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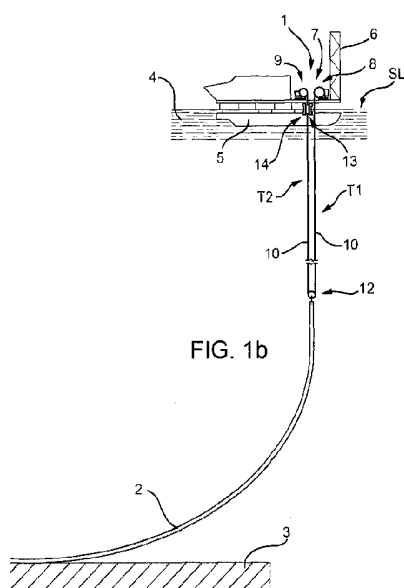
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(54) **Title:** HOISTING METHOD AND ASSEMBLY FOR ABANDONING AND/OR RECOVERING AN UNDERWATER PIPELINE FROM A LAYING VESSEL, AND LAYING VESSEL EQUIPPED WITH SUCH A HOISTING ASSEMBLY



(57) **Abstract:** A method of abandoning or recovering an underwater pipeline (2) from a laying vessel (1), the method including the steps of looping a first rope (10) about a pulley (22) connected to the free end of the pipeline (2); end- locking the first rope (10), on one side, to the laying vessel (1); and winding or unwinding the first rope (10), on the other side, by means of a first winch (8) located on the laying vessel (1) and having a first hoisting capacity.

HOISTING METHOD AND ASSEMBLY FOR ABANDONING AND/OR
RECOVERING AN UNDERWATER PIPELINE FROM A LAYING VESSEL,
AND LAYING VESSEL EQUIPPED WITH SUCH A HOISTING ASSEMBLY

5 TECHNICAL FIELD

The present invention relates to a method of
abandoning and/or recovering an underwater pipeline from
a laying vessel.

BACKGROUND ART

10 An underwater pipeline is normally assembled on
board a laying vessel, and laid on the bed of a body of
water as it is assembled. Some commonly used laying
vessels are equipped with a substantially horizontal,
on-board assembly line; and a curved lay ramp that
15 guides part of the pipeline as it is lowered onto the
bed. This laying method is known as S-laying, because of
the shape of the pipeline between the laying vessel and
the bed.

 On other laying vessels, the pipeline is assembled
20 in a substantially vertical tower and released
substantially vertically. This laying method is known as
J-laying, because of the shape of the pipeline between
the laying vessel and the bed, and is preferable to S-
laying when working in deep water.

25 Substantially two situations make it necessary to
abandon the pipeline on the bed: bad weather conditions
making laying work dangerous; and completion of the
pipeline.

The pipeline must be recovered off the bed to resume laying and assembly work interrupted by bad weather.

Methods of abandoning and/or recovering underwater
5 pipelines comprise shutting down assembly of the pipeline; connecting the free end of the pipeline to a hoisting assembly comprising at least one winch on the laying vessel, at least one rope, and a connecting device for connecting the rope to the pipeline; and
10 abandoning/recovering the pipeline by winching out/up the rope. Documents EP 1,850,043 A2; US 2007/0177944; WO 2009/002142; and WO 2009/082191 describe various abandoning and/or recovery methods, which employ hoisting assemblies comprising two winches installed on
15 board the laying vessel and operating synchronously to simultaneously control two ropes and share the load exchanged between the pipeline and the laying vessel.

The load between the laying vessel and the pipeline varies between a maximum and minimum, and depends on the
20 length of pipeline raised off the bed. When abandoning the pipeline, load is maximum at the initial stage, when a long portion of the pipeline is raised off the bed. And, conversely, when recovering the pipeline, load is maximum at the final stage, when, again, a long portion
25 of the pipeline is raised off the bed.

The load between the pipeline and the laying vessel, in fact, is a function of the weight per linear metre of the pipeline, and the length of pipeline raised

off the bed.

Whether it comprises one or more winches, the hoisting assembly must have a total capacity greater than the actually short-lived maximum load between the pipeline and the laying vessel. Which means the laying vessel as a whole must be equipped with a hoisting assembly capable of hoisting more than the maximum load exchangeable between the pipeline and the vessel. Deepwater laying vessels, normally equipped with a J-lay tower, must therefore be equipped with hoisting assemblies of over 1500-ton capacity when working with extra-large-diameter pipelines; and even a 1500-ton hoisting capacity may not always be enough when abandoning extra-large-diameter pipelines in deep water.

To solve the problem, US 6,729,802 filed by the Applicant proposes connecting the end of the pipeline to floating bodies to reduce the load between the pipeline and the laying vessel. This has proved highly successful, but is slow when the pipeline has to be abandoned rapidly in particularly bad weather conditions.

DISCLOSURE OF INVENTION

It is an object of the present invention to provide a method of abandoning or recovering an underwater pipeline from a laying vessel, designed to eliminate the drawbacks of the known art.

Another object of the present invention is to provide a method of abandoning or recovering an

underwater pipeline, even when hoisting capacity is to some extent less than that of the hoisting assembly.

According to the present invention, there is provided a method of abandoning or recovering an
5 underwater pipeline from a laying vessel, the method comprising the steps of looping a first rope about a pulley connected to the free end of the pipeline; end-locking the first rope, on one side, to the laying vessel; and winding or unwinding the first rope, on the
10 other side, by means of a first winch located on said laying vessel and having a first hoisting capacity.

The present invention provides for both abandoning and recovering an underwater pipeline using a first winch with a first hoisting capacity substantially equal
15 to half the total load between the pipeline and the laying vessel.

In a preferred embodiment of the present invention, the first rope is joined, on one side, to a second rope operated by a second winch located on the laying vessel
20 and having a second hoisting capacity lower than the first hoisting capacity. And the method comprises the steps of selectively end-locking the first rope to the laying vessel; and selectively releasing the first rope from the laying vessel, to abandon or recover the
25 pipeline using the first and second rope jointly, by unwinding or winding the first and second rope by means of the first and second winch respectively.

The preferred embodiment enables fast switching

from the end-locked first rope configuration, in which the second winch and second rope are idle, to the joint configuration of the first and second rope operated respectively by the first and second winch. Because the
5 load between the laying vessel and the pipeline is maximum at the initial stage when abandoning the pipeline, the pipeline is initially abandoned using the first winch with the first rope end-locked, and then using the first and second winch and the first and
10 second rope jointly, to speed up descent of the pipeline.

When recovering the pipeline, on the other hand, the pipeline is first hoisted using the first and second winch and the first and second rope jointly, and finally
15 using the first winch with the first rope end-locked.

The above is also achieved even when the total hoisting capacity of the first and second winch is less than the maximum load between the pipeline and the laying vessel.

20 Another object of the present invention is to provide a hoisting assembly for abandoning and/or recovering an underwater pipeline from a laying vessel, and designed to eliminate the drawbacks of the known art.

25 According to the present invention, there is provided a hoisting assembly for abandoning or recovering an underwater pipeline from a laying vessel, as claimed in Claim 11. More specifically, the hoisting

assembly comprises at least a first winch with a first hoisting capacity; a first rope operated by the first winch; a connecting device, which attaches to the pipeline and has a pulley for guiding the first rope; and a coupling device located on the laying vessel to end-lock the first rope to the laying vessel, and to at least partly abandon or recover the pipeline using the end-locked first rope and the first winch.

BRIEF DESCRIPTION OF THE DRAWINGS

10 A number of non-limiting embodiments of the present invention will be described by way of example with reference to the accompanying drawings, in which :

Figures 1a-1c show side views of three operating stages of a laying vessel equipped with a hoisting assembly in accordance with the present invention;

Figures 2 and 3 show two larger-scale side views, with parts removed for clarity, of two steps in the pipeline abandoning method according to the present invention;

20 Figures 4 and 5 show two larger-scale side views, with parts removed for clarity, of a coupling device in accordance with the present invention;

Figure 6 shows a larger-scale, partly sectioned side view, with parts removed for clarity, of a variation of the Figure 4 and 5 coupling device;

Figure 7 shows a larger-scale front view, with parts removed for clarity, of the Figure 6 coupling device;

Figure 8 shows a larger-scale side view, with parts removed for clarity, of the Figure 6 coupling device;

Figure 9 shows a larger-scale side view, with parts removed for clarity, of a spacer device;

5 Figure 10 shows a plan view, with parts removed for clarity, of the Figure 9 spacer device.

BEST MODE FOR CARRYING OUT THE INVENTION

Number 1 in Figure 1a indicates as a whole a laying vessel assembling and laying an underwater pipeline 2 on
10 the bed 3 of a body of water 4 of level SL.

In the example shown, laying vessel 1 comprises a floating structure 5; a J-lay tower 6; and a hoisting assembly 7 for abandoning and recovering pipeline 2.

Figure 1a shows the pipeline being assembled in J-lay tower 6 and gradually released by gripping
15 assemblies (not shown) associated with tower 6 and for gripping pipeline 2.

When completed, or in bad weather, pipeline 2 must be abandoned on bed 3.

20 The abandoning method comprises connecting the free end of pipeline 2 to hoisting assembly 7; and easing pipeline 2 onto bed 3. As shown in Figures 1b and 1c, as the abandoning operation proceeds, the portion of pipeline 2 detached from bed 3 and, hence, the load
25 between pipeline 2 and laying vessel 1 get smaller, which means the maximum load between laying vessel 1 and pipeline 2 occurs at the initial stage in abandoning pipeline 2.

To resume laying work, the abandoned pipeline 2 must be recovered. This is done using hoisting assembly 7 connected to pipeline 2; and the maximum load between pipeline 2 and laying vessel 1 occurs at the final recovery stage.

With reference to Figures 2 and 3, hoisting assembly 7 comprises two winches 8 and 9; two ropes 10 and 11; a connecting device 12 for connecting ropes 10 and 11 to the free end of pipeline 2; a splicing device 13 for joining ropes 10 and 11; and a coupling device 14 for connecting rope 10 to laying vessel 1.

Winch 8 is mounted on laying vessel 1, and comprises a drum 15 for winding and unwinding rope 10; a motor 16; and a reducer 17. Winch 9 is mounted on the laying vessel, and comprises a drum 18 for winding and unwinding rope 11; a motor 19; and a reducer 20. Winch 8 has a greater hoisting capacity than winch 9, so rope 10 is larger in diameter than rope 11. Ropes 10 and 11 are steel-stranded, low-twist, antirotation ropes designed for the hoisting capacities of respective winches 8 and 9.

Connecting device 12 comprises a plug 21 for plugging the free end of pipeline 2; and a pulley 22 - in the example shown, an idle pulley - that rotates on a fork 23 integral with plug 21.

With reference to Figures 4 and 5, splicing device 13 comprises two terminals 24 and 25 integral with respective ropes 10 and 11; and a pin 26 connecting

terminals 24 and 25. Splicing device 13 as a whole comprises two opposite conical portions at terminals 24 and 25; and a central portion fitted with pin 26.

Coupling device 14 is mounted on laying vessel 1 -
5 preferably suspended from a deck 27 of laying vessel 1 -
and comprises two jaws 28, which automatically grip
splicing device 13 as it runs between jaws 28 in a
direction D1. In the example shown, coupling device 14
comprises two arms 29 for supporting jaws 28 and hinged
10 to deck 27; and two actuators 30 for selectively
rotating arms 29 about their respective hinge axes. Jaws
28 form a conical seat complementary to the conical
portion of splicing device 13, so as to form a wedge-
type joint when splicing device 13 is loaded in
15 direction D1, and arms 29 are positioned as shown in
Figures 4 and 5. Jaws 28 are mounted to rotate with
respect to arms 29, so that, when the splicing device
runs between jaws 28 in a direction D2 opposite
direction D1, jaws 28 rotate about their respective axes
20 with respect to arms 29 to let splicing device 13
through, as shown in Figure 5. Splicing device 13 is
released from jaws 28 by lifting it in direction D2, and
parting arms 29 using actuators 30, so that splicing
device 13 runs freely between jaws 28 in direction D1.

25 Hoisting assembly 7 also comprises connecting
devices (not shown) for connecting rope 10 or rope 11
only to pipeline 2, so winches 8 and 9 can each be
operated singly (i.e. without pulley 22) when the load

between pipeline 2 and laying vessel 1 and the hoisting capacities of individual winches 8 and 9 allow.

Hoisting assembly 7 described is designed to operate in a number of modes. More specifically, in addition to the operating modes in which each winch 8, 9 operates fully independently of the other (single operating mode), hoisting assembly 7 also permits an operating mode in which ropes 10 and 11 are joined, run about pulley 22, and are wound or unwound by respective winches 8 and 9, so the load between pipeline 2 and laying vessel 1 is divided equally between two parallel portions T1 and T2 extending from pulley 22 to winches 8 and 9.

In another operating mode, rope 10, i.e. splicing device 13, is connected to laying vessel 1, and is wound or unwound in an end-locked configuration, in which rope 10 forms about pulley 22 an open loop with two portions T1, T2 extending between pulley 22 and the laying vessel, as shown in Figure 1b. The total load is thus divided equally between two substantially parallel portions T1, T2 of rope 10; portion T2 being connected directly to laying vessel 1, and portion T1 being wound or unwound by winch 8. Winch 8 can thus control pipeline 2 when the load between the pipeline and laying vessel 1 is substantially twice the hoisting capacity of winch 8.

Coupling device 14 provides for switching rapidly between operating winch 8 with rope 10 end-locked, and operating both winches 8 and 9 to wind or unwind ropes

10 and 11 jointly. In the joint configuration, the open loop comprising portions T1 and T2 is formed partly by rope 10 and partly by rope 11. Operating winch 8 on its own with rope 10 end-locked enables loads of substantially twice the hoisting capacity of winch 8 to be handled, but abandoning and recovery speed is half that of both winches 8 and 9 operating ropes 10 and 11 jointly.

The following are example operating modes of hoisting assembly 7, assuming winch 8 has a hoisting capacity of 750 tons, and winch 9 a hoisting capacity of 500 tons.

EXAMPLE 1

When the maximum load between pipeline 2 and laying vessel 1 is below 500 tons, the pipeline is abandoned and recovered using winch 9 and rope 11 in single mode.

EXAMPLE 2

When the maximum load between pipeline 2 and laying vessel 1 is between 500 and 750 tons, the pipeline is abandoned and recovered using winch 8 and rope 10 in single mode.

EXAMPLE 3.

When the maximum load between pipeline 2 and laying vessel 1 is between 750 and 1000 tons, the pipeline is abandoned and recovered using winches 8 and 9 operating

respective ropes 10 and 11 jointly. Winches 8 and 9 are operated simultaneously to wind or unwind respective ropes 10 and 11 as shown in Figure 1c.

5 EXAMPLE 4

When the maximum load between pipeline 2 and laying vessel 1 is between 1000 and 1500 tons, the pipeline is abandoned and recovered using winch 8 on its own, with rope 10 end-locked to laying vessel 1, as shown in
10 Figure 1b. When abandoning pipeline 2, this configuration is maintained until the load falls below 1000 tons; at which point, hoisting assembly 7 is set to the EXAMPLE 3 configuration (Figure 1c) to accelerate the abandoning operation and take advantage of the
15 greater speed and depth achievable using both ropes 10 and 11 jointly. Ropes 10 and 11, in fact, are of limited length, and the end-locked configuration of rope 10 only reaches half the depth of rope 10 used in single mode, i.e. with its end connected directly to the free end of
20 the pipeline.

Coupling device 14 provides for switching rapidly from the EXAMPLE 4 to the EXAMPLE 3 mode, and vice versa, by releasing splicing device 13 from coupling device 14, and connecting splicing device 13 to coupling
25 device 14 respectively.

In Figures 6 to 8, splicing device 13 and coupling device 14 in Figures 2 to 5 are replaced with a splicing device 31 and a coupling device 32.

Splicing device 31 comprises two terminals 33, 34; a fork 35; and two pins 36, 37. Fork 35 comprises two opposite plates 38, and a spacer 39 between and integral with plates 38.

5 Coupling device 32 comprises a rope 40 with two terminals 41; two eyelets 42 integral with deck 27; and two pins 43 fastening terminals 41 to eyelets 42.

In this variation, splicing device 31 is suspended from deck 27 by rope 40, which is run between plates 38 and about spacer 39, and fixed at the ends to eyelets 42.

With reference to Figures 9 and 10, hoisting assembly 7 also comprises a spacer device 44 for preventing contact and twisting of the two parallel portions T1, T2 connecting pulley 22 to winches 8 and 9. Spacer device 44 comprises an annular member 45; an annular member 46; and a spacer 47 connecting annular members 45 and 46. With reference to Figure 10, annular member 45 grips portion T1, and comprises two hinged half-shells 48; fasteners 49; and a liner 50. Annular member 46 attaches loosely to portion T2, to permit low-friction, relative slide between annular member 46 and portion T2. As stated, portion T1 is defined by rope 10, while portion T2 may be defined by rope 10 and/or rope 11. Annular member 46 comprises two hinged half-shells 51; and a fastener 52 for selectively opening and closing half-shells 51. The half-shells are preferably lined with teflon or other friction-reducing material.

Even if winch 9 operates at a different speed from winch 8, spacer device 44 therefore does not prevent hoisting assembly 7 from operating with portions T1 and T2 at different speeds. Hoisting assembly 7, in fact, comprises a number of spacer devices 44, which are fixed at intervals along portions T1 and T2 as ropes 10 and 11 are lowered into water 4 (Figures 1b and 1c), and, conversely, are removed from portions T1 and T2 as ropes 10 and 11 are raised from water 4 (Figures 1b and 1c).

10 In a variation not shown, the annular members of the spacer devices are adjustable in diameter, to adapt to ropes of different diameters.

Clearly, changes may be made to the present invention as described herein without, however, departing from the scope of the accompanying Claims.

15

CLAIMS

1) A method of abandoning or recovering an underwater pipeline (2) from a laying vessel (1), the method comprising the steps of looping a first rope (10) about a pulley (22) connected to the free end of the pipeline (2); end-locking the first rope (10), on one side, to the laying vessel (1); and winding or unwinding the first rope (10), on the other side, by means of a first winch (8) located on said laying vessel (1) and having a first hoisting capacity.

2) A method as claimed in Claim 1, wherein the first rope (10) is joined, on one side, to a second rope (11) operated by a second winch (9) located on the laying vessel (1) and having a second hoisting capacity lower than the first hoisting capacity; the method comprising the steps of selectively end-locking the first rope (10) to the laying vessel (1); and selectively releasing the first rope (10) from the laying vessel (1), to abandon or recover the pipeline (2) using the first and second rope (10, 11) jointly, by unwinding or winding the first and second rope (10, 11) by means of the first and second winch (8, 9) respectively.

3) A method as claimed in Claim 2, wherein the first and second rope (10, 11) are joined by a splicing device (13; 31); the method comprising the steps of selectively attaching the splicing device (13; 31) to the laying vessel (1); and selectively releasing the

splicing device (13; 31) from the laying vessel (1).

4) A method as claimed in Claim 3, and comprising the step of automatically gripping the splicing device (13) by means of a coupling device (14) on the laying vessel (1), when the splicing device (13) is located at the coupling device (14).

5) A method as claimed in Claim 3, and comprising the step of attaching the splicing device (31) to the laying vessel (1) by means of a coupling device (32) comprising a further rope (40) looped about the splicing device (31).

6) A method as claimed in any one of Claims 2 to 5, and comprising the step of abandoning or recovering the pipeline (2) using the first and second rope (10, 11) jointly and driven by the first and second winch (8, 9) respectively, when the load between the pipeline (2) and the laying vessel (1) is less than twice the second hoisting capacity and higher than the first hoisting capacity.

7) A method as claimed in any one of Claims 2 to 6, and comprising the step of abandoning or recovering the pipeline (2) using the first rope (10) end-locked to the laying vessel (1) and driven by the first winch (8), when the load between the pipeline (2) and the laying vessel (1) is less than twice the first hoisting capacity and more than twice the second hoisting capacity.

8) A method as claimed in any one of the foregoing

Claims, wherein an open loop is formed about the pulley (22) by the first rope (10) when end-locked, and by the first and second rope (10, 11) used jointly; said open loop comprising a first and second portion (T1, T2) extending between the pulley (22) and the laying vessel (1); and the method comprising the step of attaching spacer devices (44) between the first and second portion (T1, T2), when abandoning the pipeline (2), to keep the first and second portion (T1, T2) apart.

10 9) A method as claimed in Claim 8, and comprising the steps of fixing the spacer devices (44) to the first portion (T1); and connecting the spacer devices (44) in sliding manner to the second portion (T2) as the first rope (10) is unwound by the first winch (8).

15 10) A method as claimed in Claim 8, and comprising the step of removing the spacer devices (44) from the first portion (T1) and second portion (T2), as the first rope (10) is wound by the first winch (8).

20 11) A hoisting assembly for abandoning or recovering an underwater pipeline (2) from a laying vessel (1), the hoisting assembly (7) comprising at least a first winch (8) with a first hoisting capacity; a first rope (10) operated by the first winch (8); a connecting device (12), which attaches to the pipeline
25 (2) and has a pulley (22) for guiding the first rope (10); and a coupling device (14; 32) located on the laying vessel (1) to end-lock the first rope (10) to the laying vessel (1), and to at least partly abandon or

recover the pipeline (2) using the end-locked first rope (10) and the first winch (8).

12) A hoisting assembly as claimed in Claim 11, and comprising a second winch (9) with a second hoisting capacity lower than the first hoisting capacity; a second rope (11) operated by the second winch (9); and a splicing device (13; 31) for connecting the ends of the first and second rope (10, 11); the coupling device (14; 32) being designed to selectively attach the splicing device (13; 31) to the laying vessel (1) to end-lock the first rope (10); and to release the splicing device (13; 31) from the laying vessel (1), to abandon or recover the pipeline by unwinding or winding the first and second rope (10, 11) jointly, by means of the first and second winch (8, 9) respectively.

13) A hoisting assembly as claimed in Claim 12, wherein the coupling device (14) and the splicing device (13) together form a wedge-type joint, when the splicing device (13) is drawn in a first direction (D1) with respect to the coupling device (14).

14) A hoisting assembly as claimed in Claim 13, wherein the coupling device comprises jaws (28) defining a seat for at least partly housing the splicing device (13).

15) A hoisting assembly as claimed in Claim 14, wherein the jaws (28) are mounted to rotate about respective supporting arms (29), to allow the splicing device (13) to pass between the jaws (28) when the

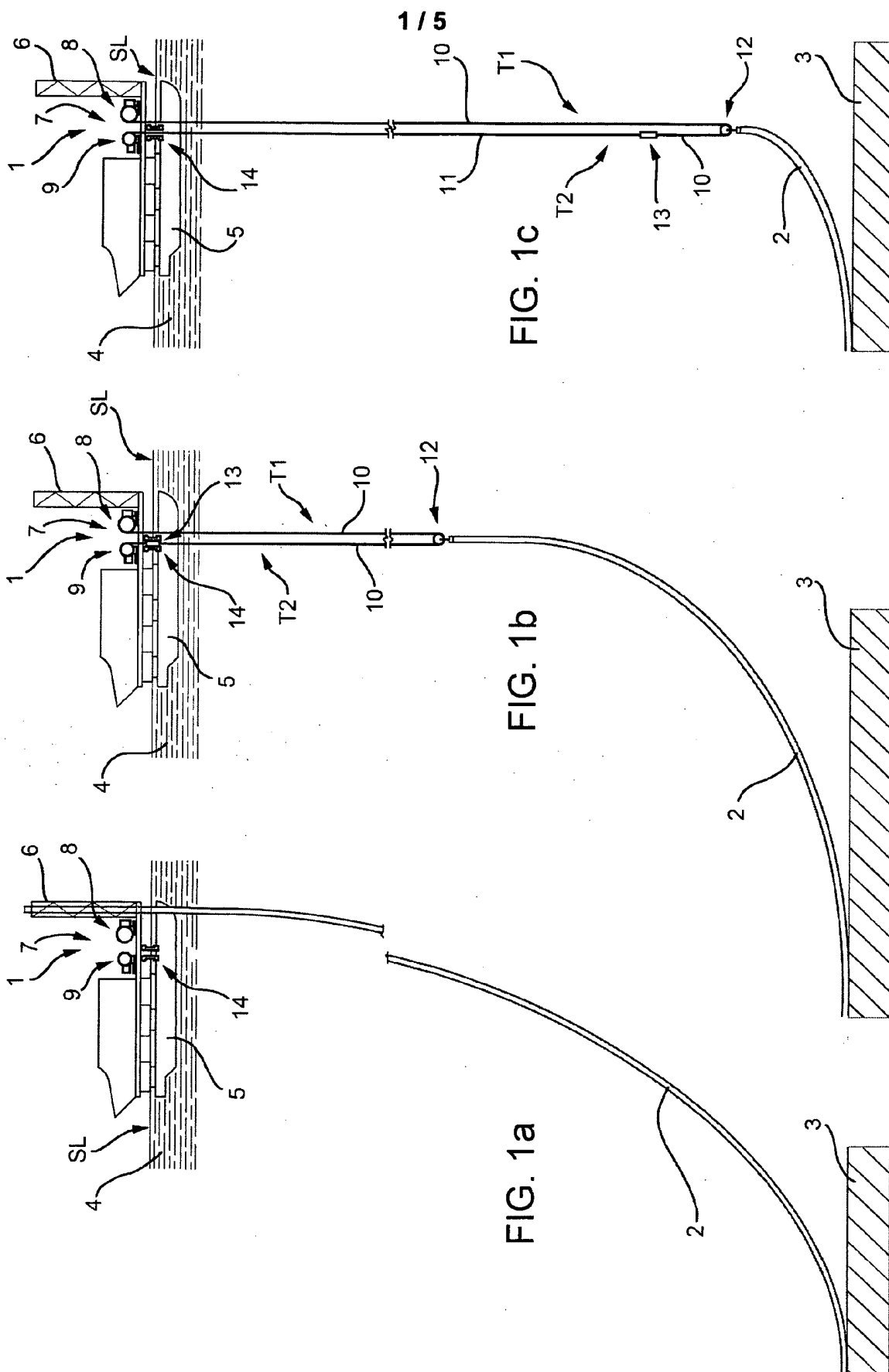
splicing device (13) is drawn between the jaws (28) in a second direction (D2) opposite the first direction (D1).

16) A hoisting assembly as claimed in Claim 12, wherein the coupling device (32) comprises a further
5 rope (40), which loops about the splicing device (31) and is secured to the laying vessel (1).

17) A hoisting assembly as claimed in any one of Claims 11 to 16, wherein an open loop is formed about the pulley (22) by the first rope (10) when end-locked,
10 and by the first and second rope (10, 11) used jointly; said open loop comprising a first and second portion (T1, T2) extending between the pulley (22) and the laying vessel (1); and the hoisting assembly (7) comprising spacer devices (44) fittable selectively to
15 the first and second portion (T1, T2).

18) A hoisting assembly as claimed in Claim 17, wherein each spacer device (44) comprises a first annular member (45) which clamps onto the first portion (T1); a second annular member (46) which fits in sliding
20 manner onto the second portion (T2); and a spacer (47) connected to the first and second annular member (45, 46).

19) A laying vessel for assembling and laying an underwater pipeline (2) on the bed (3) of a body of
25 water (4); the laying vessel (1) comprising a hoisting assembly (7) as claimed in any one of Claims 11 to 18.



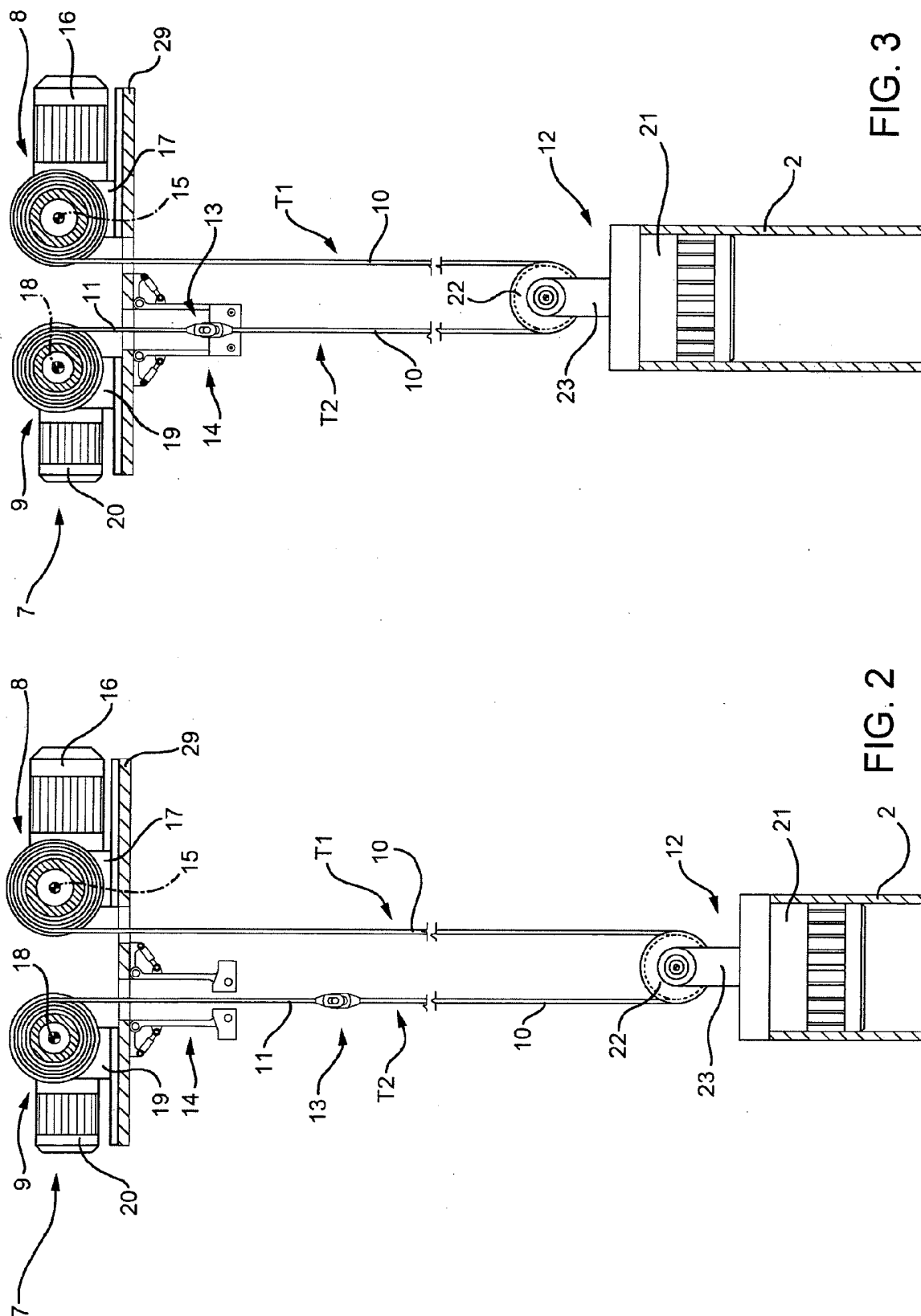


FIG. 3

FIG. 2

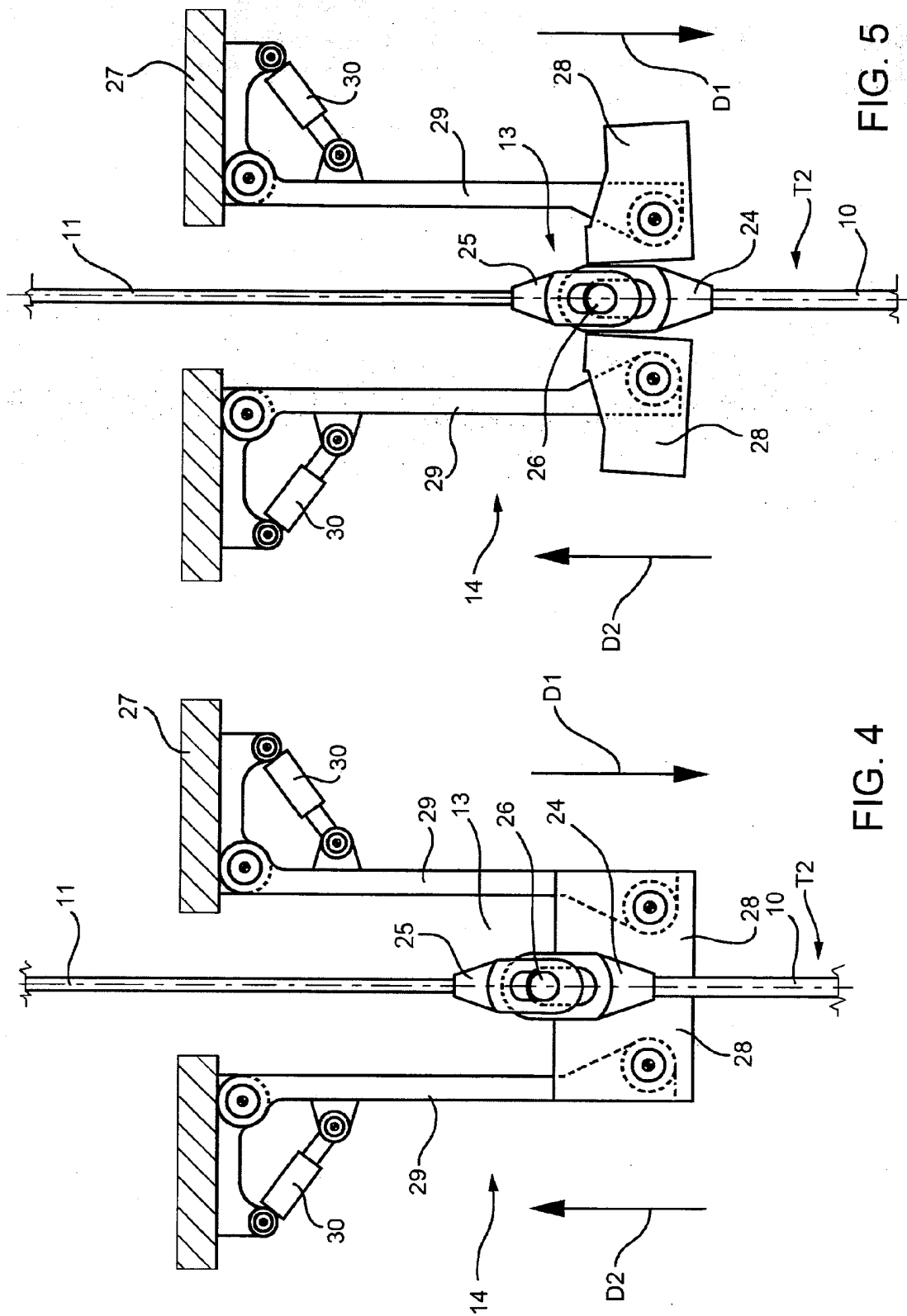


FIG. 5

FIG. 4

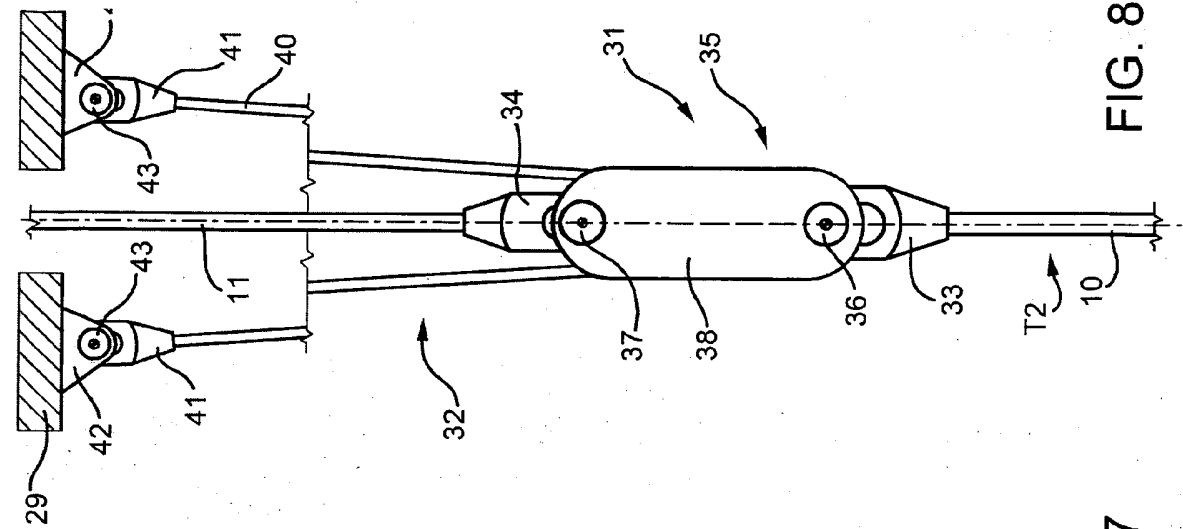


FIG. 6

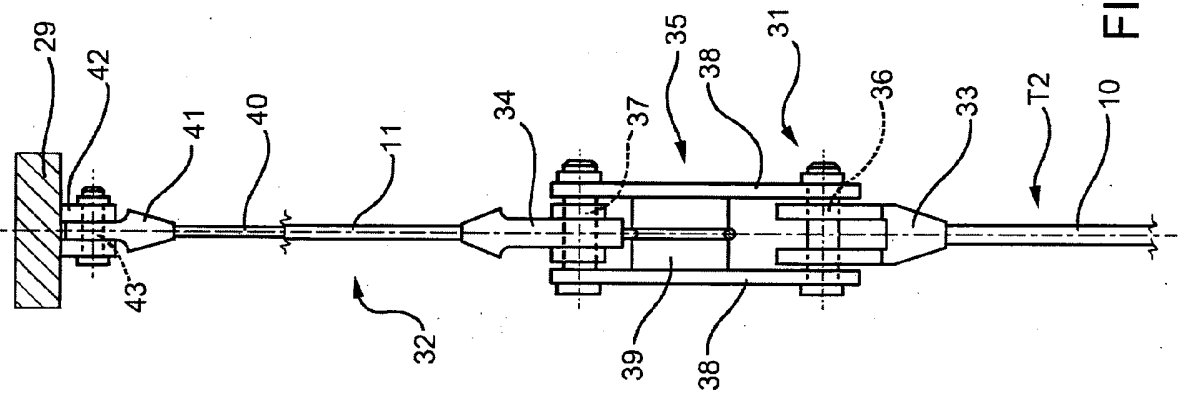


FIG. 7

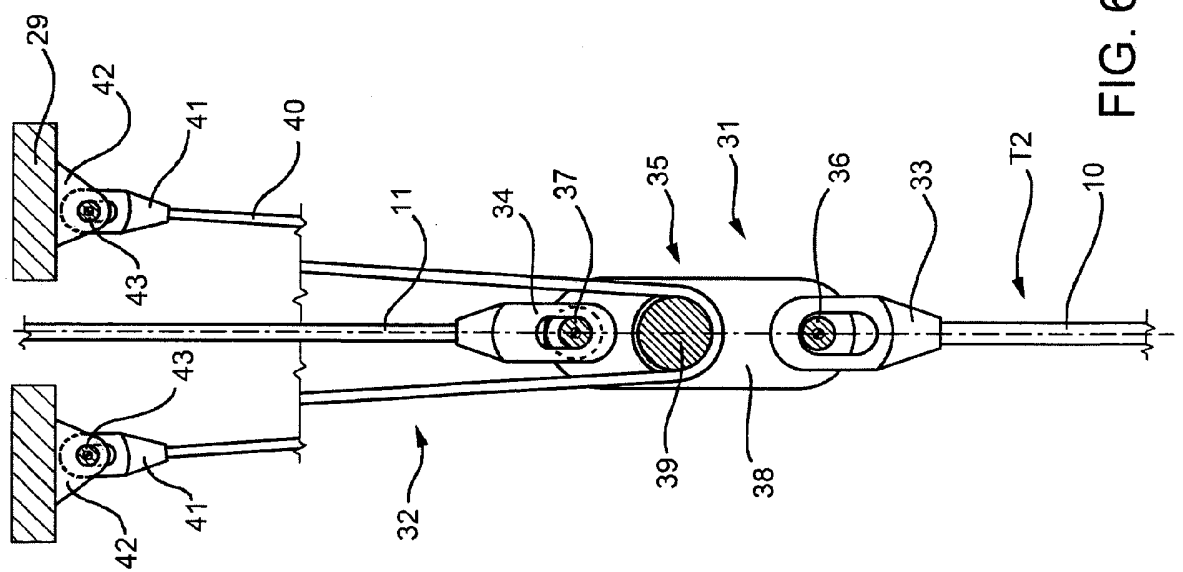


FIG. 8

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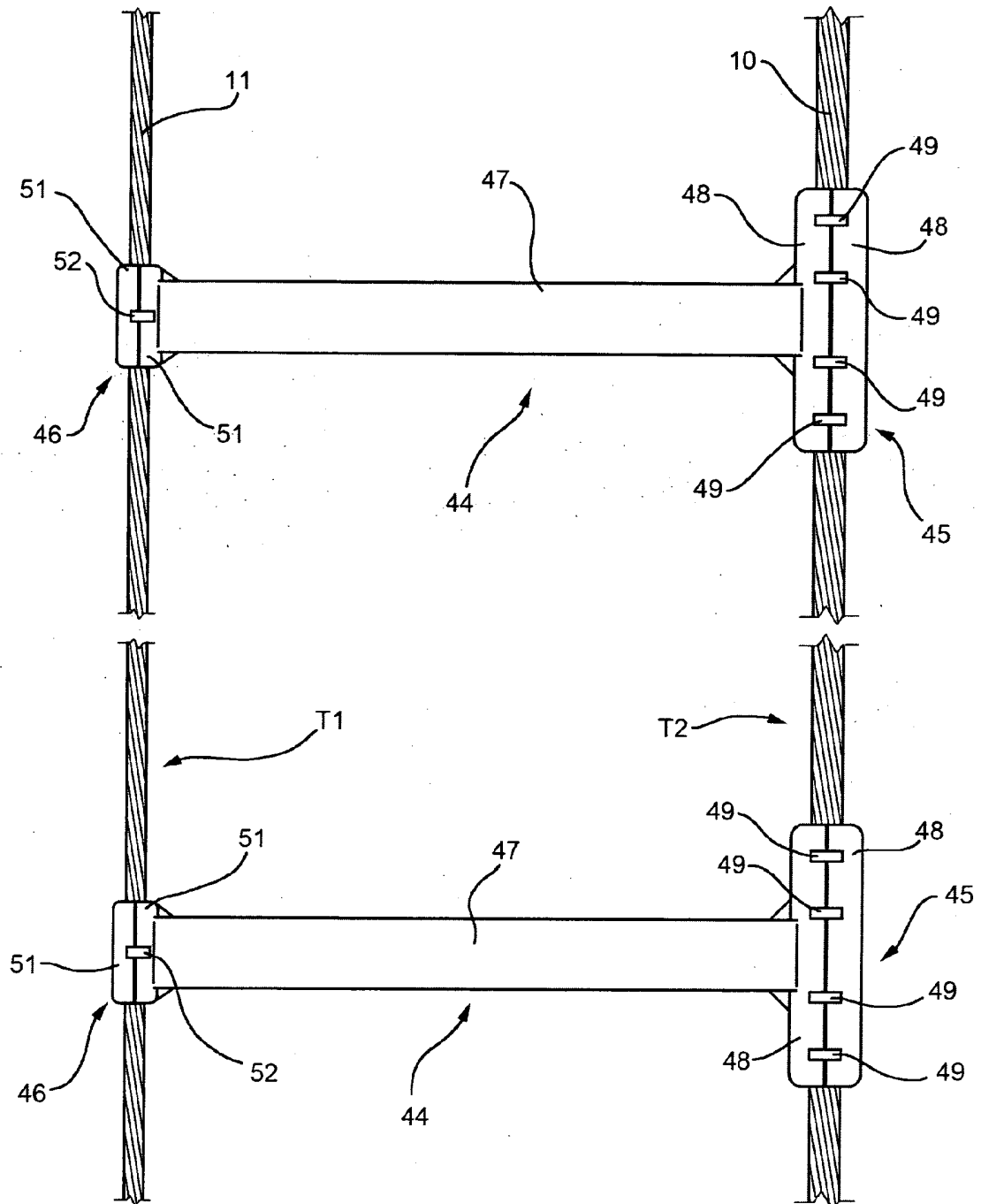


FIG. 9

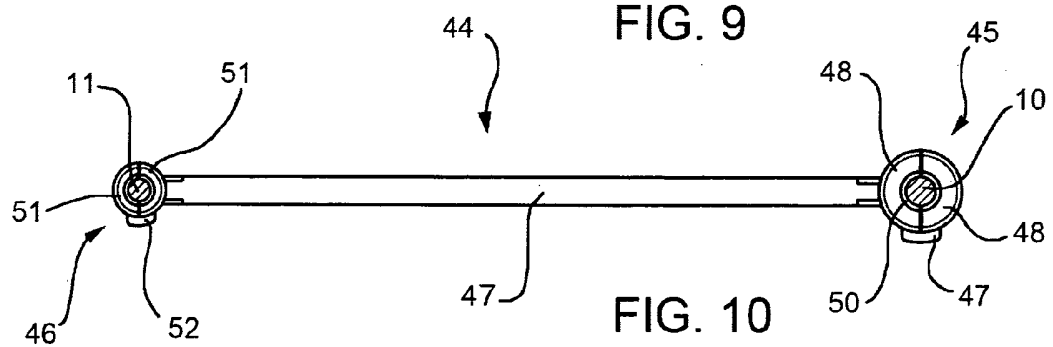


FIG. 10