

(19)



(11)

**EP 3 577 307 B1**

(12)

**EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:  
**09.04.2025 Bulletin 2025/15**

(21) Application number: **18748787.1**

(22) Date of filing: **05.02.2018**

(51) International Patent Classification (IPC):  
**E21B 19/02** <sup>(2006.01)</sup>      **E21B 29/10** <sup>(2006.01)</sup>  
**E21B 19/08** <sup>(2006.01)</sup>      **E21B 41/10** <sup>(2006.01)</sup>  
**E21B 33/035** <sup>(2006.01)</sup>      **E21B 33/064** <sup>(2006.01)</sup>  
**E21B 41/00** <sup>(2006.01)</sup>

(52) Cooperative Patent Classification (CPC):  
**E21B 33/035; E21B 33/038; E21B 33/064;**  
**E21B 41/0007; E21B 43/017**

(86) International application number:  
**PCT/US2018/016821**

(87) International publication number:  
**WO 2018/144985 (09.08.2018 Gazette 2018/32)**

**(54) SYSTEMS AND METHODS FOR TETHERING A SUBSEA STRUCTURE**

SYSTEME UND VERFAHREN ZUM FESTMACHEN EINER UNTERWASSERSTRUKTUR  
 SYSTÈMES ET PROCÉDÉS D'ATTACHE D'UNE STRUCTURE SOUS-MARINE

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB**  
**GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO**  
**PL PT RO RS SE SI SK SM TR**

(30) Priority: **03.02.2017 US 201762454472 P**

(43) Date of publication of application:  
**11.12.2019 Bulletin 2019/50**

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## Description

### BACKGROUND

[0001] The disclosure relates generally to systems and methods for tethering subsea structures. More particularly, the disclosure relates to systems and methods for enhancing the strength and fatigue performance of subsea blowout preventers, wellheads, and primary conductors during subsea drilling, completion, production, and workover operations.

[0002] In offshore drilling operations, a large diameter hole is drilled to a selected depth in the sea bed. Then, a primary conductor extending from the lower end of an outer wellhead housing, also referred to as a low pressure housing, is run into the borehole with the outer wellhead housing positioned just above the sea floor/mud line. To secure the primary conductor and outer wellhead housing in position, cement is pumped down the primary conductor and allowed to flow back up the annulus between the primary conductor and the borehole sidewall.

[0003] With the primary conductor cemented in place, a drill bit connected to the lower end of a drillstring suspended from a drilling vessel or rig at the sea surface is lowered through the primary conductor to drill the borehole to a second depth. Next, an inner wellhead housing, also referred to as a high pressure housing, is seated in the upper end of the outer wellhead housing. A string of casing extending downward from the lower end of the inner wellhead housing (or seated in the inner wellhead housing) is positioned within the primary conductor. Cement then is pumped down the casing string, and allowed to flow back up the annulus between the casing string and the primary conductor to secure the casing string in place.

[0004] Prior to continuing drilling operations in greater depths, a blowout preventer (BOP) is mounted to the wellhead and a lower marine riser package (LMRP) is mounted to the BOP. The subsea BOP and LMRP are arranged one-atop-the-other. In addition, a drilling riser extends from a flex joint at the upper end of the LMRP to a drilling vessel or rig at the sea surface. The drill string is suspended from the rig through the drilling riser, LMRP, and BOP into the well bore. Drilling generally continues while successively installing concentric casing strings that line the borehole. Each casing string is cemented in place by pumping cement down the casing and allowing it to flow back up the annulus between the casing string and the borehole sidewall. During drilling operations, drilling fluid, or mud, is delivered through the drill string, and returned up an annulus between the drill string and casing that lines the well bore.

[0005] Following drilling operations, the cased well is completed (i.e., prepared for production). For subsea architectures that employ a horizontal production tree, the horizontal subsea production tree is installed on the wellhead below the BOP and LMRP during completion

operations. Thus, the subsea production tree, BOP, and LMRP are arranged one-atop-the-other. Production tubing is run through the casing and suspended by a tubing hanger seated in a mating profile in the inner wellhead housing or production tree. Next, the BOP and LMRP are removed from the production tree, and the tree is connected to the subsea production architecture (e.g., production manifold, pipelines, etc.). From time to time, intervention and/or workover operations may be necessary to repair and/or stimulate the well to restore, prolong, or enhance production.

### BRIEF SUMMARY OF THE DISCLOSURE

[0006] The invention provides system and method for tethering a subsea blowout preventer (BOP) having the features of independent claims 1 and 9. Further embodiments are referred to in the dependent claims.

[0007] US 9,074,447 B1 is directed to a method for protecting the integrity of a wellhead which includes the steps of: (1) affixing a subsea structure to the wellhead; (2) installing at least a pair of piles into the subsea floor adjacent the wellhead; (3) extending lines between the subsea structure and the piles; and (4) tensioning the line such that each of the lines applies a tension to the subsea structure, the line having a tensioning cylinder affixed thereto, said tensioning cylinder having a ratchet rod extending therefrom, and said ratchet rod affixed to either the line or the subsea structure or the pile, wherein the step of tensioning comprises drawing said ratchet rod inwardly of said cylinder when a desired amount of tension is achieved; and fixing a position of said ratchet rod within said cylinder when the desired amount of tension is achieved. Further, an end of each of the lines is affixed to the subsea structure adjacent an upper portion of the subsea structure.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0008] For a detailed description of the invention, reference will now be made to the accompanying drawings in which:

Figure 1 is a schematic partial cross-sectional side view of a prior art offshore system for completing a subsea well including an embodiment of a subsea tethering system in accordance with the principles described herein;

Figure 2 is an enlarged partial isometric view of the offshore system of Figure 1 illustrating the tethering system;

Figure 3 is a partial isometric view of an offshore system;

Figure 4 is an enlarged partial isometric view of the offshore system of Figure 3 illustrating the anchors; Figures 5 and 6 are enlarged isometric views of one of the tensioning systems of Figure 3; and

Figure 7 is a side view of an alternate tensioning

system.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0009]** The following discussion is directed to various exemplary embodiments. However, one skilled in the art will understand that the examples disclosed herein have broad application, and that the discussion of any embodiment is meant only to be exemplary of that embodiment, and not intended to suggest that the scope of the disclosure, including the claims, is limited to that embodiment.

**[0010]** Certain terms are used throughout the following description and claims to refer to particular features or components. As one skilled in the art will appreciate, different persons may refer to the same feature or component by different names. This document does not intend to distinguish between components or features that differ in name but not function. The drawing figures are not necessarily to scale. Certain features and components herein may be shown exaggerated in scale or in somewhat schematic form and some details of conventional elements may not be shown in interest of clarity and conciseness.

**[0011]** In the following discussion and in the claims, the terms "including" and "comprising" are used in an open-ended fashion, and thus should be interpreted to mean "including, but not limited to..." Also, the term "couple" or "couples" is intended to mean either an indirect or direct connection. Thus, if a first device couples to a second device, that connection may be through a direct connection, or through an indirect connection via other devices, components, and connections. In addition, as used herein, the terms "axial" and "axially" generally mean along or parallel to a central axis (e.g., central axis of a body or a port), while the terms "radial" and "radially" generally mean perpendicular to the central axis. For instance, an axial distance refers to a distance measured along or parallel to the central axis, and a radial distance means a distance measured perpendicular to the central axis.

**[0012]** U.S. Patent No. 9,359,852 ('852 patent) describes, in reference to Figures 1 and 2, an embodiment of an offshore system 10 for interfacing with a wellbore 20. In this embodiment, system 10 includes a floating offshore vessel 30 at the sea surface 11, a horizontal production tree 40 releasably connected to a wellhead 50 disposed at an upper end of a primary conductor 51 extending into the wellbore 20, a subsea blowout preventer (BOP) 41 releasably connected to production tree 40, and a lower marine riser package (LMRP) 42 releasably connected to BOP 41. Tree 40, BOP 41, and LMRP 42 are vertically arranged or stacked one-above-the-other, and are generally coaxially aligned with wellhead 50. Wellhead 50 has a central axis 55 and extends vertically upward from wellbore 20 above the sea floor 12. In Figure 1 of the '852 patent, system 10 is shown configured for completion operations, and thus, includes

tree 40, however, for drilling operations, tree 40 may not be included.

**[0013]** As best shown in Figure 1 of the '852 patent, vessel 30 is equipped with a derrick 31 that supports a hoist (not shown). In this embodiment, vessel 30 is a semi-submersible offshore platform, however, in general, the vessel (e.g., vessel 30) can be any type of floating offshore drilling vessel including, without limitation, a moored structure (e.g., a semi-submersible platform), a dynamically positioned vessel (e.g., a drill ship), a tension leg platform, etc. A drilling riser 43 (not shown in Figure 2 of the '852 patent) extends subsea from vessel 30 to LMRP 42. During drilling operations, riser 43 takes mud returns to vessel 30. Downhole operations are carried out by a tool connected to the lower end of the tubular string (e.g., drillstring) that is supported by derrick 31 and extends from vessel 30 through riser 43, LMRP 42, and BOP 41, and tree 40 into wellbore 20. In this embodiment of the '852 patent, BOP 41 includes an outer rectangular prismatic frame 47.

**[0014]** Still referring to the '852 patent, BOP 41 and LMRP 42 are configured to controllably seal wellbore 20 and contain hydrocarbon fluids therein. Specifically, BOP 41 includes a plurality of axially stacked sets of opposed rams disposed within frame 47. In general, BOP 41 can include any number and type of rams including, without limitation, opposed double blind shear rams or blades for severing the tubular string and sealing off wellbore 20 from riser 43, opposed blind rams for sealing off wellbore 20 when no string/tubular extends through BOP 41, opposed pipe rams for engaging the string/tubular and sealing the annulus around string/tubular, or combinations thereof. LMRP 42 includes an annular blowout preventer comprising an annular elastomeric sealing element that is mechanically squeezed radially inward to seal on a string/tubular extending through LMRP 42 or seal off wellbore when no string/tubular extends through LMRP 42. The upper end of LMRP 42 includes a riser flex joint 44 that allows riser 43 to deflect and pivot angularly relative to tree 40, BOP 41, and LMRP 42 while fluids flow therethrough.

**[0015]** During drilling, completion, production, and workover operations, cyclical loads due to riser vibrations (e.g., from surface vessel motions, wave actions, current-induced VIV, or combinations thereof) are applied to BOP 41, wellhead 50, and primary conductor 51 extending from wellhead 50 into the sea floor 12. Such cyclical loads can induce fatigue. This may be of particular concern with subsea horizontal production tree architectures (e.g., system 10) due to the relatively large height and weight of the hardware secured to the wellhead proximal the mud line (i.e., tree, BOP, and LMRP). For example, in this embodiment, the hardware mounted to wellhead 50 proximal the sea floor 12, production tree 40 and BOP 41 in particular, is relatively tall, and thus, presents a relatively large surface area for interacting with environmental loads such as subsea currents. These environmental loads can also contribute to the fatigue of BOP 41,

wellhead 50, and primary conductor 51. If the wellhead 50 and primary conductor 51 do not have sufficient fatigue resistance, the integrity of the subsea well may be compromised. Still further, an uncontrolled lateral movement of vessel 30 (e.g., an uncontrolled drive off or drift off of vessel 30) from the desired operating location generally over wellhead 50 can pull LMRP 42 laterally with riser 43, thereby inducing bending moments and associated stresses in BOP 41, wellhead 50, and conductor 51. Such induced bending moments and stresses can be increased further when the relatively tall and heavy combination of tree 40 and BOP 41 is in a slight angle relative to vertical. Accordingly, in this embodiment, a tethering system 100 is provided to reinforce BOP 41, wellhead 50, and primary conductor 51 by resisting lateral loads and bending moments applied thereto. As a result, system 100 offers the potential to enhance the strength and fatigue resistance of BOP 41, wellhead 50, and conductor 51.

**[0016]** Referring again to Figures 1 and 2, in this embodiment, tethering system 100 includes a plurality of anchors 110, a plurality of pile top assemblies 120, and a plurality of flexible tension members 160. One pile top assembly 120 is mounted to the upper end of each anchor 110, and one tension member 160 extends from each pile top assembly 120 to frame 47 of BOP 41. As will be described in more detail below, each pile top assembly 120 includes a tensioning system 140 that can apply tensile loads to the corresponding tension member 160. In this embodiment, each tensioning system 140 is a winch, and thus, may also be referred to as winch 140. Each winch 140 can pay in and pay out the corresponding tensioning member 160.

**[0017]** Each tension member 160 includes a first or distal end 160a coupled to frame 47 of BOP 41, and a tensioned span or portion 161 extending from the corresponding winch 140 to end 160a. As best shown in Figure 1, each distal end 160a is coupled to frame 47 of BOP 41 at a height H measured vertically from the sea floor 12 and at a lateral distance D measured radially and horizontally from central axis 55. In this embodiment, four uniformly circumferentially spaced anchors 110 and associated tension members 160 are provided. In addition, in this embodiment, height H of each end 160a is the same, lateral distances D to each end 160a is the same. For most subsea applications, lateral distance D is preferably between 5.0 and 15.0 feet, and more preferably about 10.0 ft. However, it should be appreciated that lateral distance D may depend, at least in part, on the available connection points to the frame 47 of BOP 41. As will be described in more detail below, each height H is preferably as high as possible but below LMRP 42, and may depend on the available connection points along frame 47 of BOP 41.

**[0018]** As best shown in Figure 1, a tensile preload L is applied to each tensioned span 161. With no external loads or moments applied to BOP 41, the actual tension in each span 161 is the same or substantially the same as

the corresponding tensile preload L. However, it should be appreciated that when external loads and/or bending moments are applied to BOP 41, the actual tension in each span 161 can be greater than or less than the corresponding tensile preload L.

**[0019]** Winches 140 are positioned proximal to the sea floor 12, and ends 160a are coupled to frame 47 of BOP 41 above winches 140. Thus, each span 161 is oriented at an acute angle  $\alpha$  measured upward from horizontal. Since portions 161 are in tension and oriented at acute angles  $\alpha$ , the tensile preload L applied to frame 47 of BOP 41 by each span 161 includes an outwardly oriented horizontal or lateral preload  $L_1$  and a downwardly oriented vertical preload  $L_v$ . Without being limited by this or any particular theory, the lateral preload  $L_1$  and the vertical preload  $L_v$  applied to BOP 41 by each tension member 160 are a function of the corresponding tensile load L and the angle  $\alpha$ . For a given angle  $\alpha$ , the lateral preload  $L_1$  and the vertical preload  $L_v$  increase as the tensile load L increases, and decrease as the tensile load L decreases. For a given tensile load L, the lateral preload  $L_1$  decreases and the vertical preload  $L_v$  increases as angle  $\alpha$  increases, and the lateral preload  $L_1$  increases and the vertical preload  $L_v$  decreases as angle  $\alpha$  decreases. For example, at an angle  $\alpha$  of 45°, the lateral preload  $L_1$  and the vertical preload  $L_v$  are substantially the same; at an angle  $\alpha$  above 45°, the lateral preload  $L_1$  is less than the vertical preload  $L_v$ ; and at an angle  $\alpha$  below 45°, the lateral preload  $L_1$  is greater than the vertical preload  $L_v$ . In embodiments described herein, angle  $\alpha$  of each span 161 is preferably between 10° and 60°, and more preferably between 30° and 45°.

**[0020]** The lateral preloads  $L_1$  applied to frame 47 of BOP 41 resist external lateral loads and bending moments applied to BOP 41 (e.g., from subsea currents, riser 43, etc.). To reinforce and stabilize BOP 41, wellhead 50, and primary conductor 51 without interfering with an emergency disconnection of LMRP 42, each height H is preferably as high as possible but below LMRP 42, and may depend on the available connection points along frame 47 of BOP 41. In this embodiment, ends 160a are coupled to frame 47 proximal the upper end of BOP 41 and just below LMRP 42. By tethering frame 47 of BOP 41 at this location, system 100 restricts and/or prevents BOP 41, tree 40, wellhead 50, and primary conductor 51 from moving and bending laterally, thereby stabilizing such components, while simultaneously allowing LMRP 42 to be disconnected from BOP 41 (e.g., via emergency disconnect package) without any interference from system 100.

**[0021]** Referring again to Figures 1 and 2, the tensile preload L in each span 161 is preferably as low as possible but sufficient to pull out any slack, curve, and catenary in the corresponding span 161. In other words, the tensile preload in L in each span 161 is preferably the lowest tension that results in that span 161 extending linearly from the corresponding winch 140 to its end 160a. It should be appreciated that such tensile loads L in

tension members 160 restrict and/or prevent the initial movement and flexing of BOP 41 at the onset of the application of an external loads and/or bending moments, while minimizing the tension in each span 161 before and after the application of the external loads and/or bending moments. The latter consequence minimizes the potential risk of inadvertent damage to BOP 41, tree 40, and LMRP 42 in the event one or more tension members 160 uncontrollably break.

**[0022]** In general, each tension member 160 can include any elongate flexible member suitable for subsea use and capable of withstanding the anticipated tensile loads (i.e., the tensile preload L as well as the tensile loads induced in spans 161 via the application of external loads to BOP 41) without deforming or elongating. Examples of suitable devices for tension members 160 can include, without limitation, chain(s), wire rope, and Dyneema<sup>®</sup> rope available from DSM Dyneema LLC of Stanley, North Carolina USA. In this embodiment, each tension member 160 comprises Dyneema<sup>®</sup> rope, which is suitable for subsea use, requires the lowest tensile preload L to pull out any slack, curve, and catenary (~ 1.0 ton of tension), and is sufficiently strong to withstand the anticipated tensions.

**[0023]** Referring now to Figures 3-6, an alternate tethering system 200 includes a plurality of anchors 220, a plurality of tensioning systems 240, a plurality of flexible tension members 260. A tension member 260 is connected to the top of each of the plurality of anchors 220 and extends from each anchor 220 to a tensioning system 240 mounted on frame 47 of BOP 41. Each tensioning system 240 includes a winch or spool 242 that can pay in and pay out the corresponding tension member 260 and a gripping mechanism 244 to engage the tension member 260. A winch refers to a reel having sufficient tensioning capacity to apply to the tension member 260 a tensile preload L as discussed in the description of Figure 1. A spool refers to a reel having a tensioning capacity to apply at least a tension sufficient to avoid sagging of the tension member 260, but the tension member 260 may remain slack. A spool may, however, have a tensioning capacity larger than the tension required to prevent sagging and may have as much tensioning capacity as a winch.

**[0024]** Figure 4 illustrates one embodiment of an anchor 220 to which a tension member 260 is connected. Anchor 220 may be a driven piling, a clump weight, a suction piling, plate anchor, or any other structure used to affix a base to the sea floor. The top of the anchor 220 includes a connecting ring 270, or other feature that provides a location for affixing an end of a tension member 260. Tension member 260 includes a releasable connector 280 that allows an ROV to selectively engage and disengage the tension member 260 from the anchor 220.

**[0025]** The gripping system 310 is coupled to the BOP frame 47 or be part of or mounted on the BOP 41. Figures 5 and 6 illustrate one embodiment of a tensioning system

240 including a frame 300, gripping system 310, winch reel 320, and ROV interface 330. The tensioning system 240 may be removeably connected to the BOP frame 47 at connection points 340. An ROV, or other equipment, can be used to install each tensioning system 240 onto the BOP frame 47 subsea by flying the tensioning system 240 into place and connecting it to the connection points 340. The ROV can then be used to rotate winch reel 320 paying in or out tensioning member 260 as needed. Once the tensioning member 260 is properly installed, gripping system 310 can be activated to grip the tensioning member 260 and maintain any tension in the tension member 260. Gripping system 310 can be any type of gripping system that can apply a fixing force to the tensioning member 260, such as a hydraulic slip system, a locking ring, or a brake mechanism. The hydraulic slip is used for paying in or out tension member 260. The hydraulic slip includes one or more hydraulic cylinders and a slip or gripper that may have a first configuration for paying in the tension member 260, applying to the tension member 260 a tensile preload L as discussed in the description of Figure 1, preventing pay out of the flexible tension member 260, and/or maintaining any tension in the tension member 260. The one or more hydraulic cylinders and the slip or gripper may have a second configuration for paying out the tension member 260.

**[0026]** Referring now to Figure 7, an alternative tensioning system 400 is shown that includes a frame 300 and gripping system 310 connected to a BOP frame 47 at connection points 340. The winch assembly 410 is located remote from the tensioning system 400, such as at the surface on the drilling or service vessel. Winch assembly 410 is used to apply pay in or out to tension member 260 as needed to achieve the desired tension. Once the tension member 260 is properly tensioned, gripping system 310 can be activated to grip the tension member 260 and maintain any tension in the tension member 260.

**[0027]** While configurations have been shown and described, modifications thereof can be made by one skilled in the art without departing from the scope or teachings herein. The configurations described herein are exemplary only and are not limiting. Many variations and modifications of the systems, apparatus, and processes described herein are possible, as long as they are within the scope of the claims. For example, the relative dimensions of various parts, the materials from which the various parts are made, and other parameters can be varied. Accordingly, the scope of protection is not limited to the configurations described herein, but is only limited by the claims that follow, the scope of which shall include all equivalents of the subject matter of the claims. Unless expressly stated otherwise, the steps in a method claim may be performed in any order. The recitation of identifiers such as (a), (b), (c) or (1), (2), (3) before steps in a method claim are not intended to and do not specify a particular order to the steps, but rather are used to simplify subsequent reference to such steps.

## Claims

1. A system (200) for tethering a subsea blowout preventer (BOP) (41), the system comprising:

an anchor (220) disposed about the subsea BOP;  
 a flexible tension member (260), wherein the flexible tension member has a first end including a releasable connector engaged to the anchor, wherein the flexible tension member extends horizontally and vertically from the first end to a second end to impart a lateral preload and a vertical preload to the subsea BOP; **characterized in that** the system comprises:

a gripping system (244, 310) mounted on the subsea BOP, wherein the gripping system is configured to selectively engage the flexible tension member to prevent pay out of the flexible tension member; and further comprises a spool (242) coupled to the second end of the flexible tension member; and  
 a hydraulic cylinder coupled to the gripping system, wherein actuation of the hydraulic cylinder causes paying in or out the flexible tension member.

2. The system of claim 1 wherein the gripping system includes a slip.
3. The system of claim 1 wherein the gripping system includes a locking ring or a brake mechanism.
4. The system of claim 1 wherein the spool is located remotely from the subsea BOP, or wherein the spool is mounted to a releasable base connected to a connection point on the subsea BOP, or wherein the gripping system includes a slip.
5. A method for tethering a subsea blowout preventer (BOP) (41) coupled to a subsea wellhead, **characterized in that** the subsea BOP includes a gripping system (244, 310) connected to a frame (47) of the subsea BOP, the method comprising:

disposing an anchor (220) about the subsea BOP;  
 extending a first end of a flexible tension member (260) horizontally and vertically;  
 applying tension to the flexible tension member to impart a lateral preload and a vertical preload to the subsea BOP; and  
 engaging the flexible tension member with the gripping system to maintain tension in the flexible tension member; and wherein applying tension to the flexible tension member comprises

actuating a hydraulic cylinder coupled to the gripping system to cause paying in or out the flexible tension member.

- 5 6. The method of claim 5 comprising preventing pay out of the flexible tension member using a locking ring or a brake mechanism.

## 10 Patentansprüche

1. System (200) zum Anbinden eines Untersee-Ab-sperrventils (Blowout Preventer, BOP) (41), wobei das System Folgendes umfasst:

einen Anker (220), der um den Untersee-BOP herum angeordnet ist;  
 ein flexibles Spannelement (260), wobei das flexible Spannelement ein erstes Ende aufweist, das ein lösbares Verbindungselement enthält, das mit dem Anker in Eingriff steht, wobei sich das flexible Spannelement horizontal und vertikal von dem ersten Ende zu einem zweiten Ende erstreckt, um dem Untersee-BOP eine seitliche Vorspannung und eine vertikale Vorspannung zu verleihen; **dadurch gekennzeichnet, dass** das System Folgendes umfasst:  
 ein Greifsystem (244, 310), das an dem Untersee-BOP angebracht ist, wobei das Greifsystem so konfiguriert ist, dass es selektiv mit dem flexiblen Spannelement in Eingriff kommt, um ein Ausgeben des flexiblen Spannelements zu verhindern; und ferner Folgendes umfasst:

35 eine Spule (242), die mit dem zweiten Ende des flexiblen Spannelements gekoppelt ist; und  
 einen Hydraulikzylinder, der mit dem Greifsystem gekoppelt ist, wobei die Betätigung des Hydraulikzylinders das Ein- oder Ausziehen des flexiblen Spannelements bewirkt.

- 45 2. System nach Anspruch 1, wobei das Greifsystem einen Schlupf enthält.
3. System nach Anspruch 1, wobei das Greifsystem einen Sicherungsring oder einen Bremsmechanismus enthält.
- 50 4. System nach Anspruch 1, wobei die Spule entfernt von dem Untersee-BOP angeordnet ist, oder wobei die Spule an einer lösbaren Basis montiert ist, die mit einem Verbindungspunkt an dem Untersee-BOP verbunden ist, oder wobei das Greifsystem einen Schlupf enthält.
- 55 5. Verfahren zum Anbinden eines Untersee-Ab-sperr-

ventils (BOP) (41), das mit einem Untersee-Bohrlochkopf gekoppelt ist, **dadurch gekennzeichnet, dass** der Untersee-BOP ein Greifsystem (244, 310) enthält, das mit einem Rahmen (47) des Untersee-BOP verbunden ist, wobei das Verfahren Folgendes umfasst:

Anordnen eines Ankers (220) um den Untersee-BOP herum;  
 horizontales und vertikales Ausfahren eines ersten Endes eines flexiblen Spannelements (260);  
 Ausüben von Spannung auf das flexible Spannelement, um eine seitliche Vorspannung und eine vertikale Vorspannung auf den Untersee-BOP zu übertragen; und  
 In-Eingriff-Bringen des flexiblen Spannelements mit dem Greifsystem, um die Spannung in dem flexiblen Spannelement aufrechtzuerhalten; und wobei das Ausüben von Spannung auf das flexible Spannelement das Betätigen eines Hydraulikzylinders umfasst, der mit dem Greifsystem gekoppelt ist, um das Ein- oder Ausziehen des flexiblen Spannelements zu bewirken.

6. Verfahren nach Anspruch 5, das das Verhindern des Ausziehens des flexiblen Spannelements unter Verwendung eines Sicherungsringes oder eines Bremsmechanismus umfasst.

### Revendications

1. Système (200) permettant d'amarrer un bloc d'obturation de puits (BOP) sous-marin (41), le système comprenant :
- une ancre (220) disposée autour du BOP sous-marin ;  
 un élément de tension flexible (260), l'élément de tension flexible comportant une première extrémité comprenant un élément de liaison amovible en prise avec l'ancre, l'élément de tension flexible s'étendant horizontalement et verticalement de la première extrémité à une seconde extrémité pour transmettre une précharge latérale et une précharge verticale au BOP sous-marin ; le système étant **caractérisé en ce qu'il** comprend :  
 un système de préhension (244, 310) monté sur le BOP sous-marin, le système de préhension étant configuré pour entrer en prise de manière sélective avec l'élément de tension flexible afin d'empêcher que l'élément de tension flexible ne file ; et comprenant en outre :

un tambour (242) accouplé à la seconde

extrémité de l'élément de tension flexible ;  
 et  
 un vérin hydraulique accouplé au système de préhension, l'actionnement du vérin hydraulique provoquant la retenue de l'élément de tension flexible ou le laissant filer.

2. Système selon la revendication 1, le système de préhension comprenant un coin gripeur.
3. Système selon la revendication 1, le système de préhension comprenant une bague de verrouillage ou un mécanisme de freinage.
4. Système selon la revendication 1, le tambour étant situé à distance du BOP sous-marin, ou le tambour étant monté sur une base amovible reliée à un point de liaison sur le BOP sous-marin, ou le système de préhension comprenant un coin gripeur.
5. Procédé d'amarrage d'un bloc d'obturation de puits (BOP) sous-marin (41) accouplé à une tête de puits sous-marine, le procédé étant **caractérisé en ce que** le BOP sous-marin comprend un système de préhension (244, 310) relié à un cadre (47) du BOP sous-marin, le procédé consistant à :

disposer une ancre (220) autour du BOP sous-marin ;  
 étendre horizontalement et verticalement une première extrémité d'un élément de tension flexible (260) ;  
 appliquer une tension à l'élément de tension flexible pour transmettre une précharge latérale et une précharge verticale au BOP sous-marin ;  
 et  
 mettre en prise l'élément de tension flexible avec le système de préhension afin de maintenir une tension dans l'élément de tension flexible ;  
 et l'application d'une tension à l'élément de tension flexible consistant à actionner un vérin hydraulique accouplé au système de préhension pour provoquer la retenue de l'élément de tension flexible ou le laisser filer.

6. Procédé selon la revendication 5, consistant à empêcher que l'élément de tension flexible ne file, au moyen d'une bague de verrouillage ou d'un mécanisme de freinage.

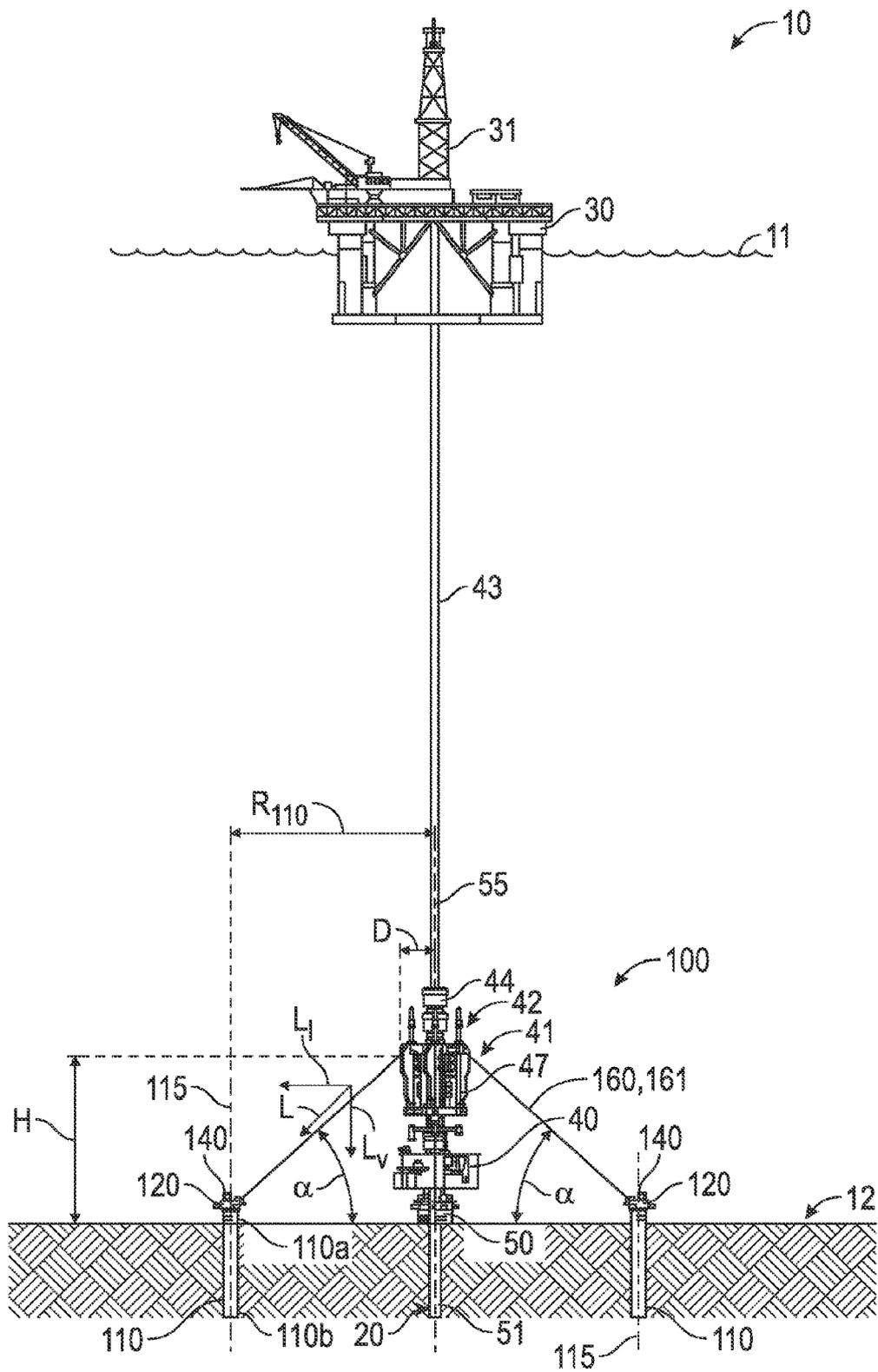


FIG. 1

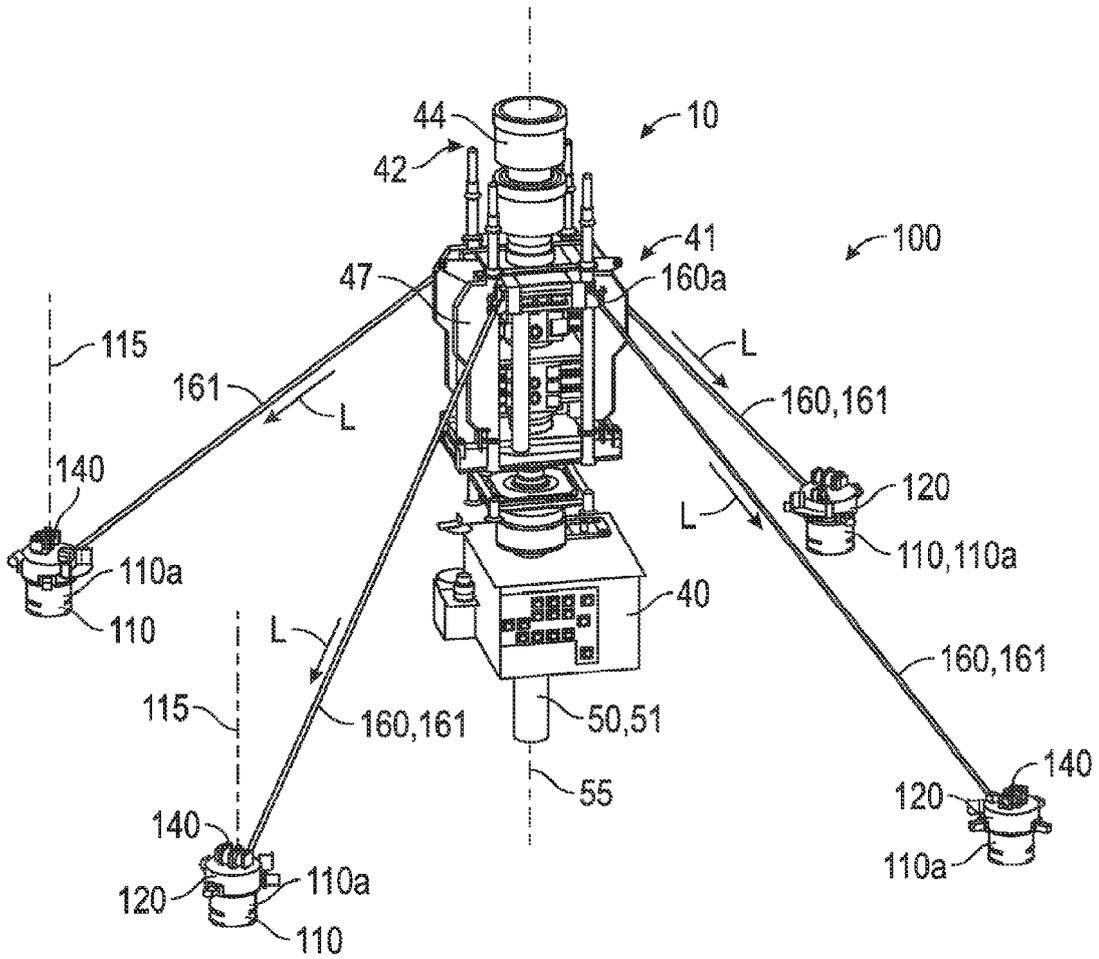


FIG. 2

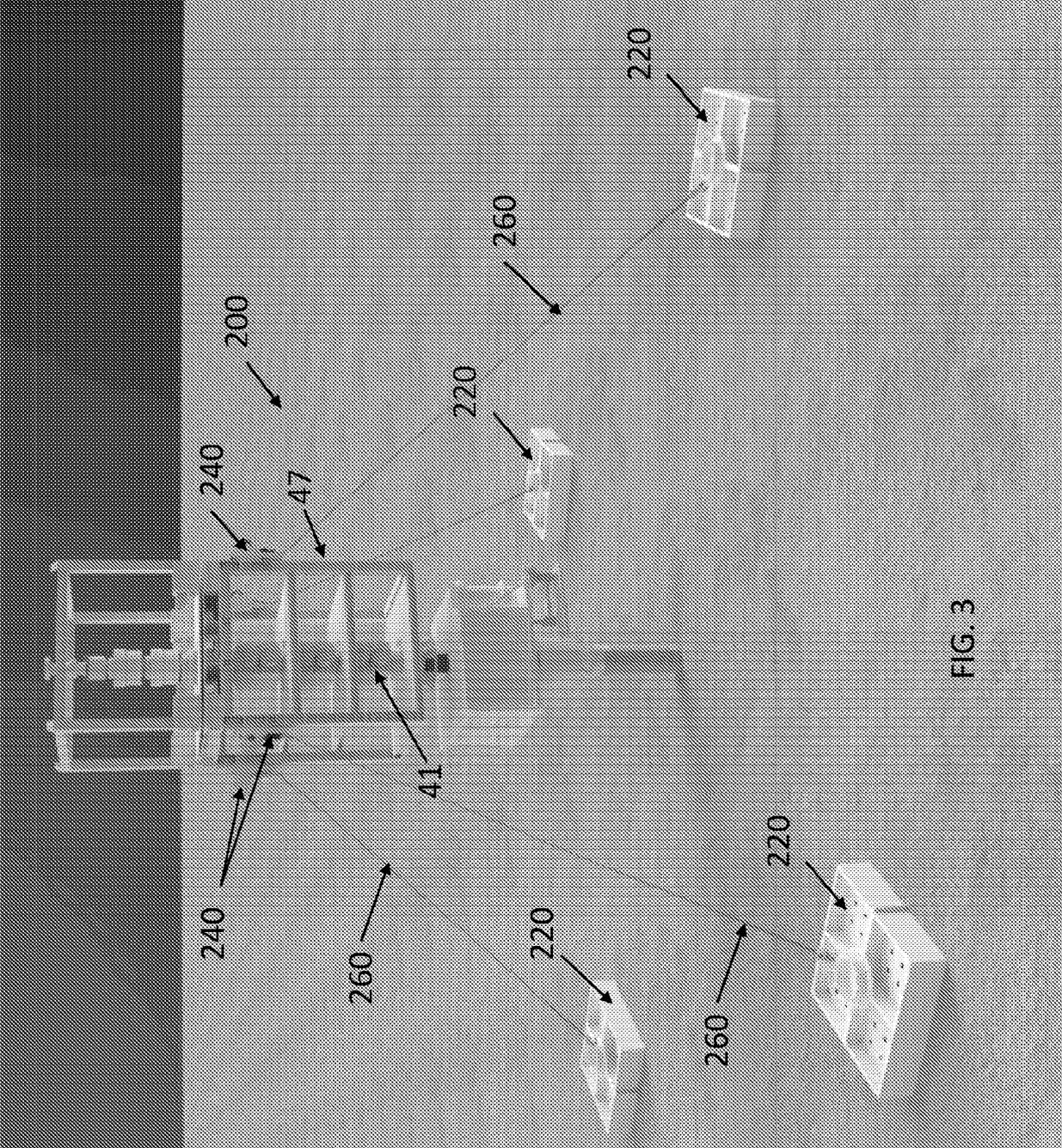


FIG. 3

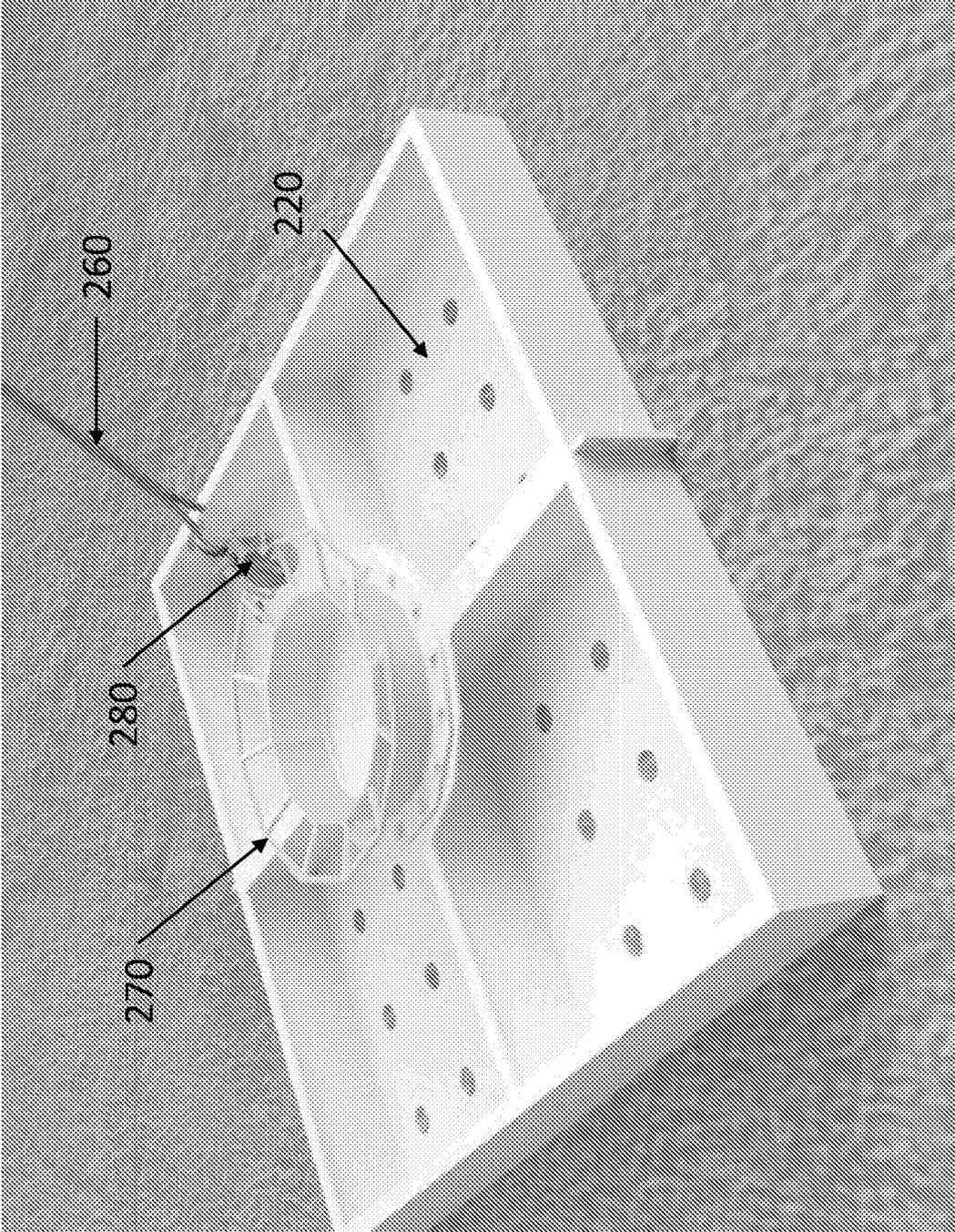


FIG. 4

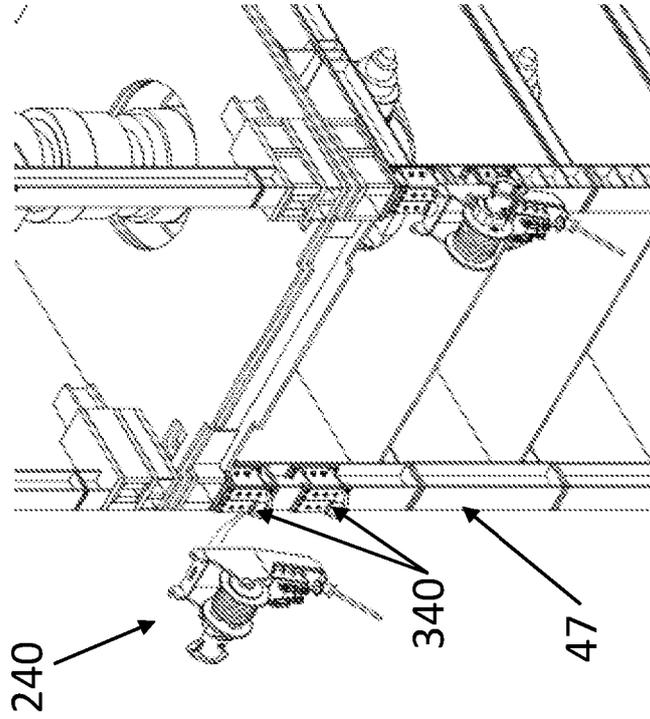


FIG. 6

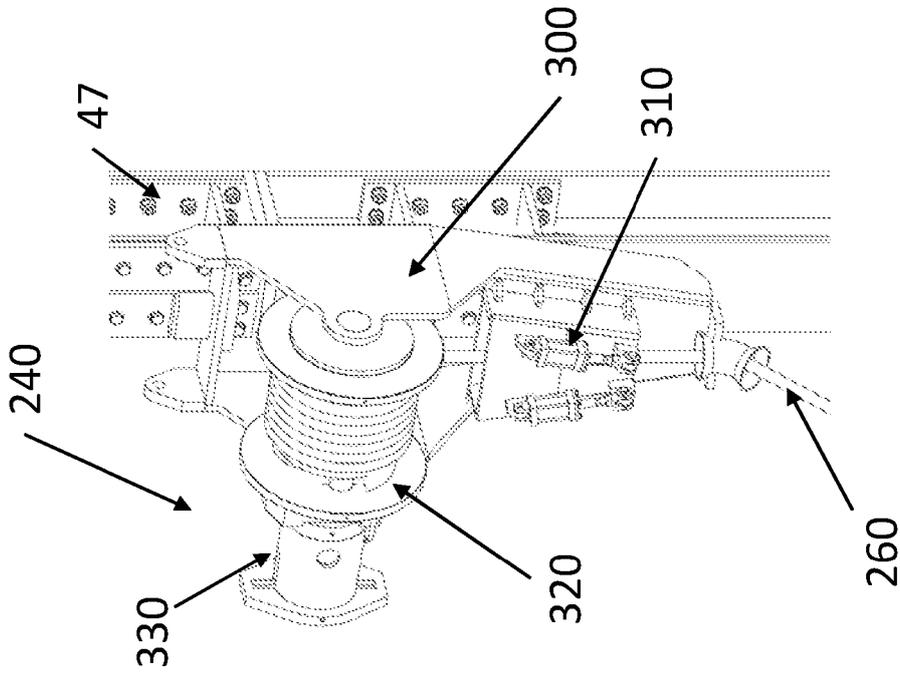


FIG. 5

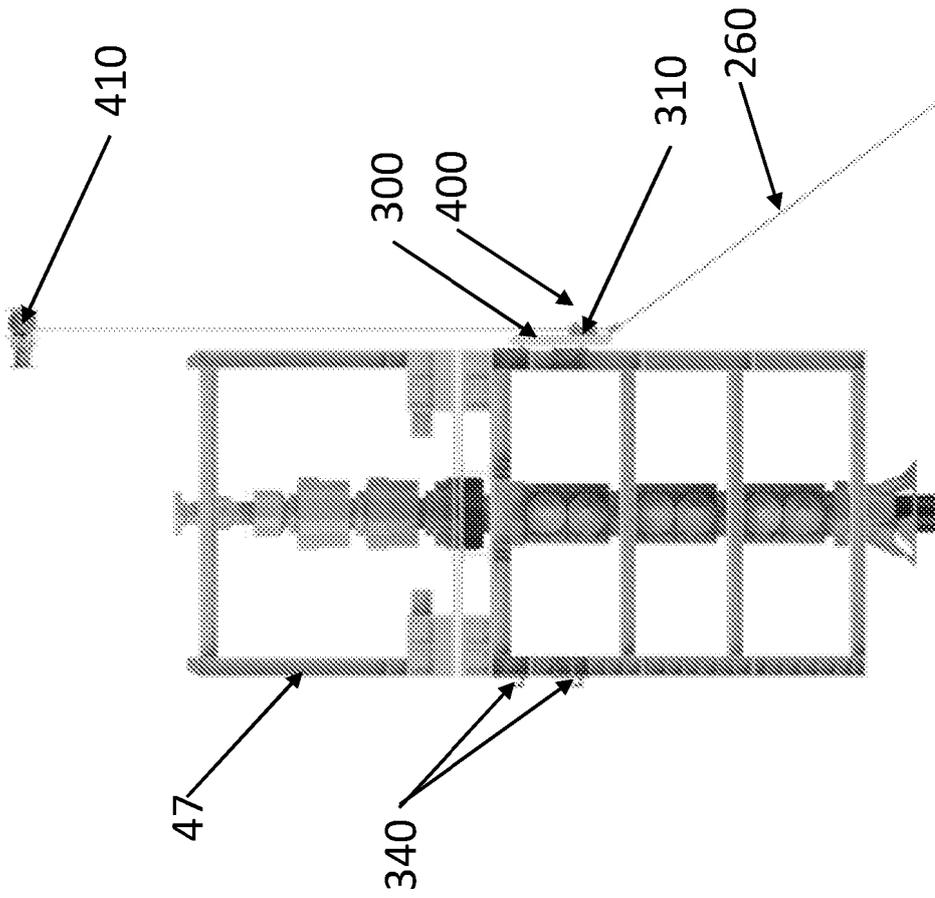


FIG. 7

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

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