be tilted around the tilting axis 11 so that the firing line 7 of the tower 1 corresponds again to the natural departure angle of the pipeline (see figure 2c) and normal installation of pipe sections can resume.

The pipe laying system and method to install a pipeline comprising pipeline equipments according to a second embodiment of the invention is shown in figures 3a-3c. The pipe laying system and method is similar to figure 2 for installing normal pipe sections,

only for installing pipeline equipment 3 the system and method is different. During installation the pipeline equipment 3 will be moved above the already installed pipeline 13 and subsequently aligned and welded to the installed pipeline (see figure 3a). During movement of the pipeline equipment 3 towards the seabed along the firing line 7 the pipeline equipment 3 may be not be able to move through the hang off device because it may be too big. The tower 1 and the firing line 7 may than be tilted around the tower tilting axis 11 such that the bottom of the tower moves away from the edge of the vessel. The installed pipe line 13 and the pipeline equipment 3 are suspended according the natural departure angle. The installed pipeline and the pipeline equipment can than be moved to the seabed by lowering the pipeline 13 with a hoisting apparatus, for example auxiliary hoisting device 6 along the natural pipe departure angle and by pass the hang off device (see figure 3b). Auxiliary hoisting device 6 does not move along the tower but pays out a wire 8. As shown in figure 2, the deck of the vessel should allow sufficient clearance for the structure 3 to pass. When the pipeline equipment has passed the bottom of the tower 1, the tower 1 can be tilted around the tilting axis 11 so that the firing line 7 of the tower 1 corresponds again to the natural departure angle of the pipeline (see figure 3c). Auxiliary hoisting device 6 can hand over the pipeline to the hang off device and normal installation of pipe sections can resume.

The pipe laying system and method to install a pipeline comprising pipeline equipment according to a third embodiment of the invention is shown in figures 4a-4c. The pipe laying system and method is similar to figure 2 for installing pipe sections, only for installing pipeline equipment 3 the system and method is different. During installation the pipeline equipment 3 will be moved above the already installed pipeline 13 and subsequently aligned and welded to the installed pipeline (see figure 4a). During movement of the pipeline equipment 3 to the seabed along the firing line 7 the pipeline equipment 3 may be not capable of moving through the hang off device because it may be too big. The tower 1 is therefore provided with a tiltable hoisting apparatus 17. Hoisting apparatus 17 may be a crane and is provided with a tiltable beam 19 for moving the pipe line 13 and the pipeline equipment 3 from the firing line to a position outside the firing line and a lowering device 21 for lowering the pipe line 13 and the pipeline equipment 3 along the auxiliary firing line 15. The installed pipeline and the pipeline equipment can than be moved to the seabed by lowering it with the lowering device 21 of the hoisting apparatus 17 along natural pipe departure angle besides the firing line 7 and by pass the hang off device (see figure 4b). When the hang off device is passed beam 19 is tilted such that the installed pipeline is moved back towards the firing line 7 of the tower 1 (see figure 4c). Hoisting device 17 can lower the pipeline onto the hang off device and normal installation of pipe sections can resume.

The pipe laying system according to the invention may be mounted on a vessel. The pipe laying system may be provided with adjusters. The adjusters may be provided with

actuators to tilt the tower with respect to the vessel. The actuators may be hydraulic, pneumatic or electric actuators. By adjusting the angle the pipeline and the pipeline equipment may be moved along a trajectory that differs from the firing line of the tower so as to move the pipeline equipment past the base of the tower.

While the above described systems and methods are suitable for installing pipeline equipment to pipe lines, such methods and systems are also suitable for installing double walled pipes. It will be apparent to those skilled in the art that various modifications can be made to the invention without departing from the spirit and scope of the invention.

Claims

1 Pipe laying method to install a pipeline comprising pipeline equipment on a seabed, the method comprising:

providing a pipe laying system comprising a tower;

installing the pipeline along a pipe departure trajectory that coincides with the tower firing line in the direction of the seabed;

engaging the pipeline with a hang-off device provided to a base of the tower to support the weight of the pipeline;

loading a pipe section including pipeline equipment in the firing line above the hang-off device;

connecting the pipe section with the pipeline equipment to the pipeline clamped by the hang-off device;

clamping the top of the pipeline to a hoisting device provided to a hoisting apparatus provided to the tower;

disengaging the pipeline from the hang-off device;

moving the tower and/or the hoisting device such that the tower firing line does no longer coincide with the pipe departure trajectory; and

lowering the pipeline and the connected pipeline equipment with the hoisting device along the pipe departure trajectory that differs from the firing line of the tower.

2. The method according to claim 1, wherein the method comprises after lowering the pipeline and the pipeline equipment underneath a base of the tower, moving the tower and/or the hoisting device such that the tower firing line coincides with the pipe departure trajectory again.

3. The method according to claim 1 wherein the hoisting apparatus is mounted on the tower.

4. The method according to claim 1, wherein moving the tower and/or the hoisting device such that the tower firing line does not longer coincide with the pipe departure trajectory comprises tilting the tower with respect to the pipeline and the connected pipeline equipment.

5. The method according to claim 1, wherein moving the tower and/or the hoisting device such that the tower firing line does not longer coincide with the pipe departure trajectory comprises moving the hoisting device with respect to the tower firing line.

6. The method according to claim 1, wherein the pipeline and the connected pipeline equipment are lowered along the trajectory that differs from the tower firing line using a hoisting cable.

7. Pipeline laying system to install a pipeline comprising pipeline equipment, the system comprising:

a tower constructed and arranged to join pipe sections and pipe line equipment to the pipeline along a firing line; wherein the tower is provided with a hoisting apparatus constructed and arranged to move the pipeline and the equipment to a trajectory that differs from the firing line of the tower.

8. Pipe laying system according to claim 7, wherein the hoisting apparatus is provided with a hoisting device constructed and arranged for lowering the pipeline with pipeline equipment along a trajectory that differs from the firing line of the tower.

9. Pipe laying system according to claim 7, wherein the hoisting apparatus is mounted on the tower.

10. Pipe laying system according to claim 8, wherein the hoisting apparatus is constructed and arranged to move the hoisting device outside the firing line of the tower so that the pipeline and the pipeline equipment can be lowered on a hoisting cable along a trajectory that differs from the firing line of the tower.

11. Pipe laying system according to claim 7 or 8, wherein the hoisting apparatus is constructed and arranged to allow the pipeline and the pipeline equipment to be suspended along the natural departure angle from the tower when the angle of the tower is adjusted.

12. Pipe laying system according to claim 7, wherein the pipe laying system comprises one or more workstations along the tower firing line.

13. Pipe laying system according to claim 12, wherein the pipeline trajectory can be separated from the firing line of the tower to an extent that a pipeline section with pipeline equipment can be lowered on the outside of the one or more workstations.

14. Pipe laying system according to claim 7, wherein the pipe laying system comprises a hang-off device along the tower firing line.

15. Pipeline laying vessel comprising the pipe laying system according to claim 7.

16. Pipeline laying vessel to install a pipeline comprising pipeline equipment, the vessel comprising a tower constructed and arranged to join pipe sections and pipe line equipment to the pipeline along a firing line; wherein the angle between the tower and the vessel is adjustable so as to move the pipeline and the equipment along a trajectory that differs from the firing line of the tower.

17. Pipe laying vessel according to claim 16, wherein the tower angle can be adjusted by having adjustable struts between the tower and the vessel for adjusting the angle between the vessel and the tower.

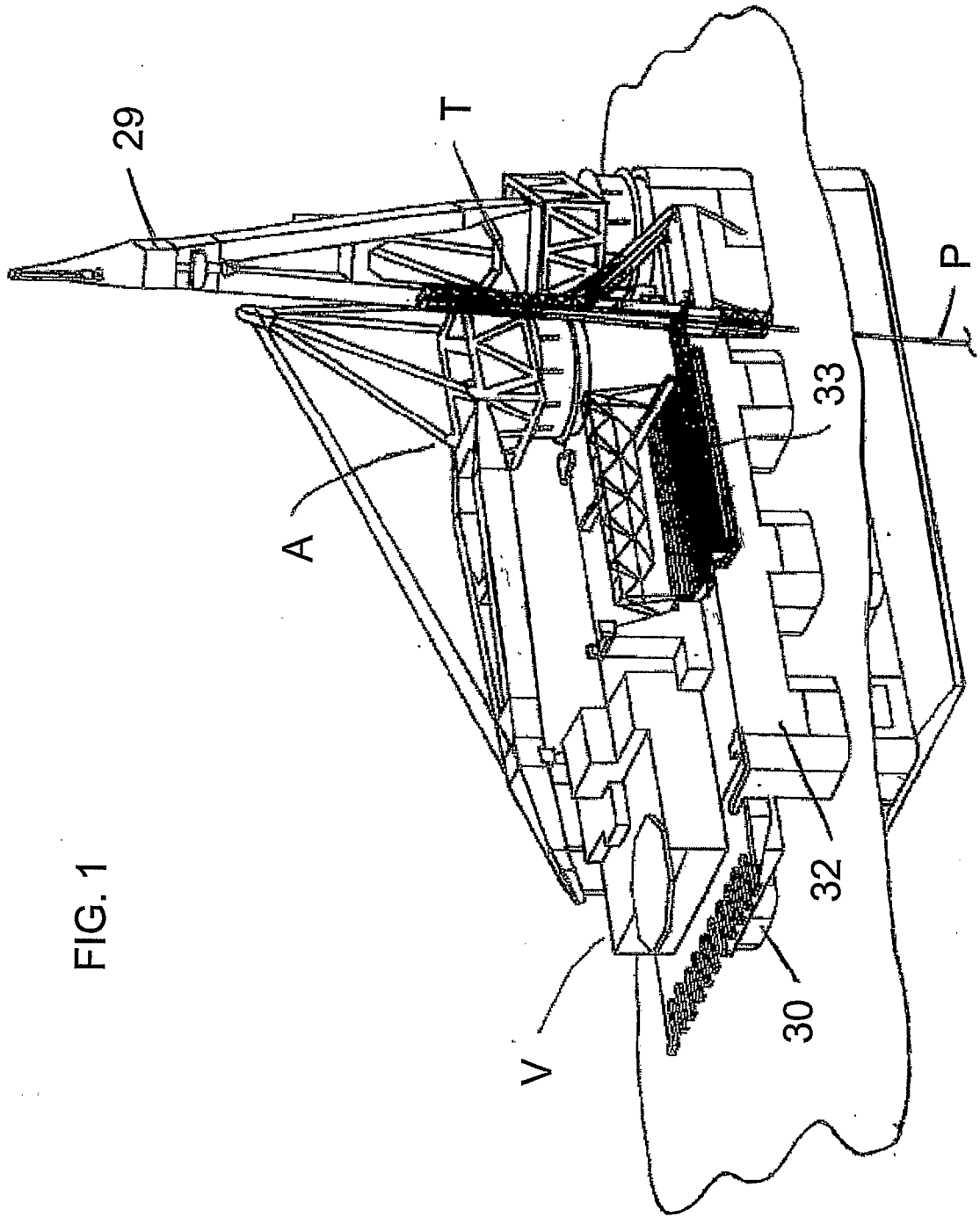

FIG. 1

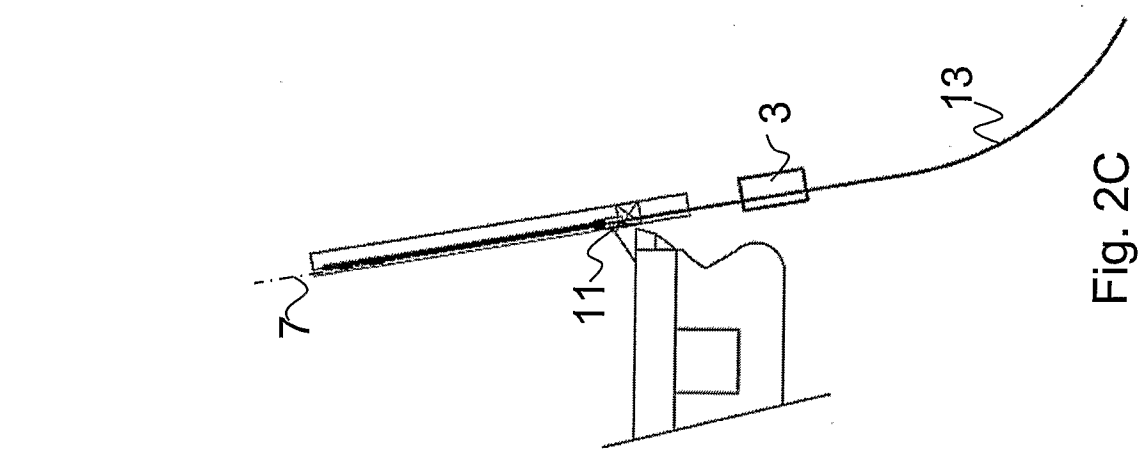

Fig. 2C

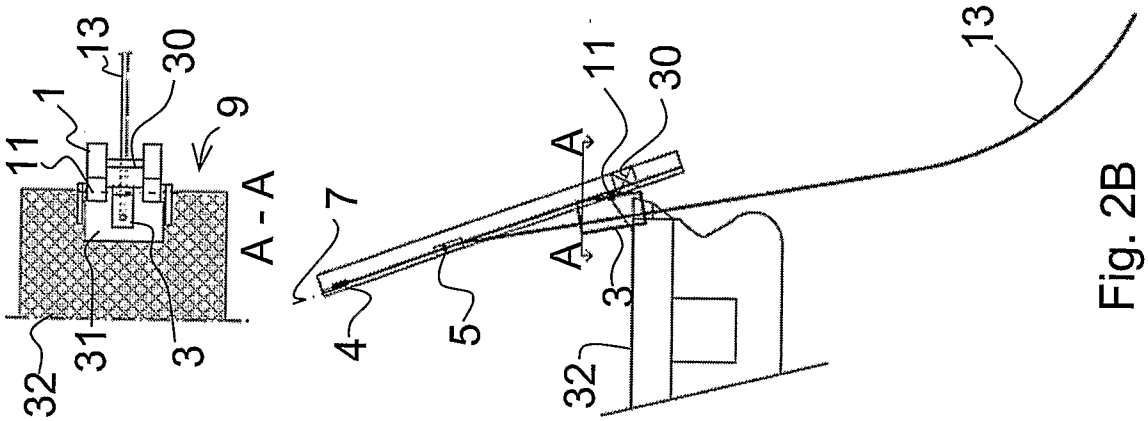

Fig. 2B

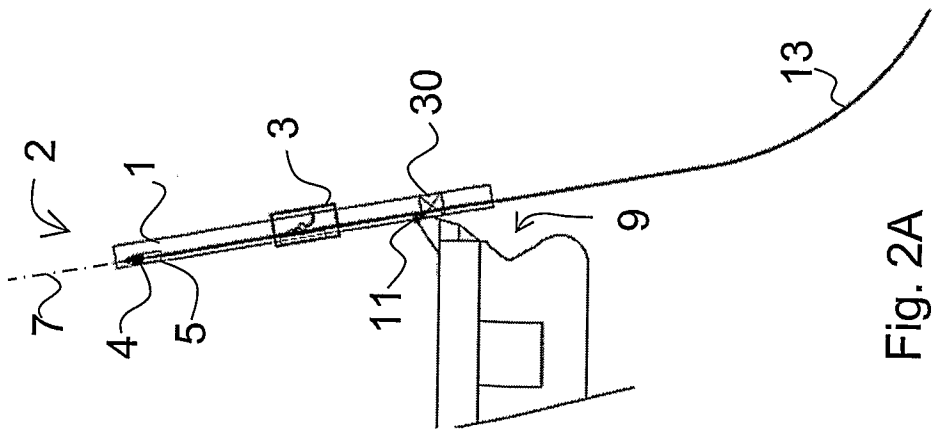

Fig. 2A

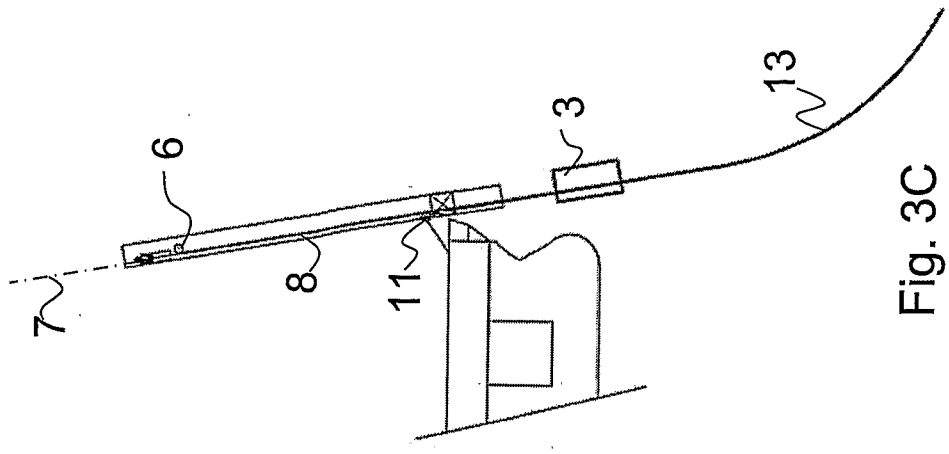

Fig. 3C

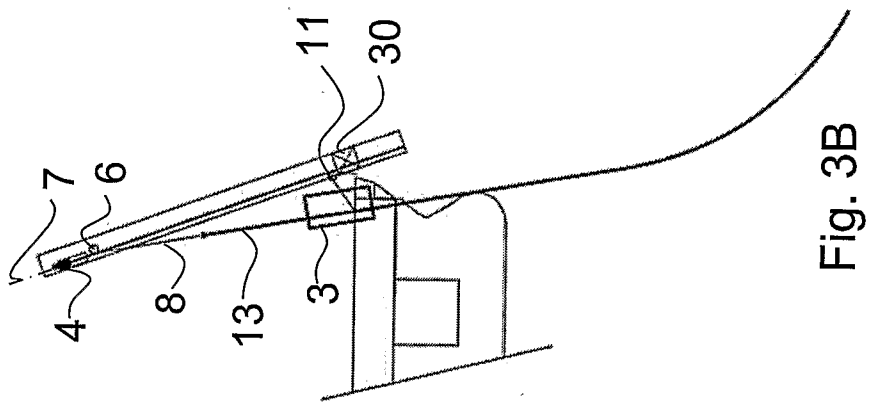

Fig. 3B

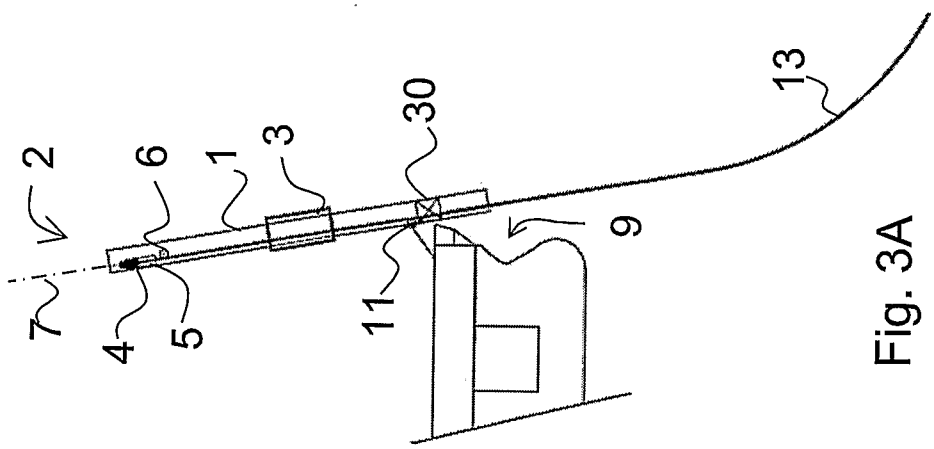

Fig. 3A

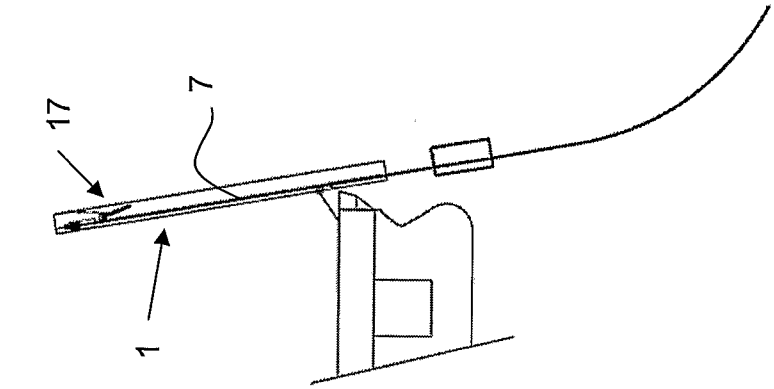

Fig. 4c

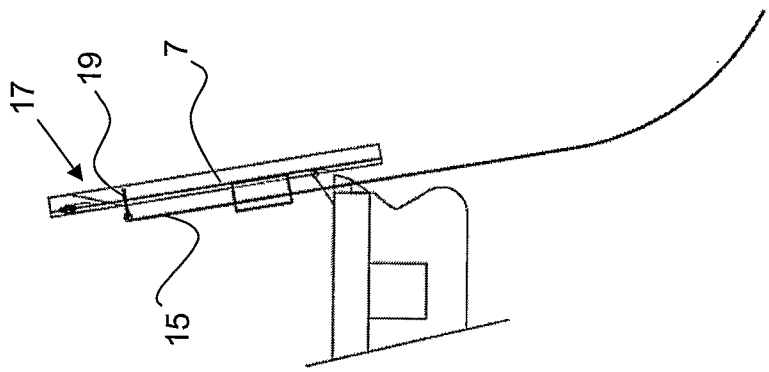

Fig. 4b

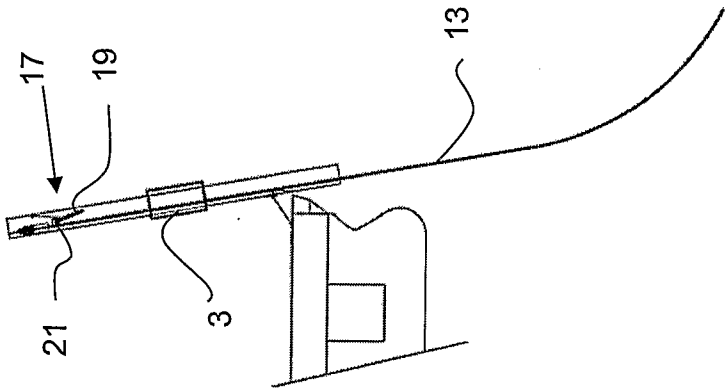

Fig. 4a