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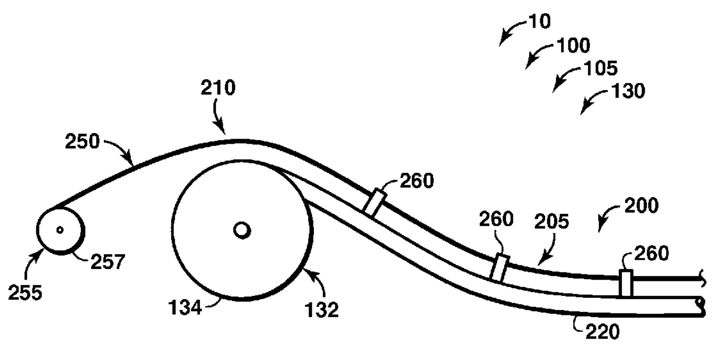

FIG. 7

(57) Abstract: Systems and methods for fluid transfer between a first vessel and a second vessel that are separated by a body of water. The systems and methods may include extending a deployed portion of a fluid conduit assembly between the first vessel and the second vessel. The fluid conduit assembly includes a fluid conduit and also may include a fluid conduit support; and, in the deployed portion, the fluid conduit may be suspended from and supported by the fluid conduit support. The systems and methods also may include the use of a conformation control assembly to automatically and/or dynamically adjust the length of the deployed portion to regulate a conformation of the deployed portion.

WO 2013/062724 A1

SYSTEMS AND METHODS FOR OFFSHORE FLUID TRANSFER

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the priority benefit of U.S. Provisional Patent Application 61/550,744 filed 24 October 2011 entitled SYSTEMS AND METHODS FOR OFFSHORE FLUID TRANSFER, the entirety of which is incorporated by reference herein.

FIELD OF THE INVENTION

[0002] The present disclosure is directed to systems and methods for transferring a fluid between vessels that are separated by a body of water.

BACKGROUND OF THE INVENTION

[0003] As the oil and gas industry explores, develops, produces, and transports hydrocarbons from submarine hydrocarbon reservoirs, the transfer of one or more fluids between vessels that are separated by a body of water may become increasingly important. As an illustrative, non-exclusive example, floating liquefied natural gas (FLNG) technology may be utilized to produce natural gas from a submarine hydrocarbon reservoir. The produced natural gas may be liquefied to produce liquefied natural gas (LNG) and stored on an offshore FLNG vessel prior to transfer to a LNG carrier vessel.

[0004] Such an approach may decrease the infrastructure needed to produce and transport the natural gas; however, it also may present unique challenges associated with transferring the LNG from the offshore FLNG vessel to the LNG carrier in unprotected and/or harsh marine environments, where wind, waves, and/or currents may produce large relative motions between the vessels. These conditions may preclude the use of more traditional fluid transfer strategies, such as side-by-side transfer thorough rigid articulated pipes and structures.

[0005] While alternative fluid transfer systems have been proposed, such as the use of an elevated platform to support a flexible fluid transfer conduit in a catenary shape between the two vessels, these systems suffer from significant limitations. These limitations include the dedication of significant deck space to the elevated platform structure on at least one of the vessels, as well as limitations on the relative motion and/or distance between the offshore FLNG vessel and the LNG carrier to prevent over-elongation if the vessels drift too far apart and/or overbend if the vessels drift too close together. Additional limitations may include a complicated fluid conduit design that is necessary to both support the weight of the fluidfilled conduit over long distances and possess sufficient flexibility to prevent damage during storage and/or use.

SUMMARY OF THE INVENTION

[0006] Systems and methods for offshore fluid transfer between a first vessel and a second vessel that are separated by a body of water. The systems and methods may include extending a deployed portion of a fluid conduit assembly between the first vessel and the second vessel. The fluid conduit assembly includes a fluid conduit and also may include a fluid conduit support; and, in the deployed portion, the fluid conduit may be suspended from and/or supported by the fluid conduit support. The systems and methods also may include the use of a conformation control assembly to automatically and/or dynamically adjust the length of the deployed portion to regulate a conformation of the deployed portion.

[0007] In some embodiments, the fluid conduit assembly includes an aerial fluid conduit assembly. In some embodiments, the fluid conduit may be configured to be attached to the fluid conduit support at a plurality of attachment points. In some embodiments, at least a portion of the plurality of attachment points may be configured to be separated. In some embodiments a transfer structure may include a fluid conduit assembly storage structure configured to contain a stored portion of the fluid conduit assembly. In some embodiments, the fluid conduit assembly storage structure may include a fluid conduit storage structure and a separate, or independent, fluid conduit support storage structure. In some embodiments, the fluid conduit support may include a cable, and the fluid conduit support storage structure may include a winch. In some embodiments, the fluid conduit storage structure may include a fluid conduit reel and/or a fluid conduit storage container. In some embodiments, the fluid conduit may include an arcuate fluid conduit and/or a helical fluid conduit.

[0008] In some embodiments, the conformation control assembly may be configured to adjust the length of the deployed portion and/or to regulate the conformation of the deployed portion responsive to a variable associated with the fluid conduit assembly. In some embodiments, the conformation control assembly may be configured to increase and/or decrease the length of the deployed portion to maintain a minimum vertical separation distance between the deployed portion and a top surface of the body of water, to maintain a vertical separation distance between the deployed portion and the top surface of the body of water within a target vertical separation distance range, to maintain a tensile force on the deployed portion within a target tensile force range, and/or to decrease a potential for damage to the fluid conduit assembly that may be caused by relative horizontal and/or vertical motion of the first vessel and the second vessel with respect to one another.

[0009] In some embodiments, the conformation control assembly includes a controller configured to control the operation of the conformation control assembly and regulate the conformation of the deployed portion. In some embodiments, the conformation control assembly includes a biasing mechanism configured to regulate the conformation of the deployed portion.

[0010] In some embodiments, the fluid conduit assembly may be utilized to transfer a fluid between the first vessel and the second vessel. In some embodiments, the fluid may include a hydrocarbon, natural gas, liquefied natural gas, and/or oil.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Fig. 1 is a schematic representation of illustrative, non-exclusive examples of a fluid transfer assembly according to the present disclosure.

[0012] Fig. 2 is a schematic representation of other illustrative, non-exclusive examples of a fluid transfer assembly according to the present disclosure and illustrating variations in a horizontal separation distance between a first vessel and a second vessel.

[0013] Fig. 3 is a schematic representation of another illustrative, non-exclusive example of a fluid transfer assembly according to the present disclosure and illustrating variations in an angle between the first vessel and the second vessel.

[0014] Fig. 4 is a schematic representation of an illustrative, non-exclusive example of a transfer structure according to the present disclosure.

[0015] Fig. 5 is a schematic representation of an illustrative, non-exclusive example of a fluid conduit assembly according to the present disclosure.

[0016] Fig. 6 is a schematic representation of another illustrative, non-exclusive example of a fluid conduit assembly according to the present disclosure.

[0017] Fig. 7 is an illustrative, non-exclusive example of a transfer structure according to the present disclosure that includes a fluid conduit support storage structure and a fluid conduit storage structure.

[0018] Fig. 8 is an illustrative, non-exclusive example of another transfer structure according to the present disclosure that includes a fluid conduit support storage structure and a fluid conduit storage structure.

[0019] Fig. 9 is a flowchart depicting illustrative, non-exclusive methods according to the present disclosure for transferring a fluid between a first vessel and a second vessel.

DETAILED DESCRIPTION AND BEST MODE OF THE INVENTION

[0020] Fig. 1 provides a schematic side view of illustrative, non-exclusive examples of a fluid transfer assembly 10 according to the present disclosure. Fluid transfer assembly 10 may be configured to transfer a fluid, or fluid stream, 20 between a first vessel 30 and a second vessel 40 that are separated by, and/or floating on, a body of water 50. The fluid transfer assembly includes a transfer structure 100 associated with first vessel 30 and/or second vessel 40. The fluid transfer assembly also includes a fluid conduit assembly 200 that is configured to extend between the first vessel and the second vessel and to transfer the fluid therebetween.

[0021] Fluid conduit assembly 200 may include a deployed portion 205 that extends between the first vessel and the second vessel, as well as stowed or otherwise stored portion 210 that does not extend between the first vessel and the second vessel. The fluid conduit assembly may include any suitable structure that is configured to extend and transfer the fluid between the first vessel and the second vessel. This may include any suitable pipe, flexible pipe, tubing, hose, and/or the illustrative, non-exclusive examples of fluid conduit assemblies that are discussed in more detail herein.

[0022] Transfer structure 100 may include a conformation control assembly 105 that is configured to automatically adjust a length of deployed portion 205 of fluid conduit assembly 200 to control, modulate, or otherwise regulate a conformation of the deployed portion. This may include adjusting the length of the deployed portion to maintain a target shape of the deployed portion, adjusting the length of the deployed portion to maintain a desired, or target, relationship between deployed portion 205 and first vessel 30, second vessel 40, and/or a top, or upper, surface 55 of body of water 50, and/or adjusting the length of the deployed portion responsive to a force that is applied to and/or acting upon the deployed portion.

[0023] As an illustrative, non-exclusive example, conformation control assembly 105 may be configured to maintain at least a portion, a substantial portion, a majority, or all of deployed portion 205 above the top surface of the body of water. When the conformation control assembly is configured to maintain all of the deployed portion above the top surface of the body of water, fluid conduit assembly 200 also may be referred to as an aerial fluid conduit assembly 200.

[0024] As another illustrative, non-exclusive example, conformation control assembly 105 may be configured to adjust the length of deployed portion 205 to maintain at least a minimum vertical separation distance 60 between fluid conduit assembly 200 and top surface 55, to maintain a target vertical separation distance, and/or to avoid contact between deployed portion 205 and top surface 55. This may include increasing the length of deployed portion 205 responsive to vertical separation distance 60 being greater than a maximum threshold vertical separation distance and/or decreasing the length of deployed portion 205 responsive to the vertical separation distance being less than a minimum threshold vertical separation distance.

[0025] Vertical separation distance 60 between the fluid conduit assembly and the top surface of the body of water may vary, and/or may be described as dynamically varying, responsive to a number of variables and/or environmental factors associated with fluid transfer assembly 10, and that conformation control assembly 105 may adjust the length of deployed portion 205 responsive, at least in part, thereto. As an illustrative, non-exclusive example, and as discussed in more detail herein, the vertical separation distance may vary based, at least in part, on a horizontal separation distance 35 between first vessel 30 and second vessel 40. As another illustrative, non-exclusive example, the vertical separation distance may vary based, at least in part, on the length of the deployed portion. As yet another illustrative, non-exclusive example, the vertical separation distance may vary based, at least in part, on a vertical separation distance between a portion of first vessel 30 and a portion of second vessel 40, such as transfer structures 100 thereof. As an illustrative, non-exclusive example, swells, troughs, and/or waves present at top surface 55 of body of water 50 may produce relative vertical motion, or heave, between first vessel 30 and second vessel 40.

[0026] As yet another illustrative, non-exclusive example, conformation control assembly 105 may be configured to maintain a tensile force on deployed portion 205 below a threshold tensile force and/or within a desired tensile force range. This may include increasing the length of deployed portion 205 responsive to the tensile force being greater than a first, or maximum, threshold tensile force and/or decreasing the length of the deployed portion responsive to the tensile force being less than a second, or minimum, threshold tensile force.

[0027] As yet another illustrative, non-exclusive example, and as discussed in more detail herein, conformation control assembly 105 may be configured to regulate the conformation of the deployed portion. This may include adjusting the length of the deployed portion to maintain a catenary, or at least substantially catenary, shape in the deployed portion, to maintain a radius of curvature of the deployed portion above a minimum radius of curvature, and/or to inhibit sagbend or other overbend within the deployed portion.

[0028] Conformation control assembly 105 may be configured to dynamically and/or automatically control, adjust, and/or modulate the length of deployed portion 205. As an illustrative, non-exclusive example, this may include dynamically and/or automatically adjusting the length of the deployed portion responsive to a change in the distance, vertical separation distance, and/or horizontal separation distance between first vessel 30 and second vessel 40. As another illustrative, non-exclusive example, this additionally or alternatively may include dynamically and/or automatically adjusting the length of the deployed portion responsive to a change in the tensile force acting on the deployed portion. As yet another illustrative, non-exclusive example, this additionally or alternatively may include dynamically and/or automatically retracting the deployed portion into transfer structure 100 responsive to damage to a portion of the fluid conduit assembly, separation of a portion of the fluid conduit assembly from at least one of the first vessel and the second vessel, leakage of the fluid from the fluid conduit assembly, and/or separation of a first portion of the fluid conduit assembly from a second portion of the fluid conduit assembly.

[0029] Conformation control assembly 105 may include and/or be in communication with a controller 110 that is configured to control the operation of the conformation control assembly. This may include dynamically and/or automatically controlling the operation of the configuration control assembly as described in more detail herein. The controller may be configured to detect a variable associated with the fluid conduit assembly and/or may be in communication with one or more sensors 115 that are configured to detect the variable associated with the fluid conduit assembly. Illustrative, non-exclusive examples of variables associated with the fluid conduit assembly include a length of a portion of the fluid conduit assembly, the length of the deployed portion, an end-to-end distance of the fluid conduit assembly, an end-to-end distance of the deployed portion, the horizontal separation distance between the first vessel and the second vessel, the vertical separation distance between the first vessel and the second vessel, a minimum distance from the deployed portion to the top surface of the body of water, a conformation of the deployed portion, a radius of curvature of the deployed portion, and/or a tensile force on the deployed portion.

[0030] The controller also may be configured to determine a target, or desired, conformation for deployed portion 205. The target conformation may be determined based at least in part on the variable associated with the fluid conduit assembly. The controller may then control the conformation of the deployed portion based at least in part on the determined target conformation. This may include increasing and/or decreasing the length of the deployed portion as discussed in more detail herein.

[0031] Conformation control assembly 105 additionally or alternatively may include, and/or be in mechanical communication with, one or more biasing mechanisms 120 that are configured to regulate the conformation of deployed portion 205. This may include dynamically and/or automatically controlling the operation of the configuration control assembly as described in more detail herein. Illustrative, non-exclusive examples of biasing mechanisms according to the present disclosure include any suitable spring, coil, tensioner, resilient material, motor, and/or tension sensor.

[0032] As discussed in more detail herein, transfer structure 100 also may include other suitable structures, illustrative, non-exclusive examples of which include fluid conduits, couplings, mounting structures, and/or fluid conduit storage structures. It is within the scope of the present disclosure that transfer structure 100 associated with first vessel 30 may be similar to or different from transfer structure 100 associated with second vessel 40. As an illustrative, non-exclusive example, only transfer structure 100 associated with first vessel 30 may include conformation control assembly 105, controller 110, sensor 115, and/or biasing mechanism 120. As another illustrative, non-exclusive example, the transfer structure associated with second vessel 40 may include a coupling, or receptacle, that is configured to accept and/or mate with a complementary coupling, or receptacle, of fluid conduit assembly 200 and form a fluid-tight seal therewith.

[0033] Fluid 20 may include any suitable fluid for transfer between the first and second vessels. As illustrative, non-exclusive examples, and when fluid transfer assembly 10 is utilized for hydrocarbon production and/or transportation, fluid 20 may include and/or be a hydrocarbon, natural gas, liquefied natural gas, and/or oil.

[0034] First vessel 30 and/or second vessel 40 may include any vessel that may be suitable for production, storage, and/or transportation of fluid 20. Illustrative, non-exclusive examples of first vessel 30 and/or second vessel 40 according to the present disclosure include a hydrocarbon production platform, an elevated hydrocarbon production platform, a hydrocarbon production vessel, a hydrocarbon transport ship, a ship, a tanker, a marine vessel, an offshore FLNG vessel, and/or a LNG carrier vessel. It is also within the scope of the present disclosure that first vessel 30 and second vessel 40 may be arranged in any suitable orientation while deployed portion 205 extends therebetween and/or while fluid 20 is being transferred therebetween. As illustrative, non-exclusive examples, the first vessel and the second vessel may be oriented in a side-by-side or a tandem configuration.

[0035] Body of water 50 may include any suitable body of water that may include and/or cover a submarine hydrocarbon deposit and/or may contain first vessel 30 and second vessel 40. Illustrative, non-exclusive examples of body of water 50 according to the present disclosure include any suitable lake, river, ocean, and/or sea present in any suitable arctic, boreal, temperate, subtropical and/or tropical environment.

[0036] Figs. 2 and 3 provide additional illustrative, non-exclusive schematic examples of fluid transfer assemblies 10 according to the present disclosure. The fluid transfer assemblies of Figs. 2 and 3 include transfer structure 100, including conformation control assembly 105, and are substantially similar to the fluid transfer assembly of Fig. 1.

[0037] Fig. 2 is a side view of fluid transfer assembly 10 and illustrates that horizontal separation distance 35 between first vessel 30 and second vessel 40 may be varied between a first horizontal separation distance 64 and a second horizontal separation distance 68. As discussed in more detail herein, when the horizontal separation distance is varied between first horizontal separation distance 64 and second horizontal separation distance 68, conformation control assembly 105 may adjust, automatically adjust, and/or dynamically adjust the length of deployed portion 205 of fluid conduit assembly 200 between first length 207 and second length 208 to regulate the conformation of the deployed portion and/or to maintain a target, or desired, conformation of the deployed portion. As discussed in more detail herein, this may include increasing and/or decreasing the length of the deployed portion.

[0038] Fig. 3 is a top view of fluid transfer assembly 10 and illustrates that transfer structure 100 may include, and/or be operatively attached to, an orientation varying structure 125 configured to vary an orientation of the transfer structure with respect to first vessel 30 and/or second vessel 40. Orientation varying structure 125 may be configured to maintain the portion(s) of deployed portion 205 that are proximal to first vessel 30, second vessel 40, and/or transfer structure(s) 100 in a linear, or at least substantially linear, conformation when viewed from the top. This may prevent, avoid, or otherwise decrease the potential for damage to fluid conduit assembly 200 due to twisting, kinking, pinching, distorting, straining, and/or bending the portion(s) of the fluid conduit assembly that is proximal to transfer structure 100.

[0039] In Fig. 3, a relative orientation of first vessel 30 with respect to second vessel 40 is varied between first relative orientation 70 and second relative orientation 75. The presence of orientation varying structure 125 on at least one of first vessel 30 and second vessel 40 may provide for pivoting and/or rotation of at least a portion of transfer structure 100 based upon, and/or responsive to, the relative orientation of the first and second vessels, thereby decreasing the potential for damage to the fluid conduit assembly. Illustrative, non-exclusive examples of orientation varying structures 125 according to the present disclosure include any suitable turntable, pivot, and/or swivel.

[0040] Orientation varying structure 125 may passively vary the orientation of transfer structure 100 with respect to first vessel 30 and/or second vessel 40. As an illustrative, non-exclusive example, orientation varying structure 125 may be configured to provide free, at least substantially free, or unbiased, rotation of the transfer structure, or a portion thereof, about a rotational axis. Additionally or alternatively, orientation varying structure may include a biasing mechanism that is configured to bias the transfer structure in a specific, given, and/or desired orientation, while also providing for rotation about the rotational axis away from this desired orientation. The torsional forces applied to transfer structure 100 by fluid conduit assembly 200 due to the relative motion of first vessel 30 with respect to second vessel 40 may provide a motive force for rotation of the transfer structure about the rotational axis.

[0041] Additionally or alternatively, it is also within the scope of the present disclosure that orientation varying structure 125 may include, be operatively attached to, and/or be in mechanical communication with one or more active orientation control structures that are configured to control the orientation of the transfer structure with respect to first vessel 30 and/or second vessel 40. Illustrative, non-exclusive examples of active orientation control structures according to the present disclosure include any suitable motor, controller, position detector, relative orientation detector, and/or force transducer.

[0042] Fig. 4 provides a schematic representation of an illustrative, non-exclusive example of a transfer structure 100 according to the present disclosure. The transfer structure of Fig. 4 includes a fluid conduit assembly storage structure 130 that is configured to contain, house, or otherwise store stored portion 210 of fluid conduit assembly 200, as well as conformation control assembly 105 that is configured to control the length of deployed portion 205. As discussed in more detail herein, conformation control assembly 105 may optionally include and/or be in communication with controller 110 and/or sensor 115.

[0043] As also shown in Fig. 4, transfer structure 100 may include, be operatively attached to, and/or be in mechanical communication with one or more mounting assemblies 122 that are configured to attach, or otherwise secure, the transfer structure, such as to the first vessel 30 and/or second vessel 40, as described herein. Additionally or alternatively, mounting assemblies 122 may include and/or be orientation varying structure 125.

[0044] Fluid conduit assembly storage structure 130 may be configured to store the stored portion of fluid conduit assembly 200 when fluid 20 is not flowing therethrough. However, it is also within the scope of the present disclosure that fluid conduit assembly storage structure 130 may be configured to store the stored portion of fluid conduit assembly 200 during use of the fluid conduit assembly to transfer fluid 20 between the first vessel and the second vessel. Illustrative, non-exclusive examples of fluid conduit assembly storage structures 130 according to the present disclosure include a fluid conduit reel 134 and/or a fluid conduit storage container 138.

[0045] It is also within the scope of the present disclosure that transfer structure 100 and/or fluid conduit assembly storage structure 130 may include any suitable mounting orientation. As an illustrative, non-exclusive example, Fig. 4 may be considered to be a side view of transfer structure 100, and vertical mounting assembly 123 may be utilized to mount fluid conduit assembly storage structure 130 in a vertical orientation. When the fluid conduit assembly storage structure is mounted in a vertical orientation, vertical mounting assembly 123 may include orientation varying structure 125 in order to provide for rotation of the fluid conduit assembly storage structure with respect to first vessel 30 and/or second vessel 40 and decrease the potential for damage to the fluid conduit assembly due to relative motion of first vessel 30 with respect to second vessel 40 as discussed in more detail herein with reference to Fig. 3.

[0046] As another illustrative, non-exclusive example, Fig. 4 may be considered to be a top or bottom view of transfer structure 100 and horizontal mounting assembly 123 may be utilized to mount fluid conduit assembly storage structure 130 in a horizontal orientation. When the fluid conduit assembly storage structure is mounted in a horizontal orientation and fluid conduit assembly storage structure 130 includes fluid conduit reel 134, it is within the scope of the present disclosure that horizontal mounting assembly 124 may not include orientation varying structure 125 since fluid conduit reel 134 may accommodate variations in the orientation of first vessel 30 with respect to second vessel 40 without damage to the fluid conduit assembly. However, it is also within the scope of the present disclosure that horizontal mounting assembly 123 may include orientation varying structure 125.

[0047] Transfer structure 100 and/or a portion thereof may be located at any suitable mounting location on and/or within first vessel 30 and/or second vessel 40. Illustrative, non-exclusive examples of mounting locations according to the present disclosure include on a deck of, below a deck of, and/or on a platform that is operatively attached to first vessel 30 and/or second vessel 40.

[0048] As shown in Fig. 4, transfer structure 100 and/or conformation control assembly 105 may include, and/or be in mechanical communication with, a drive structure 140 that is configured to regulate the length of deployed portion 205. Illustrative, non-exclusive examples of drive structures 140 according to the present disclosure include any suitable motor, electric motor, winch, and/or internal combustion engine.

[0049] Figs. 5 and 6 provide schematic representations of illustrative, non-exclusive examples of fluid conduit assemblies 200 according to the present disclosure. Fluid conduit assemblies 200 include a fluid conduit 220 and a fluid conduit support, or fluid conduit support assembly, 250. Fluid conduit support 250 is configured to be suspended between the first vessel and the second vessel, and fluid conduit 220 is configured to extend and/or be suspended between the first vessel and the second vessel and to be supported by and/or suspended from fluid conduit support 250 at a plurality of attachment points 260.

[0050] Fluid conduit 220 may include any suitable structure that is configured to provide for the transmission of fluid 20 between the first vessel and the second vessel. Illustrative, non-exclusive examples of fluid conduit 220 include any suitable flexible fluid conduit, pipe, flexible pipe, tubing, and/or hose. It is within the scope of the present disclosure that fluid conduit 220 may be configured to maintain a substantially fixed cross-sectional shape. However, it is also within the scope of the present disclosure that fluid conduit 220 may be configured to collapse or have a decreased cross-sectional area when no fluid is flowing therethrough.

[0051] Fluid conduit support 250 may include any suitable structure that is configured to extend between the first vessel and the second vessel and to support fluid conduit 220. Illustrative, non-exclusive examples of fluid conduit support assemblies 250 according to the present disclosure include any suitable cable, rope, and/or chain.

[0052] Attachment points 260, which also may be referred to as attachment structures 260 and/or attachment linkages 260, may include any suitable structure that is configured to operatively attach and/or provide a mechanical linkage between fluid conduit 220 and fluid conduit support 250. It is within the scope of the present disclosure that at least a portion of the plurality of attachment points 260 may include (but not required in all embodiments to include) permanent attachment points that are not designed and/or configured to be separated. However, it is also within the scope of the present disclosure that at least a portion of the plurality of attachment points 260 may include separable attachment points that are designed and/or configured to provide for separation of fluid conduit support 250 from fluid conduit 220 without damage to the fluid conduit support and/or the fluid conduit.

[0053] Fluid conduits 220 associated with fluid conduit assemblies 200 may include both fluid conduit 220 and fluid conduit support 250. Such fluid conduits may be (but are not required to be) less rigid, lighter in weight, cheaper to manufacture, simpler, and/or more flexible than fluid conduits that are not associated with a fluid conduit assembly that includes the fluid conduit support. This may provide for the use of a fluid conduit 220 in fluid conduit assemblies 200 according to the present disclosure that is more flexible and/or less prone to damage due to bending and/or flexing than fluid conduits that are not associated with a fluid conduit assembly that includes the fluid conduit support.

[0054] Fluid conduit 220 may include any suitable overall conformation along a longitudinal axis of the fluid conduit. As an illustrative, non-exclusive example, and as shown in Fig. 5, the longitudinal axis of the fluid conduit may include an arcuate, or at least substantially arcuate, shape 224 and the longitudinal axis of the fluid conduit may be parallel to, or at least substantially parallel to, a longitudinal axis of fluid conduit support 250. As another illustrative, non-exclusive example, and as shown in Fig. 6, the longitudinal axis of the fluid conduit may include a helical, or at least substantially helical, shape 228 and may not be parallel to the longitudinal axis of the fluid support assembly. When the longitudinal axis of fluid conduit 220 includes a helical, or at least substantially helical, shape, it is within the scope of the present disclosure that, as shown in Fig. 6, fluid conduit support 250 may be located within the helix. However, it is also within the scope of the present disclosure that the fluid conduit support may be located external to the helix, as shown in Fig. 8.

[0055] Figs. 7 and 8 provide schematic representations of illustrative, non-exclusive examples of transfer structures 100 and/or fluid conduit assembly storage structures 130 according to the present disclosure that include a fluid conduit support storage structure 255 and a separate fluid conduit storage structure 132. The fluid conduit assembly storage structures of Figs. 7 and 8 may be configured to store stored portions 210 of fluid conduits 220 of Figs. 5 and 6, respectively.

[0056] An illustrative, non-exclusive example of a fluid conduit support storage structure according to the present disclosure includes a winch 257. When, as discussed in more detail herein, fluid conduit 220 includes an arcuate shape, fluid conduit storage structure 132 may include fluid conduit reel 134, as shown in Fig. 7. Additionally or alternatively, and when, as discussed in more detail herein, fluid conduit 220 includes a helical shape, fluid conduit storage structure 132 may include a fluid conduit storage container 138, which also may be referred to as fluid conduit storage volume 138, as shown in Fig. 8.

[0057] When fluid conduit storage assembly structure 130 includes fluid conduit support storage structure 255 and separate fluid conduit storage structure 132, it is within the scope of the present disclosure that fluid conduit storage assembly structure 130, conformation control assembly 105, and/or transfer structure 100 may be configured to attach the fluid conduit to the fluid conduit support as the fluid conduit assembly is drawn therethrough and/or extended between the first vessel and the second vessel as deployed portion 205. This may include operatively attaching fluid conduit 220 to fluid conduit support 250 at a portion of the plurality of attachment points 260.

[0058] Fig. 9 provides illustrative, non-exclusive examples of methods 300 according to the present disclosure for transferring a fluid between a first vessel and a second vessel that are separated by a body of water. The methods include extending a fluid conduit from a fluid conduit storage structure at 305, extending a fluid conduit support from a fluid conduit support assembly storage structure at 310, attaching the fluid conduit to the fluid conduit support to form a fluid conduit assembly at 315, suspending the fluid conduit from the fluid conduit support at 320, and/or extending a deployed portion of the fluid conduit assembly between the first vessel and the second vessel at 325.

[0059] The methods also may optionally include detecting a variable associated with the fluid conduit assembly at 330, determining a target conformation for the deployed portion at 335, automatically regulating the conformation of the deployed portion at 340, increasing a length of the deployed portion at 345, and/or decreasing a length of the deployed portion at 350. The methods further include transferring a fluid between the first vessel and the second vessel at 355, varying the relative orientation of the fluid transfer structure at 360, retracting the fluid conduit assembly at 365, detaching the fluid conduit from the fluid conduit support at 370, storing the fluid conduit in the fluid conduit storage structure at 375, and/or storing the fluid conduit support in the fluid conduit support storage structure at 380.

[0060] Extending the fluid conduit from the fluid conduit storage structure at 305 and/or extending the fluid conduit support from the fluid conduit support assembly storage structure at 310 may include the use of any suitable system, apparatus, method and/or control strategy to extend and/or withdraw the fluid conduit and/or the fluid conduit support from their respective storage structure(s). This may include manually withdrawing, or pulling, the fluid conduit and/or the fluid conduit support from their respective storage structure(s), utilizing a winch or other mechanical device to pull the fluid conduit and/or the fluid conduit support from their respective storage structure(s), and/or utilizing a drive assembly, such as a motor and/or winch associated with the fluid conduit storage structure and/or the fluid conduit support storage structure to extend, or otherwise produce, the fluid conduit and/or the fluid conduit support from their respective storage structures.

[0061] Attaching the fluid conduit to the fluid conduit support to form the fluid conduit assembly at 315 may include the use of any suitable system and/or structure to operatively attach the fluid conduit to the fluid conduit support. As an illustrative, non-exclusive example, the attaching may include the use of the attachment points that are discussed in more detail herein.

[0062] It is within the scope of the present disclosure that the fluid conduit may be defined by a body and that the attaching may include automatically attaching the fluid conduit and/or the body thereof to the fluid conduit support at a plurality of attachment points. Additionally or alternatively, the automatically attaching also may include automatically attaching as the fluid conduit and the fluid conduit support assemblies are removed from their respective storage structures, from the fluid conduit assembly storage structure, and/or from the transfer structure.

[0063] It is also within the scope of the present disclosure that the fluid conduit assembly may include the fluid conduit but may not include the fluid conduit support. When the fluid conduit assembly includes the fluid conduit but does not include the fluid conduit support, the fluid conduit may be configured to support itself without the use of an additional support structure when the deployed portion is extended between the first vessel and the second vessel.

[0064] Suspending the fluid conduit from the fluid conduit support at 320 may include the use of any suitable structure to suspend, or otherwise support, the fluid conduit assembly from and/or by the fluid conduit support. As an illustrative, non-exclusive example, this may include hanging the fluid conduit from the fluid conduit support using a portion of the plurality of attachment points. The fluid conduit support may be configured to support a portion, at least a substantial portion, a majority, at least substantially all, and/or all of a weight of the fluid conduit, both when the fluid conduit includes the fluid therewithin and when the fluid conduit does not include the fluid therewithin.

[0065] Extending the deployed portion of the fluid conduit assembly between the first vessel and the second vessel at 325 may include the use of any suitable system, apparatus, method, and/or control strategy to extend the fluid conduit assembly from at least one of the first vessel and the second vessel to and/or toward the other of the first vessel and the second vessel. Illustrative, non-exclusive examples of these systems, apparatus, methods, and/or control strategies are discussed in more detail herein with reference to extending the fluid conduit from the fluid conduit storage structure, at 305, and/or extending the fluid conduit support from the fluid conduit support assembly storage structure at 310.

[0066] Detecting a variable associated with the fluid conduit assembly at 330 may include detecting any suitable variable associated with the fluid conduit assembly, the fluid conduit, the fluid conduit support, and/or the deployed portion of the fluid conduit assembly. Illustrative, non-exclusive examples of variables associated with the fluid conduit assembly are discussed in more detail herein.

[0067] Determining a target conformation for the deployed portion at 335 may include the use of any suitable system, method, algorithm, and/or controller to determine the target conformation. It is within the scope of the present disclosure that the determining may be based, at least in part, on the variable associated with the fluid conduit assembly. Illustrative, non-exclusive examples of target conformations for the fluid conduit assembly are discussed in more detail herein.

[0068] Automatically regulating the conformation of the deployed portion at 340 may include automatically increasing the length of the deployed portion at 345 and/or automatically decreasing the length of the deployed portion at 350. This automatically regulating also may be and/or may be referred to as automatically and/or dynamically regulating, controlling, adjusting, and/or modulating the length of the deployed portion of the fluid conduit assembly, and the automatically regulating may be accomplished using any suitable strategy, including the automatic and/or dynamic control strategies that are discussed in more detail herein.

[0069] As an illustrative, non-exclusive example, the automatically regulating may include automatically adjusting the length of the deployed portion to maintain a portion, at least a substantial portion, a majority, and/or all of the deployed portion above the top surface of the body of water. Additional illustrative, non-exclusive examples of automatically regulating that are discussed in more detail herein include automatically adjusting the length of the deployed portion to maintain a catenary shape in the deployed portion, to maintain a minimum vertical separation distance between the deployed portion and the top surface of the body of water, to avoid contact between the deployed portion and the top surface of the body of water, to maintain a tensile force in the deployed portion below a threshold tensile force and/or within a desired tensile force range, to maintain a radius of curvature of the deployed portion above a minimum radius of curvature, to inhibit sagbend, or other overbend, in the deployed portion, and/or to maintain the conformation of the deployed portion at, or at least substantially similar to, the target conformation of the deployed portion.

[0070] Transferring fluid between the first vessel and the second vessel at 355 may include the use of the fluid conduit and/or the fluid conduit assembly to provide a fluid pathway for the flow of the fluid between the first vessel and the second vessel. Any suitable system and/or method may be utilized to provide a motive force to the fluid, illustrative, non-exclusive examples of which include any suitable pump, blower, compressor, and/or gravitational force.

[0071] Varying the relative orientation of the fluid transfer structure at 360 may include the use of any suitable structure and/or control strategy to vary the orientation of the transfer structure with respect to the first vessel and/or the second vessel. As discussed in more detail herein, the varying may include varying to avoid, prevent, and/or decrease the potential for damage to the fluid conduit assembly and/or the fluid conduit due to deformation and/or bending in the portion of the extended portion of the fluid conduit that is proximal to the transfer structure.

[0072] Retracting the fluid conduit assembly at 365 may include storing at least a portion of the fluid conduit assembly within the fluid conduit assembly storage structure and/or withdrawing the deployed portion of the fluid conduit assembly from between the first vessel and the second vessel. It is within the scope of the present disclosure that the retracting may be performed responsive to completion of the transferring of fluid between the first vessel and the second vessel, as indicated at 355. However, it is also within the scope of the present disclosure that, as discussed in more detail herein, the withdrawing may be performed responsive to damage to a portion of the fluid conduit assembly, separation of a portion of the fluid conduit assembly from at least one of the first vessel and the second vessel, leakage of the fluid from the fluid conduit assembly, and/or separation of a first portion of the fluid conduit assembly from a second portion of the fluid conduit assembly and that the retracting may be initiated automatically and/or manually.

[0073] Detaching the fluid conduit from the fluid conduit support at 370 may include separating the fluid conduit from the fluid conduit support as the fluid conduit assembly is retracted into the fluid conduit assembly storage structure. This may include the use of any suitable structure and/or method to separate at least a portion of the plurality of attachment points that operatively attach the fluid conduit to the fluid conduit support.

[0074] Storing the fluid conduit in the fluid conduit storage structure at 375 and/or storing the fluid conduit support in the fluid conduit support storage structure at 380 may include the use of any suitable structure and/or method to store the fluid conduit and/or the fluid conduit support. As an illustrative, non-excusive example, and as discussed in more detail herein, when the fluid conduit support includes a cable, the storing may include storing the cable on a winch. As another illustrative, non-exclusive example, and as discussed in more detail herein, when the fluid conduit includes an arcuate fluid conduit, the storing may include storing the arcuate fluid conduit on a fluid conduit reel. As yet another illustrative, non-exclusive example, and as discussed in more detail herein, when the fluid conduit includes a helical fluid conduit, the storing may include storing the helical fluid conduit in a fluid conduit storage container, volume, or structure. Storing the fluid conduit and storing the fluid conduit support may include simultaneously storing the fluid conduit and the fluid conduit support. Alternatively, it is also within the scope of the present disclosure that the storing may include asynchronously storing the fluid conduit and the fluid conduit support.

[0075] In the present disclosure, several of the illustrative, non-exclusive examples have been discussed and/or presented in the context of flow diagrams, or flow charts, in which the methods are shown and described as a series of blocks, or steps. Unless specifically set forth in the accompanying description, it is within the scope of the present disclosure that the order of the blocks may vary from the illustrated order in the flow diagram, including with two or more of the blocks (or steps) occurring in a different order and/or concurrently. It is also within the scope of the present disclosure that the blocks, or steps, may be implemented as logic, which also may be described as implementing the blocks, or steps, as logics. In some applications, the blocks, or steps, may represent expressions and/or actions to be performed by functionally equivalent circuits or other logic devices. The illustrated blocks may, but are not required to, represent executable instructions that cause a computer, processor, and/or other logic device to respond, to perform an action, to change states, to generate an output or display, and/or to make decisions.

[0076] As used herein, the term "and/or" placed between a first entity and a second entity means one of (1) the first entity, (2) the second entity, and (3) the first entity and the second entity. Multiple entities listed with "and/or" should be construed in the same manner, i.e., "one or more" of the entities so conjoined. Other entities may optionally be present other than the entities specifically identified by the "and/or" clause, whether related or unrelated to those entities specifically identified. Thus, as a non-limiting example, a reference to "A and/or B," when used in conjunction with open-ended language such as "comprising" may refer, in one embodiment, to A only (optionally including entities other than B); in another embodiment, to B only (optionally including entities other than A); in yet another embodiment, to both A and B (optionally including other entities). These entities may refer to elements, actions, structures, steps, operations, values, and the like.

[0077] As used herein, the phrase "at least one," in reference to a list of one or more entities should be understood to mean at least one entity selected from any one or more of the entity in the list of entities, but not necessarily including at least one of each and every entity specifically listed within the list of entities and not excluding any combinations of entities in the list of entities. This definition also allows that entities may optionally be present other than the entities specifically identified within the list of entities to which the phrase "at least one" refers, whether related or unrelated to those entities specifically identified. Thus, as a non-limiting example, "at least one of A and B" (or, equivalently, "at least one of A or B," or, equivalently "at least one of A and/or B") may refer, in one embodiment, to at least one, optionally including more than one, A, with no B present (and optionally including entities other than B); in another embodiment, to at least one, optionally including more than one, B, with no A present (and optionally including entities other than A); in yet another embodiment, to at least one, optionally including more than one, A, and at least one, optionally including more than one, B (and optionally including other entities). In other words, the phrases "at least one," "one or more," and "and/or" are open-ended expressions that are both conjunctive and disjunctive in operation. For example, each of the expressions "at least one of A, B and C," "at least one of A, B, or C," "one or more of A, B, and C," "one or more of A, B, or C" and "A, B, and/or C" may mean A alone, B alone, C alone, A and B together, A and C together, B and C together, A, B and C together, and optionally any of the above in combination with at least one other entity.

[0078] In the event that any of the references that are incorporated by reference herein define a term in a manner or are otherwise inconsistent with either the non-incorporated portion of the present disclosure or with any of the other incorporated references, the non-incorporated portion of the present disclosure shall control, and the term or incorporated disclosure therein shall only control with respect to the reference in which the term is defined and/or the incorporated disclosure was originally present.

[0079] As used herein the terms "adapted" and "configured" mean that the element, component, or other subject matter is designed and/or intended to perform a given function. Thus, the use of the terms "adapted" and "configured" should not be construed to mean that a given element, component, or other subject matter is simply "capable of" performing a given function but that the element, component, and/or other subject matter is specifically selected, created, implemented, utilized, and/or designed for the purpose of performing the function. It is also within the scope of the present disclosure that elements, components, and/or other recited subject matter that is recited as being adapted to perform a particular function may additionally or alternatively be described as being configured to perform that function, and vice versa.

[0080] Illustrative, non-exclusive examples of systems and methods according to the present disclosure are presented in the following enumerated paragraphs. It is within the scope of the present disclosure that an individual step of a method recited herein, including in the following enumerated paragraphs, may additionally or alternatively be referred to as a "step for" performing the recited action.

A1. A system for controlling a conformation of a fluid conduit assembly that extends between a first vessel and a second vessel that are separated by a body of water, the system comprising:

means for regulating a conformation of a deployed portion of the fluid conduit assembly.

A2. The system of paragraph A1, wherein the means for regulating includes a conformation control assembly configured to automatically adjust a length of the deployed portion to regulate a conformation of the deployed portion.

B1. A system for controlling a conformation of a fluid conduit assembly that extends between a first vessel and a second vessel that are separated by a body of water, the system comprising:

a conformation control assembly configured to automatically adjust a length of a deployed portion of the fluid conduit assembly to regulate a conformation of the deployed portion.

C1. The system of any of paragraphs A1-B1, wherein the system further includes the fluid conduit assembly.

C2. The system of any of paragraphs A1-C1, wherein at least a portion of the deployed portion is located above a top surface of the body of water, optionally wherein a substantial portion of the deployed portion is located above the top surface of the body of water, optionally wherein a majority of the deployed portion is located above the top surface of the body of water, optionally wherein all of the deployed portion is located above the top surface of the body of water, and further optionally wherein the fluid conduit assembly is an aerial fluid conduit assembly.

C3. The system of any of paragraphs A1-C2, wherein the fluid conduit assembly is configured to transfer a fluid between the first vessel and the second vessel, and optionally wherein the fluid includes at least one of a hydrocarbon, natural gas, liquefied natural gas, and oil.

C4. The system of any of paragraphs A2-C3, wherein the conformation control assembly is configured to maintain a catenary shape in the deployed portion, and optionally wherein the conformation control assembly is configured to automatically adjust the length of the deployed portion to maintain the catenary shape.

C5. The system of any of paragraphs A2-C4, wherein the conformation control assembly is configured to maintain at least a minimum vertical separation distance between the deployed portion and a top surface of the body of water, and optionally wherein the conformation control assembly is configured to automatically adjust the length of the deployed portion to avoid contact between the deployed portion and the top surface of the body of water.

C6. The system of paragraph C5, wherein the conformation control assembly is configured to increase the length of the deployed portion responsive to a vertical separation distance between the deployed portion and the top surface of the body of water being greater than a maximum threshold vertical separation distance.

C7. The system of any of paragraphs C5-C6, wherein the conformation control assembly is configured to decrease the length of the deployed portion responsive to a vertical separation distance between the deployed portion and the top surface of the body of water being less than a minimum threshold vertical separation distance.

C8. The system of any of paragraphs A2-C7, wherein the conformation control assembly is configured to maintain a tensile force on the deployed portion below a threshold tensile force, and optionally wherein the conformation control assembly is configured to maintain the tensile force within a desired tensile force range.

C9. The system of paragraph C8, wherein the conformation control assembly is configured to increase the length of the deployed portion responsive to the tensile force being greater than a first threshold tensile force.

C10. The system of any of paragraphs C8-C9, wherein the conformation control assembly is configured to decrease the length of the deployed portion responsive to the tensile force being less than a second threshold tensile force.

C11. The system of any of paragraphs A2-C10, wherein the conformation control assembly is configured to maintain a radius of curvature of the deployed portion above a minimum radius of curvature.

C12. The system of any of paragraphs A2-C11, wherein the conformation control assembly is configured to inhibit overbend within the deployed portion.

C13. The system of any of paragraphs A2-C12, wherein the conformation control assembly is configured to dynamically control the length of the deployed portion.

C14. The system of any of paragraphs A2-C13, wherein the conformation control assembly is configured to automatically adjust the length of the deployed portion responsive to a change in a distance between the first vessel and the second vessel.

C15. The system of any of paragraphs A2-C14, wherein the conformation control assembly is configured to automatically adjust the length of the deployed portion responsive to a change in a tensile force acting upon the deployed portion.

C16. The system of any of paragraphs A2-C15, wherein the conformation control assembly is biased to automatically retract the deployed portion responsive to at least one of damage to a portion of the fluid conduit assembly, separation of a portion of the fluid conduit assembly from at least one of the first vessel and the second vessel, leakage of a fluid from the fluid conduit assembly, and/or separation of a first portion of the fluid conduit assembly from a second portion of the fluid conduit assembly.

C17. The system of any of paragraphs A2-C16, wherein the conformation control assembly includes a controller configured to control the operation of the conformation control assembly.

C18. The system of paragraph C17, wherein the controller is configured to control the operation of the conformation control assembly as described in any of paragraphs A2-C16.

C19. The system of any of paragraphs C17-C18, wherein the controller is configured to detect a variable associated with the fluid conduit assembly.

C20. The system of paragraph C19, wherein the variable associated with the fluid conduit assembly includes at least one of a length of a portion of the fluid conduit assembly, the length of the deployed portion, an end-to-end distance of the fluid conduit assembly, an end-to-end distance of the deployed portion, a horizontal separation distance between the first vessel and the second vessel, a vertical separation distance between the first vessel and the second vessel, a minimum vertical separation distance from the deployed portion to a top surface of the body of water, a conformation of the deployed portion, a radius of curvature of the deployed portion, and a tensile force on the deployed portion.

C21. The system of any of paragraphs C17-C20, wherein the controller is configured to determine a target conformation of the deployed portion.

C22. The system of paragraph C21 when depending from any of paragraphs C16-C17, wherein the controller is configured to perform the determining based at least in part on the variable associated with the fluid conduit assembly.

C23. The system of any of paragraphs C21-C22, wherein the controller is configured to control the conformation of the deployed portion based at least in part on the target conformation of the deployed portion.

C24. The system of any of paragraphs A2-C23, wherein the conformation control assembly includes a biasing mechanism configured to regulate the conformation of the deployed portion.

C25. The system of paragraph C24, wherein the biasing mechanism is configured to regulate the operation of the conformation control assembly as described in any of paragraphs A2-C16.

C26. The system of any of paragraphs A2-C25, wherein the conformation control assembly includes a fluid conduit assembly storage structure configured to store at least a stored portion of the fluid conduit assembly, and optionally wherein the storage structure is configured to store the stored portion during use of the fluid conduit assembly to transfer a fluid between the first vessel and the second vessel.

C27. The system of paragraph C26, wherein the fluid conduit assembly storage structure includes at least one of a fluid conduit reel and a fluid conduit storage container.

C28. The system of paragraph C27, wherein the fluid conduit reel includes at least one of a horizontal orientation and a vertical orientation.

C29. The system of any of paragraphs C26-C28, wherein the conformation control assembly is operatively attached to a mounting structure configured to at least temporarily secure the conformation control assembly to at least one of the first vessel and the second vessel.

C30. The system of paragraph C29, wherein the mounting structure includes a turntable configured to selectively vary an orientation of the conformation control assembly responsive to a relative orientation of the first vessel with respect to the second vessel, and optionally wherein the selectively varying includes selectively varying the orientation of the conformation control assembly to decrease a force on the deployed portion.

C31. The system of any of paragraphs A2-C30, wherein the conformation control assembly is located in at least one of on a deck of, below a deck of, and on a platform of at least one of the first vessel and the second vessel.

C32. The system of any of paragraphs A2-C31, wherein the conformation control assembly further includes a drive structure configured to regulate the length of the deployed portion, and optionally wherein the drive assembly includes at least one of a motor, an electric motor, and an internal combustion engine.

C33. The system of any of paragraphs C1-C32, wherein the fluid conduit assembly includes a fluid conduit configured to transfer a fluid between the first vessel and the second vessel.

C34. The system of paragraph C33, wherein the fluid conduit includes a pipe, and optionally wherein the pipe includes a flexible pipe.

C35. The system of any of paragraphs A1-C34, wherein at least one of the first vessel and the second vessel includes at least one of a hydrocarbon production platform, an elevated hydrocarbon production platform, a hydrocarbon production vessel, a hydrocarbon transport, a ship, and a tanker, and optionally wherein the first vessel is a hydrocarbon production vessel and the second vessel is a tanker.

C36. The system of any of paragraphs A1-C35, wherein the first vessel and the second vessel are oriented in at least one of a side-by-side and a tandem configuration.

C37. The system of any of paragraphs A1-C36, wherein at least one of the first vessel and the second vessel is a marine vessel that is floating on the body of water, and optionally wherein both the first vessel and the second vessel are marine vessels that are floating on the body of water.

D1. A fluid conduit assembly configured to be suspended between and to transfer a fluid between a first vessel and a second vessel that are separated by a body of water, the fluid conduit assembly comprising:

a fluid conduit support configured to be suspended between the first vessel and the second vessel; and

a fluid conduit, wherein the fluid conduit is defined by a body, and wherein the body is configured to be suspended between the first vessel and the second vessel and supported by the fluid conduit support.

D2. The fluid conduit assembly of paragraph D1, wherein the fluid conduit support includes at least one of a cable, a rope, and a chain.

D3. The fluid conduit assembly of any of paragraphs D1-D2, wherein the fluid conduit includes at least one of a flexible fluid conduit and a hose, and optionally wherein the fluid conduit is configured to collapse when no fluid is flowing therethrough.

D4. The fluid conduit assembly of any of paragraphs D1-D3, wherein the body is operatively attached to the fluid conduit support at a plurality of attachment points.

D5. The fluid conduit assembly of any of paragraphs D1-D4, wherein at least a portion of the plurality of attachment points are permanent attachment points.

D6. The fluid conduit assembly of any of paragraphs D1-D5, wherein at least a portion of the plurality of attachment points are separable attachment points that are configured to provide for separation of the fluid conduit support from the fluid conduit without damage to the fluid conduit support or the fluid conduit.

D7. The fluid conduit assembly of any of paragraphs D1-D6, wherein at least one of the first vessel and the second vessel is a marine vessel that is floating on the body of water, and optionally wherein both the first vessel and the second vessel are marine vessels that are floating on the body of water.

E1. A fluid transfer assembly configured to transfer a fluid between a first vessel and a second vessel that are separated by a body of water, the assembly comprising:

the fluid conduit assembly of any of paragraphs D1-D7; and

the system for controlling a conformation of a deployed portion of any of paragraphs A1-C37.

E2. The fluid transfer assembly of paragraph E1, wherein the conformation control assembly includes a fluid conduit storage structure and a fluid conduit support storage structure.

E3. The fluid transfer assembly of paragraph E2, wherein the fluid conduit storage structure is separate from the fluid conduit support storage structure.

E4. The fluid transfer assembly of any of paragraphs E2-E3, wherein the fluid conduit support storage structure includes a winch.

E5. The fluid transfer assembly of any of paragraphs E2-E4, wherein the fluid conduit storage structure includes at least one of a hose reel and a fluid conduit storage volume.

E6. The fluid transfer assembly of any of paragraphs E1-E5, wherein the conformation control assembly is configured to attach the fluid conduit to the fluid conduit support as the fluid conduit assembly is drawn through the conformation control assembly.

E7. The fluid transfer assembly of any of paragraphs E1-E6, wherein at least one of the first vessel and the second vessel is a marine vessel that is floating on the body of water, and optionally wherein both the first vessel and the second vessel are marine vessels that are floating on the body of water.

E8. The fluid transfer assembly of any of paragraphs E1-E7, wherein at least a stored portion of the fluid conduit assembly is stored within the system for controlling the conformation of the fluid conduit assembly, wherein the stored portion is stored in a coiled conformation, and further wherein the coiled conformation includes at least one of a vertical coiled conformation and a horizontal coiled conformation.

F1. A method of controlling a conformation of a fluid conduit assembly that extends between a first vessel and a second vessel that are separated by a body of water, the method comprising:

automatically adjusting a length of a deployed portion of the fluid conduit assembly to regulate a conformation of the deployed portion.

F2. The method of paragraph F1, wherein the fluid conduit assembly includes an aerial fluid conduit assembly and the automatically adjusting includes maintaining the deployed portion above a top surface of the body of water.

F3. The method of any of paragraphs F1-F2, wherein the method further includes transferring a fluid between the first vessel and the second vessel with the fluid conduit assembly, and optionally wherein the fluid includes at least one of a hydrocarbon, natural gas, liquefied natural gas, and oil.

F4. The method of any of paragraphs F1-F3, wherein the automatically adjusting includes maintaining a catenary shape in the deployed portion.

F5. The method of any of paragraphs F1-F4, wherein the automatically adjusting includes maintaining a minimum vertical separation distance between the deployed portion and a top surface of the body of water, and optionally wherein the automatically adjusting includes avoiding contact between the deployed portion and the top surface of the body of water.

F6. The method of paragraphs F5, wherein the method includes increasing the length of the deployed portion responsive to a vertical separation distance between the deployed portion and the top surface of the body of water being greater than a maximum threshold vertical separation distance.

F7. The method of any of paragraphs F5-F6, wherein the method includes decreasing the length of the deployed portion responsive to a vertical separation distance between the deployed portion and the top surface of the body of water being less than a minimum threshold vertical separation distance.

F8. The method of any of paragraphs F1-F7, wherein the automatically adjusting includes maintaining a tensile force on the deployed portion below a threshold tensile force, and optionally wherein the automatically adjusting includes maintaining the tensile force within a desired tensile force range.

F9. The method of paragraph F8, wherein the method includes increasing the length of the deployed portion responsive to the tensile force being greater than a first threshold tensile force.

F10. The method of any of paragraphs F8-F9, wherein the method includes decreasing the length of the deployed portion responsive to the tensile force being less than a second threshold tensile force.

F11. The method of any of paragraphs F1-F10, wherein the automatically adjusting includes maintaining a radius of curvature of the deployed portion above a minimum radius of curvature.

F12. The method of any of paragraphs F1-F11, wherein the automatically adjusting includes inhibiting overbend within the deployed portion.

F13. The method of any of paragraphs F1-F12, wherein the automatically adjusting includes dynamically adjusting the length of the deployed portion.

F14. The method of any of paragraphs F1-F13, wherein the method further includes detecting a variable associated with the fluid conduit assembly.

F15. The method of paragraph F14, wherein the variable associated with the fluid conduit assembly includes at least one of a length of a portion of the fluid conduit assembly, the length of the deployed portion, an end-to-end distance of the fluid conduit assembly, an end-to-end distance of the deployed portion, a horizontal separation distance between the first vessel and the second vessel, a vertical separation distance between the first vessel and the second vessel, a minimum vertical separation distance from the deployed portion to a top surface of the body of water, a conformation of the deployed portion, a radius of curvature of the deployed portion, and a tensile force on the deployed portion.

F16. The method of any of any of paragraphs F1-F15, wherein the method further includes determining a target conformation of the deployed portion, and optionally wherein the determining is based at least in part on the variable associated with the fluid conduit assembly.

F17. The method of paragraph F16, wherein the automatically adjusting includes controlling the conformation of the deployed portion based at least in part on the target conformation of the deployed portion.

F18. The method of any of paragraphs F1-F17, wherein the method further includes varying an orientation of the conformation control assembly responsive to a relative orientation of the first vessel with respect to the second vessel, and optionally wherein the varying includes selectively varying to decrease a force on the deployed portion.

F19. The method of any of paragraphs F1-F17, wherein the fluid conduit assembly includes the fluid conduit assembly of any of paragraphs D1-D5.

F20. The method of any of paragraphs F1-F17, wherein the fluid conduit assembly includes a fluid conduit and a fluid conduit support, and further wherein the fluid conduit is operatively attached to the fluid conduit support at a plurality of attachment points.

F21. The method of any of paragraphs F1-F20, wherein the method further includes extending the deployed portion between the first vessel and the second vessel.

F22. The method of any of paragraphs F1-F21, wherein at least one of the first vessel and the second vessel is a marine vessel that is floating on the body of water, and optionally wherein both the first vessel and the second vessel are marine vessels that are floating on the body of water.

G1. A method of supporting a fluid conduit that is defined by a body, wherein the fluid conduit extends between a first vessel and a second vessel that are separated by a body of water, the method comprising:

attaching the body to a fluid conduit support at a plurality of attachment points;

suspending the body from the fluid conduit support to create a fluid conduit assembly; and

extending a deployed portion of the fluid conduit assembly between the first vessel and the second vessel.

G2. The method of paragraph G1, wherein the method further includes automatically adjusting a length of the deployed portion to regulate a conformation of the deployed portion.

G3. The method of paragraph G2, wherein the automatically adjusting includes controlling a conformation of the deployed portion using any of the methods of any of paragraphs F1-F22.

G4. The method of any of paragraphs G1-G3, wherein the attaching includes automatically attaching the body to the fluid conduit support at the plurality of attachment points as the body and the fluid conduit support are removed from a fluid conduit assembly storage structure.

G5. The method of any of paragraphs G1-G4, wherein the method further includes detaching the body from the fluid conduit support as the fluid conduit assembly is retracted into a fluid conduit assembly storage structure.

G6. The method of paragraph G5, wherein the method further includes storing the fluid conduit support on a fluid conduit support storage structure, optionally wherein the fluid conduit support includes a cable and the fluid conduit support storage structure includes a winch, and further optionally wherein the storing includes simultaneously storing a stored portion of the fluid conduit assembly and transferring the fluid between the first vessel and the second vessel.

G7. The method of any of paragraphs G5-G6, wherein the method further includes storing the fluid conduit on a fluid conduit storage structure, and optionally wherein the fluid conduit includes a flexible hose and the fluid conduit storage structure includes a hose reel.

G8. The method of any of paragraphs G1-G7, wherein at least one of the first vessel and the second vessel is a marine vessel that is floating on the body of water, and optionally wherein both the first vessel and the second vessel are marine vessels that are floating on the body of water.

H1. The use of the any of the systems of any of paragraphs A1-C37 or any of the assemblies of any of paragraphs D1-E8 with any of the methods of any of paragraphs F1-G8.

H2. The use of any of the methods of any of paragraphs F1-G8 with any of the systems of any of paragraphs A1-C37 or any of the assemblies of any of paragraphs D1-E8.

H3. The use of any of the systems of any of paragraphs A1-C37, any of the assemblies of any of paragraphs D1-E8, or any of the methods of any of paragraphs F1-G8 to transfer a fluid between a first vessel and a second vessel.

H4. The use of any of the systems of any of paragraphs A1-C37, any of the assemblies of any of paragraphs D1-E8, or any of the methods of any of paragraphs F1-G8 to transfer hydrocarbons.

PCT1. A system for controlling a conformation of a fluid conduit assembly that extends between a first vessel and a second vessel that are separated by a body of water, the system comprising:

an aerial fluid conduit assembly configured to transfer a fluid between the first vessel and the second vessel, wherein the fluid includes at least one of a hydrocarbon, natural gas, liquefied natural gas, and oil; and

a conformation control assembly configured to automatically adjust a length of a deployed portion of the aerial fluid conduit assembly to regulate a conformation of the deployed portion.

PCT2. The system of paragraph PCT1, wherein the conformation control assembly is configured to maintain a catenary shape in the deployed portion.

PCT3. The system of any of paragraphs PCT1-PCT2, wherein the conformation control assembly is configured to increase the length of the deployed portion responsive to a vertical separation distance between the deployed portion and a top surface of the body of water being greater than a maximum threshold vertical separation distance, and further wherein the conformation control assembly is configured to decrease the length of the deployed portion responsive to the vertical separation distance being less than a minimum threshold vertical separation distance.

PCT4. The system of any of paragraphs PCT1-PCT3, wherein the conformation control assembly is configured to increase the length of the deployed portion responsive to a tensile force being greater than a first threshold tensile force, and further wherein the conformation control assembly is configured to decrease the length of the deployed portion responsive to the tensile force being less than a second threshold tensile force.

PCT5. The system of any of paragraphs PCT1-PCT4, wherein the conformation control assembly includes a controller configured to control the operation of the conformation control assembly, wherein the controller is configured to detect a variable associated with the aerial fluid conduit assembly, wherein the variable associated with the aerial fluid conduit assembly includes at least one of a length of a portion of the aerial fluid conduit assembly, the length of the deployed portion, an end-to-end distance of the aerial fluid conduit assembly, an end-to-end distance of the deployed portion, a horizontal separation distance between the first vessel and the second vessel, a vertical separation distance between the first vessel and the second vessel, a minimum vertical separation distance from the deployed portion to a top surface of the body of water, a conformation of the deployed portion, a radius of curvature of the deployed portion, and a tensile force on the deployed portion, and further wherein the controller is configured to determine a target conformation for the deployed portion based at least in part on the variable associated with the aerial fluid conduit assembly.

PCT6. The system of any of paragraphs PCT1-PCT5, wherein the conformation control assembly includes a biasing mechanism configured to regulate the conformation of the deployed portion.

PCT7. A fluid transfer assembly configured to transfer a fluid between a first vessel and a second vessel that are separated by a body of water, the assembly comprising:

an aerial fluid conduit assembly including a fluid conduit support configured to be suspended between the first vessel and the second vessel and a fluid conduit configured to be suspended between the first vessel and the second vessel and supported by the fluid conduit support; and

the system for controlling a conformation of a deployed portion of any of paragraphs PCT1-PCT6.

PCT8. An aerial fluid conduit assembly configured to be suspended between and to transfer a fluid between a first vessel and a second vessel that are separated by a body of water, the fluid conduit assembly comprising:

a fluid conduit support configured to be suspended between the first vessel and the second vessel, wherein the fluid conduit support includes at least one of a cable, a rope, and a chain; and

a fluid conduit, wherein the fluid conduit is defined by a body, wherein the body is configured to be suspended between the first vessel and the second vessel and to be supported by the fluid conduit support, and further wherein the body is configured to be operatively attached to the fluid conduit support at a plurality of attachment points.

PCT9. A method of controlling a conformation of an aerial fluid conduit assembly that extends between a first vessel and a second vessel that are separated by a body of water, the method comprising:

automatically adjusting a length of a deployed portion of the aerial fluid conduit assembly to regulate a conformation of the deployed portion, wherein the automatically adjusting includes maintaining the deployed portion above a top surface of the body of water; and

transferring a fluid between the first vessel and the second vessel with the aerial fluid conduit assembly, wherein the fluid includes at least one of a hydrocarbon, natural gas, liquefied natural gas, and oil.

PCT10. The method of paragraph PCT9, wherein the automatically adjusting includes maintaining a catenary shape in the deployed portion.

PCT11. The method of any of paragraphs PCT9-PCT10, wherein the method includes increasing the length of the deployed portion responsive to a vertical separation distance between the deployed portion and the top surface of the body of water being greater than a maximum threshold vertical separation distance, and further wherein the method includes decreasing the length of the deployed portion responsive to the vertical separation distance being less than a minimum threshold vertical separation distance.

PCT12. The method of any of paragraphs PCT9-PCT11, wherein the method includes increasing the length of the deployed portion responsive to the tensile force being greater than a first threshold tensile force, and further wherein the method includes decreasing the length of the deployed portion responsive to the tensile force being less than a second threshold tensile force.

PCT13. The method of any of paragraphs PCT9-PCT12, wherein the automatically adjusting includes maintaining a radius of curvature of the deployed portion above a minimum radius of curvature.

PCT14. The method of any of paragraphs PCT9-PCT13, wherein the method further includes detecting a variable associated with the aerial fluid conduit assembly, wherein the variable associated with the aerial fluid conduit assembly includes at least one of a length of a portion of the aerial fluid conduit assembly, the length of the deployed portion, an end-to-end distance of the aerial fluid conduit assembly, an end-to-end distance of the deployed portion, a horizontal separation distance between the first vessel and the second vessel, a vertical separation distance between the first vessel and the second vessel, a minimum vertical separation distance from the aerial fluid conduit assembly to the top surface of the body of water, a conformation of the deployed portion, a radius of curvature of the deployed portion, and a tensile force on the deployed portion, and further wherein the method includes determining a target conformation for the deployed portion, wherein the determining is based at least in part on the variable associated with the aerial fluid conduit assembly.

PCT15. The method of any of paragraphs PCT9-PCT14, wherein the aerial fluid conduit assembly includes an aerial fluid conduit support and a fluid conduit, and the method further includes suspending the aerial fluid conduit from the fluid conduit support.

INDUSTRIAL APPLICABILITY

[0081] The systems and methods disclosed herein are applicable to the oil and gas industry.

[0082] It is believed that the disclosure set forth above encompasses multiple distinct inventions with independent utility. While each of these inventions has been disclosed in its preferred form, the specific embodiments thereof as disclosed and illustrated herein are not to be considered in a limiting sense as numerous variations are possible. The subject matter of the inventions includes all novel and non-obvious combinations and subcombinations of the various elements, features, functions and/or properties disclosed herein. Similarly, when the disclosure, the preceding numbered paragraphs, or subsequently filed claims recite "a" or "a first" element or the equivalent thereof, such claims should be understood to include incorporation of one or more such elements, neither requiring nor excluding two or more such elements.

[0083] Applicants reserve the right to submit claims directed to certain combinations and subcombinations that are directed to one of the disclosed inventions and are believed to be novel and non-obvious. Inventions embodied in other combinations and subcombinations of features, functions, elements and/or properties may be claimed through amendment of those claims or presentation of new claims in that or a related application. Such amended or new claims, whether they are directed to a different invention or directed to the same invention, whether different, broader, narrower or equal in scope to the original claims, are also regarded as included within the subject matter of the inventions of the present disclosure.

CLAIMS

1. A system for controlling a conformation of a fluid conduit assembly that extends between a first vessel and a second vessel that are separated by a body of water, the system comprising:

a conformation control assembly configured to automatically adjust a length of a deployed portion of the fluid conduit assembly to regulate a conformation of the deployed portion.

2. The system of claim 1, wherein the system further includes the fluid conduit assembly, and further wherein the fluid conduit assembly includes an aerial fluid conduit assembly.

3. The system of claim 1, wherein the fluid conduit assembly is configured to transfer a fluid between the first vessel and the second vessel, and further wherein the fluid includes at least one of a hydrocarbon, natural gas, liquefied natural gas, and oil.

4. The system of claim 1, wherein the conformation control assembly is configured to maintain a catenary shape in the deployed portion.

5. The system of claim 1, wherein the conformation control assembly is configured to maintain at least a minimum vertical separation distance between the deployed portion and a top surface of the body of water.

6. The system of claim 5, wherein the conformation control assembly is configured to increase the length of the deployed portion responsive to a vertical separation distance between the deployed portion and the top surface of the body of water being greater than a maximum threshold vertical separation distance, and further wherein the conformation control assembly is configured to decrease the length of the deployed portion responsive to the vertical separation distance being less than a minimum threshold vertical separation distance.

7. The system of claim 1, wherein the conformation control assembly is configured to maintain a tensile force on the deployed portion within a threshold tensile force range.

8. The system of claim 7, wherein the conformation control assembly is configured to increase the length of the deployed portion responsive to the tensile force being greater than a maximum threshold tensile force, and further wherein the conformation control assembly is configured to decrease the length of the deployed portion responsive to the tensile force being less than a minimum threshold tensile force.

9. The system of claim 1, wherein the conformation control assembly includes a controller configured to control the operation of the conformation control assembly, and further wherein the controller is configured to detect a variable associated with the fluid conduit assembly.

10. The system of claim 9, wherein the variable associated with the fluid conduit assembly includes at least one of a length of a portion of the fluid conduit assembly, the length of the deployed portion, an end-to-end distance of the fluid conduit assembly, an end-to-end distance of the deployed portion, a horizontal separation distance between the first vessel and the second vessel, a vertical separation distance between the first vessel and the second vessel, a minimum vertical separation distance from the fluid conduit assembly to a top surface of the body of water, a conformation of the deployed portion, a radius of curvature of the deployed portion, and a tensile force on the deployed portion.

11. The system of claim 9, wherein the controller is configured to determine a target conformation for the deployed portion based at least in part on the variable associated with the fluid conduit assembly.

12. The system of claim 1, wherein the conformation control assembly includes a biasing mechanism configured to regulate the conformation of the deployed portion.

13. A fluid transfer assembly configured to transfer a fluid between a first vessel and a second vessel that are separated by a body of water, the fluid transfer assembly comprising:

a fluid conduit assembly including a fluid conduit support configured to be suspended between the first vessel and the second vessel and a fluid conduit configured to be suspended between the first vessel and the second vessel and supported by the fluid conduit support; and

the system for controlling the conformation of the deployed portion of claim 1.

14. A fluid conduit assembly configured to be suspended between and to transfer a fluid between a first vessel and a second vessel that are separated by a body of water, the fluid conduit assembly comprising:

a fluid conduit support configured to be suspended between the first vessel and the second vessel; and

a fluid conduit, wherein the fluid conduit is defined by a body, wherein the body is configured to be suspended between the first vessel and the second vessel and supported by the fluid conduit support, and further wherein the body is configured to be operatively attached to the fluid conduit support at a plurality of attachment points.

15. The fluid conduit assembly of claim 14, wherein the fluid conduit support includes at least one of a cable, a rope, and a chain.

16. The fluid conduit assembly of claim 14, wherein at least a separable portion of the attachment points are configured to provide for separation of the fluid conduit support from the fluid conduit without damage to the fluid conduit support or the fluid conduit.

17. A method of controlling a conformation of a fluid conduit assembly that extends between a first vessel and a second vessel that are separated by a body of water, the method comprising:

automatically adjusting a length of a deployed portion of the fluid conduit assembly to regulate a conformation of the deployed portion.

18. The method of claim 17, wherein the fluid conduit assembly includes an aerial fluid conduit assembly and the automatically adjusting includes maintaining at least the deployed portion above a top surface of the body of water.

19. The method of claim 17, wherein the method further includes transferring a fluid between the first vessel and the second vessel with the fluid conduit assembly, and further wherein the fluid includes at least one of a hydrocarbon, natural gas, liquefied natural gas, and oil.

20. The method of claim 17, wherein the automatically adjusting includes maintaining a catenary shape in the deployed portion.

21. The method of claim 17, wherein the automatically adjusting includes maintaining a minimum vertical separation distance between the deployed portion and a top surface of the body of water.

22. The method of claim 21, wherein the method includes increasing the length of the deployed portion responsive to a vertical separation distance between the deployed portion and the top surface of the body of water being greater than a maximum threshold vertical separation distance, and further wherein the method includes decreasing the length of the deployed portion responsive to the vertical separation distance being less than a minimum threshold vertical separation distance.

23. The method of claim 17, wherein the automatically adjusting includes maintaining a tensile force on the deployed portion below a threshold tensile force.

24. The method of claim 23, wherein the method includes increasing the length of the deployed portion responsive to the tensile force being greater than a maximum threshold tensile force, and further wherein the method includes decreasing the length of the deployed portion responsive to the tensile force being less than a minimum threshold tensile force.

25. The method of claim 17, wherein the automatically adjusting includes maintaining a radius of curvature of the deployed portion above a minimum radius of curvature.

26. The method of claim 17, wherein the method further includes detecting a variable associated with the fluid conduit assembly.

27. The method of claim 26, wherein the variable associated with the fluid conduit assembly includes at least one of a length of a portion of the fluid conduit assembly, the length of the deployed portion, an end-to-end distance of the fluid conduit assembly, an end-to-end distance of the deployed portion, a horizontal separation distance between the first vessel and the second vessel, a vertical separation distance between the first vessel and the second vessel, a minimum vertical separation distance from the fluid conduit assembly to a top surface of the body of water, the conformation of the deployed portion, a radius of curvature of the deployed portion, and a tensile force on the deployed portion.

28. The method of claim 26, wherein the method further includes determining a target conformation for the deployed portion, wherein the determining is based at least in part on the variable associated with the fluid conduit assembly.

29. The method of claim 17, wherein the fluid conduit assembly includes a fluid conduit and a fluid conduit support, and further wherein the fluid conduit is operatively attached to the fluid conduit support at a plurality of attachment points.

30. The method of claim 17, wherein the method further includes extending the deployed portion between the first vessel and the second vessel.

31. The method of claim 17, wherein the fluid conduit assembly includes a fluid conduit support and a fluid conduit, and the method further includes suspending the fluid conduit from the fluid conduit support.

32. A method of supporting a fluid conduit that is defined by a body, wherein the fluid conduit extends between a first vessel and a second vessel that are separated by a body of water, the method comprising:

attaching the body to a fluid conduit support at a plurality of attachment points;

suspending the body from the fluid conduit support to create a fluid conduit assembly; and

extending a deployed portion of the fluid conduit assembly between the first vessel and the second vessel.

33. The method of claim 32, wherein the method further includes automatically adjusting a length of the deployed portion of the fluid conduit support that extends between the first vessel and the second vessel to regulate a conformation of the deployed portion.

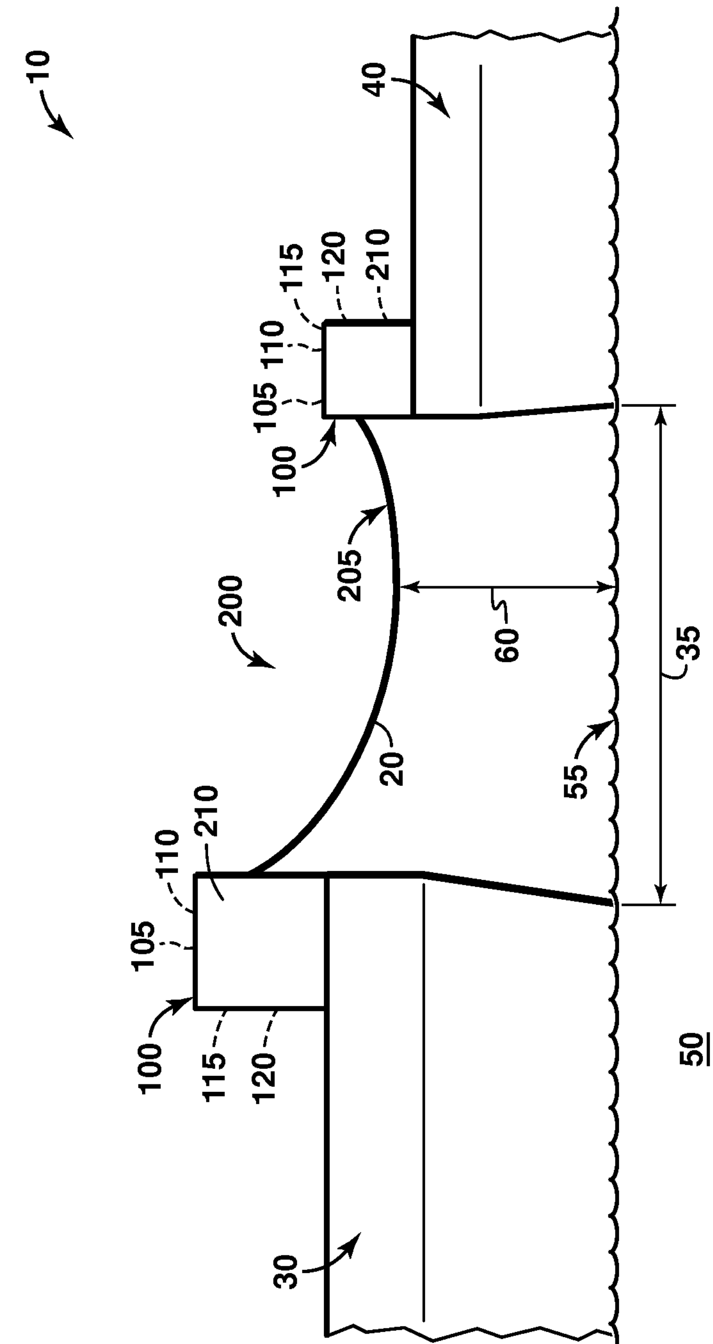
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FIG. 1

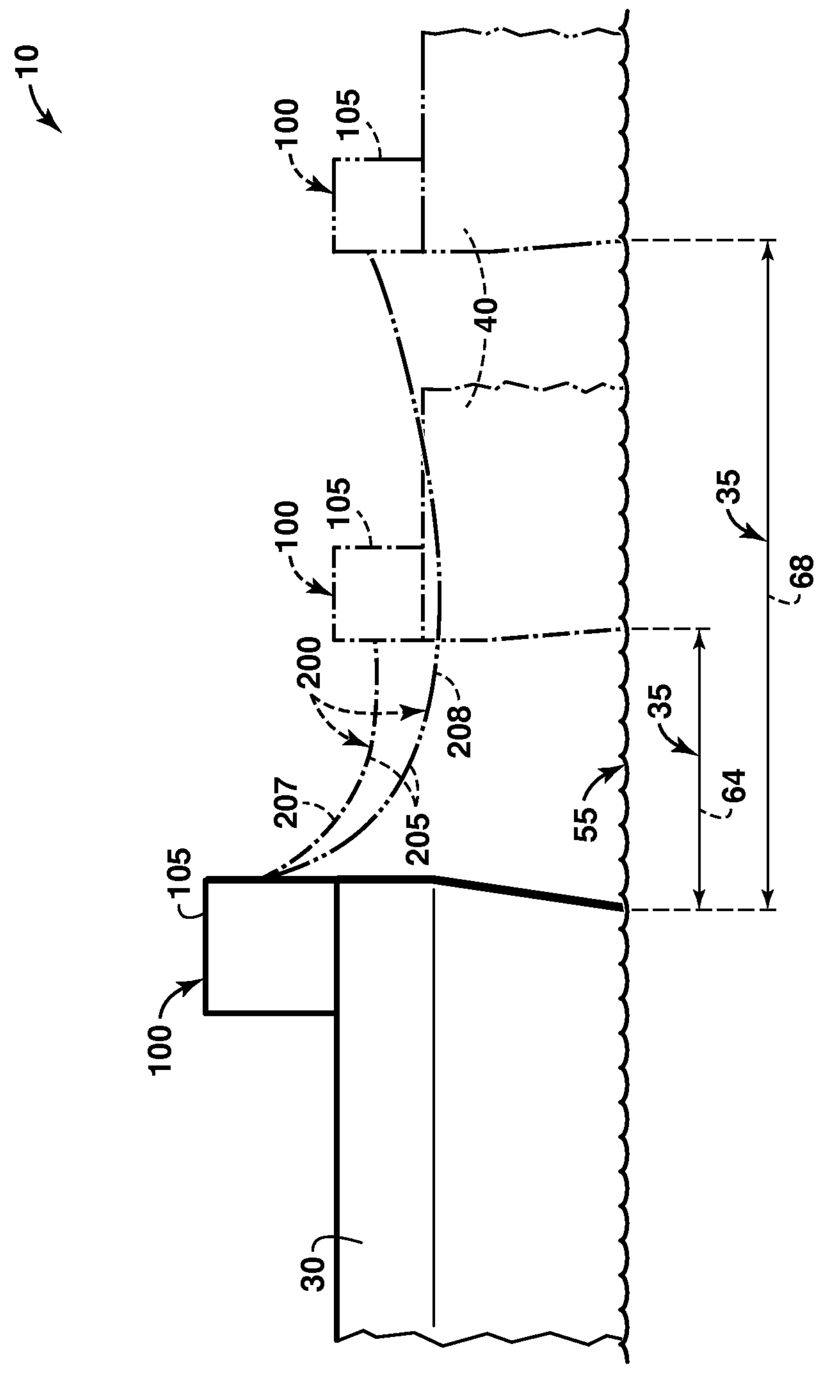

FIG. 2

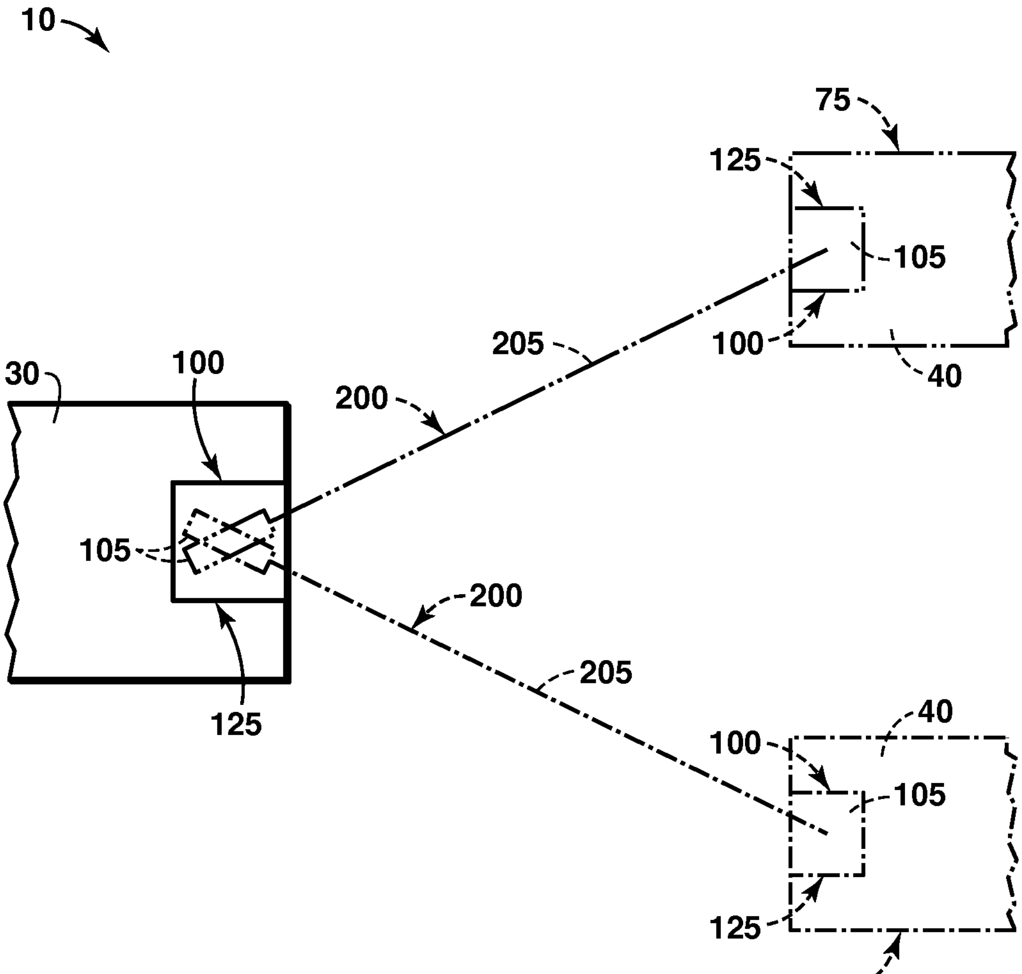
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FIG. 3

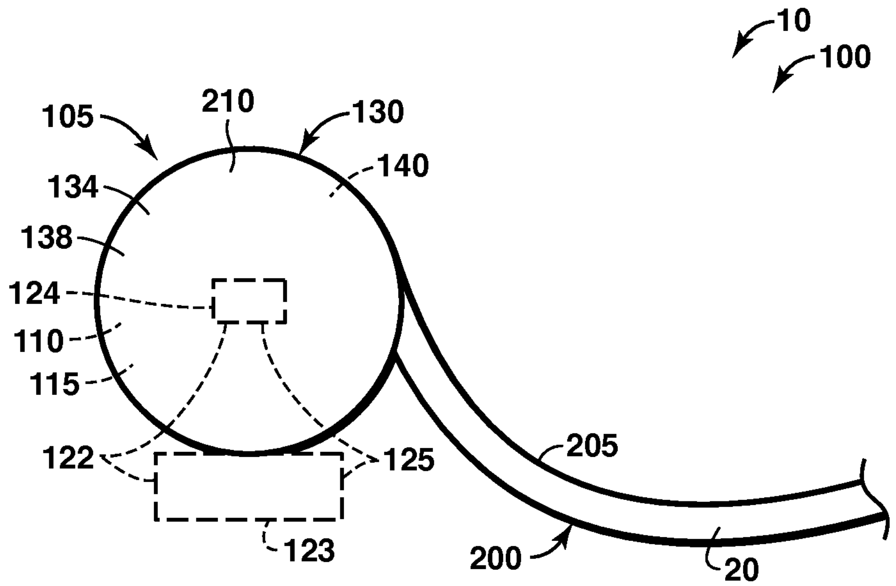

FIG. 4

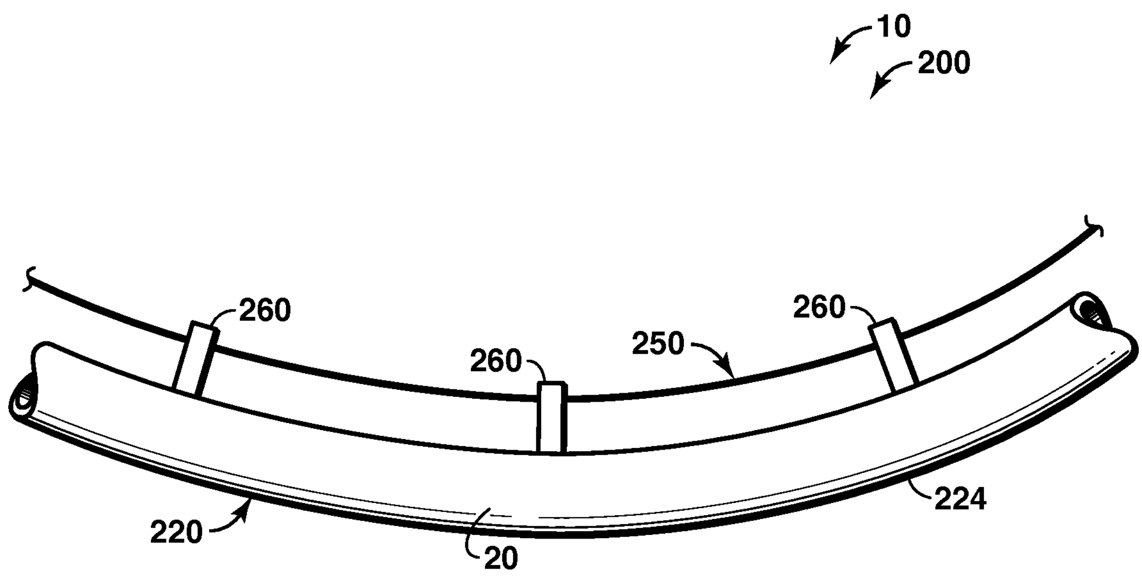
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FIG. 5

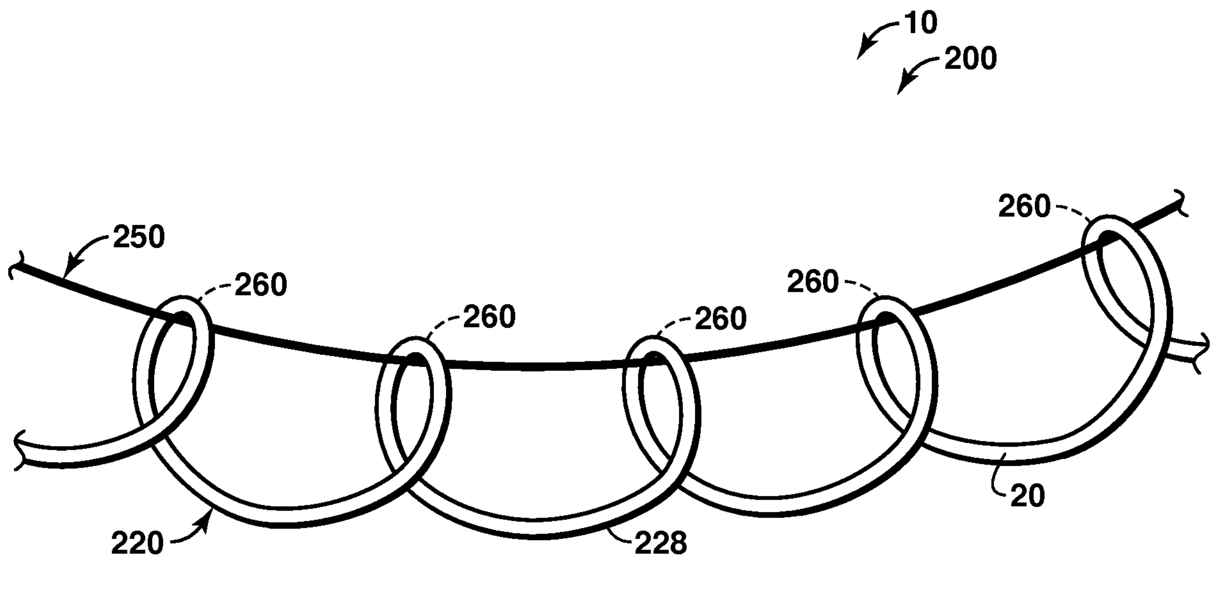
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FIG. 6

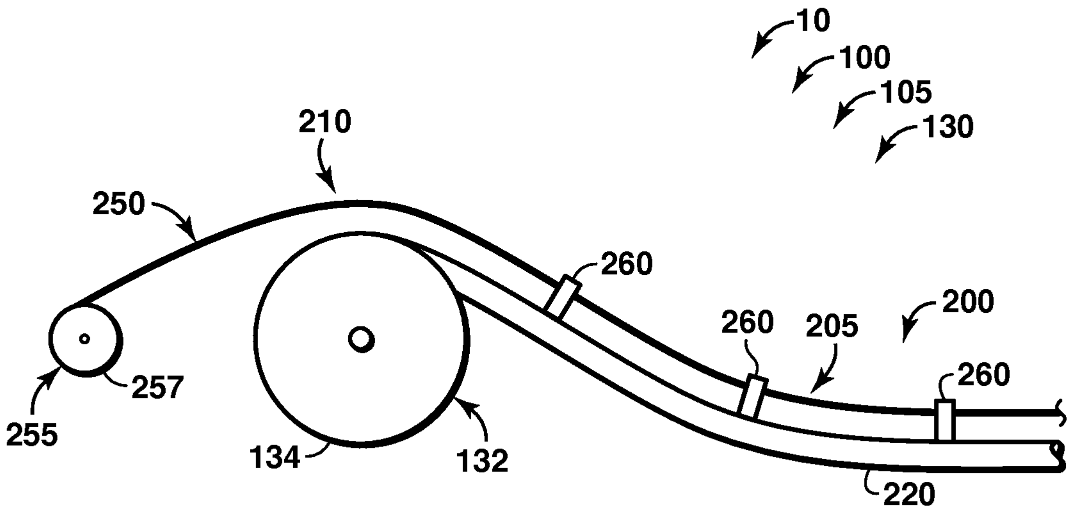
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FIG. 7

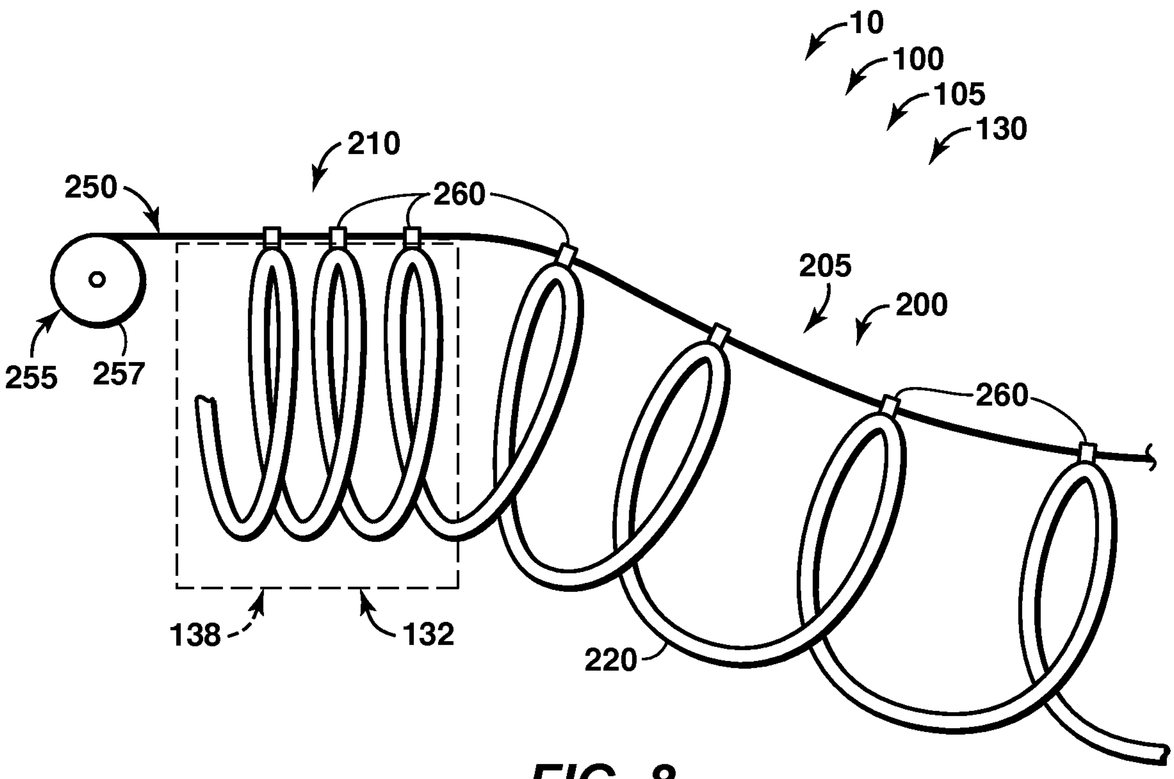
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FIG. 8

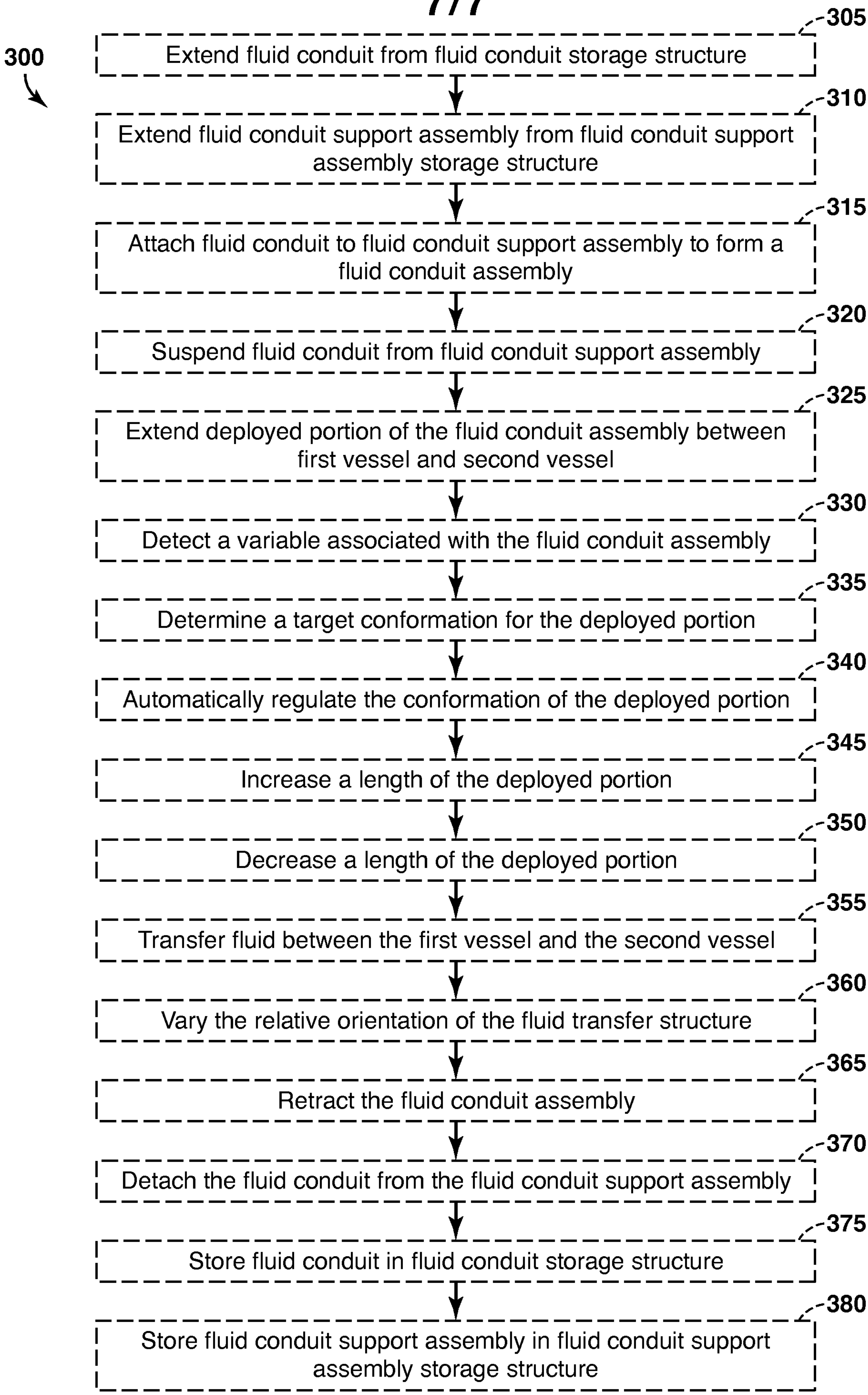
300
305
Extend fluid conduit from fluid conduit storage structure
310
Extend fluid conduit support assembly from fluid conduit support assembly storage structure
315
Attach fluid conduit to fluid conduit support assembly to form a fluid conduit assembly
320
Suspend fluid conduit from fluid conduit support assembly
325
Extend deployed portion of the fluid conduit assembly between first vessel and second vessel
330
Detect a variable associated with the fluid conduit assembly
335
Determine a target conformation for the deployed portion
340
Automatically regulate the conformation of the deployed portion
345
Increase a length of the deployed portion
350
Decrease a length of the deployed portion
355
Transfer fluid between the first vessel and the second vessel
360
Vary the relative orientation of the fluid transfer structure
365
Retract the fluid conduit assembly
370
Detach the fluid conduit from the fluid conduit support assembly
375
Store fluid conduit in fluid conduit storage structure
380
Store fluid conduit support assembly in fluid conduit support assembly storage structure

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No. PCT/US 12/58313

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B65B 37/00 (2012.02)
USPC - 137/899.2
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) -- B65B 37/00 (2012.02)
USPC -- 137/899.2

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC(8) -- B65B 37/00; B65B (2012.02) USPC -- 137/1,899.2; 114/230.2,230.21,230.22,230.24, 230.27; 141/1,231,312,382,387; 242/410,413, 413.2,413.3 (keyword limited; terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Patbase; PubWest (PGPB,USPT,USOC,EPAB,JPAB); USPTO; Espacenet; Google Scholar -- Search Terms Used: CABLE CATENARY CHAIN CONDUIT HANGING HOSE OCEAN PLATFORM ROPE SEA SHIP SURFACE SUSPEND$ TENSION TRANSFER$ VESSEL WATER

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2,839,021 A (Patterson) 17 June 1958 (17.06.1958) Fig 1; col 1, ln 18-20; col 1, ln 31-41; col 2, ln 15-25; col 3, ln 4-13; col 5, ln 22-35	1-33
A	US 1,685,927 A (Miller) 02 October 1928 (02.10.1928) Fig 1-4	1-33
A	US 3,658,101 A (Waldron) 24 April 1972 (24.04.1972) Fig 1; abstract	1-33
A	US 6,367,522 B1 (Tyer) 09 April 2002 (09.04.2002) Fig 1; abstract	1-33
A	US 2005/0051237 A1 (Dupont et al.) 10 March 2005 (10.03.2005) Fig 1-3; abstract	1-33
A	US 3,949,496 A (de Konig et al.) 13 April 1976 (13.04.1976) abstract	1-33

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 NOVEMBER 2012 (29.11.2012)	11 DEC 2012

Name and mailing address of the ISA/US	Authorized officer:
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 12/58313

Patbase Files:

Full-text: AU BE BR CA CH CN DE DK EP ES FI FR GB IN JP KR SE TH TW US WO

Bibliographic: (Europe) AT BA BE BG CH CS CY CZ DD DK EE ES FI GE GR HR HU IE IS IT LT LU LV MC MD MT NL NO PL PT RO RS SE SI SK SM TR UA YU (Asia) EA GC HK ID IL IN KZ MN MY PH RU SG SU TH TJ TW UZ VN (North America) CA CR CU DO GT HN MX NI PA SV TT (South America) AR BR CL CO EC PE UY (Australasia) AU NZ (Africa) AP DZ EG KE MA MW OA ZA ZM ZW