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(54) **FOUNDATION FOR OFFSHORE WIND TURBINE AND METHOD AND MEANS FOR ITS TRANSPORTATION AND INSTALLATION IN DEEPWATERS**

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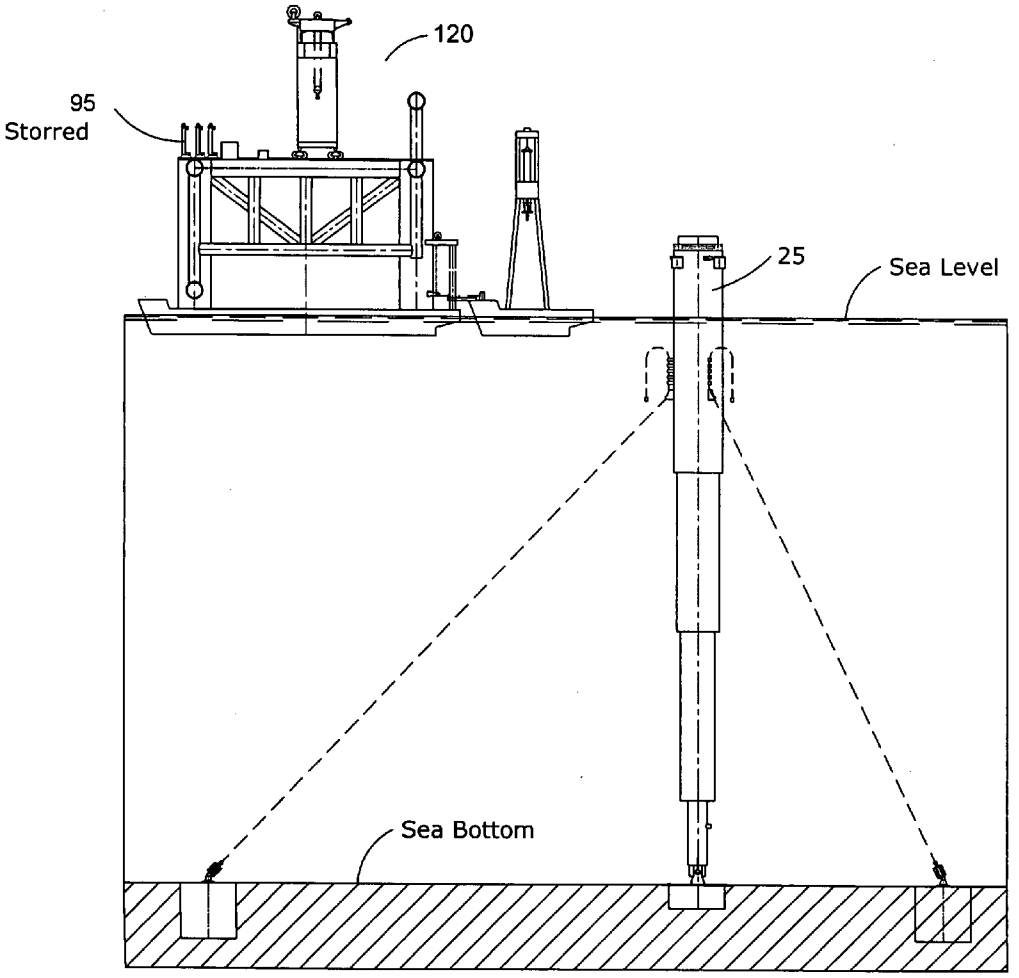
E02D 5/54 (2006.01)

(52) **U.S. Cl.** **405/203**; 405/224

(57) **ABSTRACT**

The main goal of the proposed by present invention compliant guyed tower is to increase the depth in which offshore wind turbines can be installed from present limit of 50 meters to 200+ meters. The specifics of compliant guyed towers, which are widely used by offshore oil industry for installation platforms in water depth starting from 300 meters and up to 1,000 meters, is in their long mooring lines, which have springiness that allows to mitigate dynamics of wind and waves forces acting on platforms. The length of mooring lines for wind turbines installed in the relatively shallow waters is not sufficient to have required springiness. By present invention the mooring line are attached to anchors on seabed through a pneumatic hydraulic spring, which provides to the mooring line the needed additional springiness.

The other innovation is in the method and means for simplification and expedition of the process of delivery and installation wind turbines foundation by using specialized Catamaran Foundation Installer and Transfer Pier.



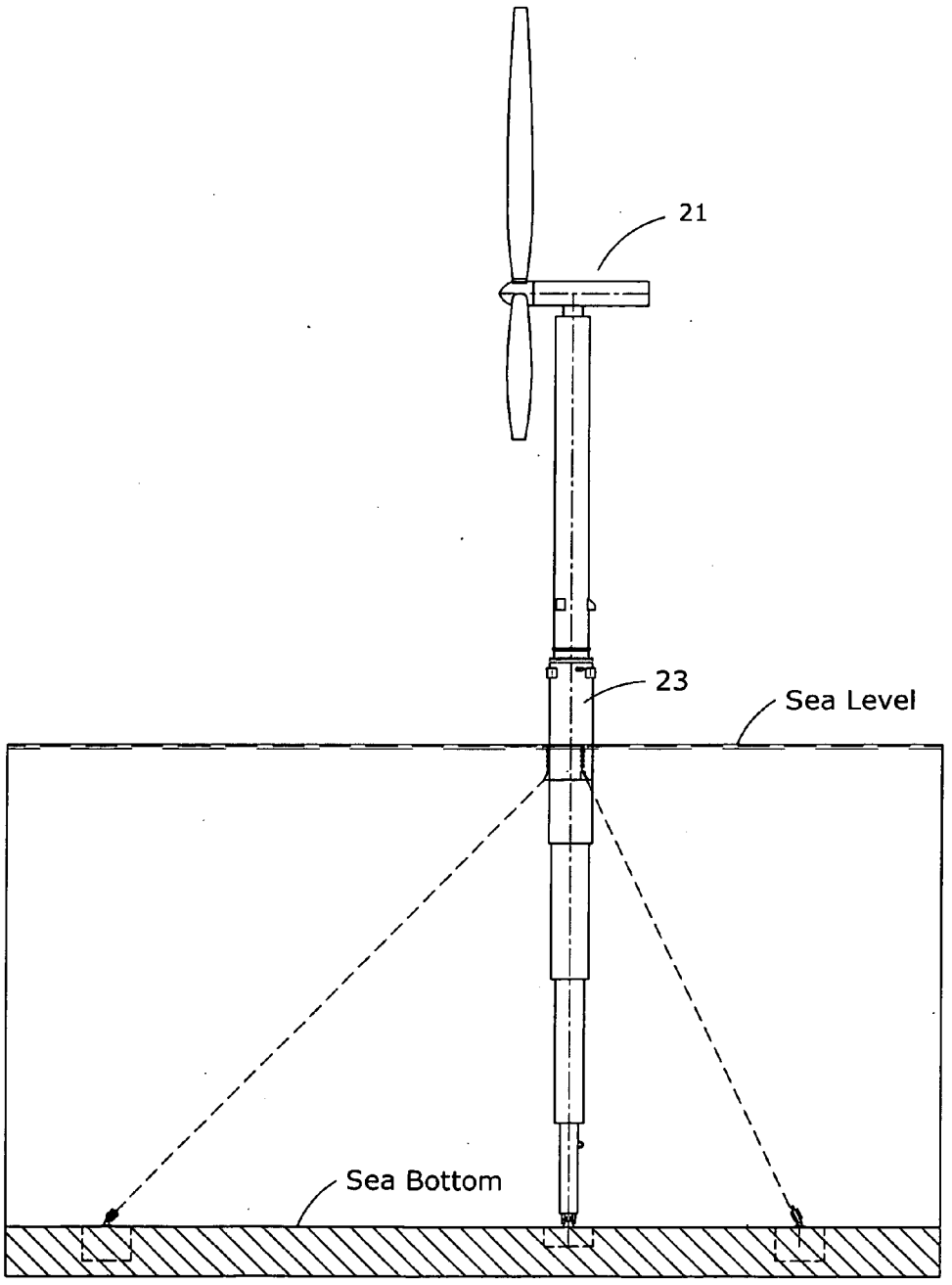
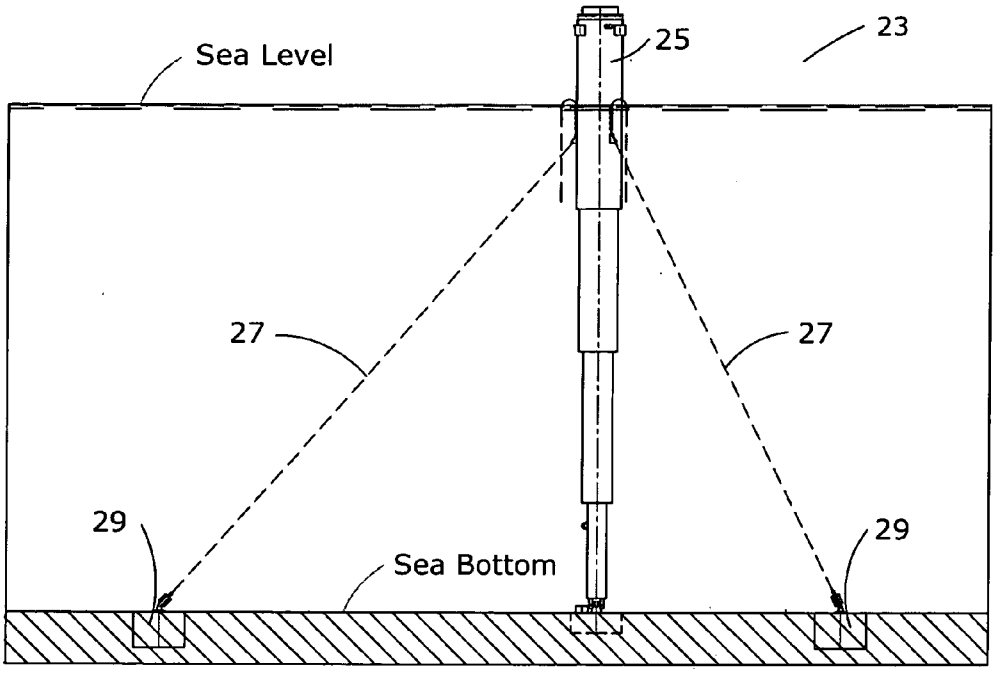


Fig. 1



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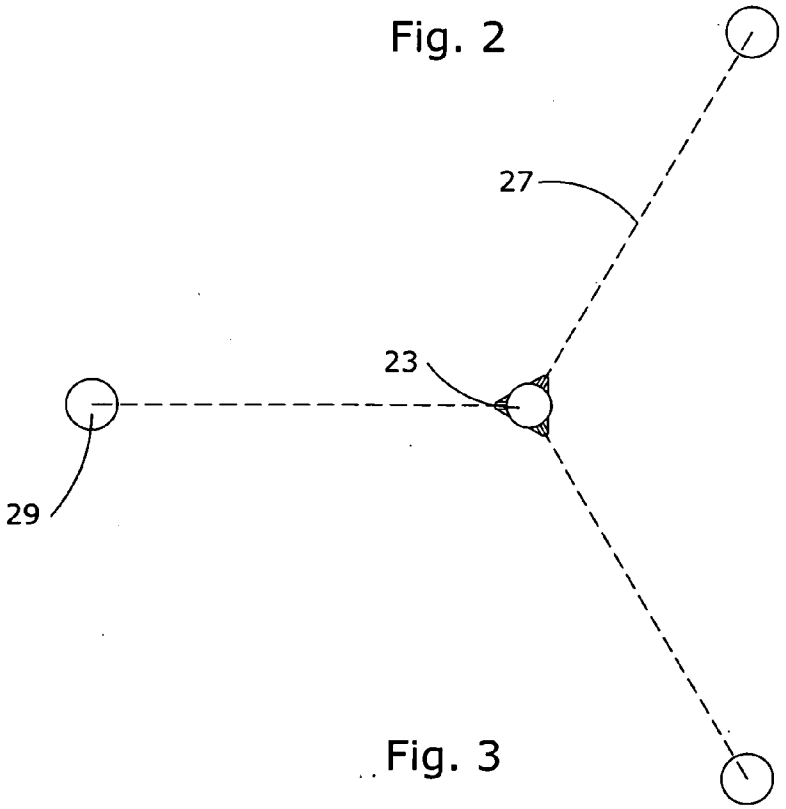
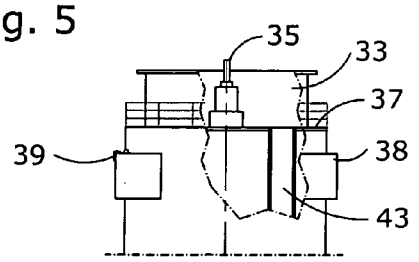


Fig. 3

Fig. 5



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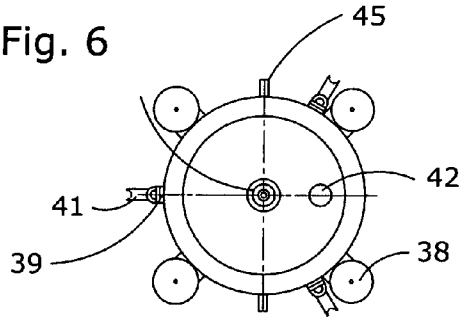

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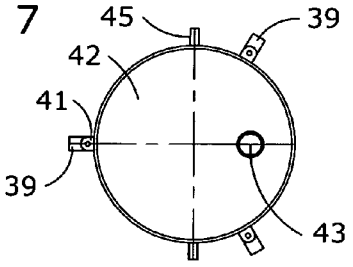


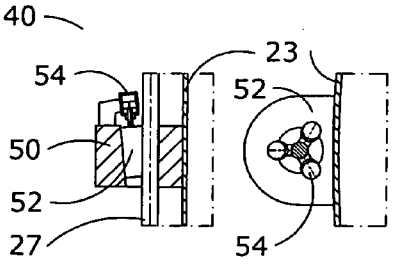
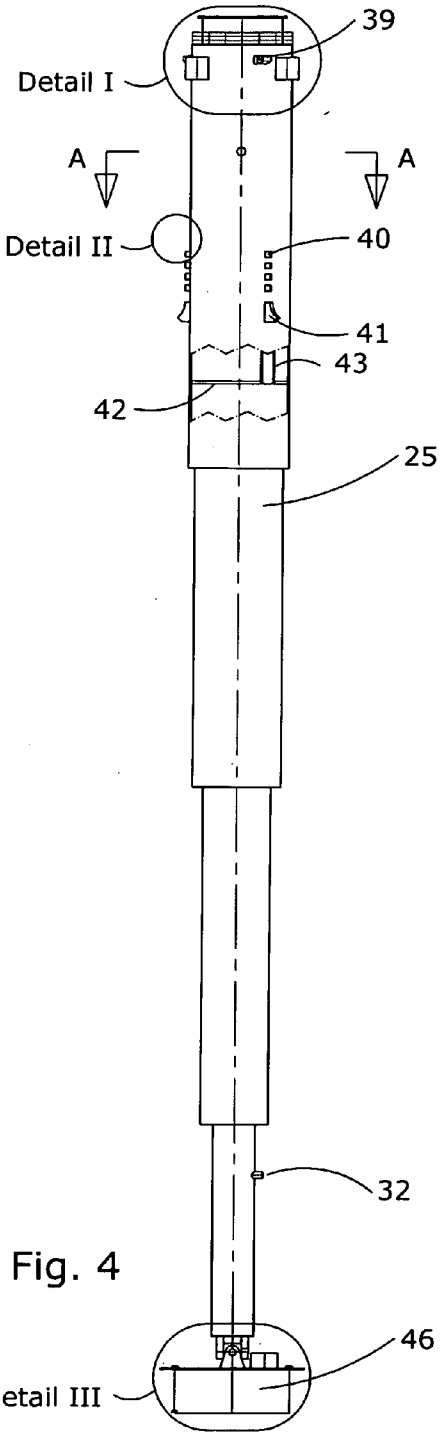


Fig. 8 Fig. 9



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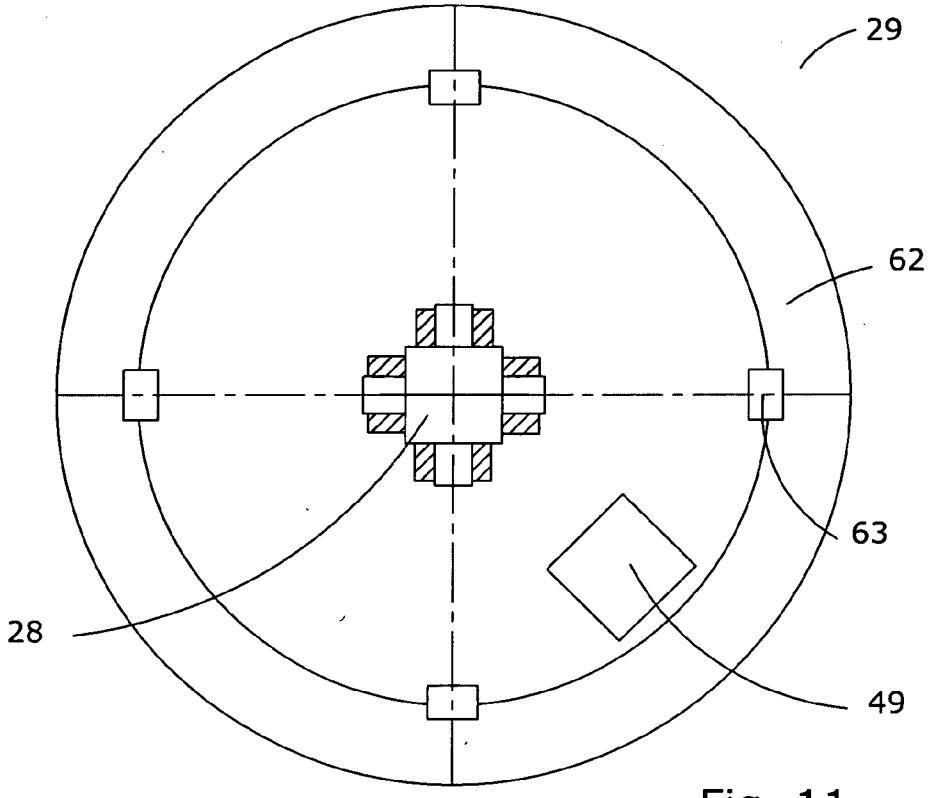

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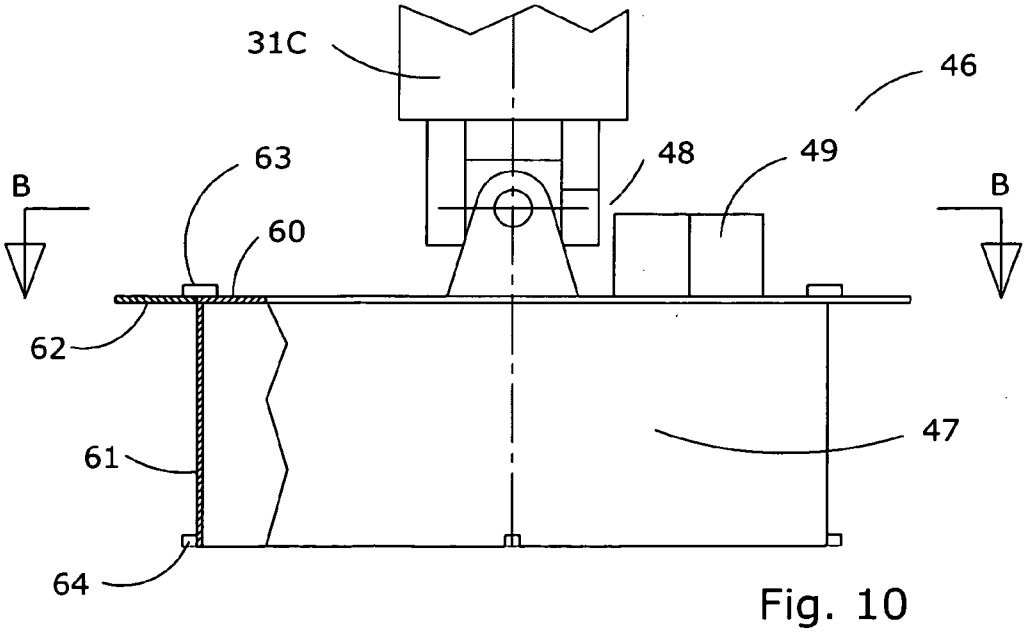

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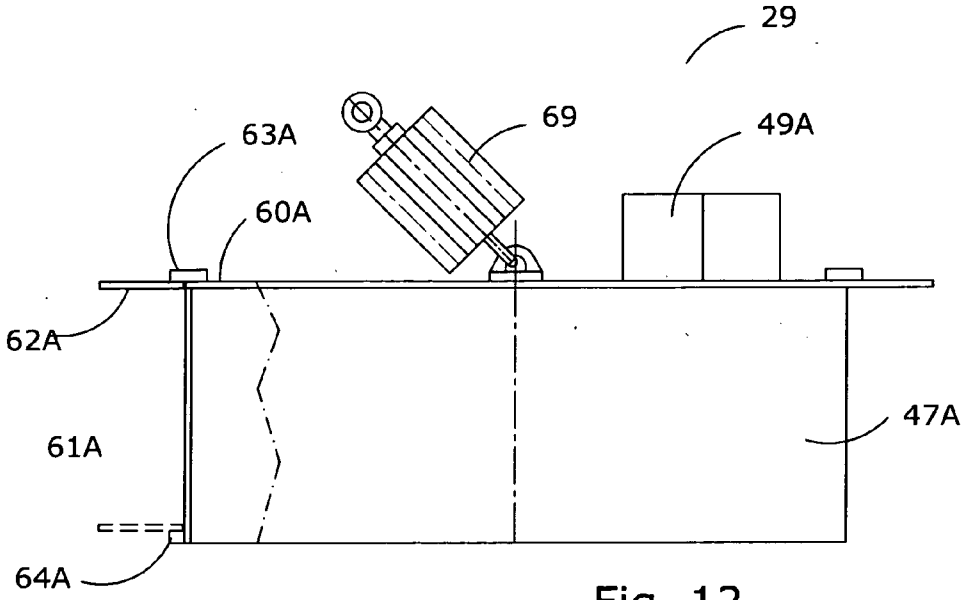

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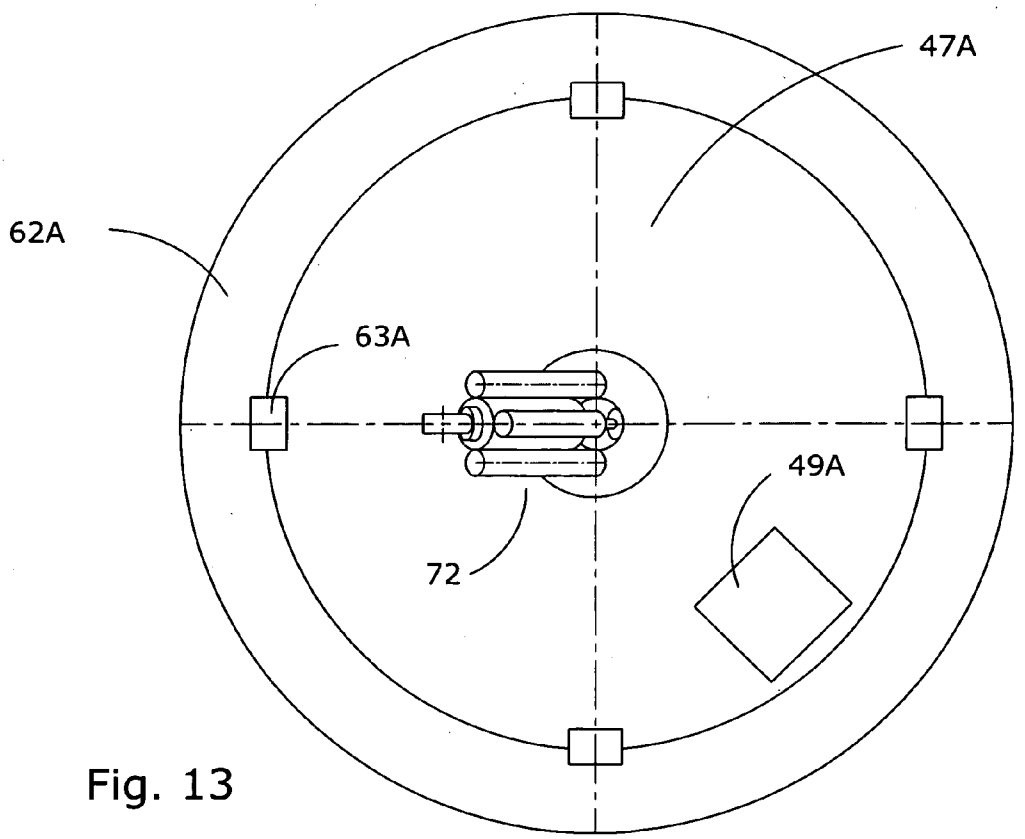

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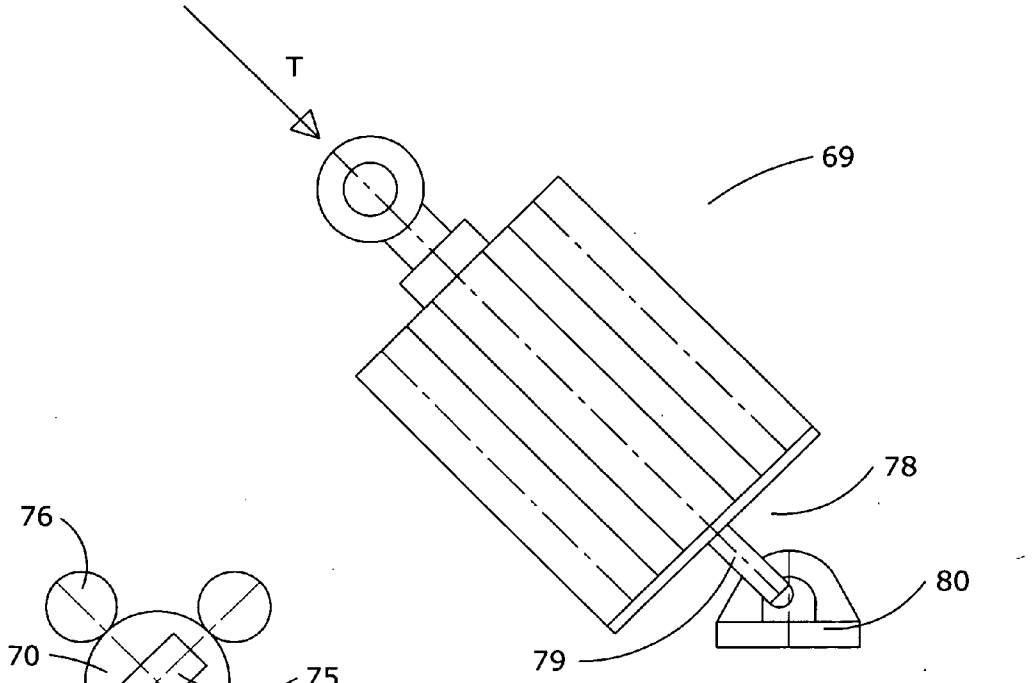

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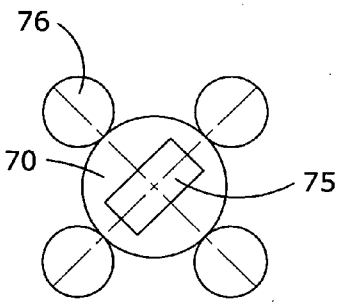

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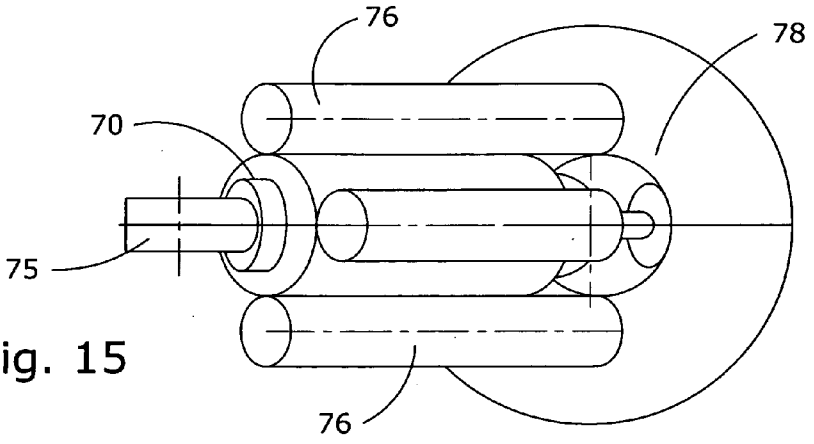

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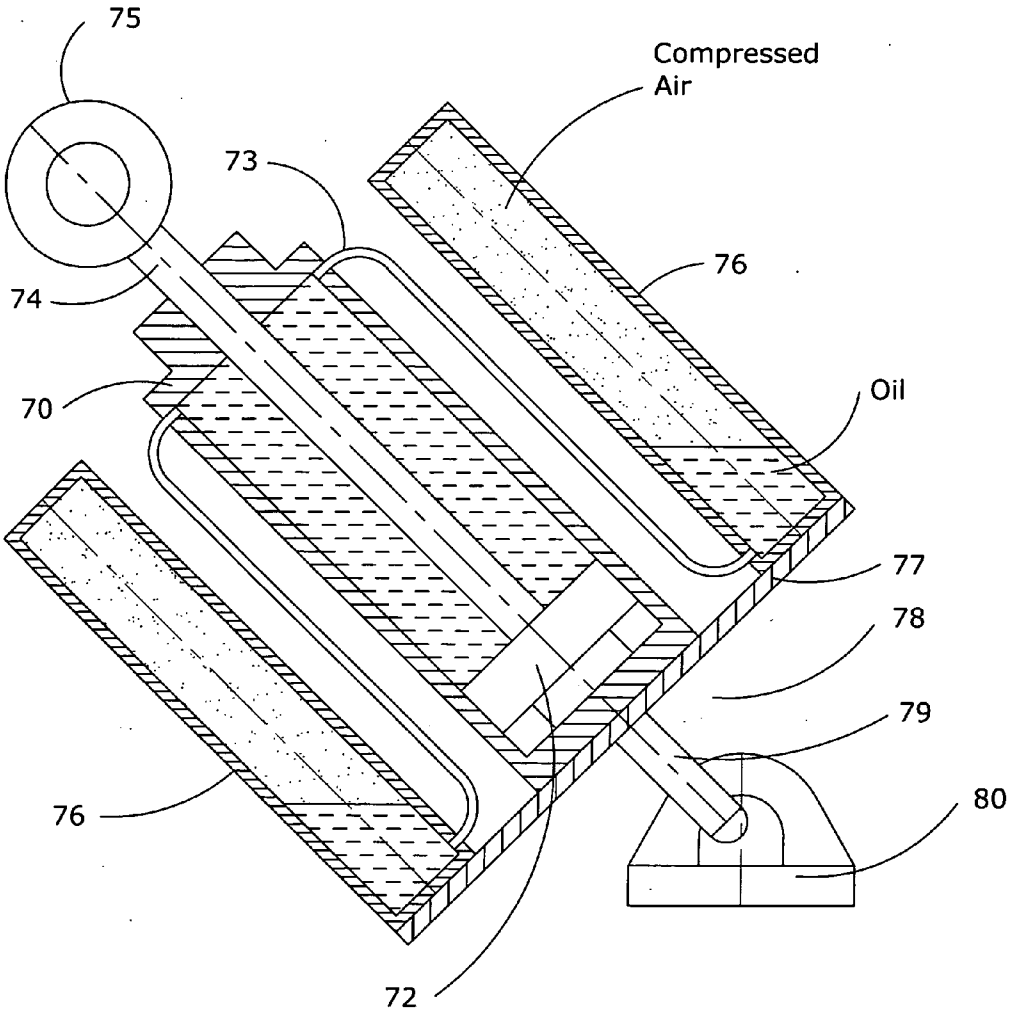

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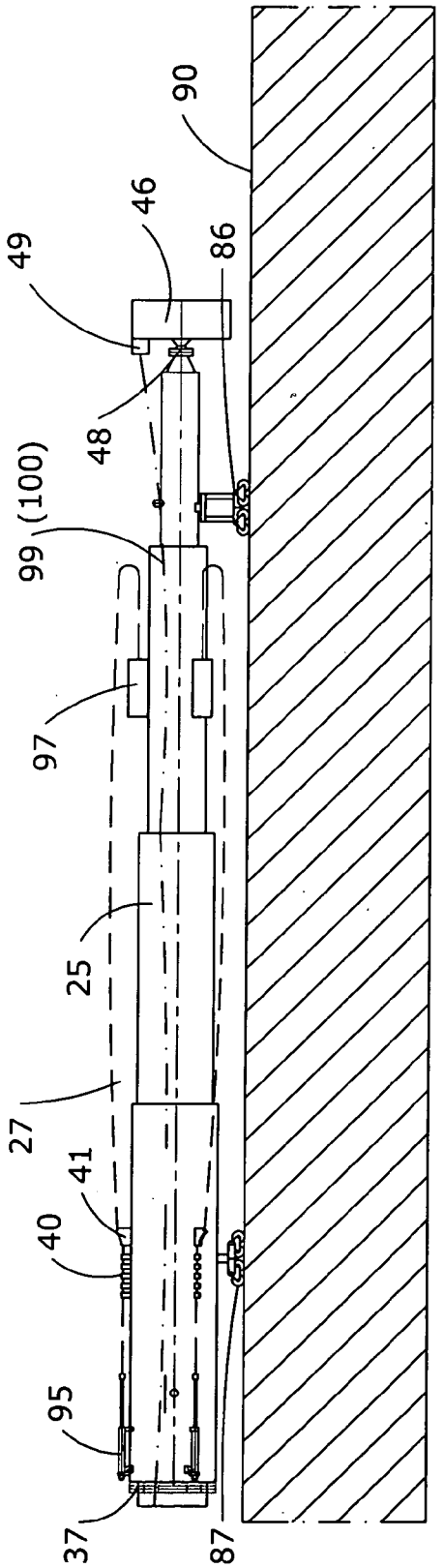

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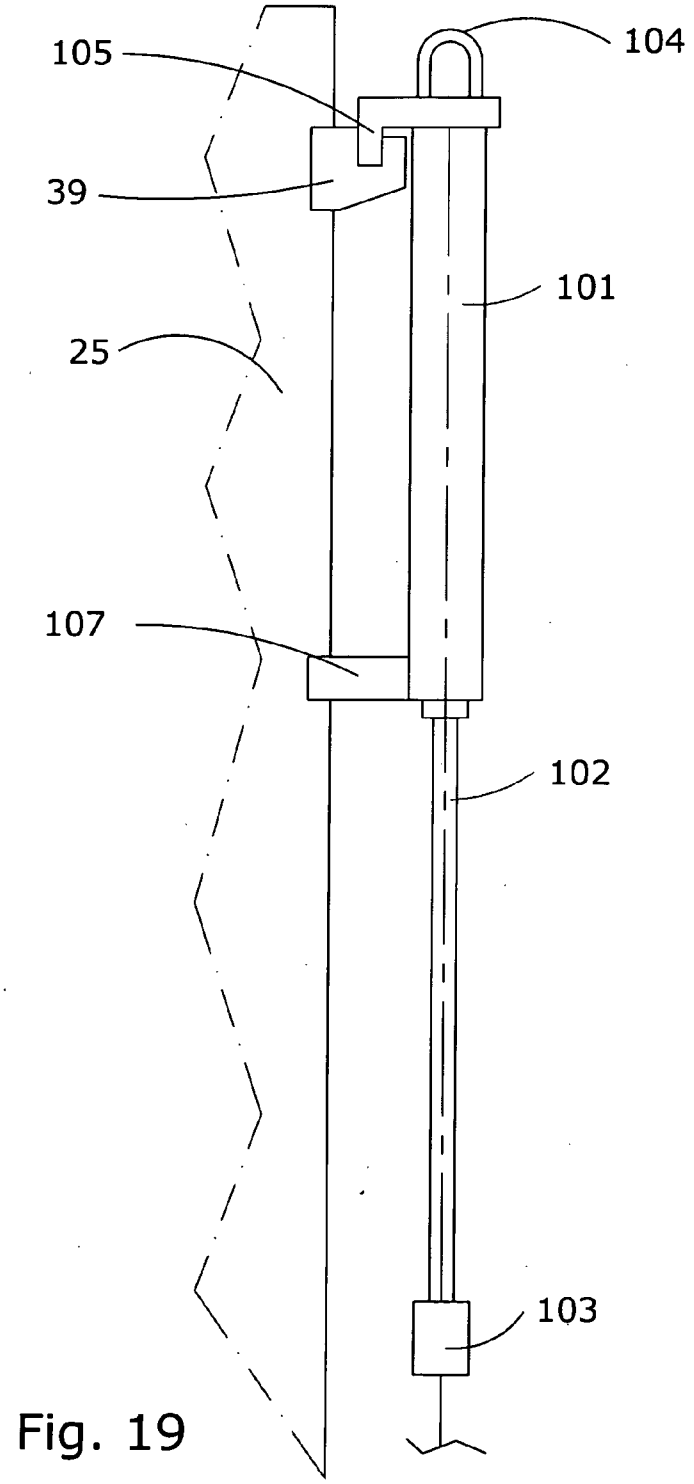

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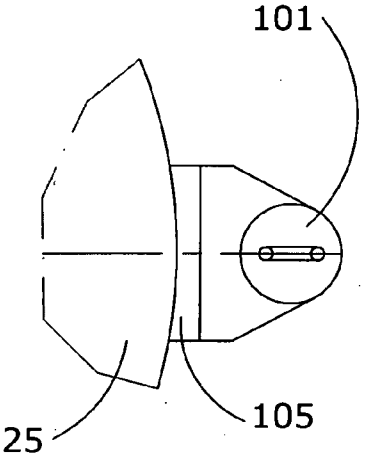

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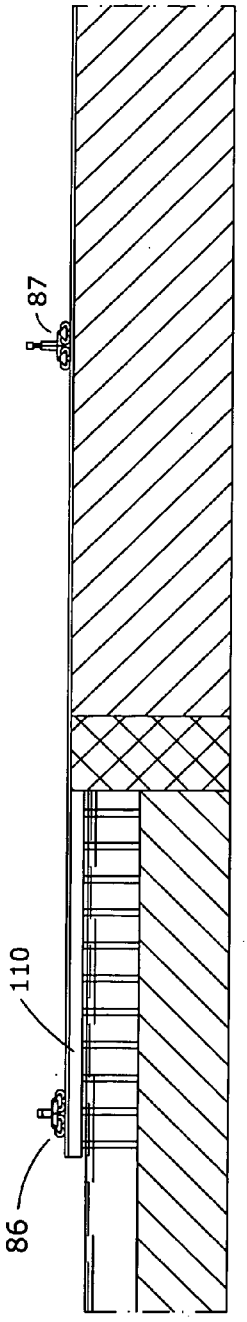

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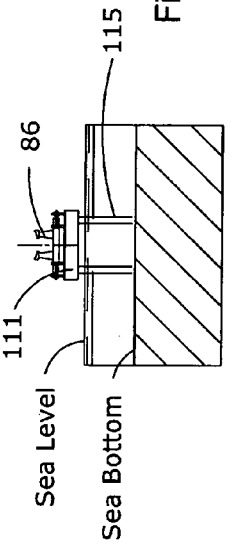

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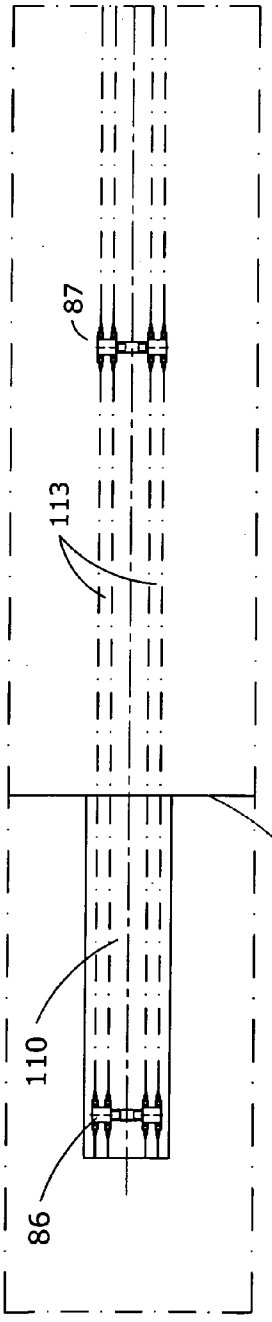

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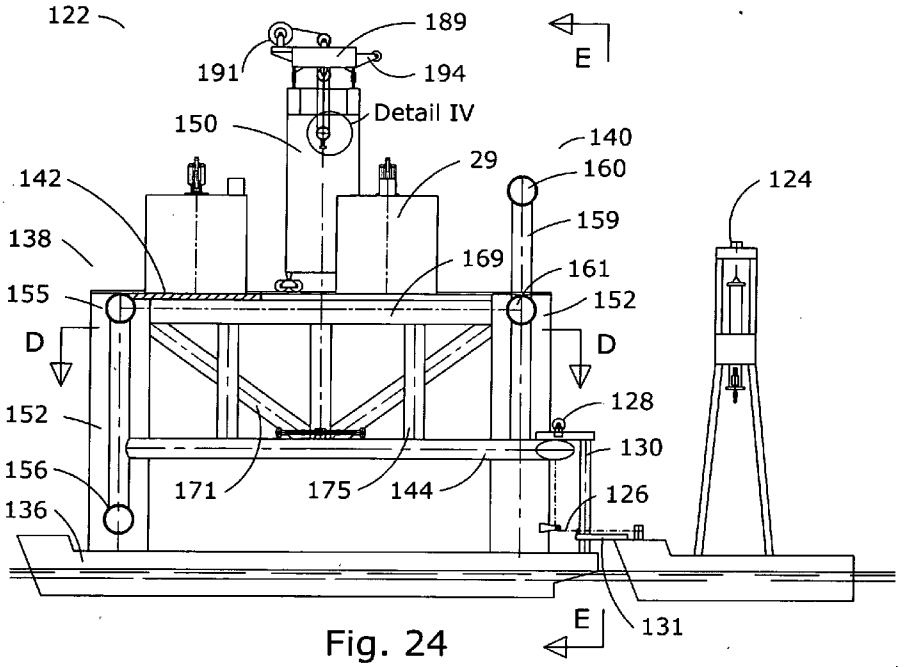
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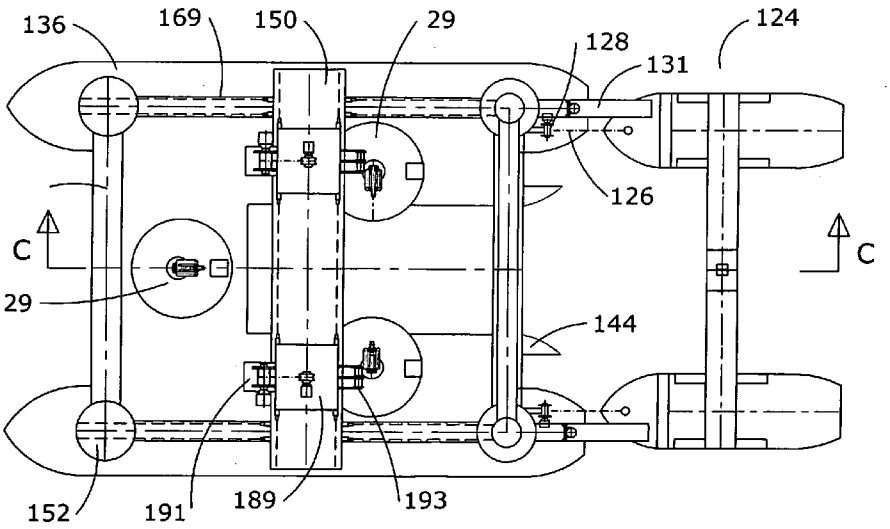
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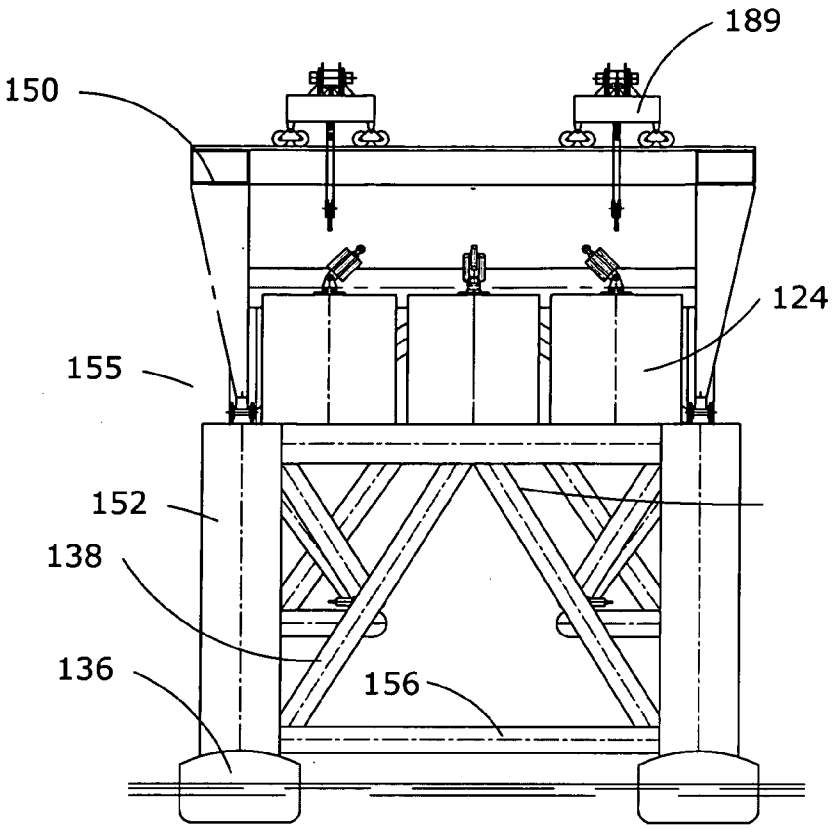
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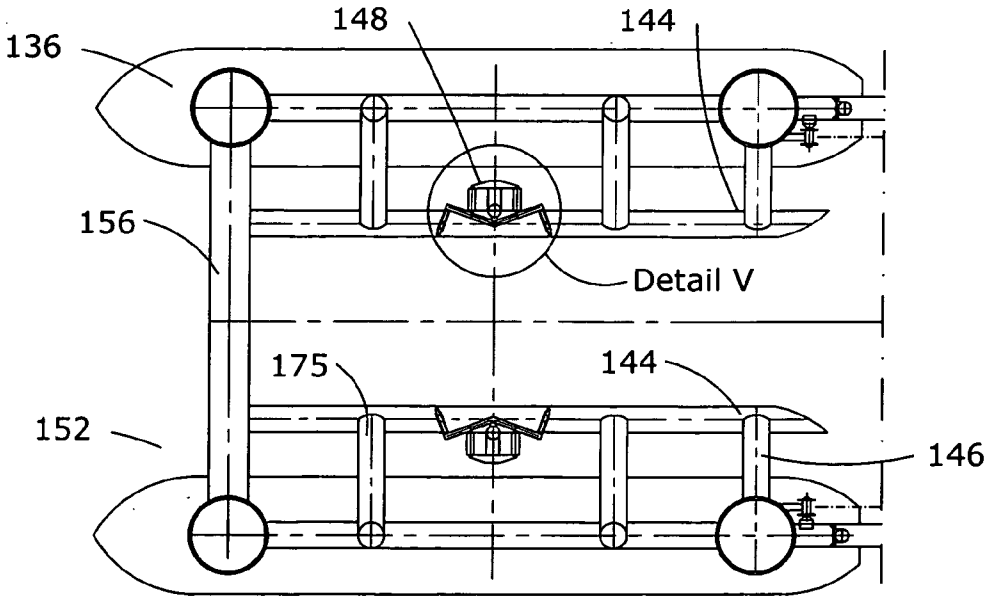
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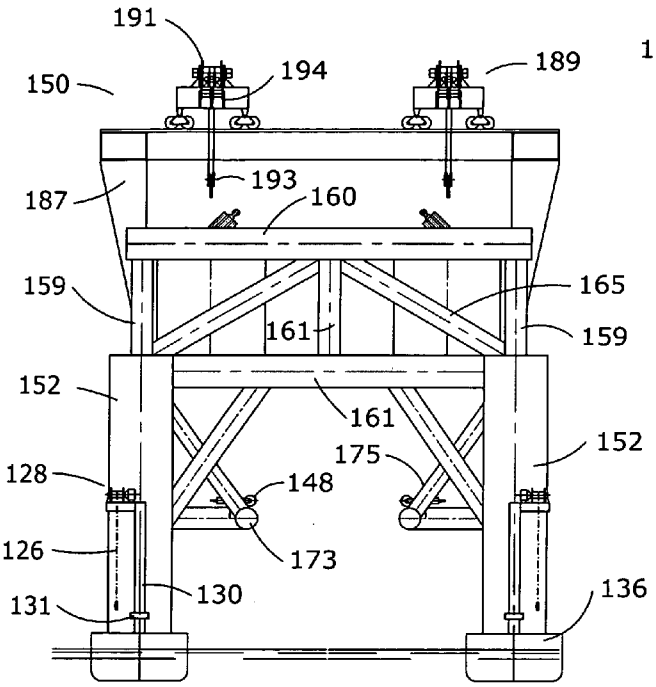

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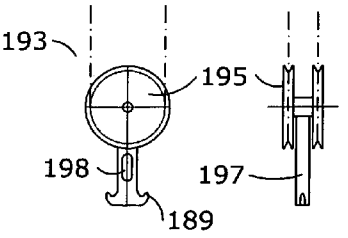
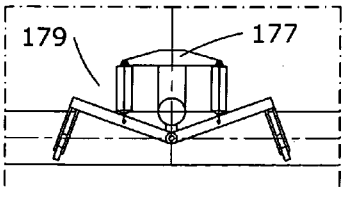


Fig. 29 Fig. 30



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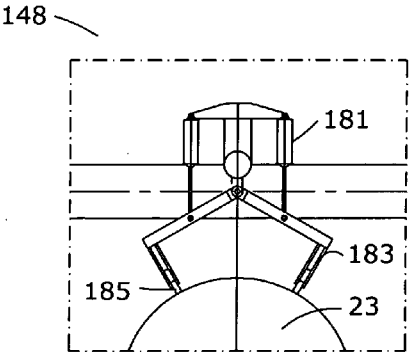

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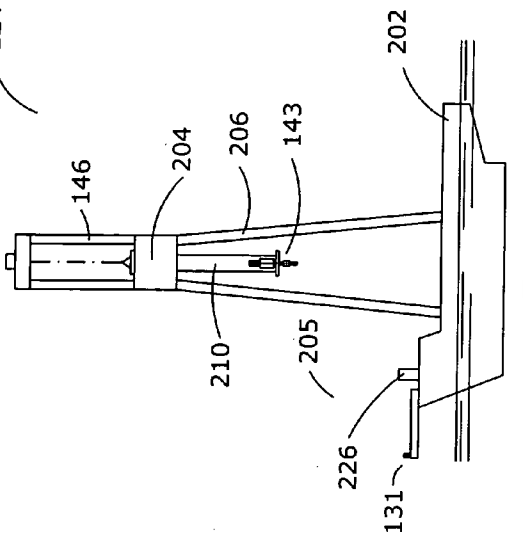

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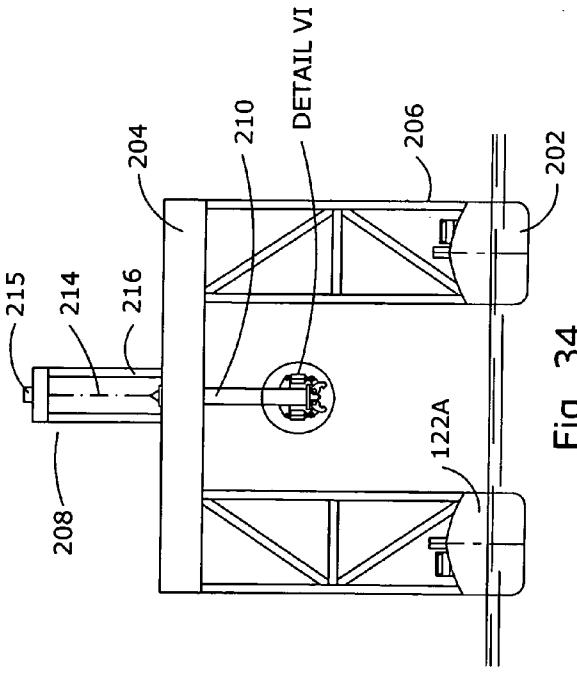

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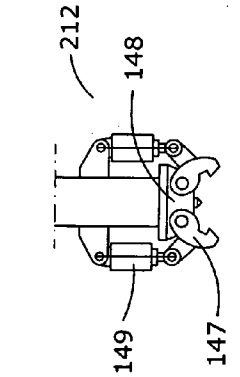

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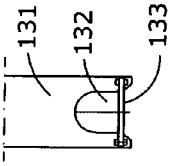

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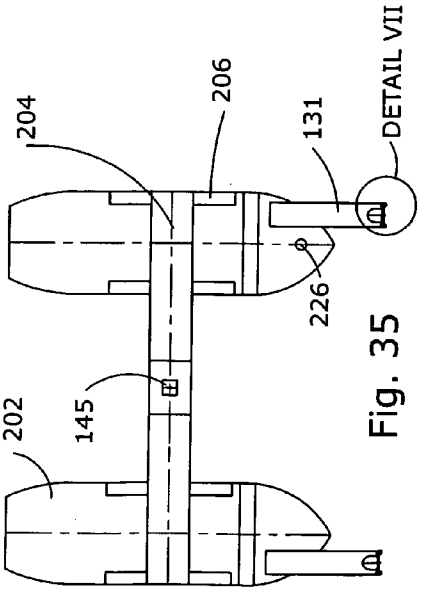

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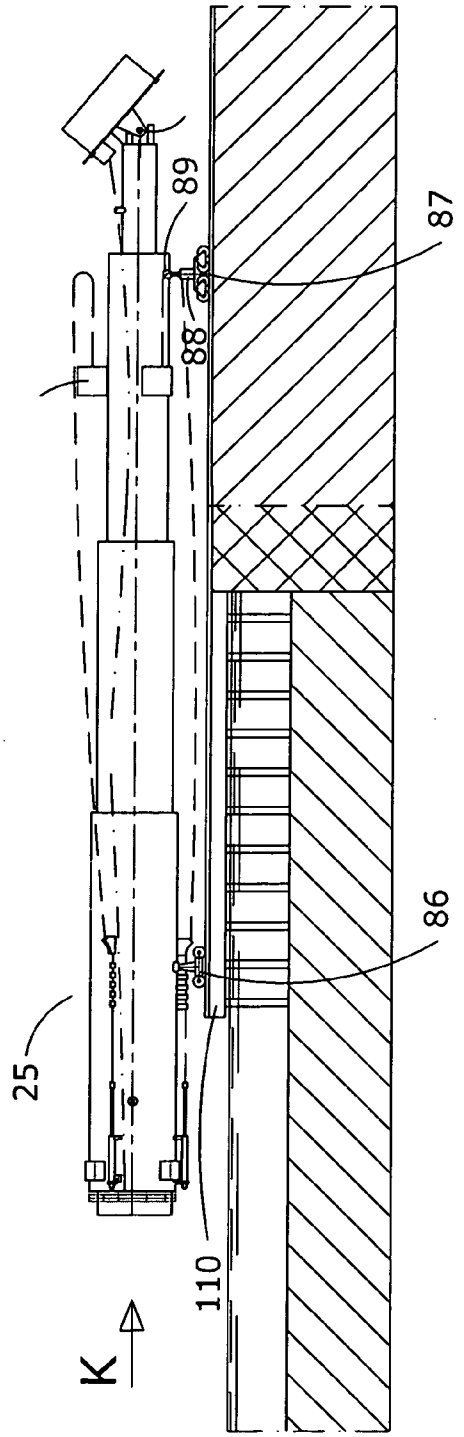

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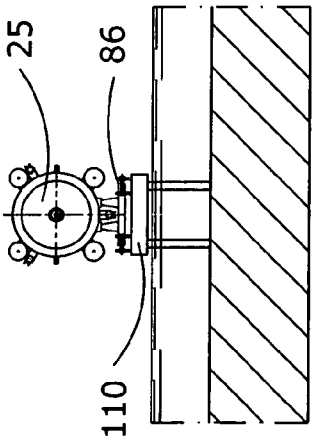

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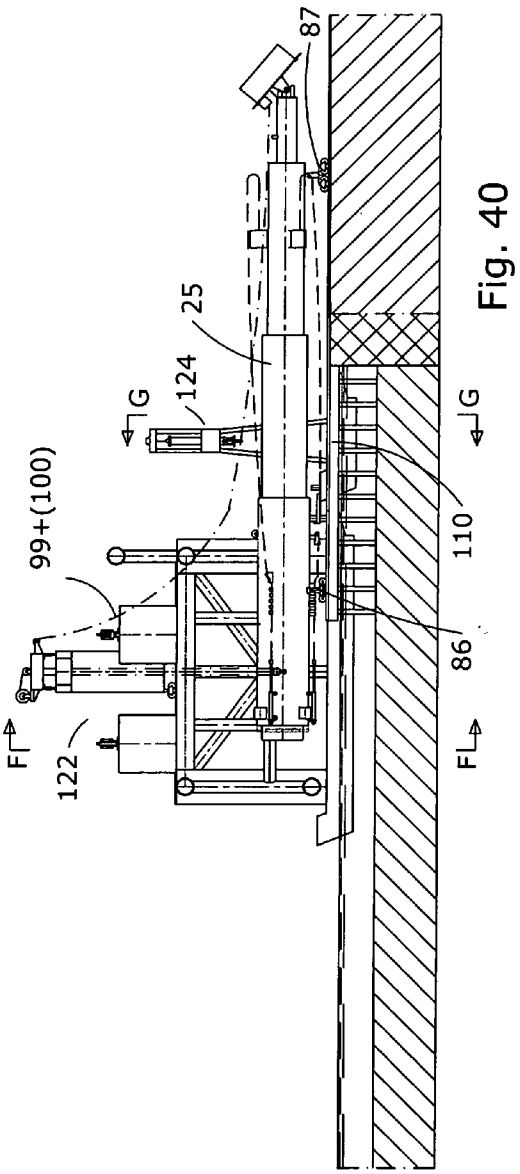

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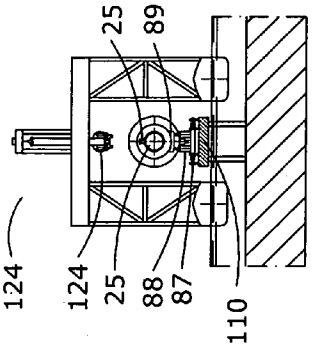

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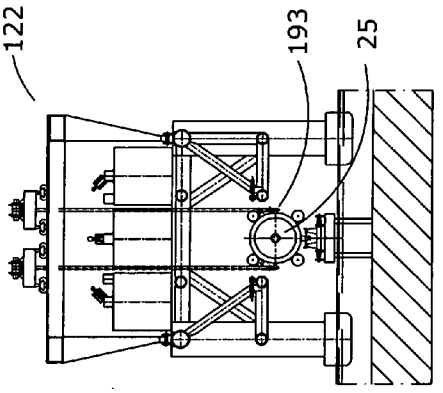

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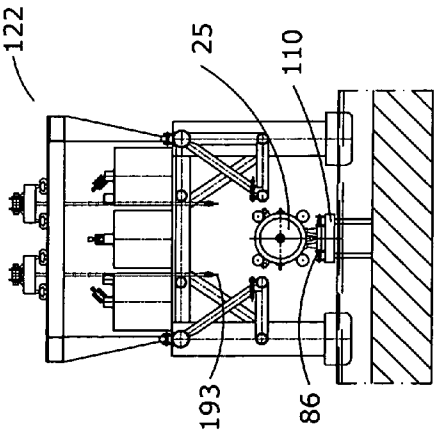

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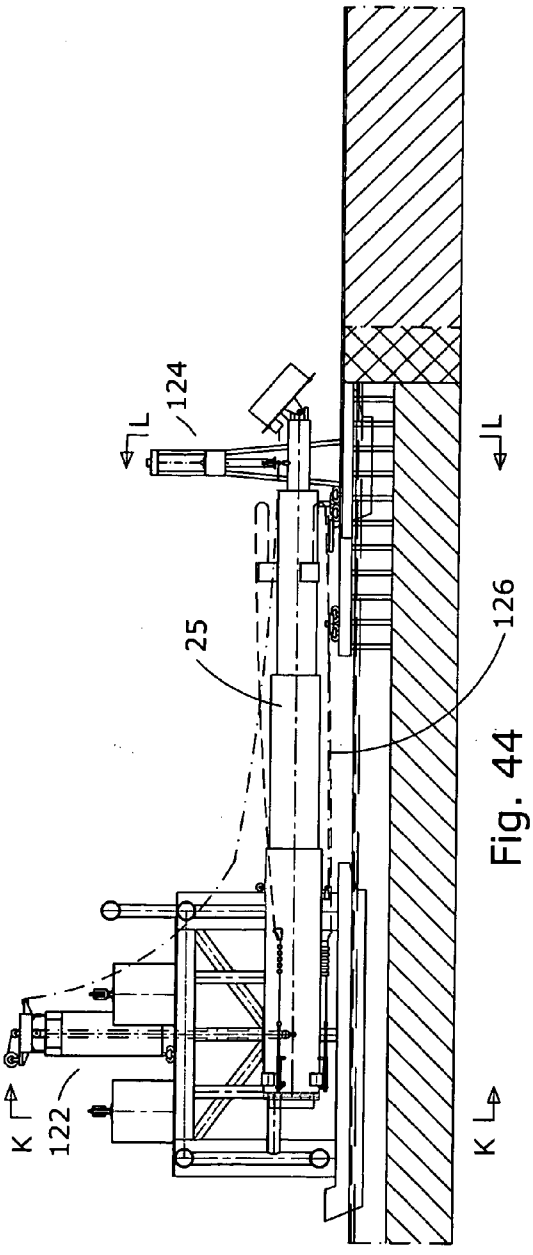

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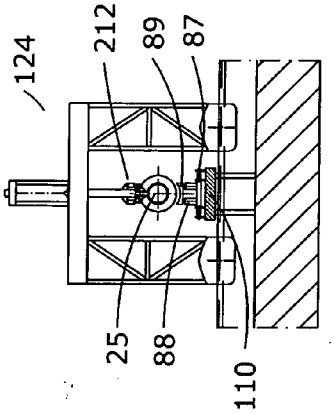

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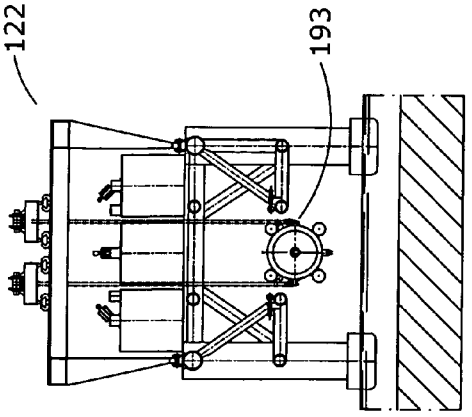

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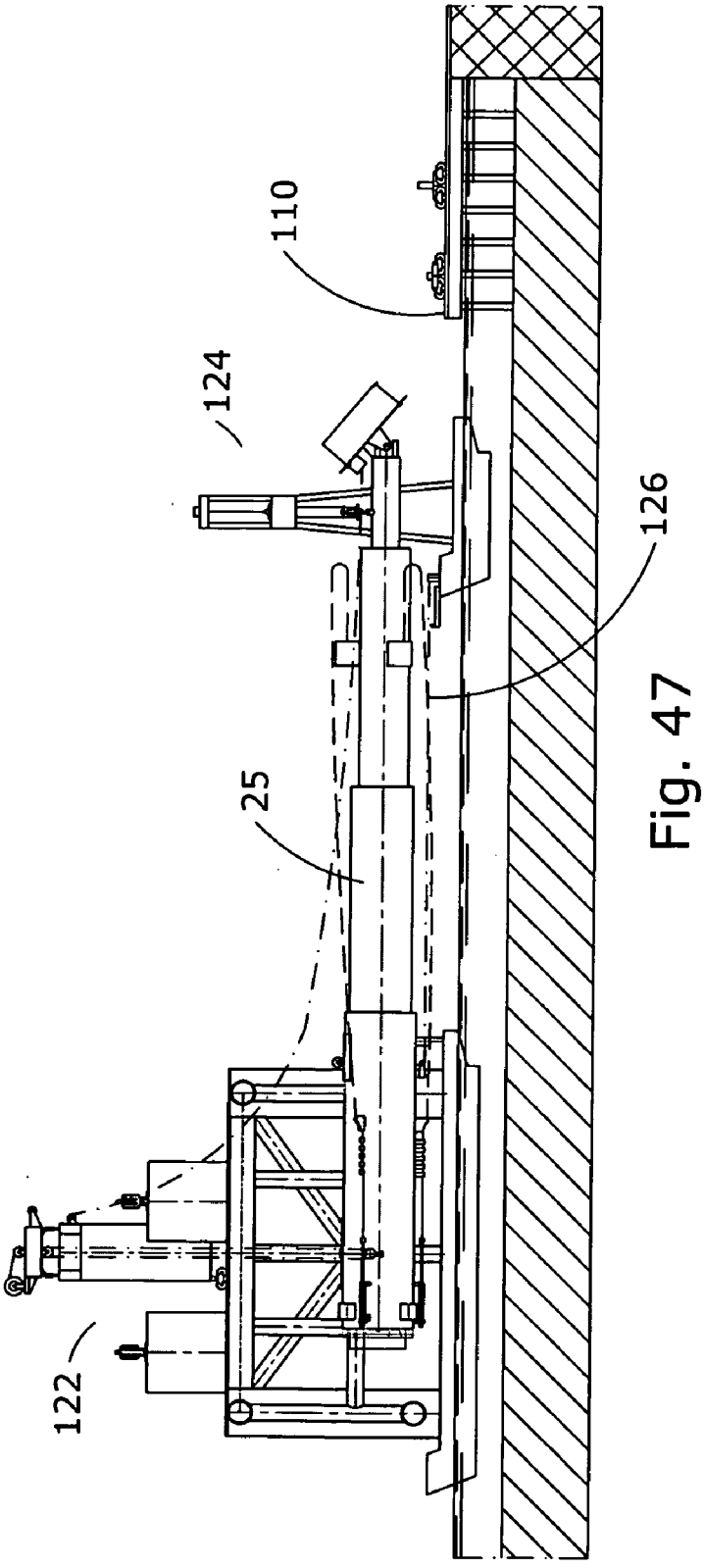

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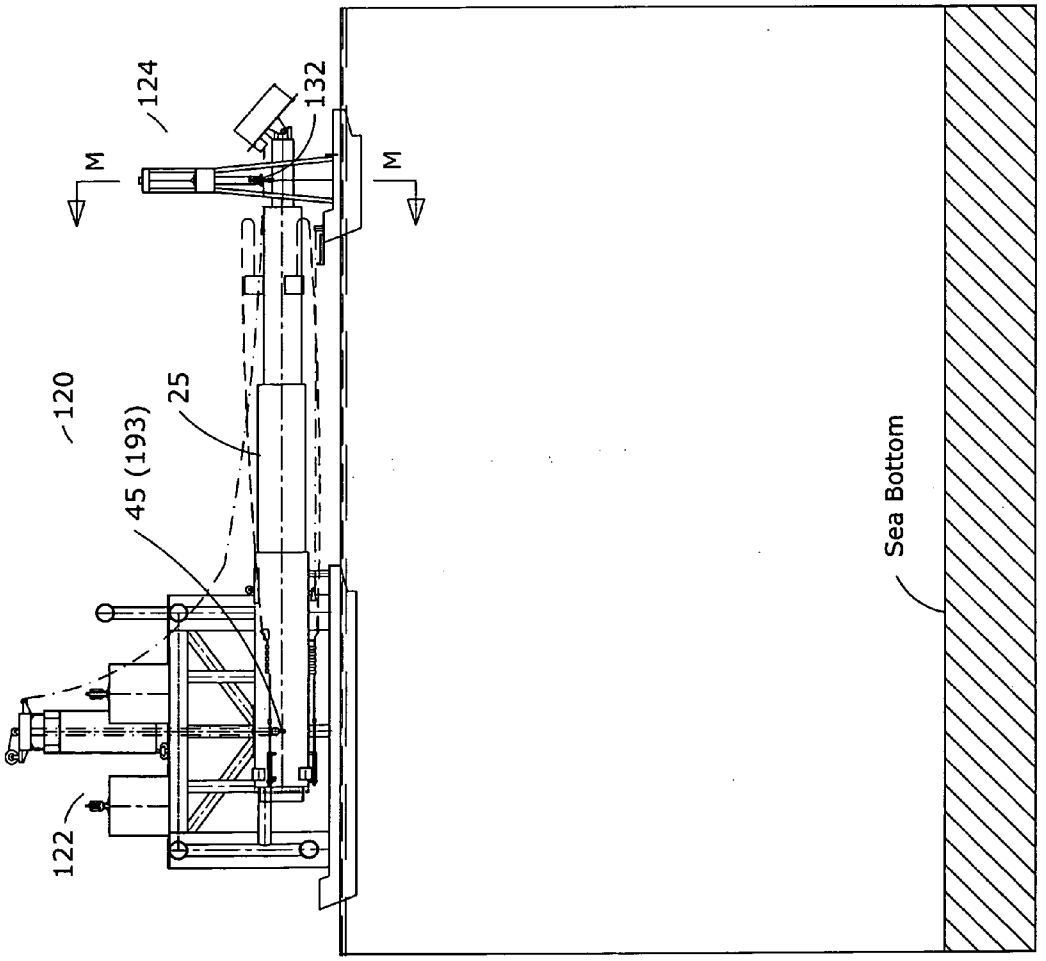

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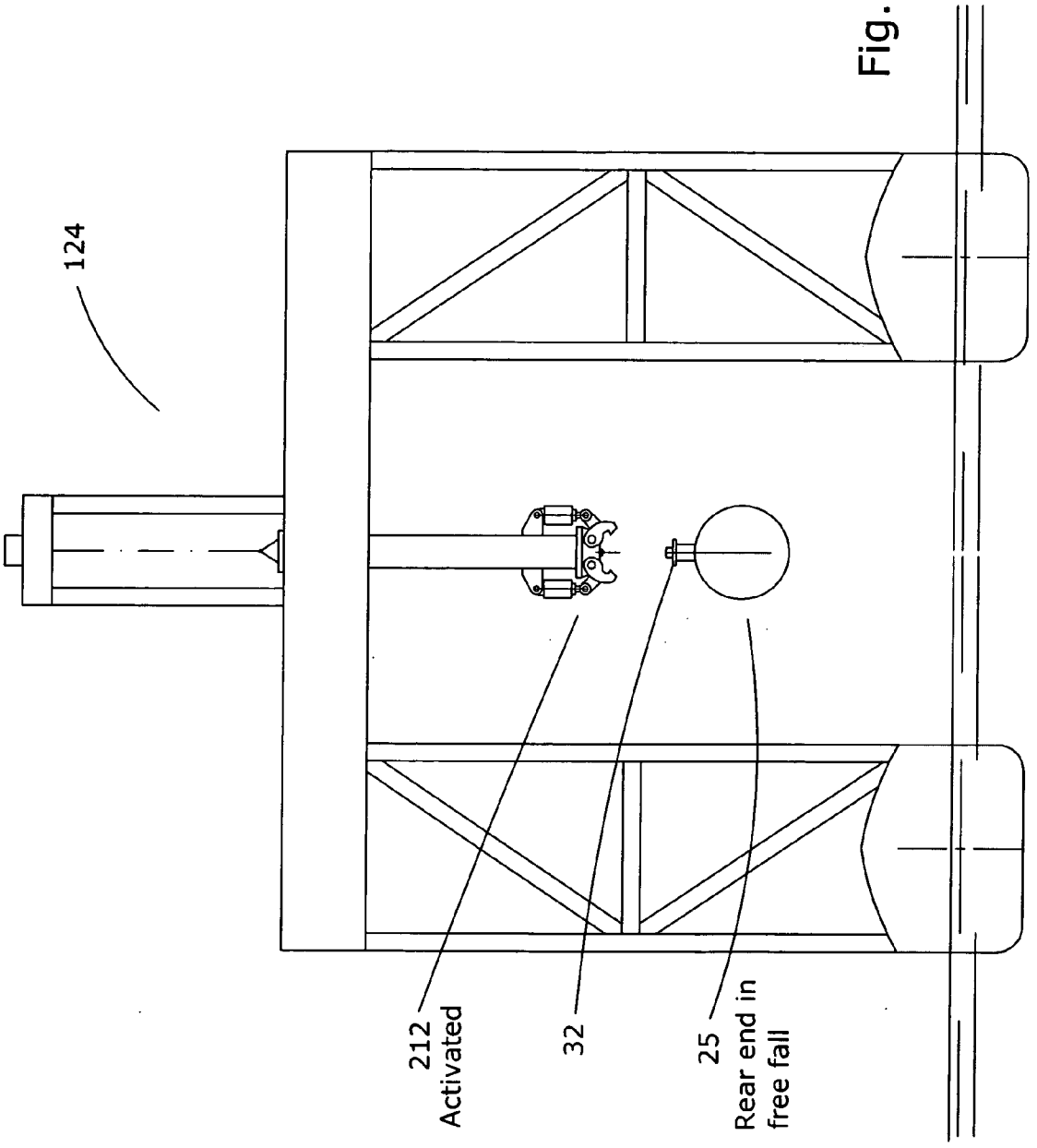

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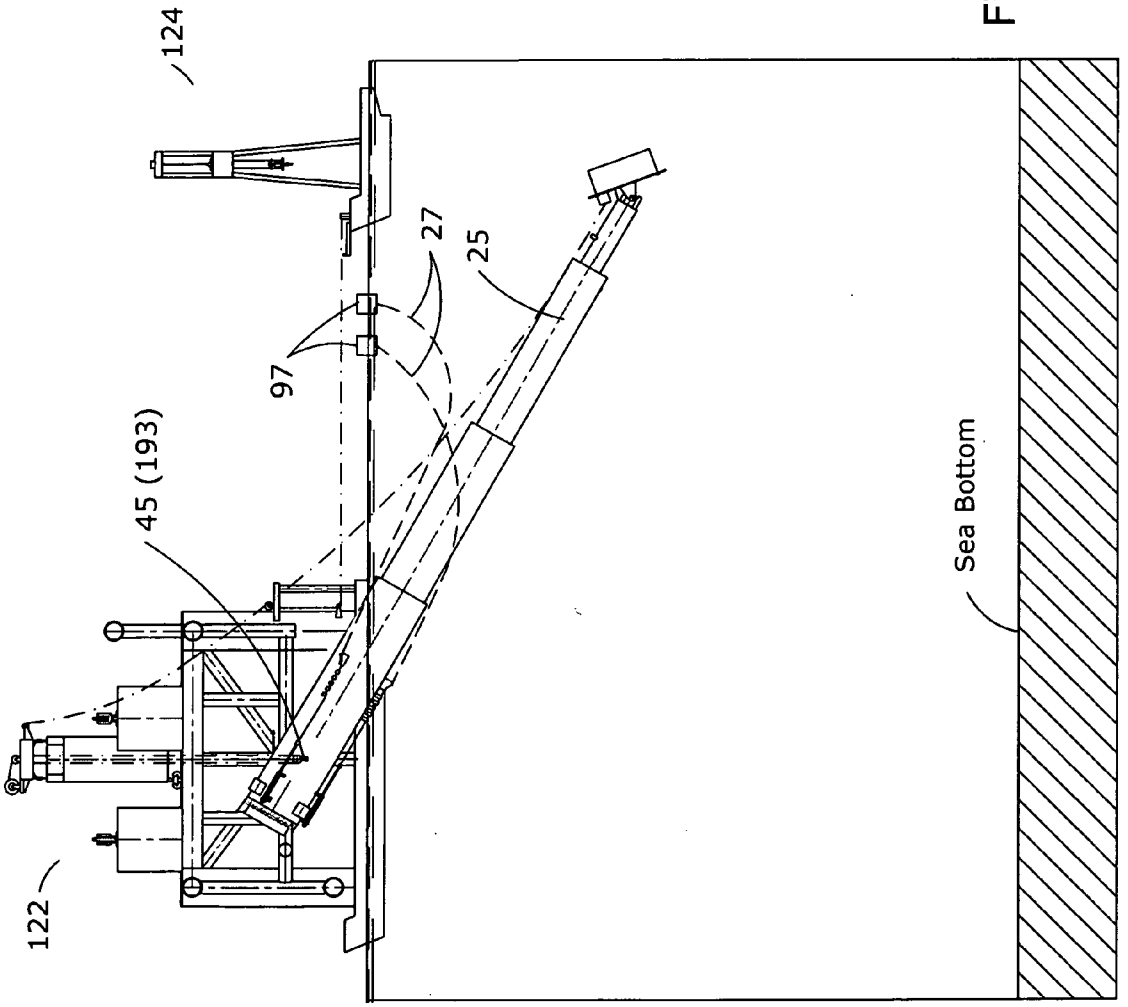

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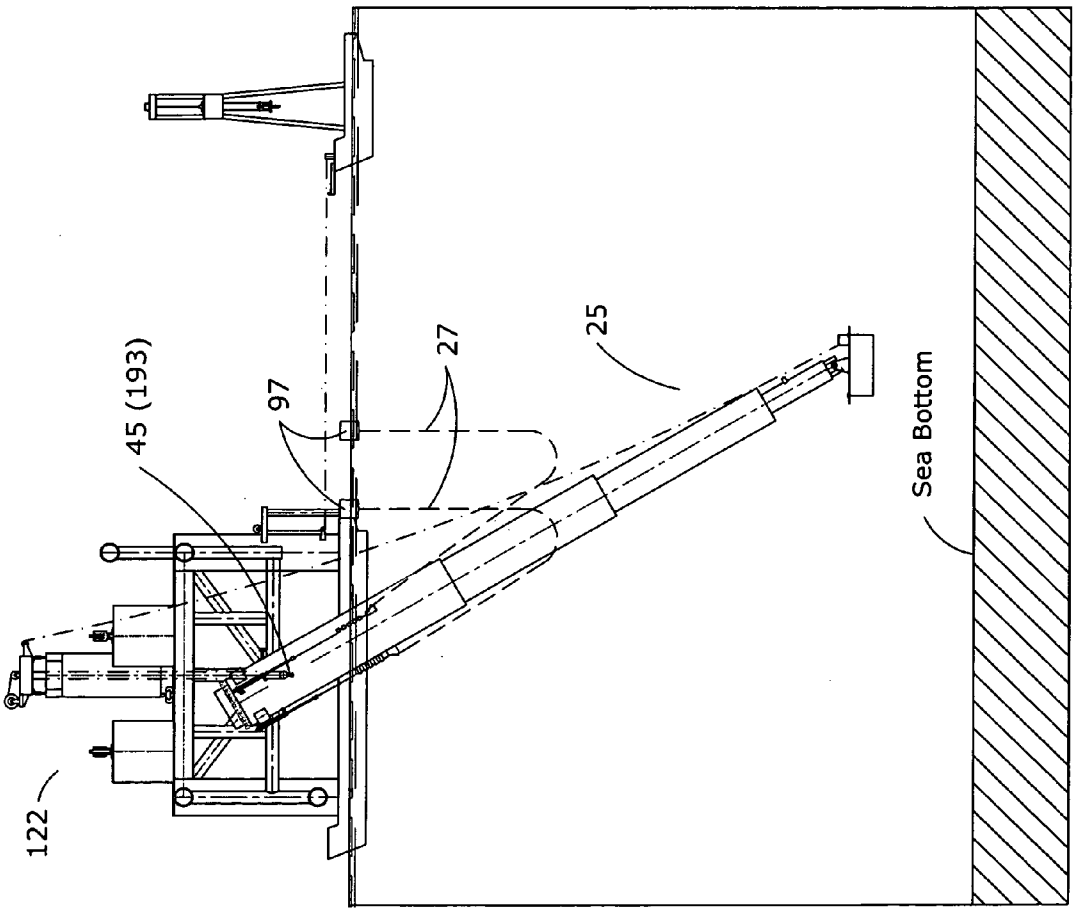

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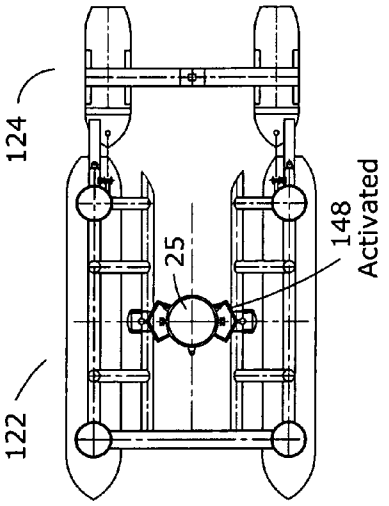
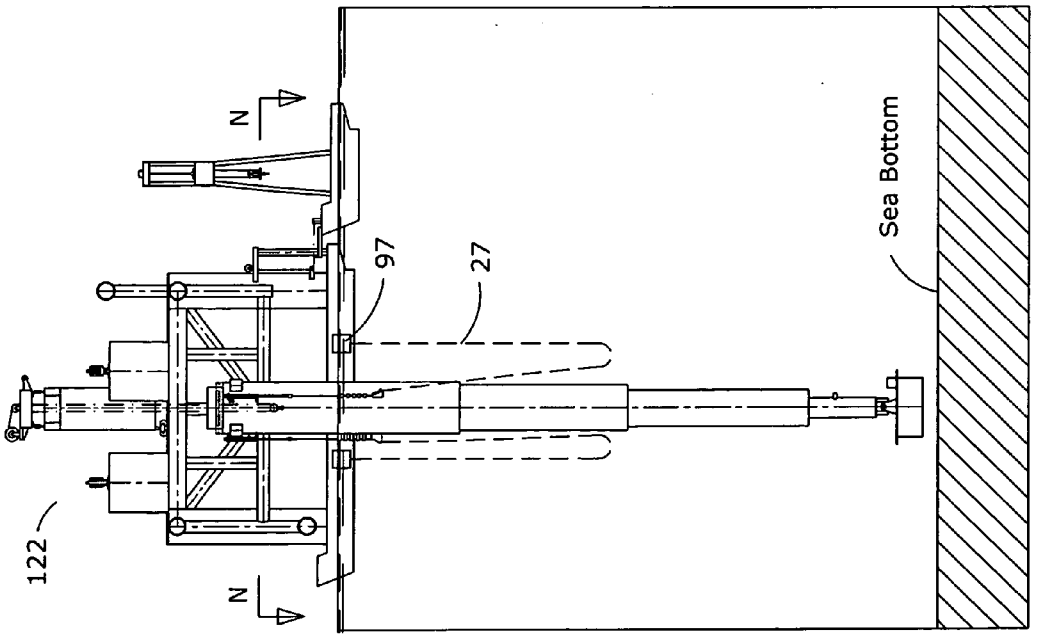
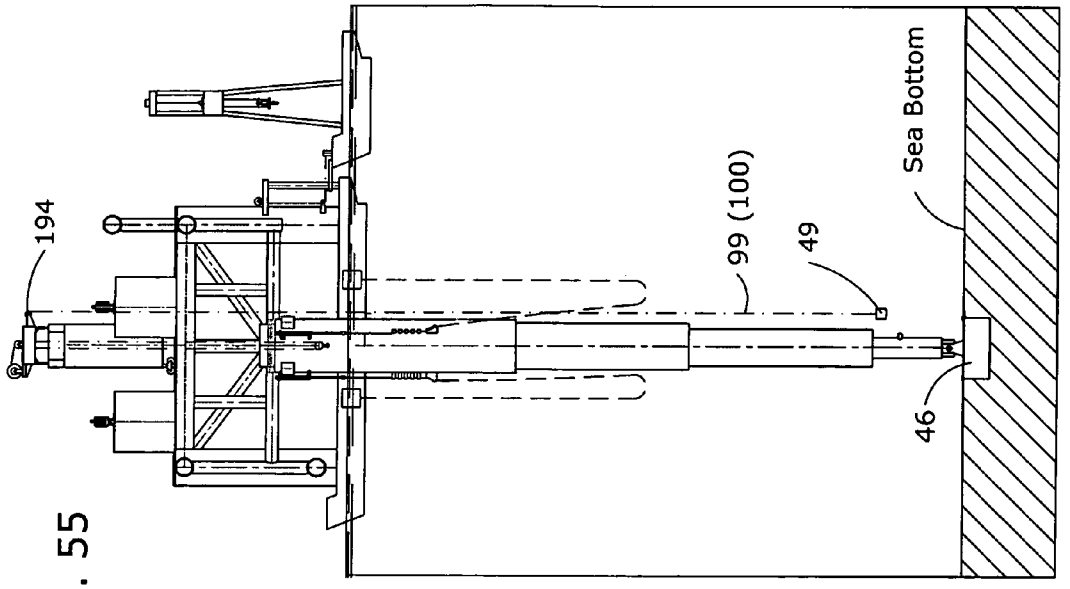


Fig. 53

Fig. 52





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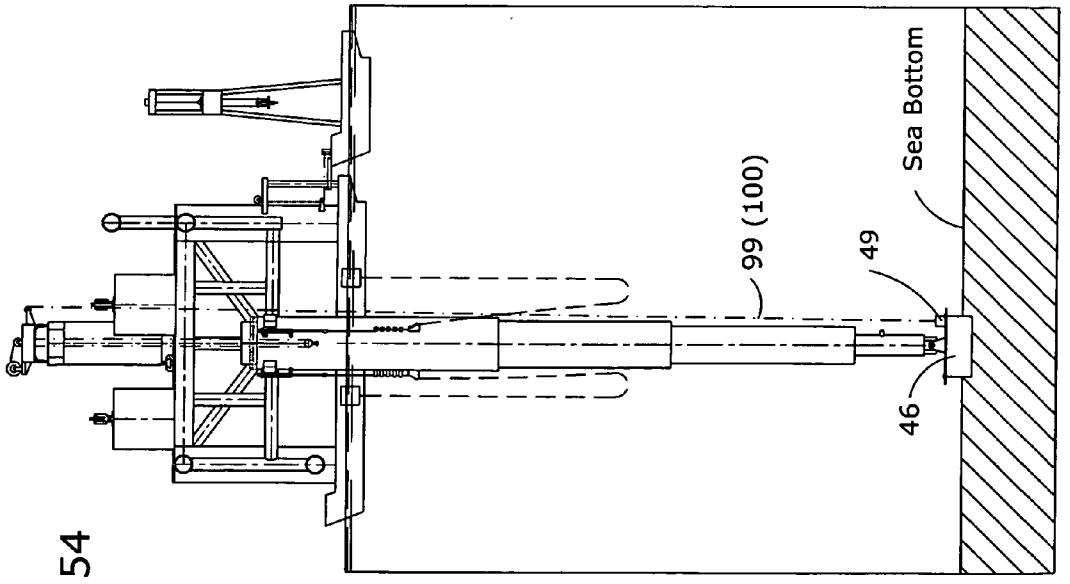

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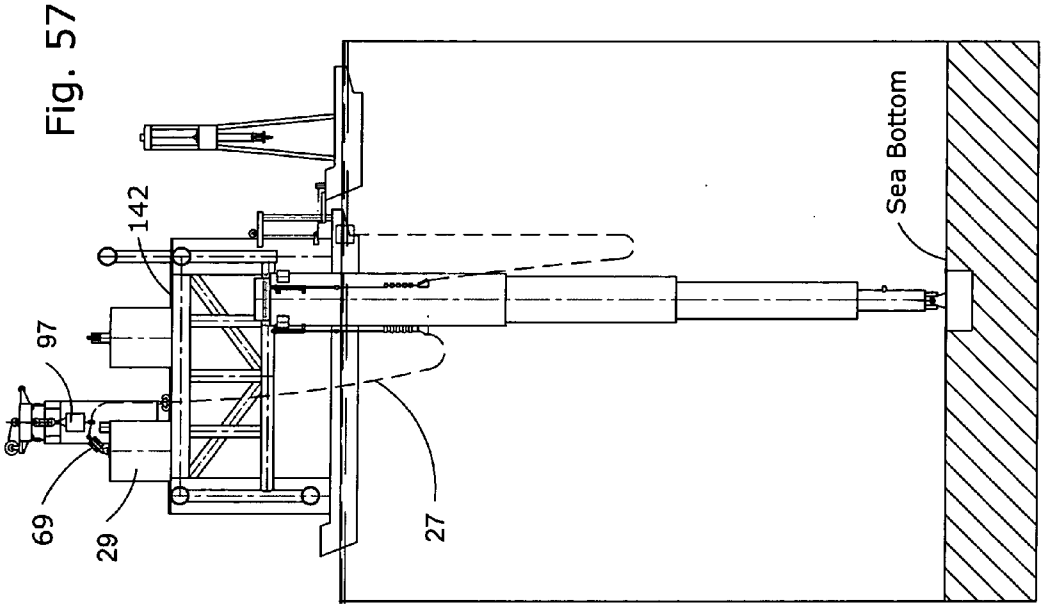


Fig. 57

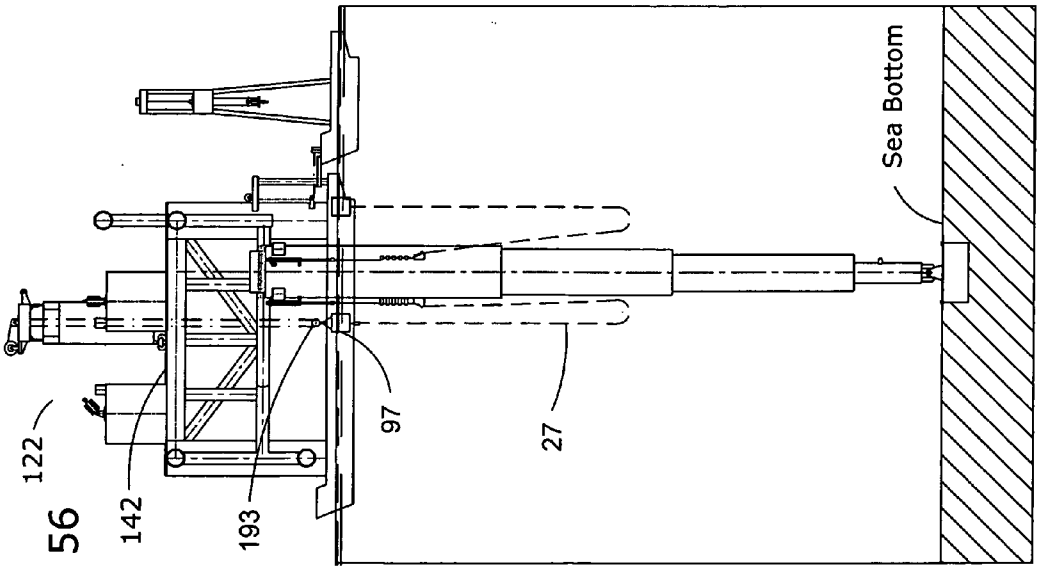
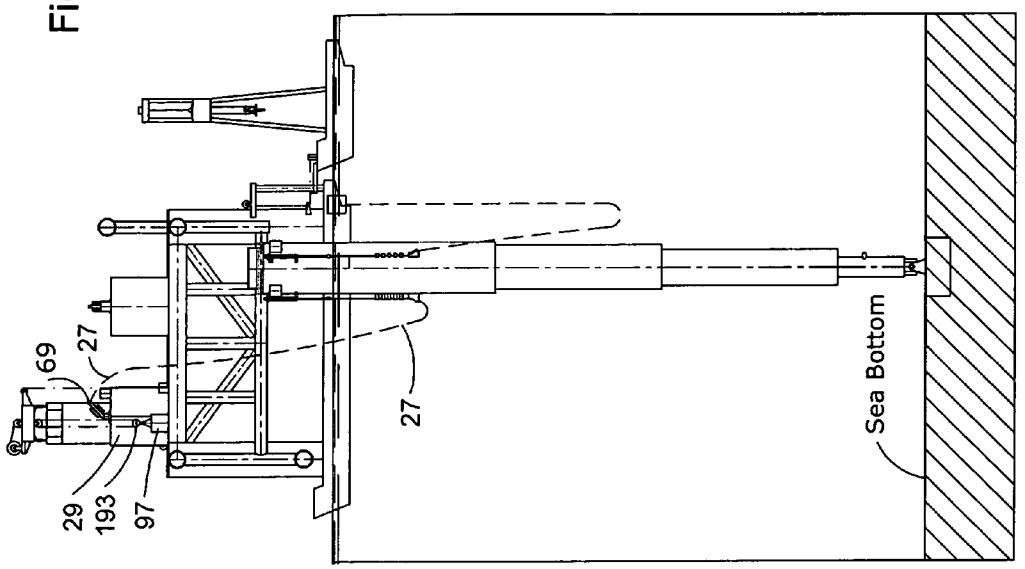


Fig. 56

Fig. 58



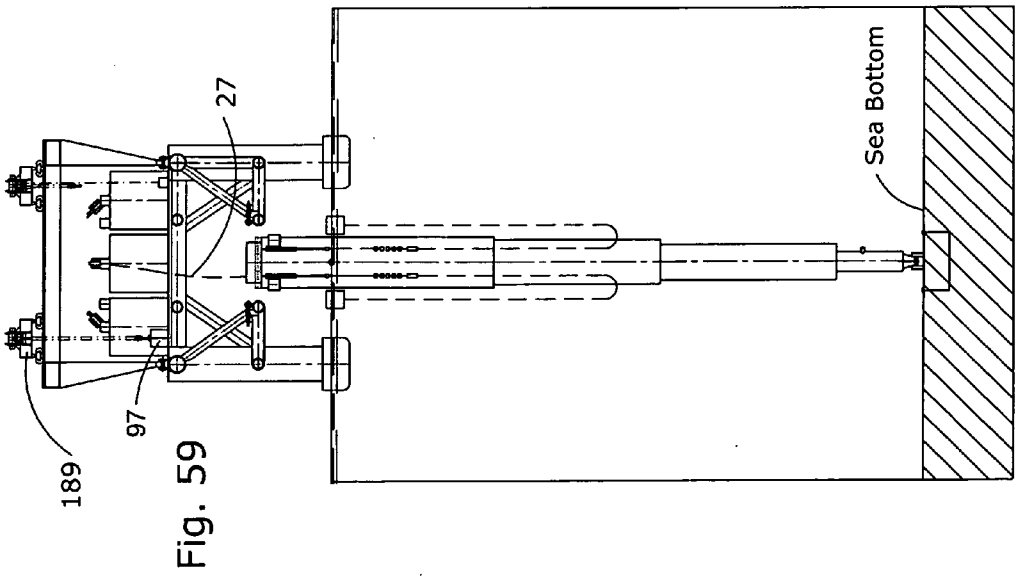


Fig. 59

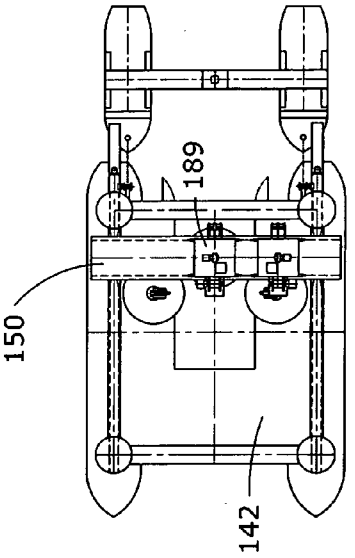


Fig. 61

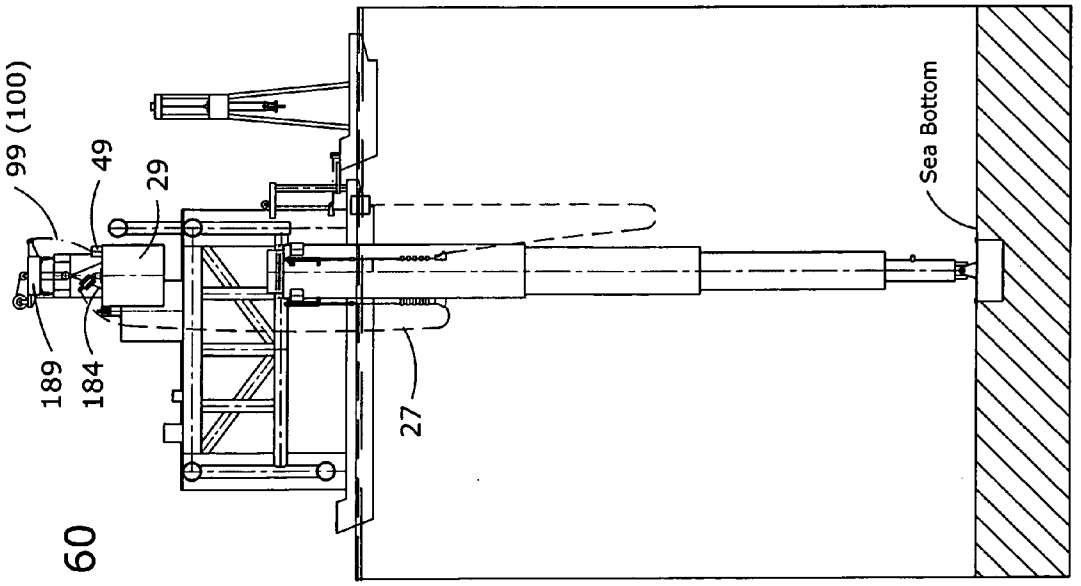


Fig. 60

Fig. 62

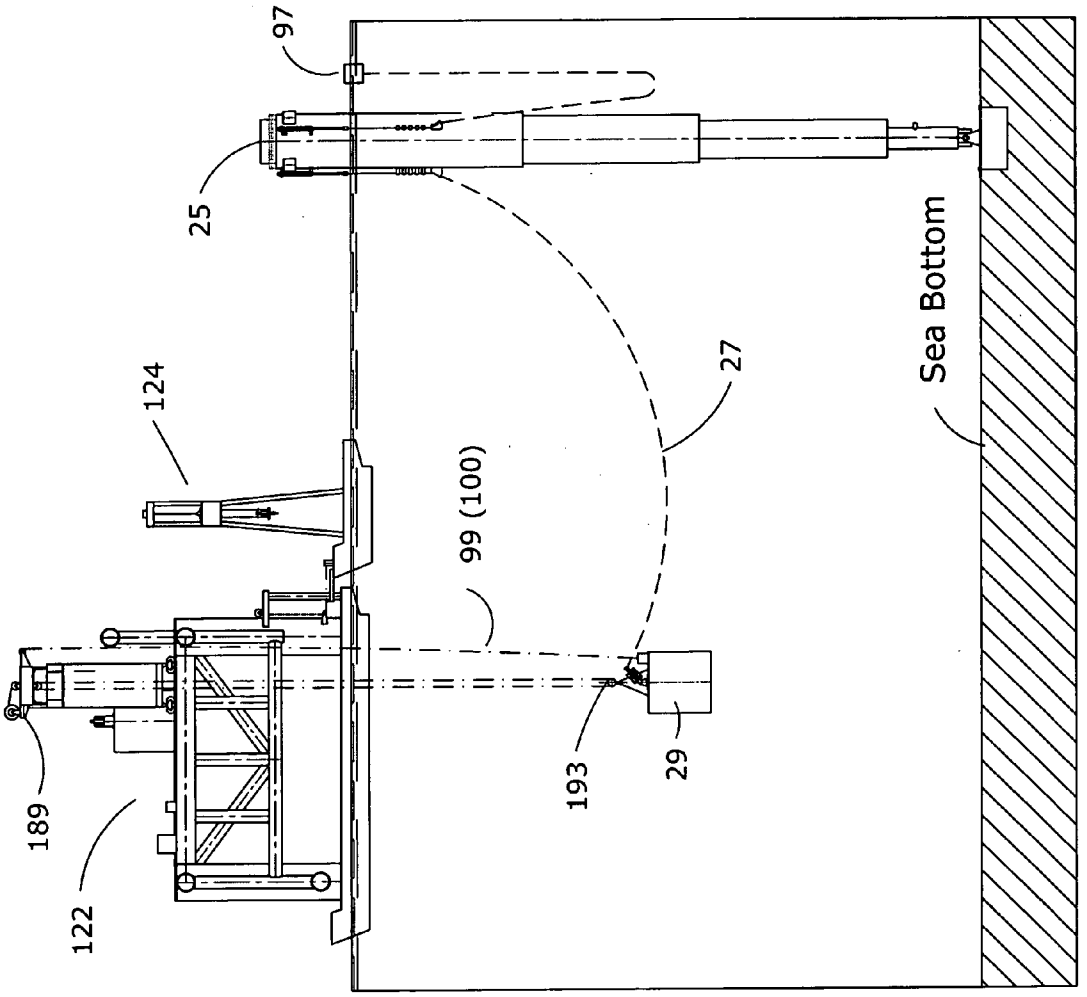
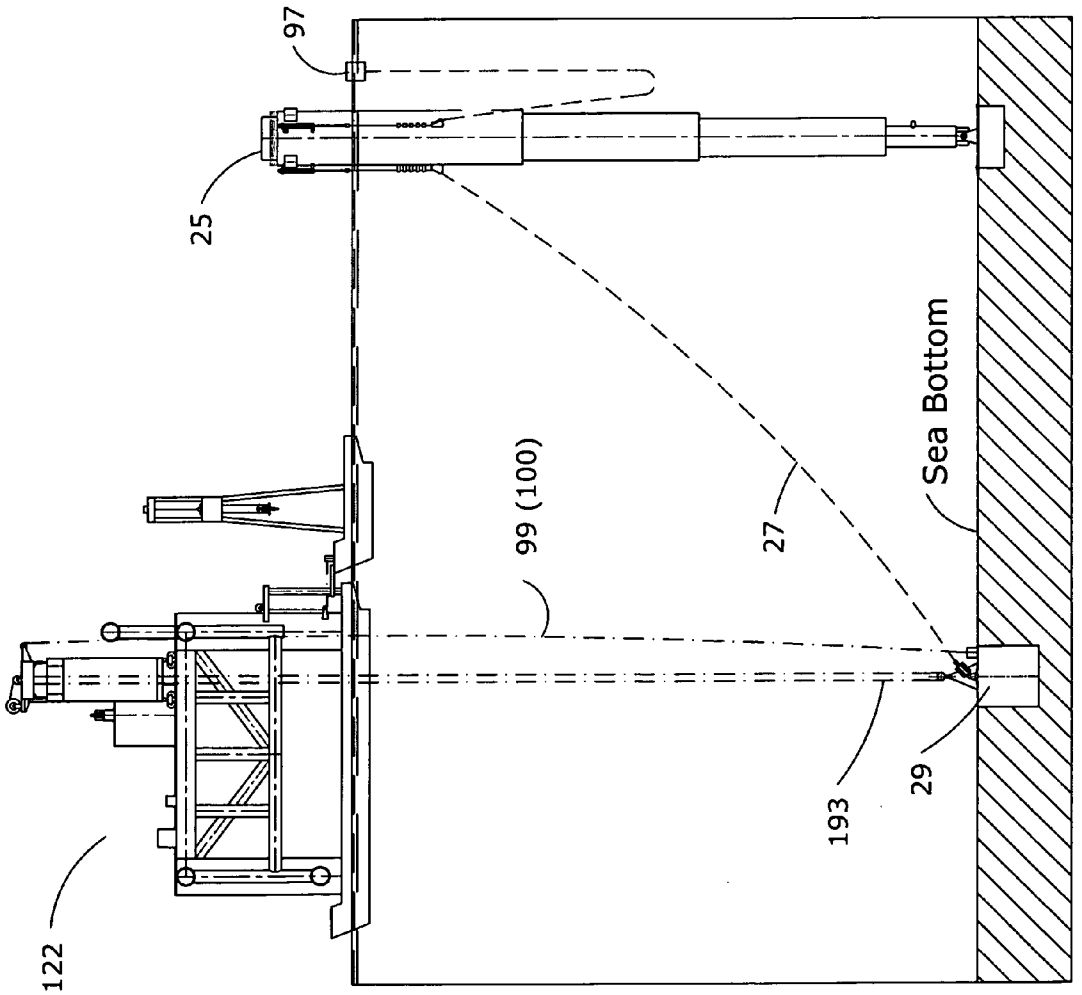


Fig. 63



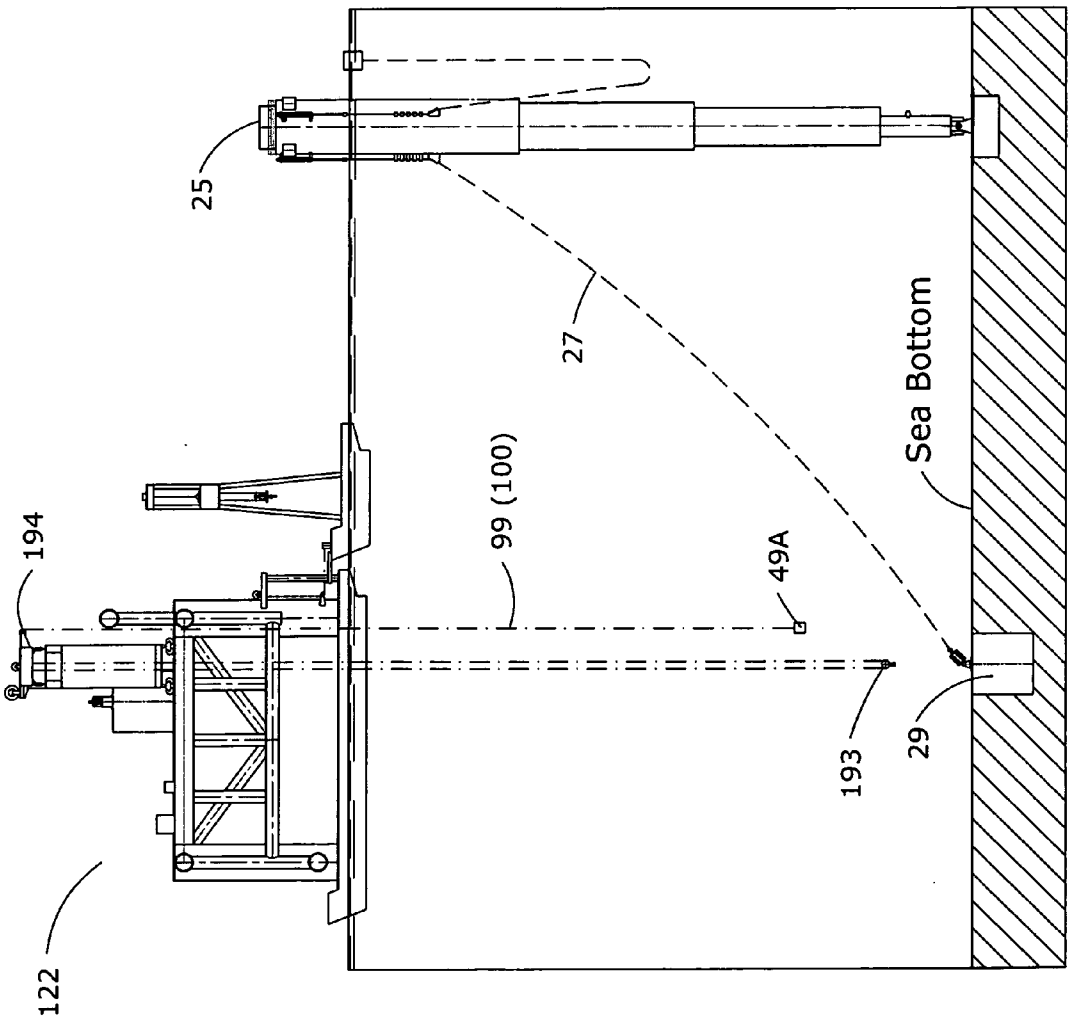
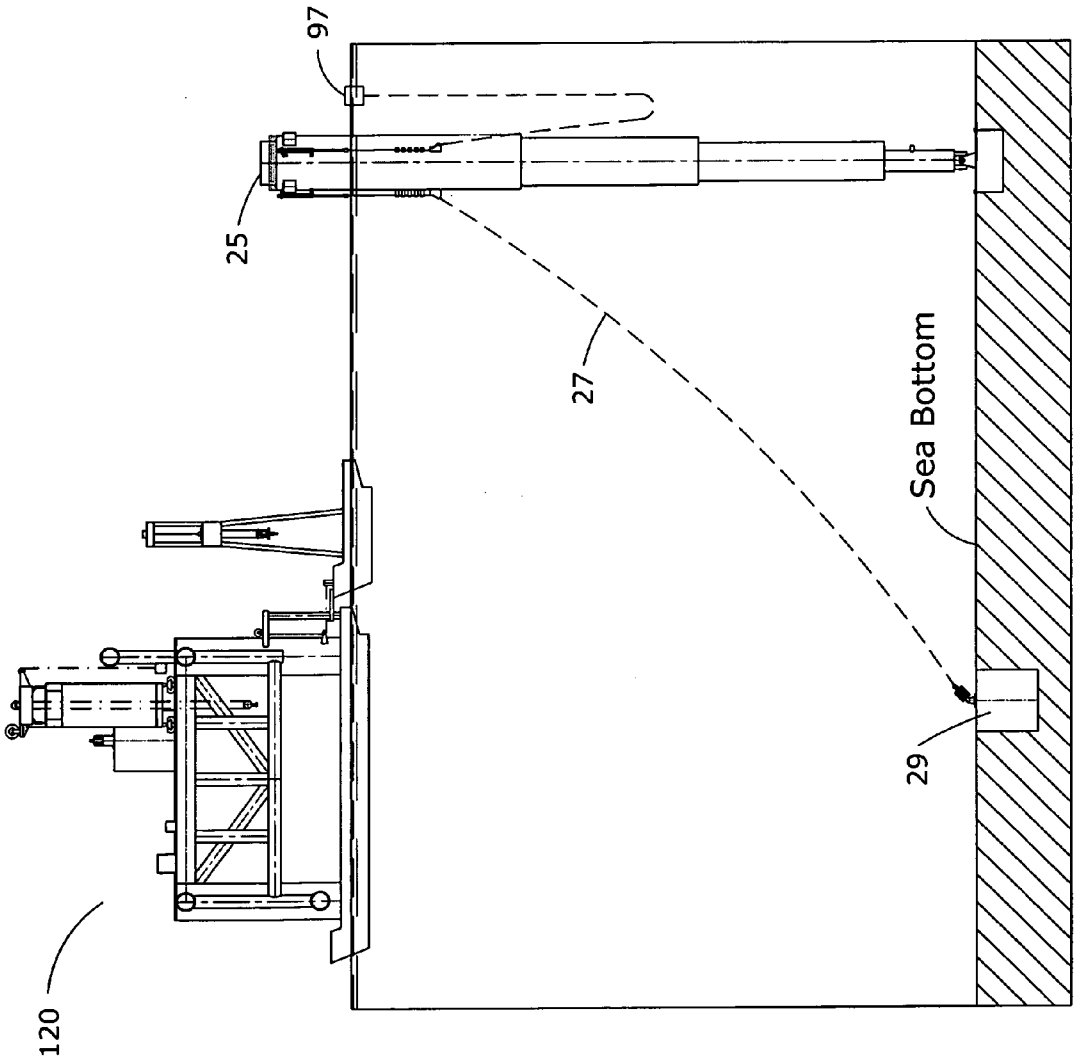


Fig. 64

Fig. 65



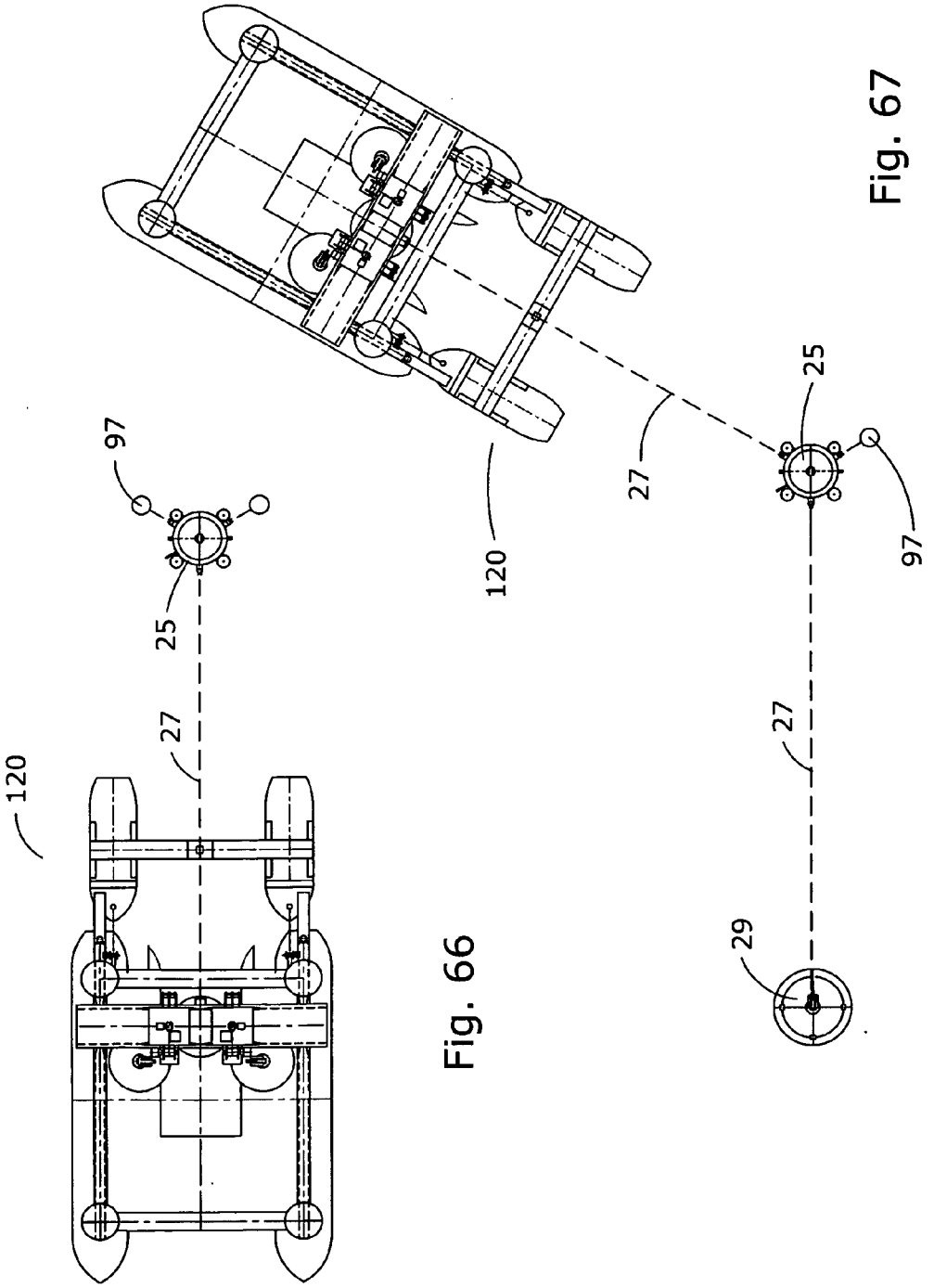


Fig. 66

Fig. 67

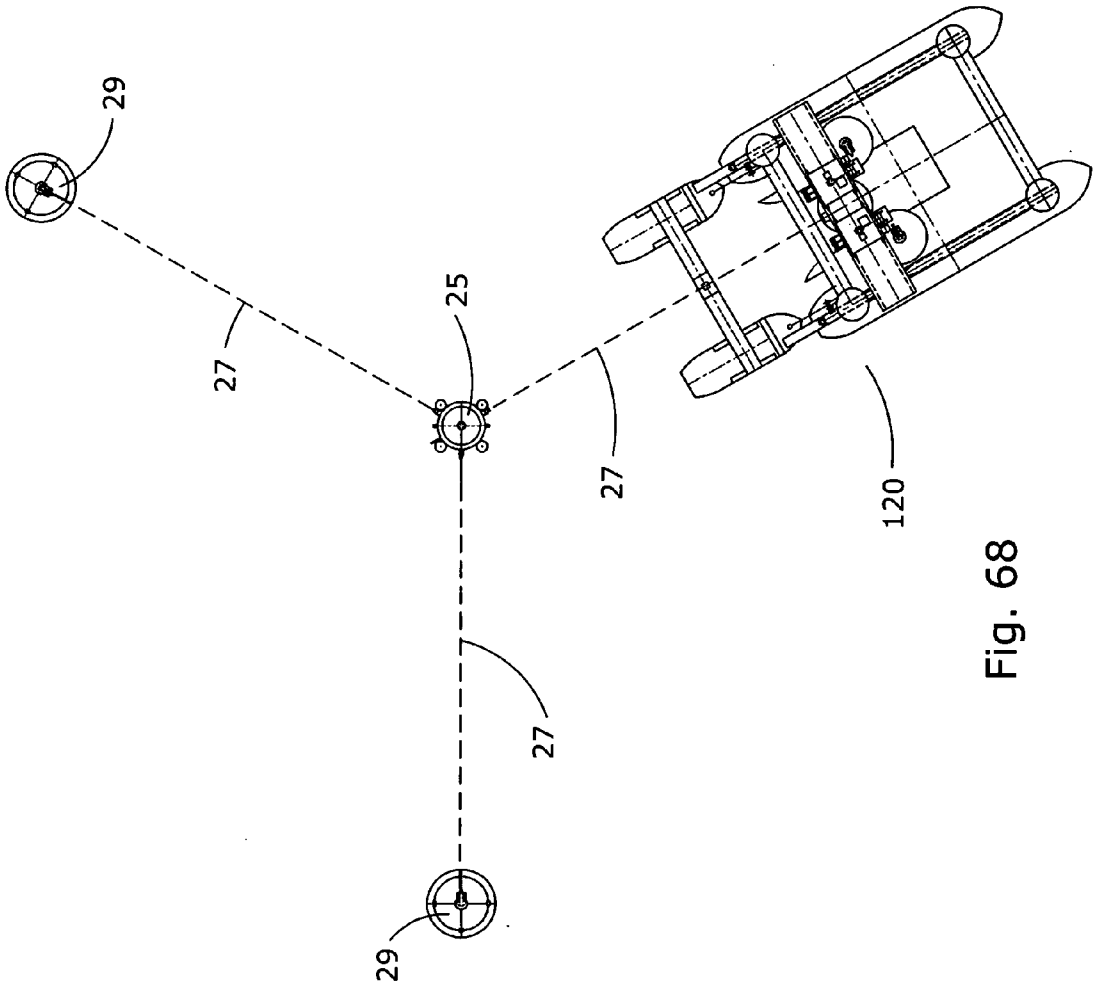


Fig. 68

Fig. 69

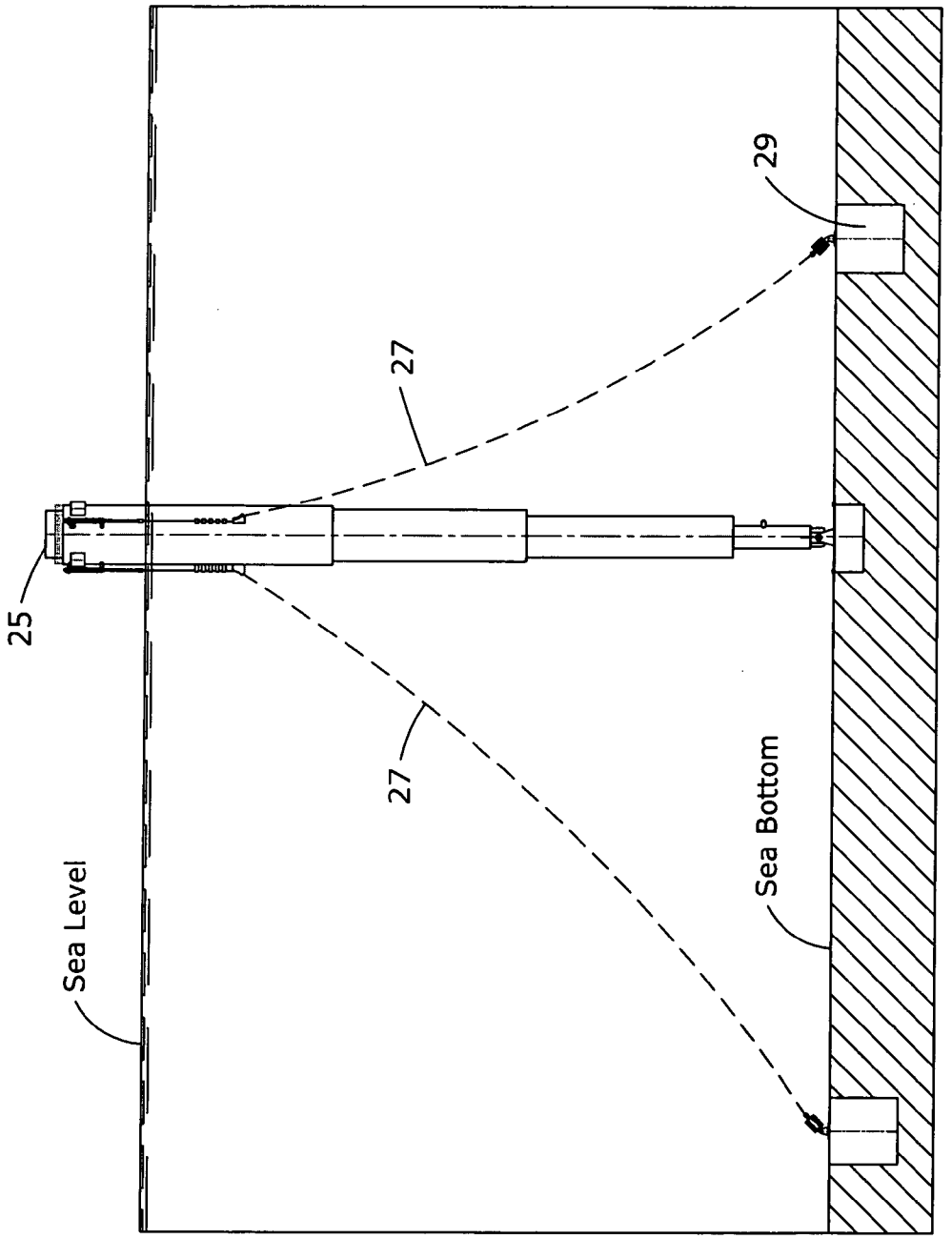
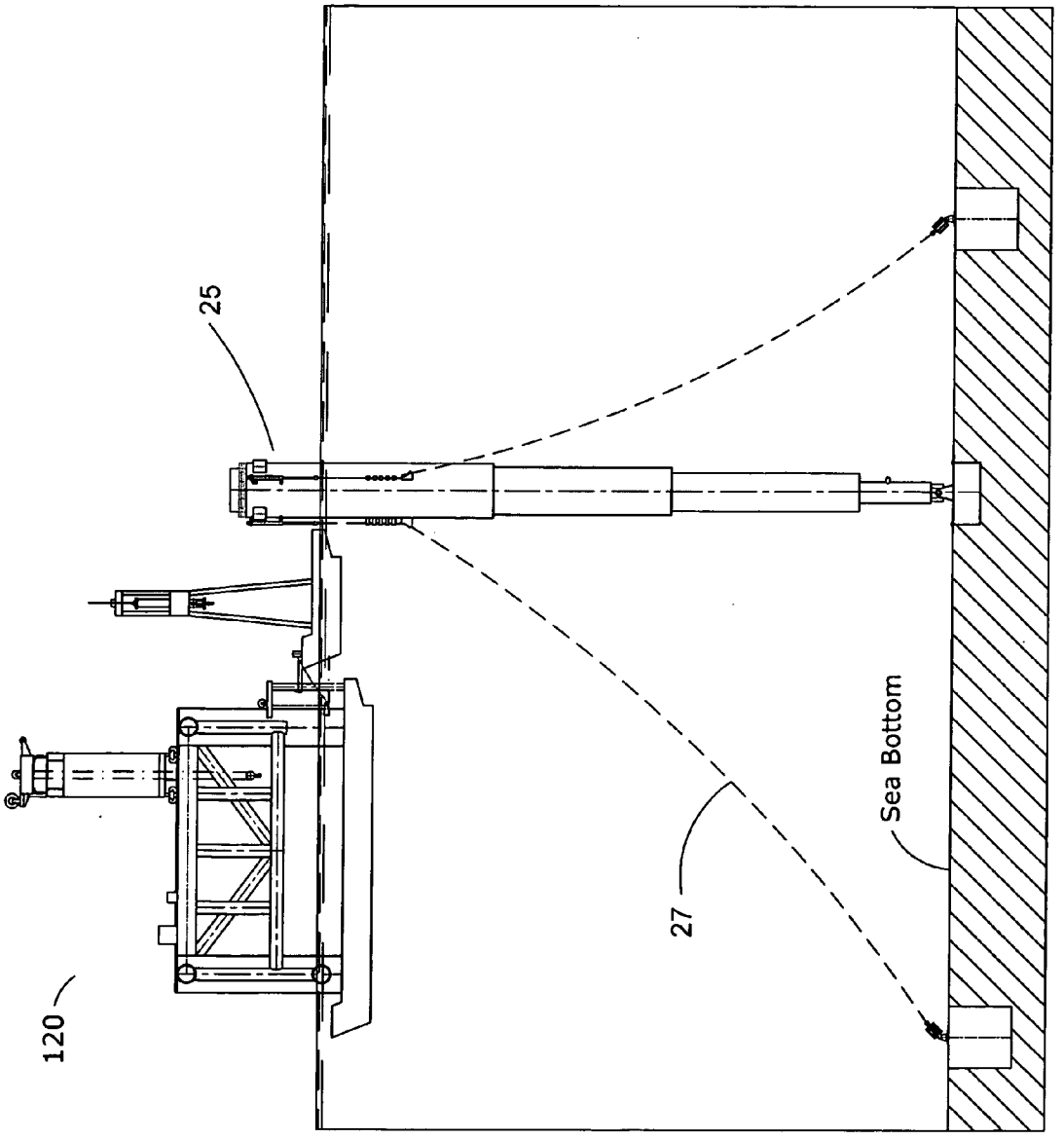


Fig. 70



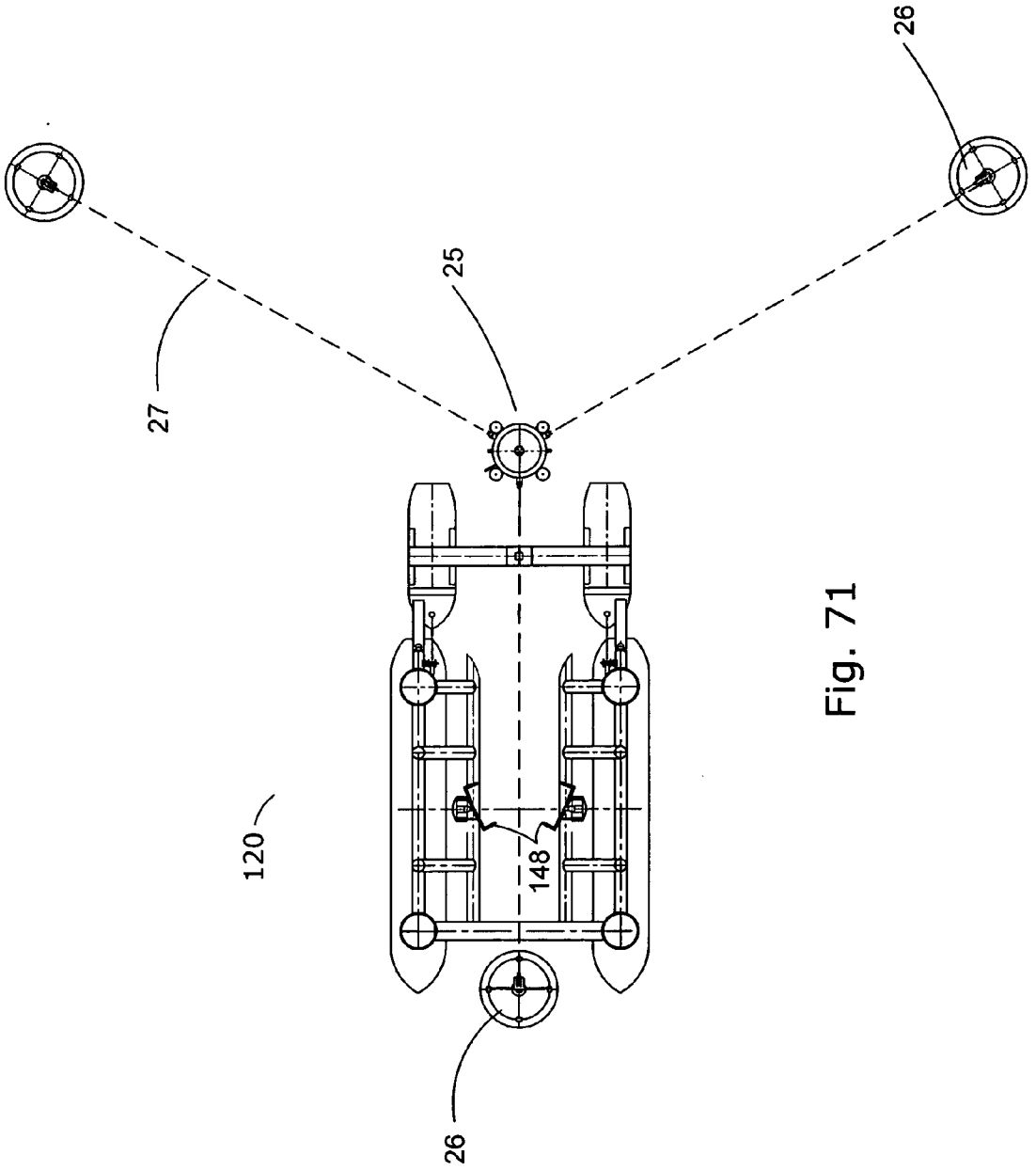
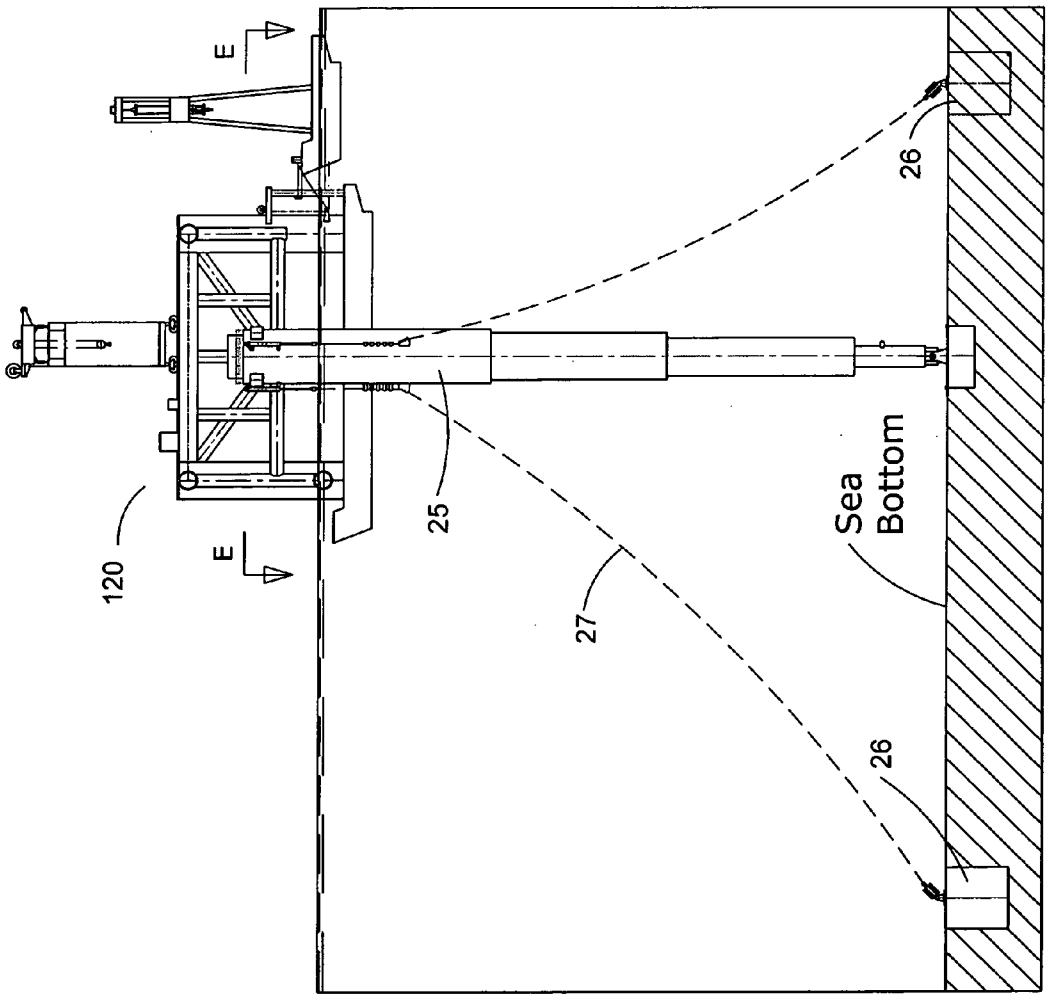


Fig. 71

Fig. 72



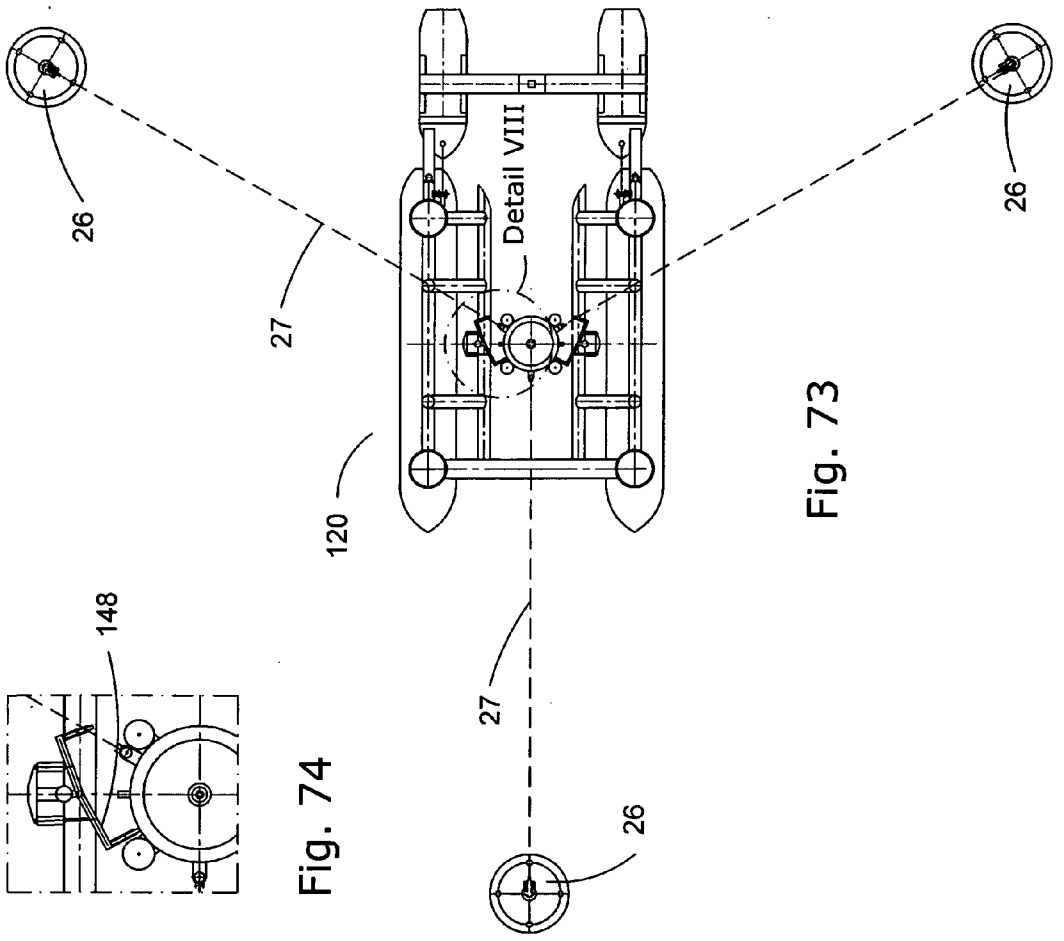


Fig. 73

Fig. 74

Fig. 75

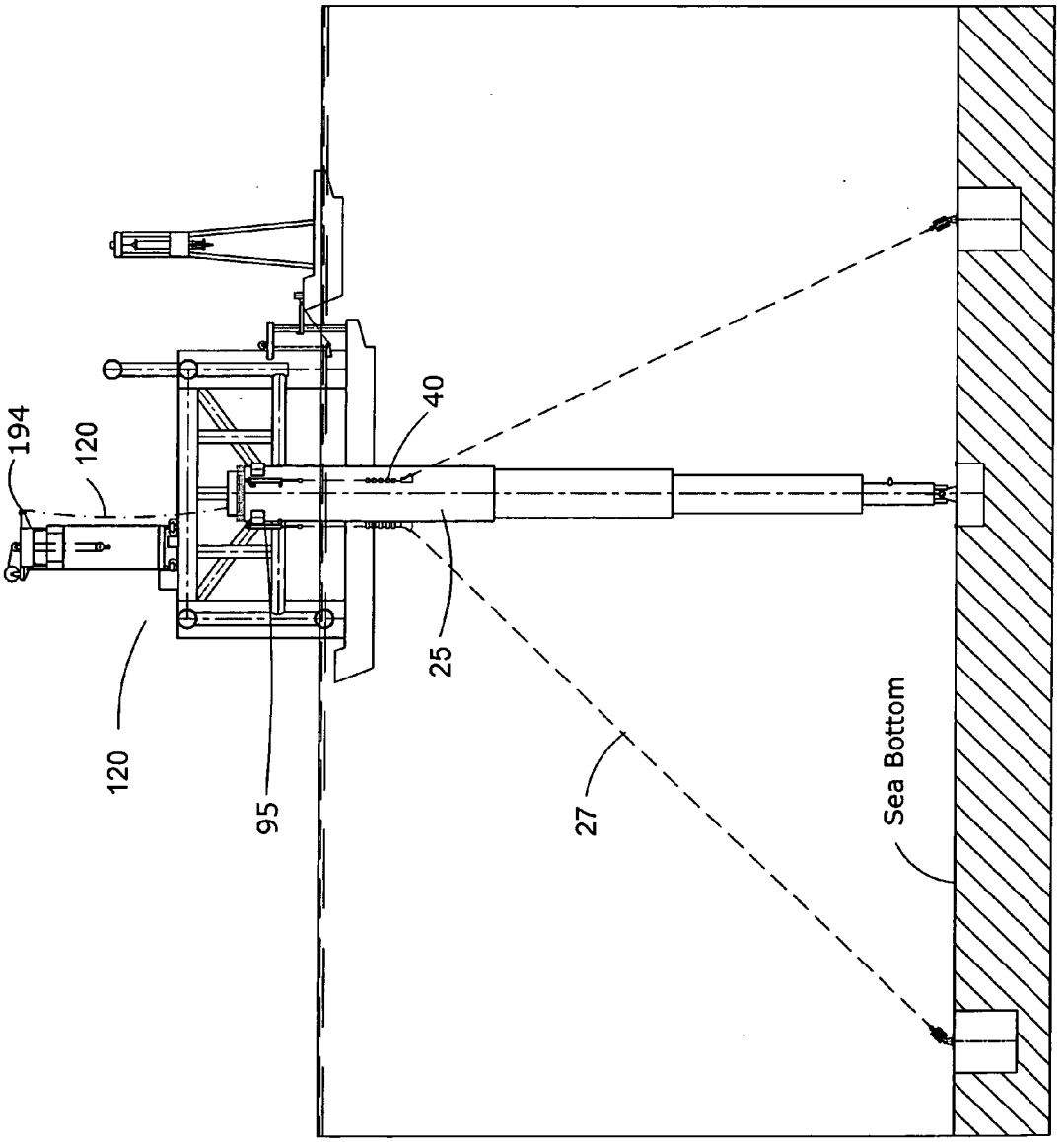
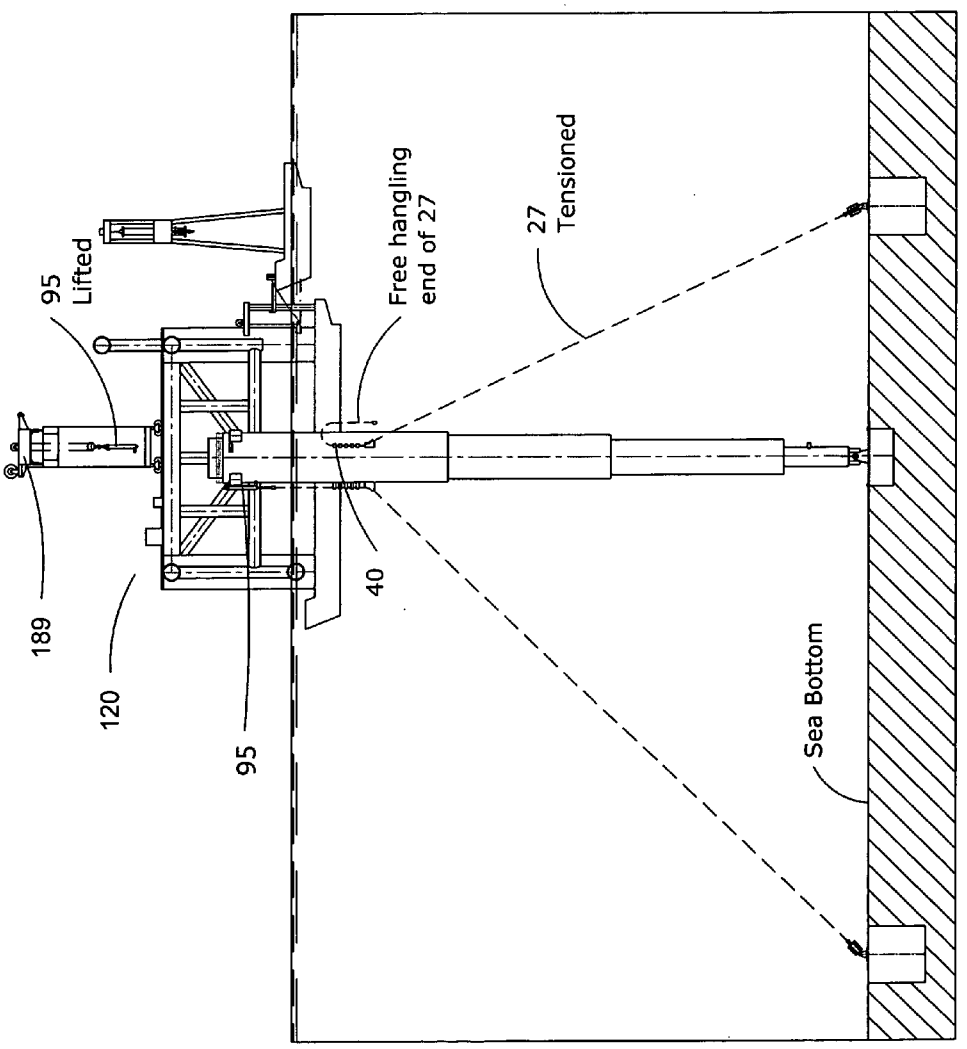


Fig. 76


95
Lifted
Free hangling
end of 27
27
Tensioned
189
120
95
40
Sea Bottom

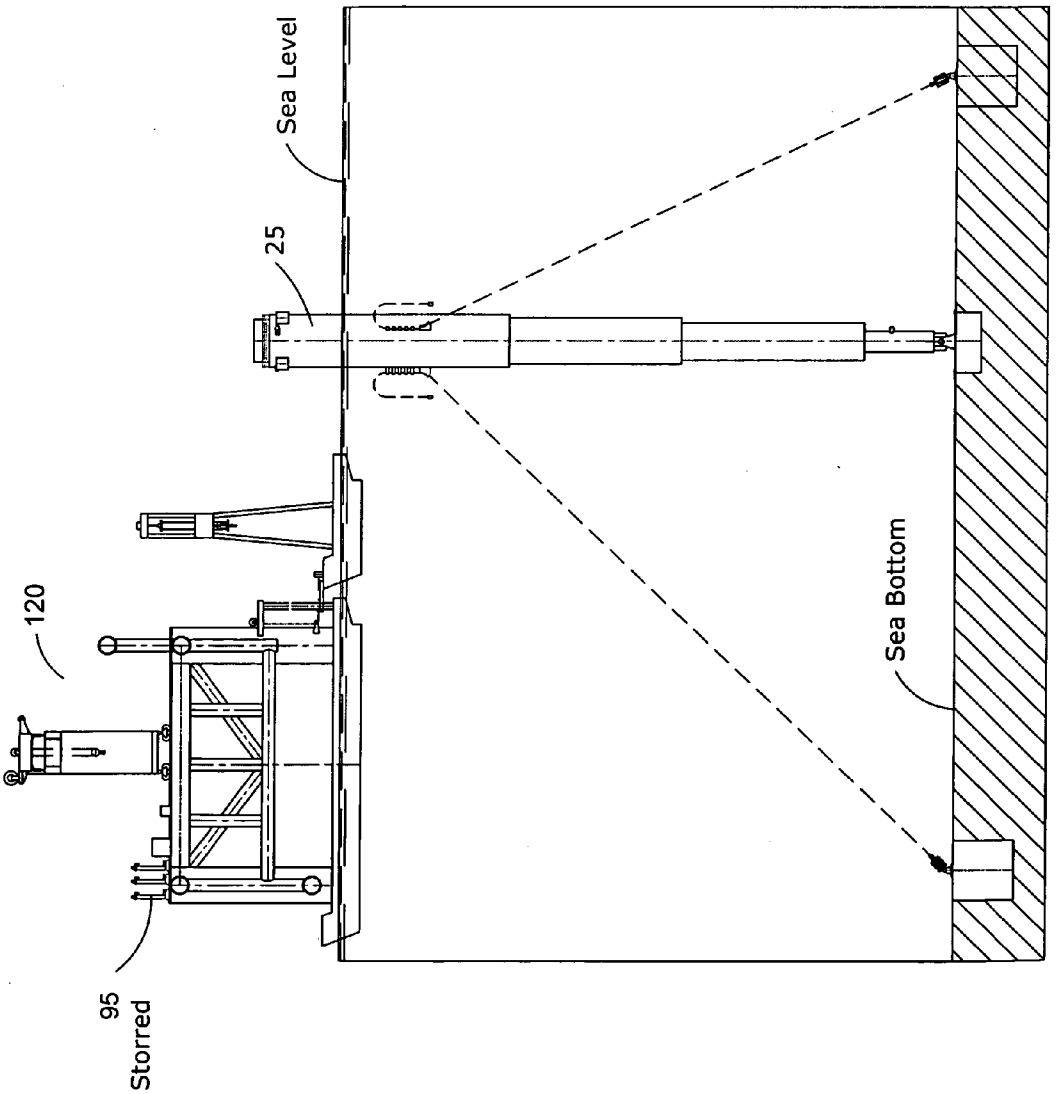


Fig. 77

FOUNDATION FOR OFFSHORE WIND TURBINE AND METHOD AND MEANS FOR ITS TRANSPORTATION AND INSTALLATION IN DEEPWATERS

FIELD OF THE INVENTION

[0001] This invention relates to harvesting wind energy offshore by wind power plants installed on the stationary foundations.

BACKGROUND OF THE INVENTION

[0002] The Compliant Guyed Tower concept is presently widely used as foundations for platforms supporting oil rigs by oil offshore industry in waters depth starting from 300 meters and to about 1,000 meters. Because of this significant depth the mooring lines elongation under ultimate forces provides to the guyed tower flexibility and resistance force, which mitigate the wind and waves dynamic forces acting on it. As the result of this the guyed towers are significant lighter and less expensive that fixed towers. Since offshore wind turbines applications is seen for relatively shallow waters (from 30 to about 200 meters) along ocean continental shelf the length of mooring lines supporting guyed tower, serving as the foundation for wind turbine, is not sufficient to provide to tower the flexibility needed to mitigate wind and waves dynamic impacts.

[0003] At the present time offshore wind power industry uses variety of stationary foundations for supporting wind turbines offshore, among them are monopoles, gravity structures, tripod and jackets. Until recently the depth of wind turbine installation was limited to 20-30 meters. Today there are a few floating cranes with lifting capacity and jack up capabilities to install wind turbines in depth up to 50 meters. Further increase in depth increases the overturning moment acting on foundation, which leads to not proportionally increases in foundation sizes, weight and in the cost of their installation. These limitations exclude the use of vast areas along ocean continental shelf, which average depth is about 200+ meters, for the purpose of harvesting energy.

SUMMARY OF THE PRESENT INVENTION

[0004] The objectives of the present invention are to increase the depth of wind turbines foundations installation along the ocean continental shelf and to reduce the time required for their installation in comparison versus ongoing technologies of installing foundations for wind turbines offshore.

These objectives are achieved through the following innovations made by present invention:

[0005] The first innovation is in the use of guyed tower concept as the base for design of foundation for wind turbines offshore.

[0006] The second is in the insertion of a pneumatic-hydraulic spring into each mooring line of the proposed compliant guyed tower. Because of these springs the moorings lines would provide to the tower sufficient flexibility to mitigate the dynamic forces of wind and waves acting on the tower.

[0007] The third is in the connection of the guyed tower to its foundation through a flexible element (universal joint), which would provide to guyed tower the capability to incline in any direction during installation process under waves and wind actions. The restoration on guyed tower into vertical position would be done due to guyed tower capability to float like a buoy. This capability is achieved by insertion of bulkhead and vent pipe into the upper part of the tower. The bulkhead restricts upper inner volume of guyed tower from being flooded by water and by this provide to tower buoy capability. The vent pipe allows air to escape from floated space and allows water to expand into it inner space, thus minimizing lost of tower buoyancy. The buoy capability would allow tower to incline on some degree under wind and waves forces and to return back to vertical position under its own buoyancy force. This capability would allow performing installations of tower and anchors in sequence, because the first installed tower might be in position to survive stormy seas without support of mooring lines.

[0008] The fourth innovation is in the use of suction bucket as a foundation for the guyed tower and as the anchors for mooring lines. Suction buckets are more efficient for forming underwater foundations that ongoing practice of underwater piling. To prevent scorching, which is frequent in shallow waters, the suction buckets used by present invention have preventive rings.

[0009] The fifth innovation is in the use of method and means for pretensioning mooring lines using quick installing and removing portable tensioning hydraulic cylinders. Also the fifth innovation is in the use of means for clamping mooring lines to tower before portable tensioning hydraulic cylinder are removed. These innovations would allow using one set of portable hydraulic cylinders as the reusable tool for tensioning mooring lines during multiple guyed towers installations.

[0010] The sixth innovation is in the design of a special Catamaran Foundation Installer enabling it to:

[0011] Lifting guyed tower from horizontal position on the transfer pier, transporting it to the destination site, rotating it into vertical position and anchors it to seabed.

[0012] Delivery Mooring Lines Anchors to destination site simultaneously with guyed tower and their installation on equal distance from the installed guyed tower.

[0013] Tensioning mooring lines and removing portable hydraulic cylinders from the installed guyed tower.

[0014] The seventh innovation is in the sequence of steps (method) by which guyed tower is delivered to destination site, installed and tensioned, using Catamaran Foundation Installer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** shows wind turbine installed on Compliant Guyed Tower.

[0016] FIG. **2** shows Compliant Guyed Tower (General Arrangement).

[0017] FIG. **3** is a Plan View from FIG. **2**.

[0018] FIG. **4** shows Tower.

[0019] FIG. **5** Detail I from FIG. **4**.

[0020] FIG. **6** Plan View from FIG. **4**.

[0021] FIG. **7** is Section A-A from FIG. **4**.

[0022] FIG. **8** Detail II from FIG. **4**.

[0023] FIG. **9** Plan View from FIG. **8**.

[0024] FIG. **10** Detail III from FIG. **4**.

[0025] FIG. **11** is Section B-B from FIG. **10**.

[0026] FIG. **12** shows Suction Bucket Anchor (General Arrangement).

[0027] FIG. **13** is a Plan View from FIG. **12**.

[0028] FIG. **14** shows Pneumatic-Hydraulic Spring.
[0029] FIG. **15** is a Plan View from FIG. **14**.
[0030] FIG. **16** is a View "T" from FIG. **14**.
[0031] FIG. **17** is a Schematic of Pneumatic-Hydraulic Spring.
[0032] FIG. **18** shows Guyed Tower Assembled in horizontal position on assembling yard.
[0033] FIG. **19** shows Portable Hydraulic Cylinder (Elevation).
[0034] FIG. **20** is a Plan View from FIG. **19**.
[0035] FIG. **21** shows Transfer Pier (Elevation).
[0036] FIG. **22** is a Plan View from FIG. **21**.
[0037] FIG. **23** is a Side View from FIG. **21**.
[0038] FIG. **24** Shows Catamaran Foundation Installer (Section C-C from FIG. **25**).
[0039] FIG. **25** is a Plan View from FIG. **24**.
[0040] FIG. **26** is a Side View from FIG. **24**.
[0041] FIG. **27** is a Plan Section D-D from FIG. **24**.
[0042] FIG. **28** is a Section E-E from FIG. **24**
[0043] FIG. **29** is a Detail IV from FIG. **24**.
[0044] FIG. **30** is a Side View from FIG. **31**.
[0045] FIG. **31** is a Detail V from FIG. **27** illustrating tower centering and grabbing arrangement in stored position.
[0046] FIG. **32** is a Detail V from FIG. **27** illustrating tower centering and grabbing arrangement in activated position.
[0047] FIG. **33** snows Support Catamaran (Elevation).
[0048] FIG. **34** is a Side View from FIG. **33**.
[0049] FIG. **35** is a Plan View from FIG. **34**.
[0050] FIG. **36** is Detail VI from FIG. **34**.
[0051] FIG. **37** is Detail VII from FIG. **35**.
[0052] FIG. **38** shows Tower positioned on the Transfer Pier.
[0053] FIG. **39** is View K from FIG. **38**.
[0054] FIG. **40** shows Lead Catamaran and Support Catamaran engaged with Transfer Pier (Elevation).
[0055] FIG. **41** is a Section F-F from FIG. **40** illustrating initial position of engagement with Tower pivot journal.
[0056] FIG. **42** is a Section F-F from FIG. **40** illustrates completed engagement with Tower pivot journal.
[0057] FIG. **43** is a Section G-G from FIG. **40**.
[0058] FIG. **44** shows Lead Catamaran moved out of Transfer pier and Support Catamaran engaging with the lower end of Tower.
[0059] FIG. **45** is a Section K-K from FIG. **44**.
[0060] FIG. **46** is a Section L-L from FIG. **44**.
[0061] FIG. **47** shows Catamaran Foundation Installer carrying Tower mowed out of engagement with Transfer Pier and on his way to destination site.
[0062] FIG. **48** shows Catamaran Foundation Installer arrived to destination site.
[0063] FIG. **49** is a section M-M from FIG. **49** illustrating the rear part of Guyed Tower in a free fall.
[0064] FIG. **50** illustrates submerging of Guyed Tower by rotating around journal on the upper part of the Guyed Tower, which is supported by Lead Catamaran.
[0065] FIG. **51** illustrates further submerging of Guyed Tower.
[0066] FIG. **52** illustrates Guyed Tower came to the vertical position.
[0067] FIG. **53** illustrates process of centering Guyed Tower vertical position.
[0068] FIG. **54** illustrates initial penetration Guyed Tower foundation into soil.
[0069] FIG. **55** Illustrates completion of Guyed Tower penetration into soil.
[0070] FIG. **56** illustrates initial process of lifting mooring line buoy from sea.
[0071] FIG. **57** illustrates process of connecting mooring line to anchor onboard of Catamaran Foundation Installer.
[0072] FIG. **58** illustrates process of lowering mooring line buoy on the deck of Lead Catamaran.
[0073] FIG. **59** is a Side View from FIG. **58**.
[0074] FIG. **60** illustrates process of lifting Anchor from Lead Catamaran.
[0075] FIG. **61** is a Plan View from FIG. **60**.
[0076] FIG. **62** illustrates the process of lowering Suction Bucket Anchor on seabed.
[0077] FIG. **63** illustrates completion of the process of Suction Bucket Anchor penetration into seabed soil.
[0078] FIG. **64** illustrates process of disconnecting Crane Hoist and Pump from Suction Bucket Anchor and lifting them back to Lead Catamaran.
[0079] FIG. **65** shows completely installed one Suction bucket Anchor with mooring line attaching it to floating in vertical position Guyed Tower.
[0080] FIG. **66** is a Plan View of the first Anchor installation process.
[0081] FIG. **67** is a Plan View of the second Anchor installation process.
[0082] FIG. **68** is a Plan View of the third Anchor installation process.
[0083] FIG. **69** shows free floating Guyed Tower attached to three Anchor by not tensioned Mooring Lines.
[0084] FIG. **70** shows Catamaran Foundation Installer in a semisubmersible mode approaching free floating Guyed Tower.
[0085] FIG. **71** is a Plan View from FIG. **70**.
[0086] FIG. **72** illustrates Catamaran Foundation Installer engaged with Guyed Tower.
[0087] FIG. **73** is a Plan View from FIG. **72**.
[0088] FIG. **74** is a Detail VIII from FIG. **73**.
[0089] FIG. **75** shows a moment of lowering on the top of Guyed Tower a combined power and control cables, after which the process of tensioning Mooring Lines starts.
[0090] FIG. **76** illustrates process of removing Portable Hydraulic Cylinders from Guyed Tower after tensioning of Mooring Lines is completed.
[0091] FIG. **77** shows Catamaran Foundation Installer moving away from installed Guyed Tower with Portable Hydraulic Cylinders onboard.

DESCRIPTION OF THE COMPLIANT GUYED TOWER

[0092] FIG. **1** illustrate installation of a typical offshore wind turbine **21** on a stationary foundation **23**, which is in the form of Compliant Guyed Tower.
FIGS. **2** and **3** illustrate design of Compliant Guyed Tower **23**, consisting of Tower **25**, Mooring Lines **27** and Anchors **29**.
FIGS. **4** through **9** illustrate design of the Tower **25**. The upper part of Tower **25** (see FIG. **5**) contains connector **33**, through which the turbine **21** is attached to Tower **25** and inside of which is located shock absorber **35**. Also the upper part of Tower **25** includes the landing platform **37**, four gangway attachments **38** and three receivers **39** for portable hydraulic cylinders **95**. Inside the upper part of Tower **25** is located bulkhead **42** and vent pipe **43**. On the outer surface of Tower **25** upper part are located a pair of pivot journals **45** (see FIGS.

6 and 7) and three sets of mooring lines 27 clamps 40 and guides 41. Each set of clamps 40 (see FIGS. 8 and 9) consisting of a block 50 attached to body of Tower 25, three wedges 52 each engaged with mooring line 27 and threes hydraulic cylinder 54 engaged with wedges 52.

The lower part of Tower 25 includes Foundation Base 46 (see FIGS. 10 and 11), which consists of Suction Bucket 47, Universal Joint 48 and Suction Pump 49. Also in the lower part of Tower 25 is placed lifting gear 32. The Tower 25 is connected to Foundation Base 46 through Universal Joint 48. The Suction Bucket 47 consists of upper plate 60 and cylindrical body 61. It also includes scorching preventive ring 62 and its upper and lower stoppers 63 and 64.

FIGS. 12 and 13 illustrate Anchor 29, which consists of a Suction Bucket 47A, Pneumatic-Hydraulic Spring 62 and Suction Pump 49A. Suction Bucket Consists of upper plate 60A and cylindrical body 61A. It also includes scorching preventive ring 62A and its upper and lower stoppers 63A and 64A.

The Pneumatic-Hydraulic Spring 69 (see FIGS. 14 through 17) consists of one large hydraulic cylinder 70, which includes piston 72, rod 74 and rod head 75, several small pneumatic cylinders-vessels 76 located around hydraulic cylinder 70, rigid conduit pipe 73 that interconnects lower parts of pneumatic cylinders 68 with upper part of hydraulic cylinder 70, common base 77 for hydraulic cylinder 70 and pneumatic cylinders-vessels 76 and a chain-type connector 78 consisting of half of chain link 79 and base link 80, which is fixed to upper plate 60A.

FIG. 18 shows Tower 25, supported by front carriage 86 and rear carriage 87 in horizontal position on the assembling yard 90. Carriage 87 includes hydraulic cylinders 88 and support block 89. For the purpose of accelerating process of Tower 25 installation it is equipped with 3 sets of Portable Hydraulic Cylinders 95 with full length Mooring Lines 27 and Buoys 97 attached to Mooring Lines ends. Also there is a set of Pump Hoisting Lines 99 with power and control cables 100 attached to Pump 49 on Foundation Base 46 by one ends and by others ends attached to landing platform 37.

FIGS. 19 and 20 show Portable Hydraulic Cylinder 95, which consists of a cylinder 101, having piston road 102, quick activating gear 103 for disconnecting from mooring line 2,7 and lifting ear 104 and tooth 105 for rapid engagement with receiver 39 on upper part of Tower 25. On the lower part of cylinder 101 is located trust support 107.

Description of the Means that Support Transport and Installation of Compliant Guyed Tower

[0093] FIGS. 21, 22 and 23 shows Transfer Pier 110, which consists upper structure 111 supported by piles 115. Along the pier are laid rails 113, on which run carriages 86 and 87. The carriage 87 has a hydraulic jack up support 88 (see FIGS. 43 and 46).

FIGS. 24 through 37 shows Catamaran Foundation Installer 120, which consists of Lead Catamaran 122 and Support Catamaran 124. Both 122 and 124 Catamarans during the process of transporting Tower 25 to destination side are interconnected by pair of towing lines 126, each having towing winch 128. When both Catamarans 122 and 124 are traveling without Tower 25 they are connected to each other through pair of pals 130 on Lead Catamaran and the pair of engaging bars 131 on Support Catamaran. Each of engaging bar 131 has a slot 132 and a stopper 133.

Catamaran 122 consists of two pontoons 136, front cross frame 138, rear cross frame 140, upper deck 142, horizontal guides 144 with supports 146, Tower 25 centering and grabbing arrangement 148 and gantry crane 150. On deck 142 are positioned three anchors 29.

The front cross frame 138 consists of two vertical columns 152, two brackets 154, upper cross beam 155 and lower cross beam 156. The rear cross frame 140 includes two vertical columns 152 with two extension columns 159, two cross beams 160 and 161, one middle column 163, two upper brackets 165 and two lower brackets 167. Both front cross frames 138 and rear cross frame 140 are interconnected by two pair of longitudinal beams 169 and by brackets 171. Between longitudinal beams 169 are located horizontal guides 173 with support-brackets 175.

Inside pontoons 136 and vertical columns 152 would be located propulsion engines and pumps and compressors required for Catamaran Foundation Installer operation, which are not shown.

The two Tower 25 centering and grabbing arrangements 148 (see FIGS. 31 and 32) are shown in stored and in activated positions. Each consists of a base 177, two arms 179, each having hydraulic cylinder 181 and a lever 183 with contact roller 185.

The gantry crane 150 consists of traveling frame 187 and two crane carriages 189. Each crane carriage 189 has heavy lift hoist arrangement 191 with hook arrangement 193 and winch 194 for handling pump 49 hoisting line 99 and combined power/control cable 100. The hook arrangement 193 (see FIGS. 29 and 30) consists of two sheaves 195, vertical body 197 with elongated opening 198, for engaging with pivot journal 45, and two horns on its lower part for engaging with Portable Hydraulic Cylinder 95.

Support Catamaran 124, (see FIGS. 33 through 36) consists of two pontoons 201 and cross-frame 204. It also has a mooring arrangement 205 through which it engages with the Lead Catamaran. The cross-frame 204 is supported by four columns 206. In the middle of cross-frame 204 is located Quick Connect-Disconnect Arrangement 208. The Quick Connect-Disconnect Arrangement 208 consists of a sliding column 210, which has on its lower part a hydraulically operated engager 212. Sliding column 210 through its upper end is supported through hoisting line 214 by which 215 positioned on frame 216. The hydraulically operated engager 218 consists of a pair pivoted hooks 220, base 222 and pair of hydraulic cylinders 224. The mooring arrangement 205 consists of engaging bar 131 and mooring bit 226. Engaging bar 131 has a slot 132 and a stopper 133.

Description of the Process of Transporting Compliant Guyed Tower to the Designated Site and Installing it there

[0094] The process of picking up Tower 25 from the Transfer Pier 110 and delivery it to destination site is illustrated by FIGS. 38 though 48 and consists of the following steps:

[0095] Completely assembled Tower 25 is moved on two carriages 86 and 87 from Assembly Yard 90 to Transfer Pier 110 (see FIGS. 32 and 33).

[0096] Catamaran Foundation Installer 120, which consists of Main Catamaran 122 and Support Catamaran 124, approaches Transfer Pier 110 with Support Catamaran 124 first.

[0097] The two hook arrangements **193** of the Crane Carriages **189** are lowered down and engaged with the pivot journals **45** on the upper part of Guyed Tower **25**.

[0098] The Crane carriages **189** lift Guyed Tower **25** slightly above carriage **86**. Simultaneously the Main Catamaran **122** disconnects from Support Catamaran **124** by removing stopper **133** from slot **132** and releasing towing lines **126**.

[0099] The Main Catamaran moves forward and pulls Guyed Tower **25**. When the Quick Connect-Disconnect Arrangement **212** of the Support Catamaran **124** would align with the lifting gear **32** then the Arrangement **212** would be lowered down and would engaged with lifting gear **32**.

[0100] Support **88** on which lower part of Guyed Tower **25** is resting would be lowered and the weight of Guyed Tower **25** would be transferred to Support Catamaran **124**.

[0101] The towing lines **126** would be tensioned by winch **128**.

[0102] The Main Catamaran **122** resumes its forward movement and by this the caravan consisting of Main Catamaran **122**, Guyed Tower **25** and Support Catamaran **124** would go out of engagement with Transfer Pier **110** and would float to destination site.

[0103] The process of rotating Guyed Tower **15** from horizontal position to vertical position and anchoring it to seabed is illustrated by FIGS. **48** through **55** and consists of the following steps:

[0104] At the destination site (see FIGS. **48** and **49**) the Quick Connect-Disconnect Arrangement **141** on Support Catamaran **124** opens up and the lower part of Tower **25** starts free fall rotating around journal **45**, which is supported by Main Catamaran **120** crane carriages **189** through hoist arrangements **193**.

[0105] When lower part of Tower **25** would become under surface water would start to flow inside it through the openings on the Tower **25** bottom and air would be vented through the vent pipe **43**.

[0106] Further rotation of Tower **25** around its journey **45** from horizontal position to vertical position is illustrated by FIGS. **50**, **51** and **52**. During the Tower **25** rotation the buoys **97** would flow up to the surface.

[0107] When Tower **25** reaches vertical position the water expansion inside it would be prevented by bulkhead **42**, but would allow water to flow into vent pipe internal space and by this providing additional buoyancy to Tower **25**, which only partially would compensate the total weight of Tower **25**.

[0108] After vertical position of Tower **25** would be stabilized by centering and grabbing arrangements **148** the crane carriages would start to lower Tower **25**. After Tower **25** foundation **46** cylinder **51** would touch the ocean bottom it would pressed by gravity force into soil on the depth sufficient to hermetic its inner space, which required for starting suction pump **49** (see FIGS. **54** and **55**).

[0109] In the following steps the signal sent from Lead Catamaran **122** through power-control cable **99** would activated pump **49** and it would move water out from the upper part of foundation **46** and created vacuum would cause hydrostatic pressure to press foundation completely into soil. After this step is completed the winch **194** of the Lead Catamaran **122** would through combined control, power and hoist line **99**/**100** disconnect pump **49** from foundation **46** and lifted it up and move away from the installed Tower **25**.

[0110] The process of installing anchors **29** is illustrated by FIGS. **56** through **69**. It consists of the following steps:

[0111] Catamaran Foundation Installer **120**, which is already positioned near Tower **25** engages with one of the floating mooring buoys **97** through one of its crane carriages **189** and lifts it up to the level at winch the end of Mooring Line **27** attached to buoy **97** would be possible to connect to Anchor **29** through rod head **75** of pneumatic-hydraulic spring **69** (see FIGS. **56** and **57**).

[0112] Crane carriage **183** places disconnected from mooring line buoy **97** on the deck **142** of the Lead Catamaran **122** (see FIGS. **58** and **59**).

[0113] Crane carriage **183** connects power and control cables **99** and hoist line **100** to pump **49**A. After that crane **153** lifts anchor **29** through slings **184** from deck **142** it moves anchor **29** to an opening in the deck **142**.

[0114] By the next step Catamaran Foundation Installer moves out of connection with Tower **25** on a certain distance and starts to lower downward anchor **29** with attached pump **49**.

[0115] After anchor **29** initial penetration into soil under own weight of anchor **29** the signal from Catamaran Foundation Installer **120** activates pump **49**A, which generates inside suction bucket vacuum and by this creates hydrostatic force sufficient for anchor **29** to be fully penetrated into soil. After this part of the process is completed the pump **49**A, by signal coming through power and control cable **99**, disconnects hook arrangement **193** from slings **184** and pump **49**A from being arranged on suction bucket **47**A. The pump is lifted through hoist line **100** by winch **194**.

[0116] After completion of the first anchor **29** installation the Catamaran Foundation Installer moves to position second anchor **29** on seabed on the same distance from Tower **25** but 120 degrees from the first anchor **29** installed (see FIG. **67**). The process of lowering anchor **29** to seabed is similar to process done for installation of the first anchor **29**. The process of installing the third anchor **29** is similar to installation of the second anchor **29**.

[0117] The process of tensioning mooring lines **27** and removing Portable Hydraulic Cylinders **95** from Tower **25** is illustrated by FIGS. **70** through **77** and consists of the following steps:

[0118] Catamaran Foundation Installer **120** in a semisubmersible mode approaches floating Tower **25** already connected to anchor **29** with slackened mooring lines **27**. Since Tower **25** is a cylinder the Catamaran Foundation Installer **120** can approach it from any angle, thus would allow moving it versus the prevailed direction of wind and wave and by this control the speed by which Crane Catamaran **150** would get in contact with Tower **25** and this would also exclude Crane Catamaran roll.

[0119] Centering Crane Catamaran **150** with Tower **25** would be done by centering system **148** (see FIGS. **73** and **74**). The first impact between them would be absorbed through levers **179** and by hydraulic cylinders **181**.

[0120] Lowering the power and control cables on the landing platform **37** and connecting them with hydraulic tensioning cylinders **95**.

[0121] Activating, by command from Catamaran Foundation Installer **120**, the hydraulic cylinders **95**, would tension mooring lines **27**. To assure that Tower **25** is exactly in vertical position the tension in each hydraulic cylinder **95** would be adjusted accordingly.

[0122] After the exact vertical position of Tower **25** is achieved the clamp **40** (see FIGS. **8** and **9**) wedges the moor-

ing line **27** into the block **50** by activating hydraulic cylinders **54**, which push wedges **52** between block **50** and mooring line **27**.

[0123] Removing one by one hydraulic tensioning winches **95** from Tower **25** and placing them on the Catamaran Foundation Installer **120** deck **142**.

[0124] Mowing Crane Catamaran **150** away from the installed Compliant Guyed Tower **23** having on board removed from Tower **25** hydraulic tensioning cylinders **95**, from anchors **29** pumps **49**A and mooring lines buoys **97** from mooring lines **27**.

What is claimed is:

1. A foundation for offshore wind turbine and the means for transporting it from transfer pier, to the destination site, installing and anchoring it there, comprising:

a said foundation for offshore wind turbine, which is based on the concept of Compliant Guided Tower, consisting of Tower and three Mooring Lines attached to three Anchors,

a said transfer pier consisting of upper structure, supported by piles, along said upper structure are positioned at least two carriages that moves on rails along the said upper structure,

a said means for transporting said tower assembled with said mooring lines to the destination site, installing and anchoring them, are in the form of Catamaran Foundation Installer, which includes Lead Catamaran and Support Catamaran.

2. The foundation for offshore wind turbine according to claim **1**, wherein said foundation for offshore wind turbine, which is based on the concept of Compliant Guided Tower, consisting of Tower and three Mooring Lines attached to three Anchors, comprising:

Tower, consisting of upper and lower parts;

said upper part of said Tower includes:

a connector, through which said wind turbine is connected to said Tower and which contains inside it a shock absorber that will reduce impact during the process of lowering said wind turbine on the said Tower of said Foundation for offshore wind turbine;

a landing platform,

three receivers for hydraulic cylinders, that would tension said mooring lines during the process of said foundation for offshore wind turbine installation;

three sets of clamps with guides for fixing said mooring lines to said tower at the end of the process of installing said foundation for offshore wind turbine;

a bulkhead inside said tower upper part that forms buoyancy force that keeps said tower floating vertically during the processes of its installation an anchoring;

a pair of journals serving as the lifting points and as a rotating axis for said tower during the processes of its lifting and installation;

the said lower part of said tower includes:

lifting gear;

foundation base, which is in the form of a typical suction bucket that consists of cylindrical body and the upper plate on which are placed vacuum pump and the universal joint through which said foundation base is connected with said tower lower part; as the innovative feature the said foundation base includes scorching prevention ring with upper and lower position stoppers.

three said Mooring Lines each having upper end engaged with said clamps on said upper part of said Tower and their lower ends engaged with hydro-pneumatic springs located on the top of said anchors;

said three Anchors, based on a typical design of suction bucket, each having a cylindrical body and a top plate, which supports vacuum pump and said hydro-pneumatic spring;

said hydro-pneumatic spring consists of:

central hydraulic cylinder with piston and rod, to which the lower end of said Mooring Line is connected;

several vessels-accumulators, located around said central hydraulic cylinder, each containing mix of gas in their upper part and liquid in their lower part;

said lower parts of said vessel-accumulators are interconnected by fixed conduit with upper part of said central hydraulic cylinder;

a common base on which said central cylinder and said several vessels-accumulators are assembled;

a said common base is connected to upper plate of said suction bucket type foundation through a chain type connection.

3. The foundation for offshore wind turbine according to claim **1**, wherein said means for transporting said Tower assembled with said mooring lines to the destination site, installing and anchoring them, comprising:

a Catamaran Foundation Installer includes Lead Catamaran and Support Catamaran, which are interconnected by pair of towing lines, each towing lines by one end is fixed to said Support Catamaran and other end is winded up on a towing winch on the said Lead Catamaran, thus allowing to control the distance between said Lead Catamaran and said Support Catamaran;

a said Lead Catamaran includes:

two pontoons,

a front and rear cross frames,

a deck interconnecting cross frames,

a gantry crane consisting of a traveling frame with two crane carriages, each of said crane carriage has heavy lift hoist arrangement and auxiliary winch for handling said vacuum pumps on said Anchors;

a pair of horizontal guides,

a pair of Tower centering and grabbing arrangement, each consisting a base to which, through hydraulic cylinders are attached two arms, which can center and grab said Tower, each said arm has on its end a contact roller;

a said Support Catamaran includes:

two pontoons;

two mooring arrangements consisting of a bit and engaging bar, which includes a slot and a stopper;

a cross-frame, which is fixed to said pontoons through four legs and having in its middle a Quick Connect-Disconnect Arrangement consisting of:

a frame, a which is positioned on the top of said cross-frame,

a sliding column inside of said frame is suspended through a hoisting line from a said winch, on the lower part of said sliding column is positioned hydraulically operated engager consisting of:

a base, a pair of pivoted hooks and a pair of hydraulic cylinders.

4. A method of lifting completely assembled Tower from Transfer Pier, transporting it to destination site, installing and anchoring it there, comprising the following steps:

the Lead Catamaran lifts up the upper part of said completely assembled Tower from transport carriage on Transfer Pier using Gantry Crane both crane carriages;

the Lead Catamaran pulls assembled Tower, which lower part is supported by transport carriage, along the Transfer Pier, when Quick Connect-Disconnect Arrangement on the Support Catamaran aligns with lifting gear then the Quick Connect-Disconnect Arrangement engages with lifting gear;

after the transport carriage moves out of contact with Tower and by this transferring all weight of Tower to the Lead Catamaran and to Support Catamaran, the caravan consisting of Main and Support Catamarans interconnected by Tower floats to the destinations site.

at the destination site the Support Catamaran disconnects from the Tower, which in a free fall would be rotated around the pivot journals on the upper part of the Tower and finally would come into vertical position;

when Tower reaches vertical position the crane carriages on the Gantry Crane would lower Tower further down until its foundation, which is in the form of a suction bucket, would penetrated seabed on a some distance;

by the following steps the vacuum pump on the foundation would be actuated and by this it would create a conditions under which under hydrostatic force the foundation would be fully pressed into seabed;

since the Tower is connected with foundation through universal joint and its upper part would not be flooded the Tower would float in vertical position and would be capable of withstand wind and wave actions, and by this allowing the Catamaran Foundation Installer placing Anchors, which are already preattached to Tower through mooring lines, around the floating Tower;

after all Anchors, which are suction buckets, are firmly entrenched into seabed the Catamaran Foundation Installer gets back to Tower and pretension simultaneously all three mooring lines through the preinstalled Portable Hydraulic Cylinders;

after the pretension of mooring lines would be completed and Tower would be in the exact vertical position the mooring lines would be clamp to the Tower by hydraulically actuated wedges;

as the final step of foundation installation the preinstalled Portable Hydraulic Cylinders would be removed from the Tower.

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