March 2, 1965 L. J. ROUSSEL 3,171,259

OFFSHORE DRILLING BARGE

Filed Sept. 30, 1960 11 Sheets-Sheet 1

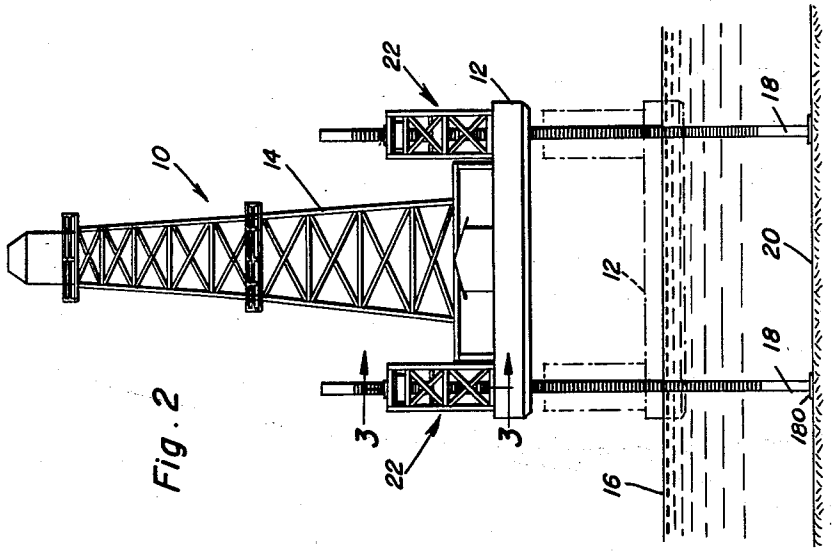

Fig. 2

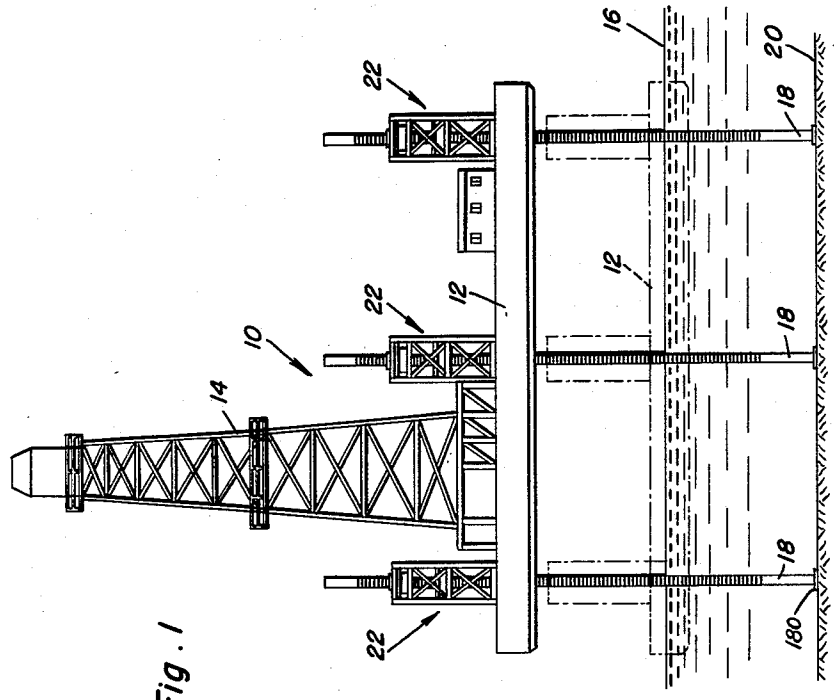

Fig. 1

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March 2, 1965 L. J. ROUSSEL 3,171,259

OFFSHORE DRILLING BARGE

Filed Sept. 30, 1960 11 Sheets-Sheet 2

Fig. 3

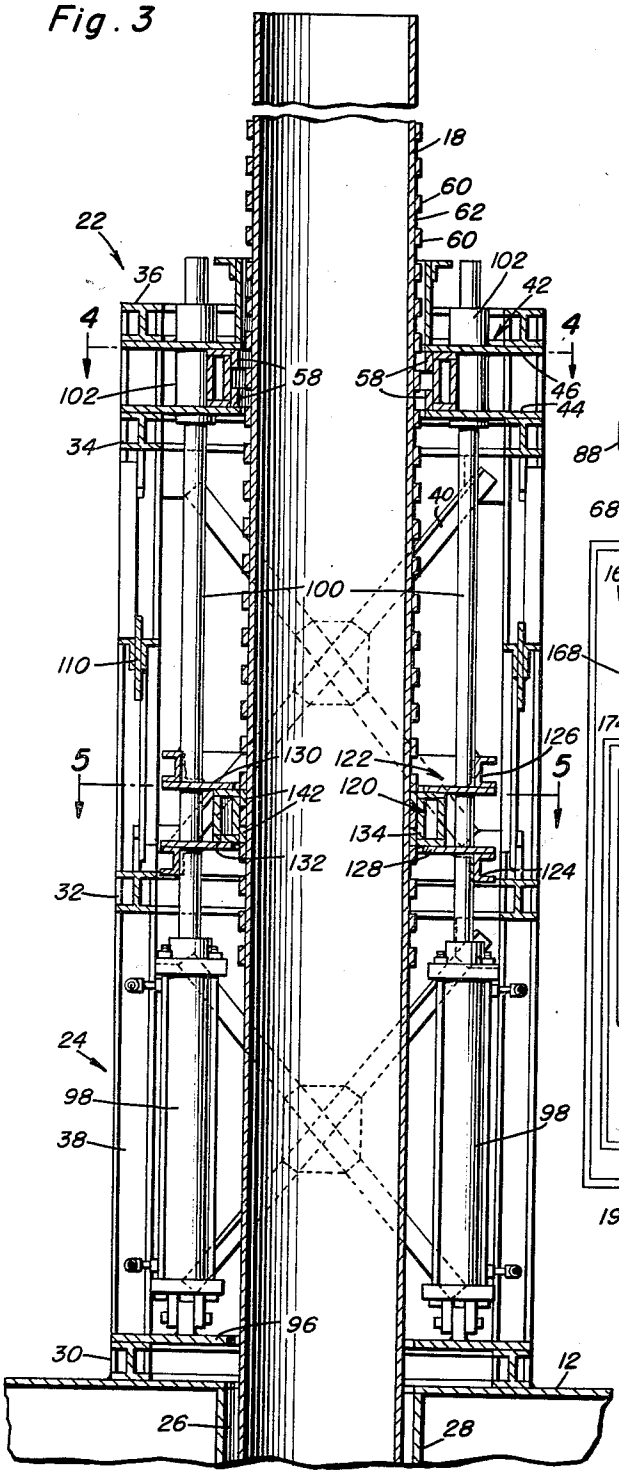
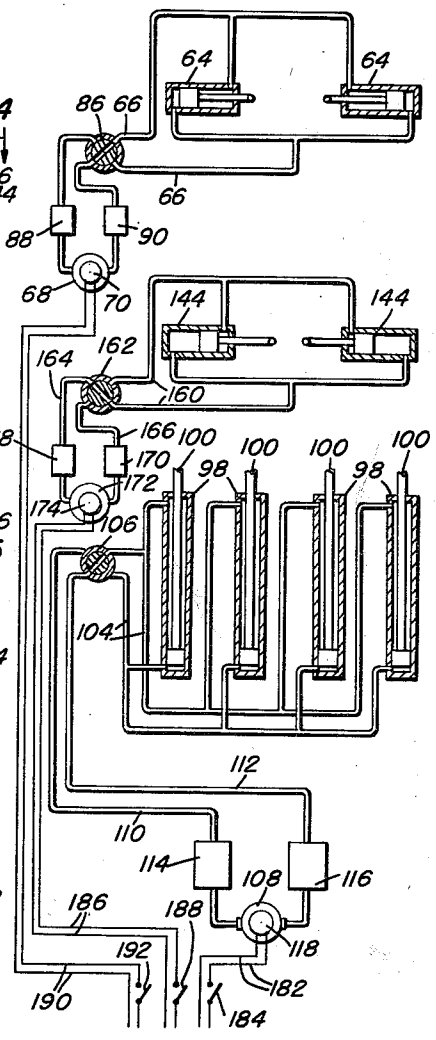


Fig. 9



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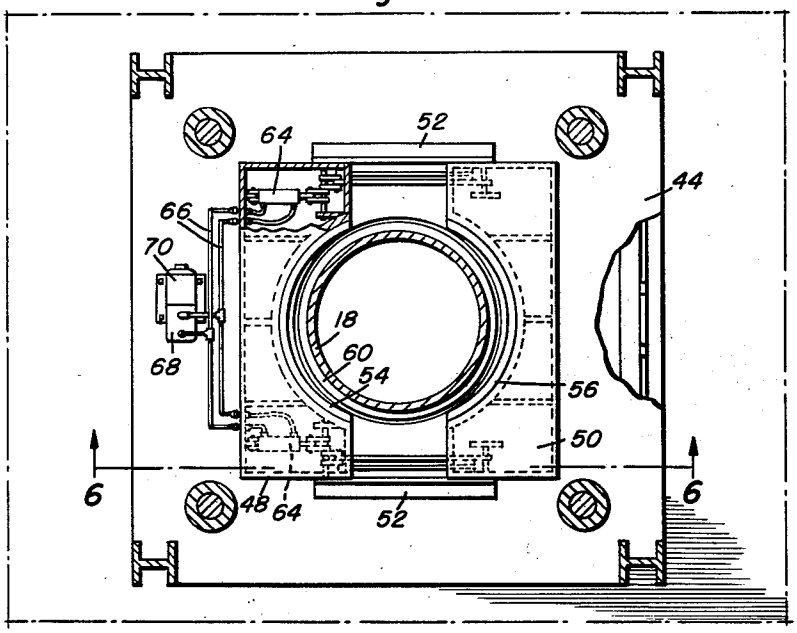
March 2, 1965 L. J. ROUSSEL 3,171,259

OFFSHORE DRILLING BARGE

Filed Sept. 30, 1960 11 Sheets-Sheet 3

Fig. 4



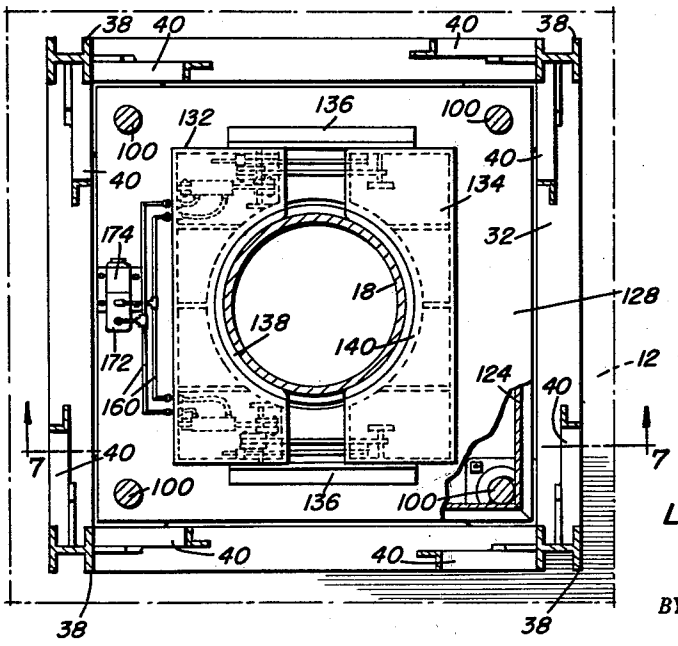


Fig. 5

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March 2, 1965 L. J. ROUSSEL 3,171,259

OFFSHORE DRILLING BARGE

Filed Sept. 30, 1960 11 Sheets-Sheet 4

Fig. 6

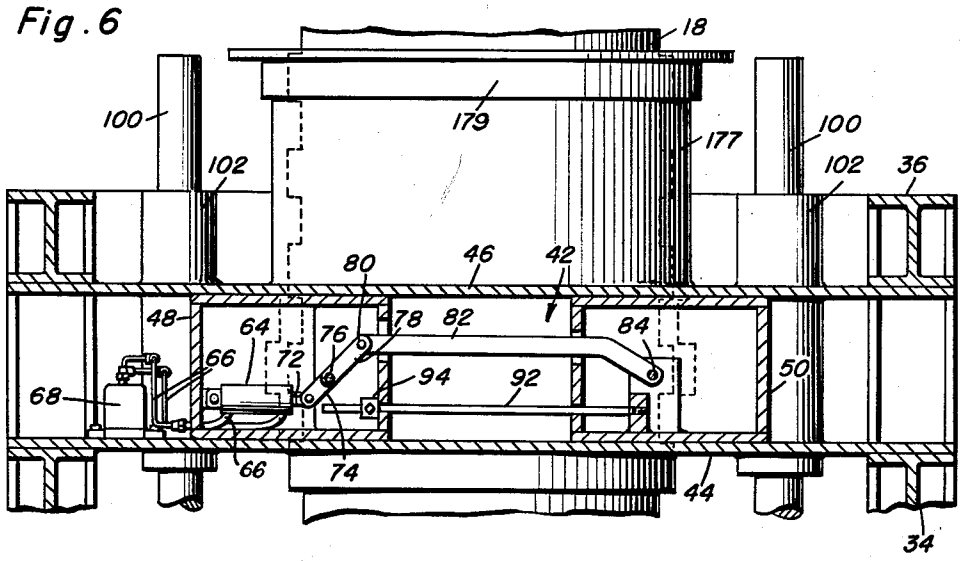


Fig. 7

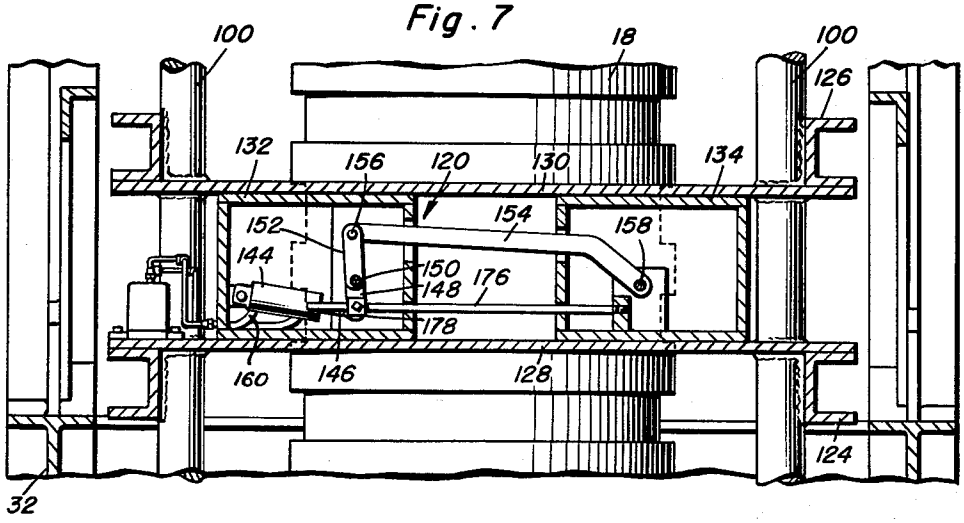
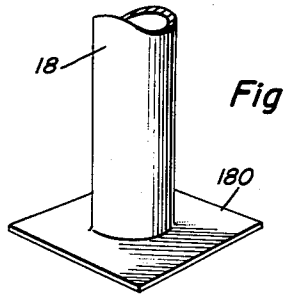


Fig. 8



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March 2, 1965 L. J. ROUSSEL 3,171,259

OFFSHORE DRILLING BARGE

Filed Sept. 30, 1960 11 Sheets-Sheet 5

Fig. 11

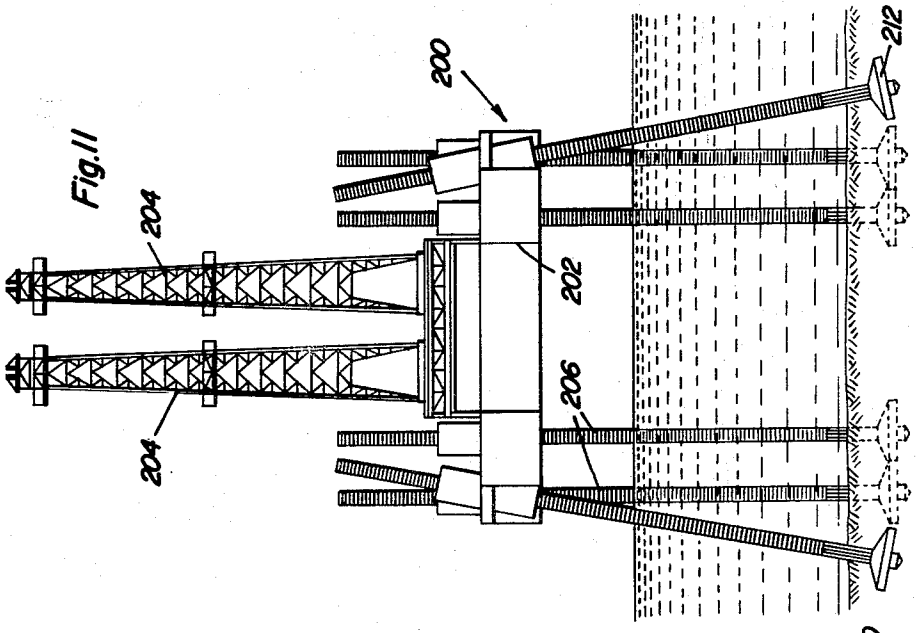


Fig. 10

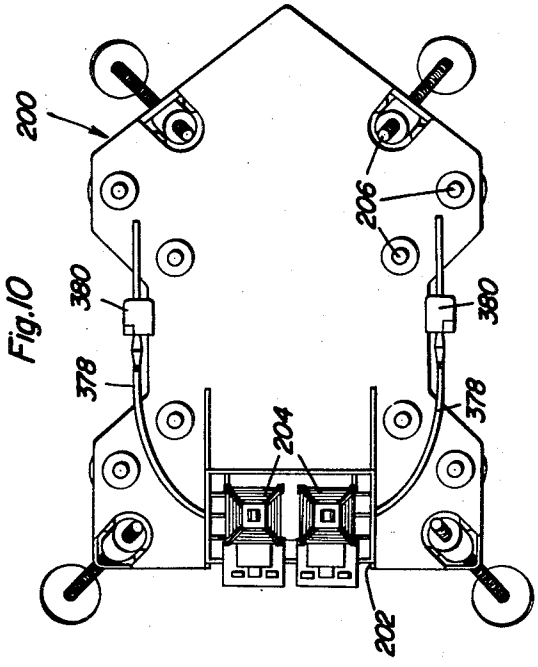
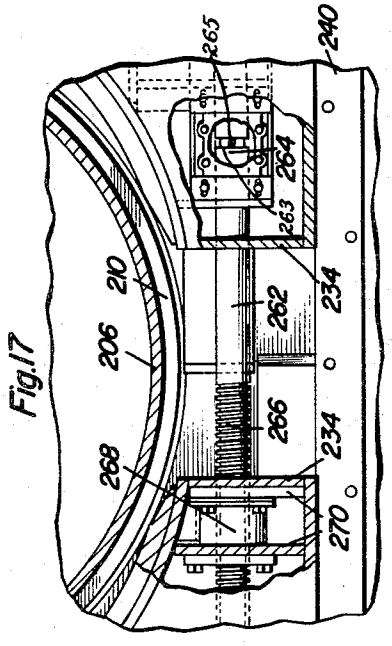


Fig. 17



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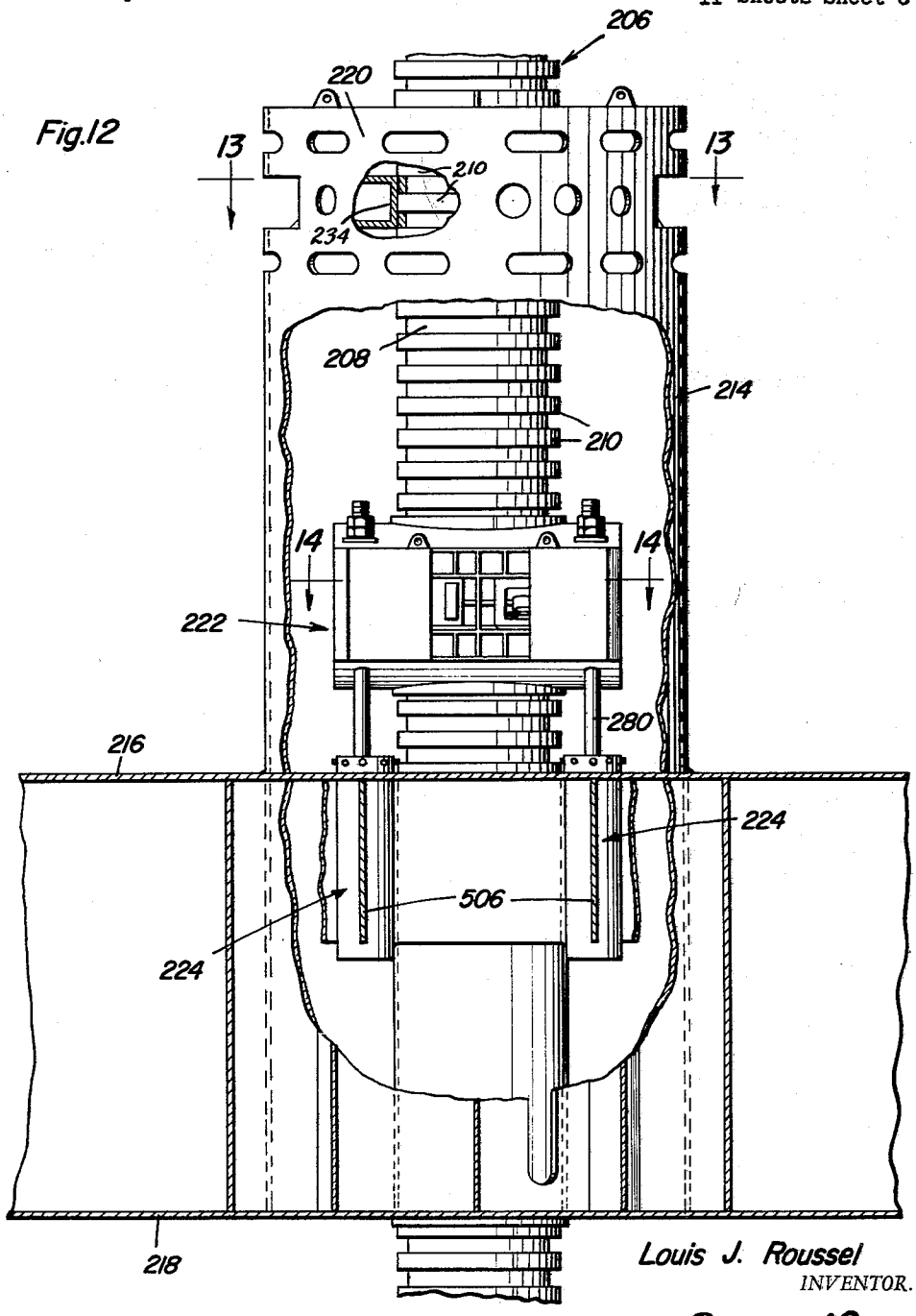
March 2, 1965 L. J. ROUSSEL 3,171,259

OFFSHORE DRILLING BARGE

Filed Sept. 30, 1960 11 Sheets-Sheet 6

Fig.12



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March 2, 1965 L. J. ROUSSEL 3,171,259

OFFSHORE DRILLING BARGE

Filed Sept. 30, 1960 11 Sheets-Sheet 7

Fig.13

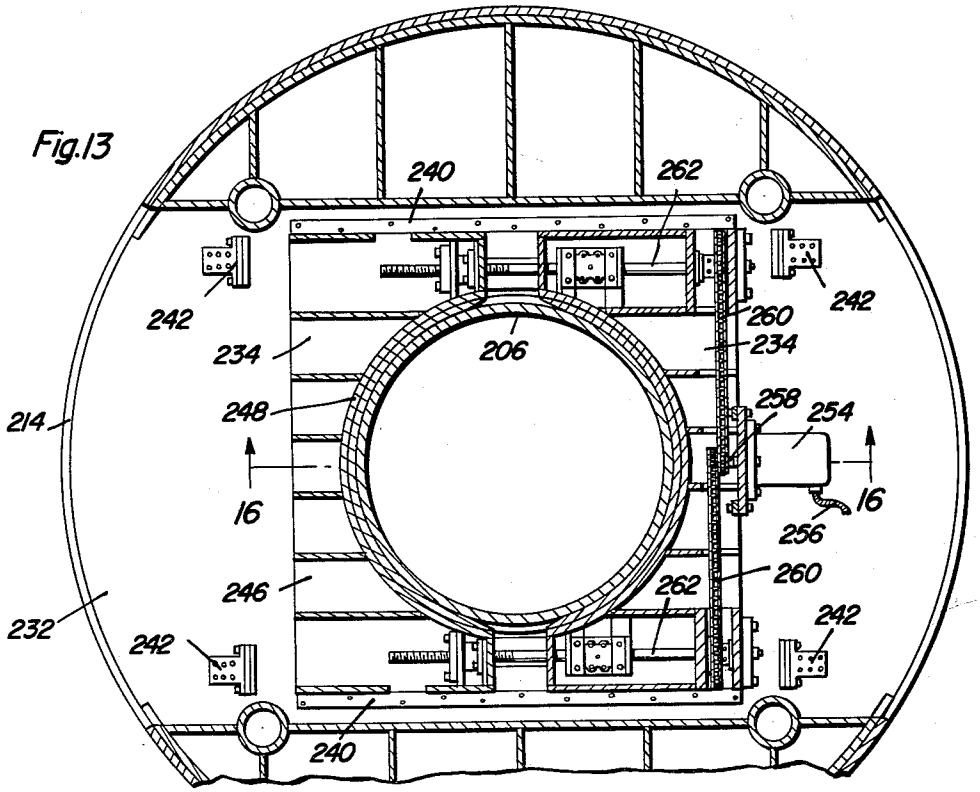
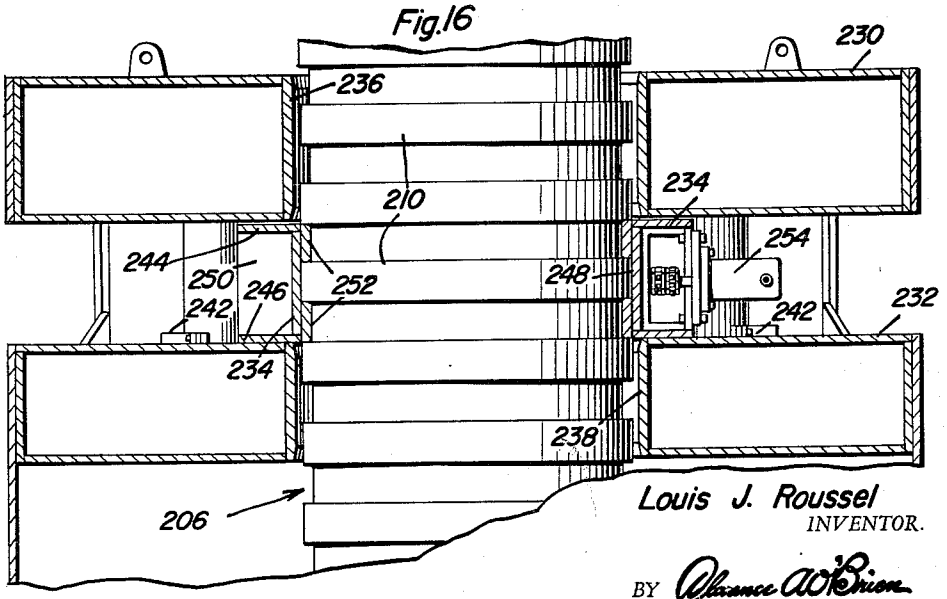


Fig.16



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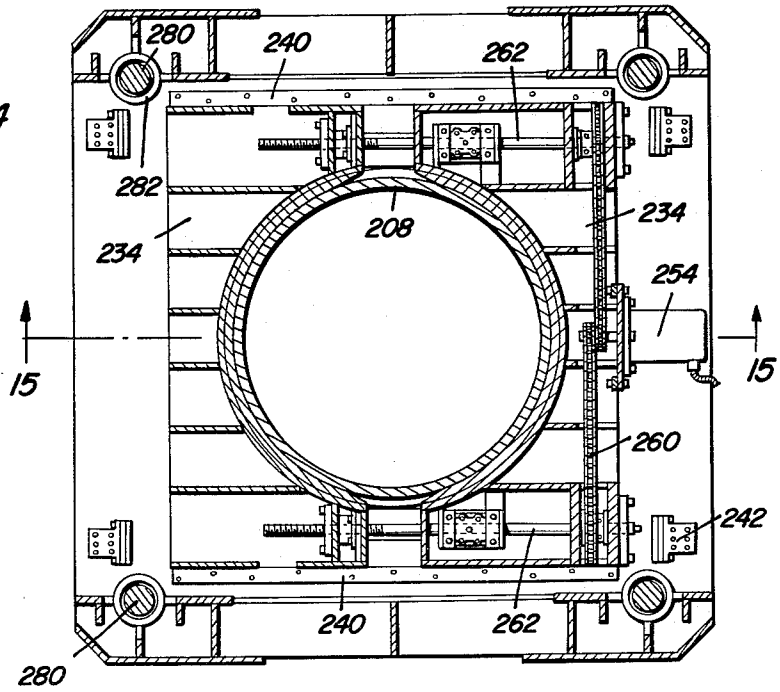
March 2, 1965 L. J. ROUSSEL 3,171,259

OFFSHORE DRILLING BARGE

Filed Sept. 30, 1960 11 Sheets-Sheet 8

Fig.14



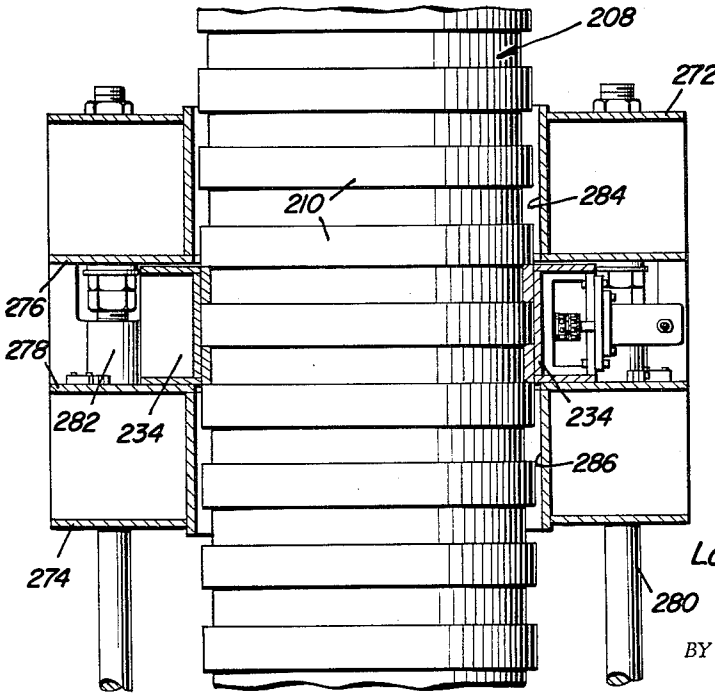


Fig.15

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March 2, 1965 L. J. ROUSSEL 3,171,259

OFFSHORE DRILLING BARGE

Filed Sept. 30, 1960 11 Sheets-Sheet 9

Fig.18

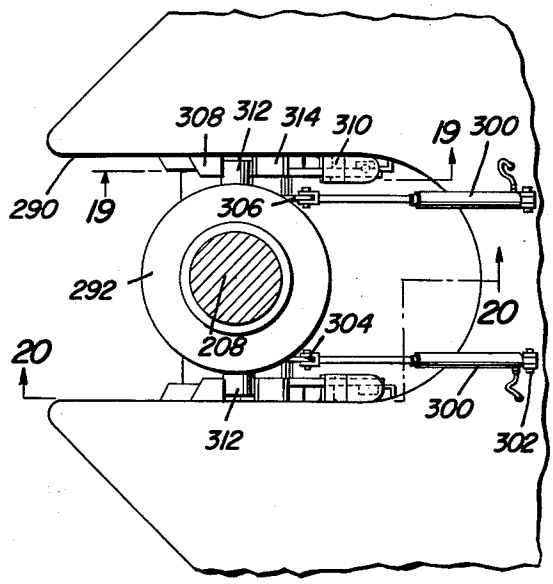


Fig.20

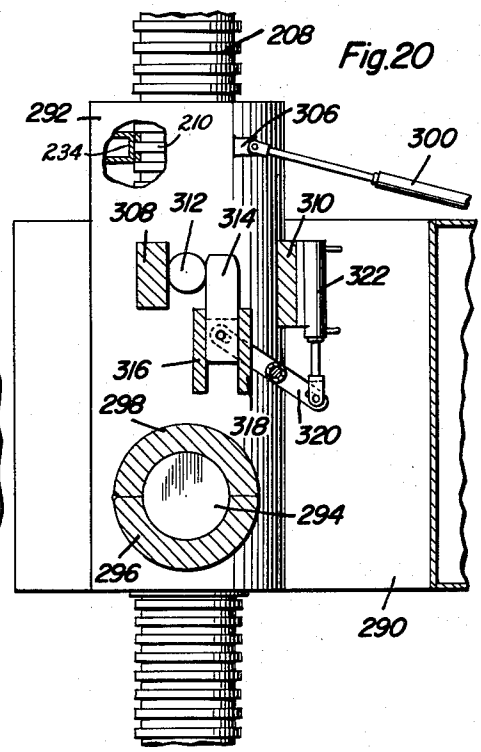


Fig.21

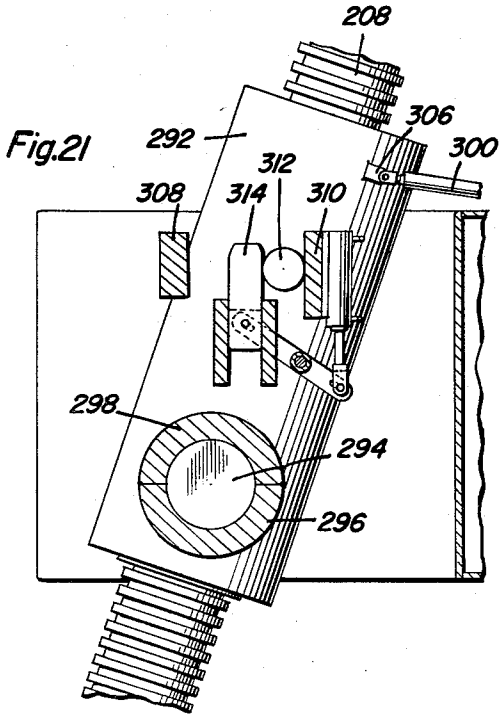
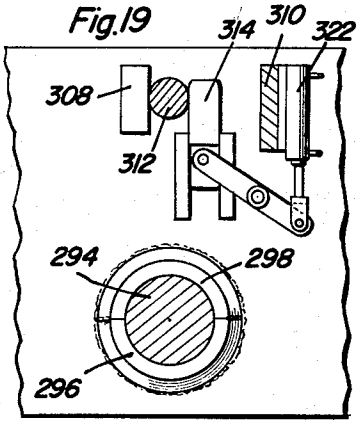


Fig.19



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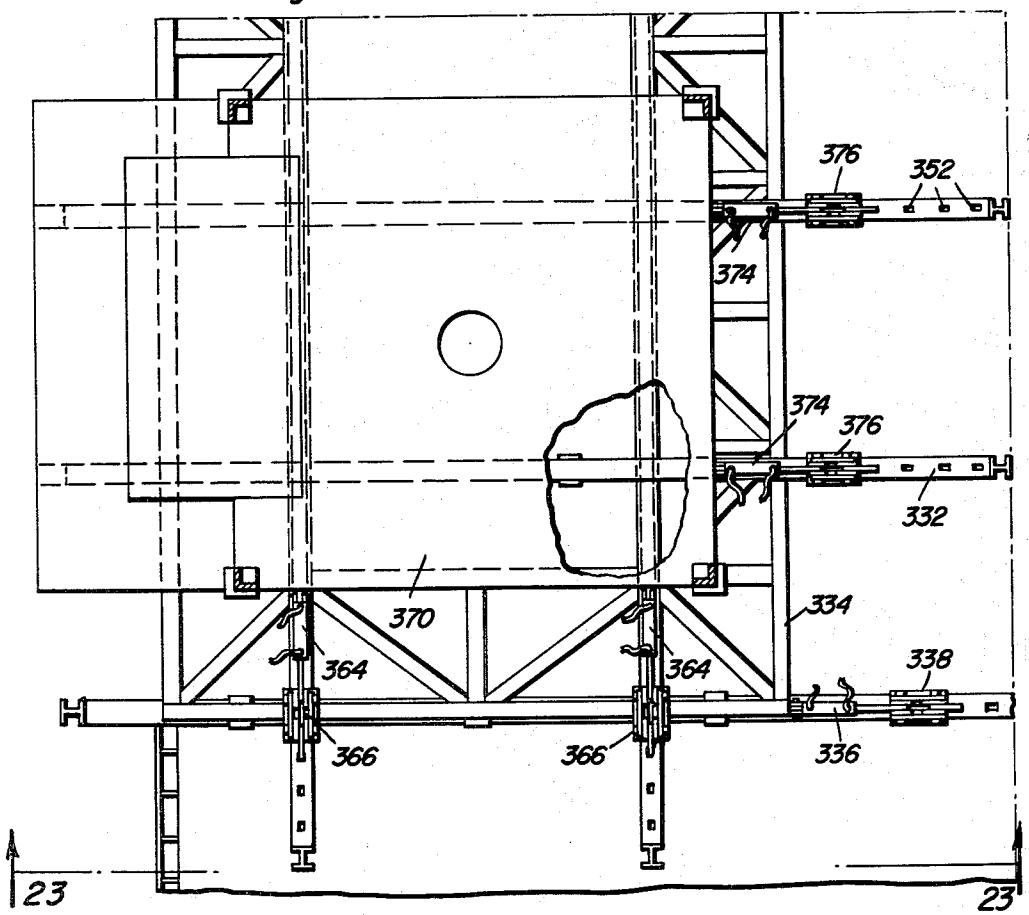
March 2, 1965 L. J. ROUSSEL 3,171,259

OFFSHORE DRILLING BARGE

Filed Sept. 30, 1960 11 Sheets-Sheet 10

Fig.22



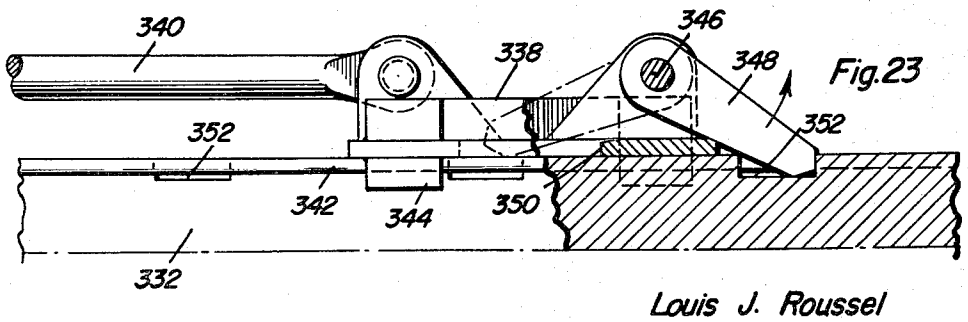


Fig.23

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March 2, 1965 L. J. ROUSSEL 3,171,259

OFFSHORE DRILLING BARGE

Filed Sept. 30, 1960 11 Sheets-Sheet 11

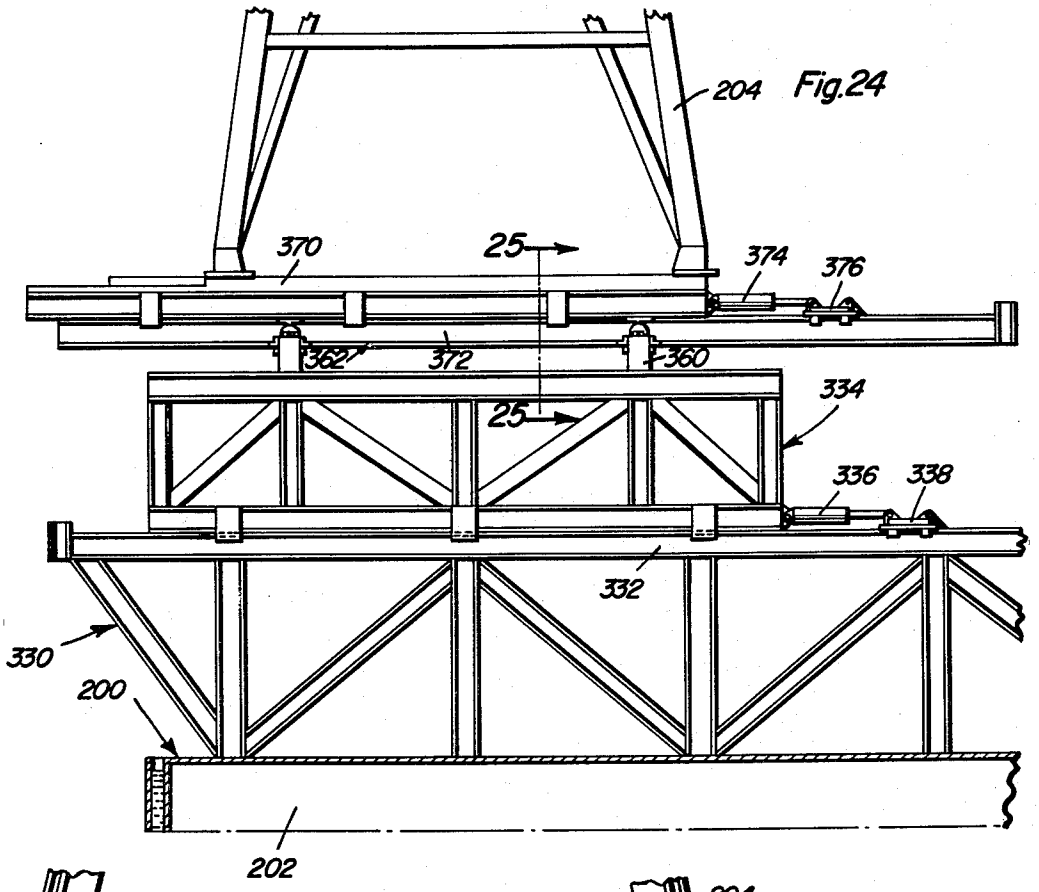

Fig.24

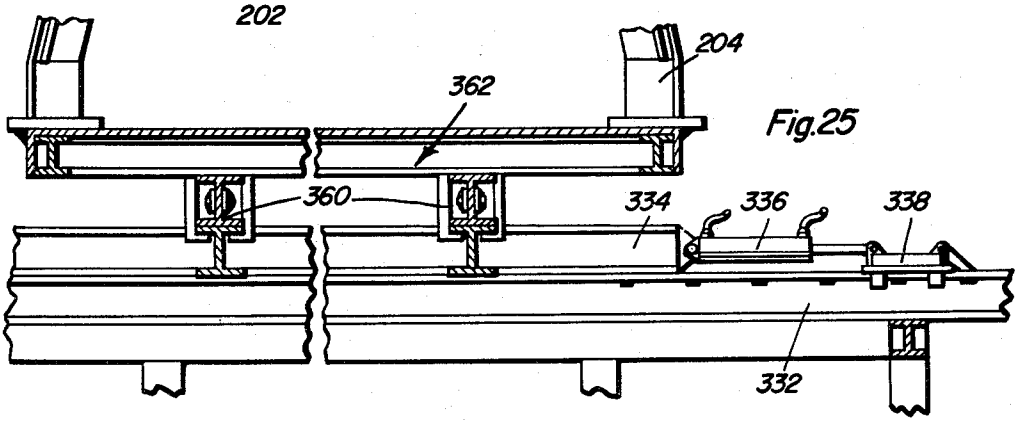

Fig.25

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United States Patent Office 3,171,259 Patented Mar. 2, 1965

3,171,259

OFFSHORE DRILLING BARGE

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Filed Sept. 30, 1960, Ser. No. 60,262
9 Claims. (Cl. 61—46.5)

This invention comprises a novel and useful offshore drilling barge and relates in general to barges of the type adapted for offshore drilling operations and which are provided with power operated caissons for adjustably elevating the barge above the surface of the water whereby to provide a stable drilling platform above wave action.

This application is a continuation in part of my prior co-pending application Serial No. 568,761, filed March 1, 1956, for Hydraulic Jack Assembly for Barge Caissons, now abandoned, and which application in turn is a continuation in part of my still further prior co-pending application Serial No. 541,379, filed October 19, 1955, and now abandoned.

There are many instances where it is desired to mount a platform on caissons with the platform being disposed above the water and being supported by the caissons. Examples of this can be found in platforms for offshore drilling rigs, portable docks, dry docks and the like. In each of these instances it is desired that the platform be only temporarily mounted on the caissons and that the caissons be salvageable for further use. Inasmuch as the caissons must be floated into position, as well as the platform, it is desirable that the platform be in the form of a barge normally supporting the caissons for flotation purposes. It is also desirable that the caisson and the barge be movable relative to each other so that the barge may eventually be lifted above the level of the water after the caissons have been properly seated on the bottom of the body of water in which the barge was floating.

It is therefore the primary object of this invention to provide a hydraulic jack assembly for barge caissons which is so constructed that caissons carried by a barge may be first moved downwardly with respect to the barge for seating on the bottom of a body of water, and then the barge may be lifted on the caissons and locked thereto in a position above the water.

Another object of this invention is to provide an improved hydraulic jack assembly for barge caissons which is so constructed that a barge may be lifted on caissons, the lifting process being of a step-by-step nature, there being provided suitable means for locking the barge to the caissons for direct supporting thereby between lifting operations.

Still another object of this invention is to provide a suitable lock for locking caissons of a barge to either the barge or to a jack assembly carried by the barge, the lock being of such a nature that the weight of the barge and equipment carried thereby may be supported by the caissons through the lock and at the same time the lock is releasable so that the jack assembly may be utilized in the raising and lowering of the barge.

A further object of this invention is to provide an improved hydraulic jack assembly for barge caissons, the hydraulic jack assembly including first clamp means carried by the barge assembly for at least temporarily locking the barge assembly to the caissons so that the caissons will directly support the barge assembly, and extensible hydraulic motors carrying second clamp means which are also selectively engageable with the caissons for supporting the weight of the barge through the hydraulic motors and for raising and lowering the barge as desired when the first mentioned clamp means are released from the caissons.

An additional important object of the invention is to

provide an improved jack mechanism wherein the pairs of jaws of both the fixed and movable gripping jaw assemblies shall be free floating or self-centering with respect to the caissons being gripped thereby and wherein the entire operating power for moving these jaws may be applied to one jaw only of a pair of jaws until the latter has reached its extreme movement.

A further object of the invention is to provide a jack mechanism in accordance with the immediately preceding object wherein the sliding lateral or horizontal movement of the jaws towards and from their associated caissons shall be completely independent of the jack housing and which therefore will not require a relatively fixed engagement of the jaws with the jack housing and further wherein the jaws shall have a floating action so that they are only loosely confined and guided for horizontal movement within their housing relative to the column or caisson.

Yet another object of the invention is to provide a jack mechanism in accordance with the immediately preceding objects wherein lateral forces transmitted by canting of the caissons are transmitted to solid frame constructions and are not transmitted by means of the applied and gripping jaws through the jack actuating means, screw threads or the like.

Still another object is to provide jack mechanisms, each operatively connected to a caisson and which shall afford a highly effective guiding action upon its caisson whereby to limit to very close tolerances any tendency of a caisson to cant relative to enclosing jack mechanism.

A further object of the invention is to provide a caisson mounting and arrangement for offshore drilling barges wherein certain of the caissons shall be capable of a controlled tilting movement with respect to the vertical in order to thereby greatly stabilize the barge against lateral thrusts and the like and against horizontal movement.

Another object of the invention in accordance with the immediately preceding object is to arrange the tiltable leg assemblies or caissons in such a manner as to not interfere with the other non-tiltable caissons during the tilting of the tiltable legs.

Still another important object of the invention in accordance with the immediately preceding objects is to provide a tiltable caisson construction which will enable a maximum spread of the legs across the drilling slot; will provide adequate bearing and journalling engagement for the trunnions of the tiltable legs; and will provide maximum bearing areas for the trunnions of the tiltable legs.

Yet another important object of the invention in accordance with the immediately preceding objects is to provide means for effecting a positive control of the tilting of the tiltable caissons; a positive locking of the tiltable caissons in either extremes of tilted movement; and to enable the caissons to be tilted during the lifting or lowering of the barge thereon as desired.

A further and very important object of the invention is to provide a mechanism which will prevent the inadvertent simultaneous release of both the stationary and the movable gripping jaw assemblies on a given column or caisson and which will provide an interlocking connection between the jaw actuating means for this purpose.

Yet another important object of the invention is to provide an improved lifting ram mounting means which will enable the easy installation or replacement of a ram element as a unitary assembly; will permit a better transmission of stresses and thrust from the ram elements to solid frame members; will allow a limited amount of flexibility in the mounting of the ram assembly to permit any necessary canting of the same; will allow the use of unitary and interchangeable sub-assemblies; and will offer a complete independence of the lift system of one

column with respect to that of any other column or caisson of the barge.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIGURE 1 is a side elevational view of a work platform formed from a barge, the work platform supporting an oil well rig, the barge being supported above the water by a plurality of depending caissons, the floating position of the barge being shown in dotted lines;

FIGURE 2 is an end view of the barge and caisson construction of FIGURE 1;

FIGURE 3 is an enlarged fragmentary vertical sectional view taken substantially upon the plane indicated by the section line **3—3** of FIGURE 2 and shows the specific details of the jack assembly and the relationship between the jack assembly, the barge and one of the caissons, the caisson being shown in a retracted position;

FIGURE 4 is an enlarged transverse horizontal sectional view taken substantially upon the plane indicated by the section line **4—4** of FIGURE 3 and shows the details of the first releasable clamp means for clamping the caisson relative to the barge, the releasable clamp means being carried by a framework extending upwardly from the barge with the caisson passing therethrough;

FIGURE 5 is an enlarged transverse horizontal sectional view taken substantially upon the plane indicated by the section line **5—5** of FIGURE 3 and shows the specific details of the second releasable clamp means carried by the hydraulic motors for clamping the caisson to the hydraulic motors whereby the barge may be selectively moved with respect to the caissons through the hydraulic motors;

FIGURE 6 is an enlarged fragmentary vertical sectional view taken substantially upon the plane indicated by the section line **6—6** of FIGURE 4 and shows the mechanism for moving the clamping jaws of the first clamp means into and out of engagement with the caisson;

FIGURE 7 is a fragmentary transverse vertical sectional view taken substantially upon the plane indicated by the section line **7—7** of FIGURE 5 and shows the means for moving the clamping jaws of the second clamp means into and out of engagement with the caisson;

FIGURE 8 is an enlarged fragmentary perspective view of the lower end of one of the caissons and shows the details of a footing carried thereby;

FIGURE 9 is a combined wiring and hydraulic diagram for the hydraulic jack assembly for one of the caissons;

FIGURE 10 is a top plan view of a modified construction of offshore drilling barge in accordance with this invention;

FIGURE 11 is an end elevational view of the barge of FIGURE 10 as viewed from the drilling slot end thereof and illustrating the disposition of two drilling rigs over the drilling slot and also the arrangement of the vertical and the tiltable caissons supporting the drilling barge;

FIGURE 12 is a fragmentary detailed view taken in vertical section with parts being broken away and other parts shown in elevation through a portion of the hull of a drilling barge and through one of the caisson supporting frameworks which house the jack mechanism for operating a single caisson of the barge;

FIGURE 13 is a horizontal sectional view, parts being broken away, taken substantially upon the plane indicated by section line **13—13** of FIGURE 12 and showing the arrangement of the stationary gripping jaw assembly of a jack mechanism;

FIGURE 14 is a horizontal sectional detail view taken substantially upon the plane indicated by section line **14—14** of FIGURE 12 and showing the movable gripping jaw assembly;

FIGURE 15 is a detailed view in vertical section taken substantially upon the plane indicated by section line **15—15** of FIGURE 14 and showing in particular the disposition of the movable jaw assembly with respect to its associated caisson;

FIGURE 16 is a view similar to FIGURE 15 but taken in vertical section substantially upon the plane indicated by the section line **16—16** of FIGURE 13 and of the stationary gripping jaw assembly;

FIGURE 17 is a detailed view taken upon an enlarged scale and in horizontal section showing a portion of a jaw assembly and its actuating means;

FIGURE 18 is a detailed view in top plan showing the disposition of one of the tiltable caissons in a caisson receiving slot in the barge hull, the caisson being shown in horizontal section and being shown in its vertical position;

FIGURE 19 is a detailed view in vertical section taken substantially upon the plane indicated by the section line **19—19** of FIGURE 18 and showing the locking means for selectively retaining the caisson locked in its vertical position;

FIGURE 20 is a vertical sectional view taken susbtantially upon the plane indicated by the broken section line **20—20** of FIGURE 18 and showing the tiltable caisson, its mounting and its actuating means and showing the locking means by which the same is retained in its vertical position;

FIGURE 21 is a view similar to FIGURE 20 but showing the position of the locking mechanism and of the caisson in the tilted position of the latter;

FIGURE 22 is a somewhat diagrammatic view illustrating an interlock connection between the actuating means of the fixed or stationary and the movable gripping jaw assemblies of a caisson jack mechanism for preventing the simultaneous disengagement of both sets of jaws from the caisson;

FIGURE 23 is a detail view partly in horizontal section and partly in plan showing the disposition of the four lifting rams of the jack mechanism of one of the caissons of the barge;

FIGURE 24 is a detail view taken in vertical section upon an enlarged scale and substantially upon the plane indicated by the section line **24—24** of FIGURE 23, with parts being broken away and showing details of the mounting of a unitary lifting ram assembly of a jack mechanism; and

FIGURE 25 is an exploded perspective view of the means for retaining and mounting a lifting ram assembly in its seat in the hull of the barge.

MODIFICATION OF FIGURES 1–9

Referring now first to the embodiment shown in FIGURES 1–9 which forms the entire and complete subject matter shown and described in my copending application Serial No. 568,761, it will be seen that there is illustrated in FIGURE 1 an offshore drilling rig which is referred to in general by the reference numeral **10**. The offshore drilling rig **10** includes a platform which is in the form of a barge **12**. Carried by the barge **12** is suitable oil well drilling equipment **14**. In order that the barge **12** may be supported above the level of the water **16**, there is provided a plurality of caissons **18**. Inasmuch as the individual caissons are identical, only one of the caissons **18** will be set forth in detail hereinafter.

It is the purpose of the present invention to so mount the caissons **18** with respect to the barge **12** that the caissons **18** may be retracted relative to the barge **12** so that they do not extend below the barge **12**. The barge **12** may then be floated to the desired location and may then be anchored with respect to the bottom **20** of the body of water **16** by first lowering the caissons **18** and

seating them on the bottom 20, and then lifting the barge 12, upon the caissons, to its elevated position of FIGURES 1 and 2. In order to accomplish this, there is provided for each of the caissons 18 a hydraulic jack assembly which is referred to in general by the reference numeral 22.

Referring now to FIGURE 3 in particular, it will be seen that each hydraulic jack assembly 22 includes a framework which is referred to in general by the reference numeral 24. The framework 24 is seated on the barge 12 and extends upwardly therefrom in alignment with a well 26 extending through the barge 12, the well 26 being defined by a sleeve 28 which extends vertically entirely through the barge 12. Extending upwardly through the well 26 and through the framework 24 is one of the caissons 18.

The framework 24 includes a base frame 30, an intermediate frame 32, an upper frame 34 and an uppermost frame 36. The frames 30, 32, 34 and 36 are connected together at their corners by suitable standards 38. Suitable cross bracing 40 may be provided between the adjacent frames 30, 32 and 34.

In order that the caisson 18 may be connection to the barge 12 for supporting the barge 12 in a desired position, there are provided stationarily mounted first releasable clamp means which are referred to in general by the reference numeral 42, see FIGURE 6. The clamp means 42 includes a platform formed by a lower plate 44 seated on the upper frame 34 and an upper plate 46 secured to the underside of the uppermost frame 36, the plates 44 and 46 being in vertically spaced relation. Seated on the lower plate 44 and engaging the underside of the upper plate 46 so as to be restrained against vertical movement is a pair of opposed horizontally slidable clamping jaws 48 and 50. The clamping jaws 48 and 50 are generally rectangular in outline and are guided and confined for movement only towards and away from each other by suitable guide members 52, see also FIGURE 4, carried at least by the plate 44. The clamping jaws 48 and 50 are hollow and have recessed opposed central portions 54 and 56, respectively. The recessed opposed portions 54 and 56 are provided with projecting vertically spaced annular parts 58 as shown in FIGURE 3.

As is best illustrated in FIGURE 3, the caisson 18 has welded to the upper portion thereof a plurality of vertically spaced bands 60. The bands 60 combine to form annular recesses 62 in the periphery of the caisson 18. The projecting parts 58 are complementary to the recesses 62 and disposable therein for interlocking engagement with the bands 60 so as to clamp the caisson 18 to the barge 12 through the framework 24.

In order that the clamping jaws 48 and 50 may be selectively moved towards each other or apart, there are mounted in the hollow clamping jaw 48 on opposite sides of the recessed portion 54 small hydraulic motors 64 of the extensible type. The hydraulic motors 64 are double acting and have connected thereto by suitable piping 66 a hydraulic pump 68 which is driven by an electric motor 70.

Each hydraulic motor 64 includes an extensible plunger 72 which is connected to link 74. The links 74 are in turn connected each to a transverse shaft 76 which is suitably mounted within the clamping jaw 48. Carried by the ends of the transverse shafts 76 are links 78 each of which is connected by a pivot pin 80 to an elongated link 82. The opposite ends of the links 82 are pivotally mounted on transverse shafts 84 suitably mounted in the hollow clamping jaw 50. It is to be understood that there is one of the links 82 on each of the opposite sides of the caisson 18. By actuating the hydraulic pump 68, see FIGURE 9, and controlling the direction of flow through the hydraulic line 66 by means of a valve 86, the hydraulic motors 64 may be operated in the desired direction to cause the links 82 to move the clamping jaws 48 and 50 either apart or towards each other. If desired, the piping 66 may be provided with a suitable supply reservoir 88 and a pressure reservoir 90.

In order to assure equal movement of the clamping jaws 48 and 50, there is connected to the clamping jaw 50 at each side thereof a rod 92. The rod 92 extends into the clamping jaw 48 and is provided with an adjustable stop 94. Thus separation of the clamping jaws 48 and 50 is limited.

Overlying the base frame 30 is a base plate 96. Suitably secured to the base plate 96 and extending upwardly therefrom is a plurality of relatively elongated, vertically disposed hydraulic motors 98. Each of the hydraulic motors 98 includes a column 100 which is actually in the form of an extensible piston rod of the hydraulic motor 98. Carried by the plates 44 and 46 and extending therebetween and upwardly thereabove is a tubular guide member 102 for each of the columns 100. The upper end of each of the columns 100 passes through its tubular guide member 102 and is restrtained against movement other than vertical.

Referring now to FIGURE 9 in particular, it will be seen that the hydraulic motors 98 are each of the double acting type and have connected thereto fluid lines 104 which are in turn connected to a control valve 106. The control valve 106 is connected to a hydraulic pump 108 by means of a return line 110 and a supply line 112. If desired, the return line 110 may be provided with a supply reservoir 114 and a supply line 112 may be provided with a pressure reservoir 116. The hydraulic pump 108 is driven by an electric motor 118.

Carried by lower portions of the columns 100 are the movably mounted or second releasable clamp means which are referred to in general by the reference numeral 120. The clamp means 120 includes a platform which is referred to in general by the reference numeral 122. The plaftorm 122 is formed of a lower frame 124 and an upper frame 126 which pass around and enclose the columns 100 and which are suitably secured thereto. Carried by the frame 124 is a lower plate 128 which rests upon the frame 124. Secured to the underside of the frame 126 is an upper plate 130. Disposed between the plates 128 and 130 and prevented from moving vertically thereby are opposed clamping jaws 132 and 134.

Referring now to FIGURE 5 in particular, it will be seen that the clamping jaws are disposed on opposite sides of the caisson 18 and are limited to sliding movement towards and away from each other by suitable guide rails 136 which are disposed at least on the lower plate 128, and which, if desired, may be disposed on the underside of the upper plate 130. The clamping jaws 132 and 134 are provided with opposed intermediate recess portions 138 and 140, respectively. The recessed portions 138 and 140 conform to the general outline of the caisson 18 and include projecting fingers 142, see FIGURE 3, which are received in the annular recesses 62 of the caisson 18 which interlock with the bands 60 so that the caisson 18 may be locked with respect to the barge 12 through the hydraulic motors 98.

In order to effect movement of the jaws 132 and 134 towards and away from each other, there is mounted within the hollow jaw 132 on each side of the caisson 18 a small hydraulic motor 144 which is of the double acting, extensible type, the hydraulic motors 144 being identical with the hydraulic motors 64. Connected to an extensible piston rod 146 of each hydraulic motor 144 are links 148, see also FIGURE 7, which in turn, are connected to transverse shafts 150 which are suitably journaled in the jaws 132. Carried by each of the transverse shafts 150 is a lever 152 which is in turn connected to a link 154 by means of pivot pin 156. The links 154 extend between the jaws 132 and 134 and have their opposite ends connected to the jaw 134 by means of transverse shafts 158 which are suitably mounted in the jaw 134.

In order that the hydraulic motors **144** may be operated, see FIGURE 9, there is connected thereto suitable piping **160**. The piping **160** is connected to a control valve **162** which has connected thereto a return line **164** and a supply line **166**. Mounted in the return line **164** is a fluid supply reservoir **168**. A fluid pressure reservoir **170** is mounted in the supply line **166**. The lines **164** and **166** are connected to the hydraulic pump **172** which is driven by an electric motor **174**.

In order to limit relative movement of the clamping jaws **132** and **134** away from each other, there is provided, see FIGURE 7, a rod **176** which extends between the jaws **132** and **134**. One end of the rod **176** is anchored with respect to the jaw **134** and the other end portion of the rod **176** is provided with a stop **178** which is selectively engageable with the jaw **132** to restrict movement thereof away from the jaw **134**.

If it is so desired, the upper plate **46** may have secured thereto an upwardly projecting sleeve **177** which functions as a guide for the upper part of the caisson **18**. The upper end of the sleeve **177** is reinforced by a suitable band **179**.

The construction of the lower ends of the caissons **18** may be of any type. However, in the case of soft bottoms, it will be desired to provide each caisson **18** with a suitable footing **180** which may be in the form of a rectangular plate.

In order that the electric motor **118** may be operated, there is provided a supply line **182** which is controlled by a switch **184**. A similar supply line **186** is connected to the electric motor **174** and is controlled by means of a switch **188**. A supply line **190** is connected to the electric motor **70** and controlled by a switch **192**.

As illustrated, the valves **86**, **106** and **162** are manually operated. However, if desired, they may be controlled remotely by a suitable electric operator so that all of the hydraulic jack assemblies **22** may be simultaneously operated from a master control board.

In the operation of the present invention, the barge **12** is floated out to the desired position with the caissons **18** retracted. At this time the caissons **18** are held in their uppermost position by the clamp means **42**. When it is desired to lower the caissons **18**, the clamp means **120** are raised to a position immediately below the clamp means **42** by means of the hydraulic motors **98**. The jaws **132** and **134** are then engaged with the caisson **18**. Next the clamp means **42** are released and the clamp means **120** moved downwardly by the hydraulic motors **98**. Inasmuch as the caisson **18** is locked to the columns **100** by the clamp means **120**, it will be seen that the caisson **18** will be lowered through the barge **12**.

After the clamp means **120** have been lowered to the lowermost point of the travel of the columns **100**, the clamp means **42** are again reengaged with the caisson **18**, the clamp means **120** is released from the caisson, raised and again connected to the caisson. The process is repeated until such time as the caissons **18** become engaged with the bottom **20**. It is now necessary to use the hydraulic jack assemblies **22** for the purpose of elevating the barge **12** above the body of water **16** with the caissons **18** supporting the barge **12**. This is accomplished by raising the clamp means **120** to the uppermost position thereof and locking the clamp means **120** with respect to the caisson **18**. Inasmuch as the hydraulic motors **98** are connected to the barge **12**, when the clamp means **42** are released and the hydraulic motors **98** operated to withdraw the columns **100**, since the caissons **18** cannot move downwardly, the barge **12** is lifted. The barge **12** may be repeatedly lifted utilizing the clamp means **42** and **120** and when it reaches its uppermost position, it may be locked in place by the clamp means **42**. If desired, the clamp means **120** may also be used as a safety device.

Although four hydraulic motors **98** have been shown as forming a part of each of the hydraulic jack assemblies **22**, it is to be understood that the number of hydraulic motors **98** may vary. Further, it is to be understood that the size of the hydraulic motors **98** may be varied so that different loads may be lifted thereby. Also, the number of caissons **18** supporting the barge **12** may be varied as is found necessary.

MODIFICATION OF FIGURES 10–25

Fixed and movable gripping jaw assemblies and their actuating means (FIGURES 10–17)

The barge shown in FIGURES 10–25 operates upon the same general principles as those of the preceding embodiment of FIGURES 1–9 but has a number of important differences. Thus, referring specifically to FIGURES 10–17, there is provided a hull indicated generally by the numeral **200** and which in plan is of the contour shown in FIGURE 10. At what may be termed the rear or drilling slot end of this hull there is provided a forwardly opening drilling slot **202** therethrough over which are mounted a pair of drilling rigs **204** of any conventional character.

As in the preceding embodiment, the barge hull is adjustably supported by a plurality of caissons or supporting columns or legs and which are indicated each by the numeral **206**. As will be observed from the plan view of FIGURE 10, the caissons illustrated are disposed in four groups of three each, positioned at what may be termed the four corners of the barge. In each group of three caissons, two of these are supported in a fixed or non-tilting vertical position while one caisson of each group is supported for tilting movement by power operated tilt adjusting mechanism to be subsequently set forth in order that a supporting lateral thrust may be given to the barge at its four corners to improve the lateral stability of the same. It is to be understood that any desired number and arrangement of the tiltable and non-tiltable caissons may be employed.

Each of the caissons **206** may be of the construction set forth in the description of the preceding embodiment, with each caisson as shown more clearly in FIGURES 12, 15 and 16 comprising a hollow cylindrical column **208** of uniform diameter throughout its length and which at uniform longitudinally spaced intervals along its length is provided with annular radially projecting ribs, bands or rings **210** constituting a means engageable by gripping jaws with a positive, non-slipping, interlocking action to effect relative vetrical movement of the caisson with respect to the barge and to lock the caisson in vertically adjusted position with respect to the barge as set forth hereinafter.

At the lower edge of each caisson there is preferably provided a foot structure as at **212** of any conventional design which may rest upon or be forced and embedded into the bed of the ocean in order to secure a firm anchorage for supporting the barge.

As in the preceding embodiment, each caisson is provided with a jack mechanism which includes a pair of gripping jaw assemblies for cooperation with the rings **210** upon the associated caisson. Each jack assembly including those for both the fixedly mounted and the tiltably mounted caissons consists of an enclosing casing or housing **214** rigidly secured to and rising above the deck of the barge, and which may extend if desired throughout the entire space between the top deck plate **216** and the bottom hull plate **218** of the barge as suggested in FIGURE 12. Rigidly secured to and supported above the deck of the barge in any suitable manner and disposed in the casing **214**, is an upper or fixed jaw assembly housing **220** in which is mounted a fixed jaw assembly. Preferably the housing **214** may consist of a single sheet of material which is disposed about and encircles and encloses the upper housing **220**.

Disposed within the casing **214** and relatively movable between the upper housing **220** and the deck **216** of the barge is a power operated movable platform or movable jaw assembly housing indicated generally by the numeral **222** in which is received a set of relatively vertically

movable gripping jaws constituting a movable jaw assembly and which cooperates with the associated caisson to raise or lower the latter relative to the barge as set forth hereinafter.

A series of jacks preferably in the form of hydraulically actuated rams each indicated generally by the numeral **224** are mounted in a recessed manner in the structure of the barge hull and are operatively connected to the movable platform or housing **222** to effect lifting or lowering of the latter as shown in these drawings, four such rams being depicted in equidistantly spaced relation about each caisson as a satisfactory arrangement to provide a power operating means for elevating or lowering the barge upon the caissons. Obviously other numbers or arrangements of the lifting rams could be utilized for this purpose.

Referring now particularly to FIGURES 13 and 16 for a detailed consideration of the construction of the fixed jaw assembly it will be observed that the stationary jaw assembly housing or support structure consists of rigid and rigidly connected spaced upper and lower guide members **230** and **232** which thus provide a shelf-like space therebetween in which is received a gripping jaw assembly comprising a pair of complementary horizontally or transversely slidable gripping jaws each indicated by the numeral **234**. It should be further noted in FIGURE 16 that the members **230** and **232** have cylindrical bores or wells **236** and **238** therebetween in which is slidably received the associated caisson **206**. In view of the rigid mounting of the members **230, 232** with respect to the structure of the barge hull these members operate as guides for the caissons and in practice a very close fit is provided between the walls of the wells **236, 238** and the peripheral surfaces of the caisson rings or bands **210**, this clearance being in the order of about ½ inch with the caissons themselves being about 6 feet in diameter. As set forth hereinafter a similar guiding action is provided by the disposition of the caissons in the vertical wells extending through the hull of the barge in which the caissons slide so as to provide spaced vertical guides for the caissons which extend over a substantial length of the same and thus greatly contribute towards minimizing any tendency towards canting of the caissons thereby effecting stable support of the barge upon the caissons.

The pair of gripping jaws **234** of the fixed jaw assembly are slidably disposed between the flat adjacent horizontal surfaces of the members **230, 232** so that the vertical thrust of the caisson when the jaws are clamped thereto may be directly carried by one or the other of the surfaces depending upon the direction of the thrust.

The jaws have a limited free floating movement and are positioned for lateral or horizontal sliding movement in the shelf-like space provided between the two members **230, 232**, and are retained for rectilinear guided movement between a pair of guide rails, each indicated by the numeral **240** in FIGURE 13 and which are secured to either or both of the adjacent surfaces of the members **230, 232** on opposite sides of the pair of jaws. Thus the jaws are confined to straight line movement towards and from each other and are disposed on opposite sides of the caisson with which they cooperate.

There are further provided fixed stops in the form of blocks or other members **242** which are fixedly secured to one or both of the adjacent surfaces of the members **230, 232** and are positioned so as to be engaged by the jaws **234** to limit the movement of the latter away from each other and away from their associated caisson.

At this point it is important to note that except for their guided action between the guide members **240** and their confinement between the adjacent surfaces of the members **230, 232**, the jaws are horizontally free floating with respect to each other, with respect to the caisson and with respect to the jaw housing structure **220**, within the limits provided by the stops **242**. By means of this construction, when the jaws are clamped to the caisson they may shift slightly in a lateral or horizontal direction with the caisson and within the relatively slight tolerances or limits allowed by the above mentioned very slight clearance between the caisson and the wells **236, 238** in the fixed jaw housing **220** and also within the well extending through the barge hull. By this means although a rigid secure vertical engagement of the jaw assembly with the caisson is attained, no lateral strain or thrust of the caisson is transmitted by the jaws to the jaw housing means since the jaw assembly is free-floating or self centering therein.

The jaw assemblies are preferably hollow or box-like in structure having, as shown best in FIGURE 16, top and bottom plates **244** and **246** which at their sides adjacent to the caisson are connected by vertically extending webs **248** and vertically extending end walls **250**, see also FIGURE 13, with their sides which are remote from the caissons being open. Each web **248** is dished or convexed to correspond to the complementary surface of the caisson and there are provided a pair of arcuate ribs **252** rigidly secured to the web **248** and appropriately spaced to effect complementary interlocking engagement with the corresponding rings **210** of the caisson as shown in FIGURE 16.

Power operated means are provided for effecting movement of the jaws toward and from each other in order that the jaws may be caused to effectively grip or release the associated caisson. For this purpose, the actuating means shown preferably comprises a source of power such as an electric motor **254**, controlled in any suitable manner and supplied by electric power of any suitable source as through a conduit means **256**. This electric motor is mounted within and is carried by one of the hollow jaws **234** for movement therewith, and has its drive shaft **258** operatively connected as by a pair of sprocket chains **260** to a pair of jaw operating shafts **262** each of which is suitably journalled in the adjacent ends of the pair of jaws **234**. It is of course understood that in some instances the electric motors may be replaced by other sources of power.

As shown in greater detail in FIGURE 17, the shafts **262** are rotatably journaled in one of the jaws but are retained therein against axial movement as by a bearing assembly **264**, but have their other screw threaded extremities **266** journaled in the other jaw **234** of the pair of jaws and threadedly engaged in a travelling mechanism **268** which is retained between a pair of lugs **270** against movement axially of the shaft. As shown in FIGURE 17, the right end of the shaft **262** has a circumferential groove or channel **263** in which is engaged a pin **265** carried by the assembly **264** to permit rotation but prevent axial movement of the shaft **262** relative to the associated jaw **234**. As a result of this arrangement upon rotation of the two jaw actuating shafts **262** simultaneously by the source of power **254**, the jaws are forced to move toward or from each other. Since the jaws are each freely slidable horizontally in their housing, it is evident that when the jaws are not engaged with either the caisson or with their abutments **242**, either or both of the jaws is free to move. Thus, with the jaws moving toward each other, when one of the jaws engages the caisson, it will then draw the other jaw thereto and thus effect a secure clamping engagement with the caisson. Conversely, when the jaws separate, one of the jaws will first engage the stops **242**, whereupon the other jaws will be pushed bodily away therefrom and thus effect complete disengagement of the jaws from the caisson. The jaws are thus free floating as previously mentioned in order that they may center themselves with respect to the caisson and yet are positively operated to and from their gripping engagement with the caisson. Moreover, in this arrangement all of the operating power of the jaws is made available to each jaw in turn, if necessary.

Referring next more particularly to FIGURES 14 and 15 it will be observed that the movable jaw assembly **222** although smaller in cross sectional area is quite similar in construction to that of the fixed jaw assembly. Thus, the

vertically movable housing or platform of the movable jaw assembly **222** consists of vertically spaced housing members **272, 274** rigidly connected together in suitable manner in a fixed vertically spaced relation to provide adjacent horizontally extending plate members **276** and **278**. Slidable between these plate members is a pair of gripping jaws, which being of the same construction as the jaws **234** and with their similar components and associated structure being designated by the same numerals. The same guide structure, stop means, jaw structure and jaw actuating means previously described is then employed with this assembly and accordingly a further description of the same is believed to be unnecessary. The operation of the jaws in moving toward and from each other to engage or release the caisson, and the free floating and self-centering action of the jaws in order that they may accommodate themselves to any slight tilting of the caisson is identical with that previously described in connection with the fixed jaw assembly.

However, extending through and fixedly secured in any desired manner to the upper and lower members **272, 274** of the movable jaw assembly are the piston rods **280** forming a part of the hydraulic rams **224**.

As will be now apparent from a consideration of FIGURES 12, 14 and 15, the piston rods **280** extend through, are fixedly attached to and are received in appropriately spaced sleeves or bushings **282** which are provided in the members **272, 274** and also extend therebetween as shown in FIGURE 15. In this manner the platform or movable jaw assembly **222** is rigidly secured to the piston rods **280** for vertical movement relative to the barge and relative to the fixed jaw assembly **220**.

It will be noted from FIGURE 15 that the movable platform upper and lower members **272** and **274** are likewise provided with cylindrical wells or bores **284** and **286** therein which provide the necessary working clearance between the jaws and the caisson to enable sliding of the jaw assembly over the caisson when the jaws are to grip the caisson at a different location during the operation of the jack mechanism.

Tilting leg assemblies and their actuating means (FIGURES 18–21)

As was previously mentioned, each of the four groups of three caissons and their mounting means has one caisson which is mounted for tilting movement. For this purpose, an adjacent side edge of the barge hull is notched or cutaway as at **290** to receive therein a tiltable caisson mounting assembly. In this mounting assembly a cylindrical housing **292** is provided with a pair of diametrically opposed fixed trunnions **294** which are journalled in bearing segments **296** and **298** which are carried by the opposite vertical side walls of the recess or notch **290**. By this means the bodies **292** are tiltably mounted in these notches which latter are of sufficient extent to permit the desired tilting movement of the housings.

In actual practice one of the bearing segments such as the lower segment **296** is preferably integrally formed as a boss or projection from the side wall of the notch **290** or may be welded thereto if desired, while the other or upper segment **298** is welded to the side wall and to the lower segment after the trunnions have been placed in position in the lower segments. Thus, the tiltable housing **292** is securely mounted in the notches in the barge hull.

At this point it should be observed that the housing **292** has therein identically the same arrangement of relatively fixed and relatively movable jaw assemblies and the jacking mechanism previously described in connection with FIGURES 10–17 in order that operation of the hydraulically actuated rams **224** may effect a positive raising or lowering of the caisson with respect to its housing **292** and thus with respect to the barge.

In order to effect a desired tilting movement of the tiltable housings **292** about the horizontal axes of their trunnions **294**, there are provided as shown best in FIGURE 18 an actuating means in the form of a hydraulic cylinder and piston unit **300** there being a pair of these units each secured pivotally as at **302** to a suitable portion of the barge hull framework and being further pivoted as at **304** to the tiltable housings **292** as to lugs **306** thereon. Thus upon operation of the pair of rams, tilting movement in either direction about the horizontal axis of the trunnions can be obtained.

The invention further contemplates a means for positively locking the tiltable caisson mounting housings **292** at either extremes of their tilted movement. For this purpose, the locking or latching means shown in FIGURES 19–21 may be advantageously employed. The locking means includes a pair of horizontally spaced fixed abutments **308** and **310** which are fixedly secured to and project laterally from each of the side walls of the notches **290**. Laterally projecting latch pins **312** are carried by the housing **292** on opposite sides thereof and are positioned for movement between the two stops, so that the two stops define the limits of tilting movement in opposite directions of the caisson housing **292**.

A latch member is provided to engage the latch pin **312** and retain the same against a selected stop and thus lock the tiltable caisson at either end of its tilting movement. The latch pin consists of a slidable bolt **314** guidingly retained between a pair of guide lugs **316** and **318** which likewise are carried by the side walls of the notch so that the pin may be moved vertically into and out of locking engagement at the mid-portion of the space between the two locking abutments **308, 310**. Actuation of the latch pin **314** is effected by a latch lever **320** which is pivotally connected to the latch pin and also to a fluid pressure actuating member **322** likewise suitably carried by the side wall of the notch **290**.

The arrangement is such, that when the caisson and its mounting cylinder **292** are in an erect or vertical position, the latch pin **312** will engage the abutment **308** and thus confine the caisson at one end of its tilting movement and in a vertical position. In this position, as shown in FIGURE 20, the latch pin **314** retains the latch pin against the abutment **308**. When it is desired to tilt the caisson as to the position shown in FIGURE 21, the latch pin is withdrawn by actuation of the member **322**, the tilting rams **300** are operated and the caisson tilted from the position shown in FIGURE 20 to that shown in FIGURE 21, at which time the latch pin **312** will engage against the abutment **310**, and the latch bar **314** will be again actuated to thereby engage and maintain the latch pin against the abutment **310** and the caisson in its tilted position.

As will be understood, various actuating means may be utilized to effect the tilting of the housings **292** and to operate the latch pins **314**. Further, latch means may be employed which will allow the locking of the tiltable caissons in various degrees of inclination from the vertical.

Interlock connection between fixed and movable gripping jaw assemblies (FIGURE 22)

It is important that both the fixed and movable jaw assemblies **220** and **222** may never simultaneously disengage from a caisson **208** since this could result in dropping a caisson with possible serious damage to the barge if the barge is in a buoyant floating condition; or could result in dropping of the barge on a caisson if the barge is in an elevated position.

Accordingly, an interlock connection is provided between the electrical circuits of the two motors **254** which actuate the fixed and movable jaw assemblies **220** and **222** of each of the caisson jacking mechanisms. A diagrammatic electrical circuit means is indicated in FIGURE 22 to illustrate one manner of carrying out this feature of the invention. A pair of electrical contacts **450** and **452** are suitably positioned for engagement by a switch blade **454**. The switch blade is secured to or otherwise assoicated with one of the jaw actuating shafts **262** so that the switch will be closed when the jaws **234** of

the corresponding switch are engaged or locked upon the rings 210 of the caisson 208. The two sets of switches are connected into an electrical circuit system by which electric current is supplied from the power line 456 to the motors 254. The swtiches are so arranged that when both of the sets of jaws are locked upon the caisson, both switches are closed and the circuits to each of the reversible electric motors 254 is thus rendered available for operation by the control panel of the barge. However, as soon as one of the jaws is moved to a jaw disengaging position from the caisson, the associated switch blade 454 disengages from the contact 450, 452 and thus opens the circuit for the other motor thereby preventing any movement of the other set of jaws until the first set of jaws has been again closed upon the caisson. This arrangement insures that both sets of jaws cannot be simultaneously released from the caisson.

Since it is evident that various circuitry and arrangements for interlocking or interconnecting the control of the jaw actuating means, and since the details of this feature of the invention are not essential to an understanding of the invention claimed herein, a further description thereof is superfluous.

Lifting ram mounting means for the jacking mechanism (FIGURES 23–25)

In view of the extremely heavy duty to which the lifting ram units 224 are placed, it is highly desirable that provision be made for enabling the ready removal of the rams from their mountings in order to service the same or replace the rams as desired. To facilitate assembly and disassembly of the rams from their mounting means the construction shown in FIGURES 23–25 is provided. Each of the rams as shown in FIGURE 24 is mounted in a recessed manner below the deck structure 216 of the barge. Thus, as shown in FIGURE 23, the four operating rams for each caisson are disposed uniformly about that caisson. There are provided openings 500 cut in the top deck 216 of the barge and a cylindrical housing 502 is inserted into each of these openings and is then rigidly secured in place as by welding at 504 to the deck 216 and by suitable other bracing and reinforcing ribs such as those indicated at 506 in FIGURE 12. The upper end of the cylinder 502 projects upwardly above the deck 216 as shown in FIGURE 24.

Disposed within the interior of the cylinder 502 and below the deck plate 216 there is welded a supporting band or ring 508. The hydraulic ram 224 includes a laerally projecting cover or end plate 510 which is inserted in the open end of the cylinder 502 and rests upon the seating ring 508. A segmental pressure ring 512 is disposed in the cylinder resting upon the flange 510 of the ram to hold the latter against its seat and locking ring segments 514 are then placed upon the pressure ring and are received in the annular locking ring channel 516 formed upon the interior of the cylinder 502. A lock ring retainer 518 is then disposed within the locking ring segments 514 to retain them seated in the locking ring channel 516, and it will be observed that the underside of both of the locking ring segments 514 and the locking ring retainer 518 engages upon a top surface of the pressure ring segment 512. Finally, a releasable retainer ring 520 is secuerd in the upper open end of the cylinder 502, being releasably secured thereto by means of detachable fastening bolts 522 which extend through registering apertures in the releasable retainer ring 520 and in the upper edge portion of the cylinder 502. It will be observed that the releasable retainer ring 520 includes an inturned annular flange 524 which overlies both the locking ring segments 514 and the locking ring retainer 518 to thus securely retain the latter in position. In this manner the ram unit 224 is held down against its seat 508 by pressure exerted through the locking ring segments 514, the locking channel 516 and the pressure ring 512, while the releasable retainer ring 520 serves merely to retain the locking components in a locked position and is not itself subjected to any of the load or thrust of the ram unit.

Thus, any ram unit may be easily and quickly replaced with a minimum of effort.

Inasmuch as the ram cylinder is supported only at its upper end by its flanged upper end 510, there is allowable a limited amount of flexibility to enable canting of the ram element if necessary, and suitable gasket means can be utilized for this purpose. There is also permitted the use of unitary and interchangeable sub-assemblies of the rams and their mounting means and their is retained the complete independence of the lift system of one caisson with respect to that of any other.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. An offshore drilling barge capable of being raised above the water on caissons, said barge having a plurality of caisson receiving guide wells therein extending vertically entirely therethrough, a plurality of rigid supporting structures each fixedly secured adjacent its lower end to said barge and extending upwardly therefrom generally coaxially with the vertical axis of each guide well, said supporting structures each including a caisson guide fixedly positioned in the upper portion thereof, a plurality of hollow cylindrical supporting caissons each disposed in, extending through and having a slidable guided engagement with both a well and a caisson guide of an associated supporting structure, a gripping jaw assembly carried upon an upper portion of each supporting structure in a vertically stationary position thereon during a barge raising operation, a movable gripping jaw assembly mounted within each supporting structure for vertical movement therein, each gripping jaw assembly including jaw means for engaging and disengaging the caisson, an actuating means for each gripping jaw assembly connected to said jaw means capable of selectively moving the latter toward and from the caisson between caisson engaging and caisson releasing positions, complementary engaging means on said caisson engageable with said jaw means to establish a positive, non-slipping vertically interlocking engagement between said caisson and jaw means when said jaw means is moved toward said caisson, fluid operated elevating cylinder assemblies within said supporting structures, said elevating cylinder assemblies each having a vertically extensible piston rod, said piston rod being connected to one of said associated gripping jaw assemblies, and said cylinder assemblies being operatively connected between the gripping jaw assemblies for effecting axial movement therebetween, whereby the guide wells and the caisson guides in the upper portion of the supporting structures limit canting movement of respective caissons to thereby avoid excessive lateral loading of the elevating assemblies.

2. The combination of claim 1 wherein each of said actuating means includes an element operatively connected thereto for movement with its respective jaw means when said respective jaw means is moved to positions for engaging and releasing an associated caisson, means interconnecting the element of each one of the actuating means to the other actuating means for rendering inoperative said other actuating means and for preventing movement of its associated jaw means to prevent disengagement of said last-mentioned jaw means from its caisson when the jaw means of the other jaw assembly is disengaged from said caisson.

3. A mobile offshore barge construction as set forth in claim 1, in which said jaw means includes a pair of opposed laterally movable members, and wherein said complementary engaging means includes vertically spaced horizontal rings extending entirely about each caisson for engagement by the jaws, and wherein said gripping jaw assemblies each further includes a pair of horizontally disposed vertically spaced guiding elements confining said members for lateral sliding movement therebetween.

4. A mobile offshore barge construction as set forth in claim 3, in which each laterally movable member has a face thereon contoured complementarily to the periphery of said caisson, said face including spaced lugs thereon, said lugs being vertically spaced and dimensioned to seat within the space between said rings to thereby establish positive vertical engagement between said members and caisson.

5. The combination of claim 3 including a pair of spaced elongated rigid members connected adjacent respective ends thereof to associated opposed laterally movable members, the associated caisson passing between each pair of spaced rigid members, driving means connected to each of said spaced rigid members for selectively effecting movement of said jaws toward and away from each other, and stop means carried by said gripping jaw assemblies and positioned in the path of movement of said members for limiting movement of associated opposed laterally movable members away from said caisson.

6. In an offshore drilling barge adapted to be elevated and supported above the water, a plurality of first spaced rigid supporting structures, means carried by the barge mounting each of said supporting structures for tilting about a substantially horizontal axis, a plurality of spaced first elongated supports, each first support being axially slidable and guidingly mounted within and extending through one of said first supporting structures, a first jacking means including, a gripping jaw assembly carried within associated supporting structures, said gripping jaw assembly being fixed within an associated supporting structure during a barge supporting operation, a movable gripping jaw assembly mounted within associated supporting structures for axial movement therein, fluid operated cylinder assemblies each having a vertically extensible piston rod, said piston rod being connected to one of said gripping jaw assemblies disposed within associated supporting structures, said cylinder assembleis being operatively connected between the gripping jaw assemblies for effecting axial movement therebetween, each gripping jaw assembly including jaw means for engaging and disengaging the elongated supports, an actuating means for each gripping jaw assembly connected to said jaw means for selectively moving the latter toward and from associated elongated supports between engaging and releasing positions, vertically spaced complementary engaging means on said elongated supports engageable with said jaw means to establish a positive non-slipping interlocking engagement therebetween, a plurality of spaced second elongated supports, each second support being axially slidable and guidingly mounted for vertical movement within the barge in second spaced rigid supporting structures, a second jacking means in accordance with said first jacking means associated with each of said second elongated supports, means connected to said first supporting structures for effecting controlled tilting thereof, locking means engageable with said barge and said first supporting structures for retaining said first supporting structures in tilted position, said barge being elevated upon said second elongated supports and supported by said first elongated supports in tilted position, and at least one of said gripping jaw assemblies fixing each elongated support with respect to the barge when the barge is in raised position.

7. The combination of claim 6, in which said locking means includes a pair of stop means carried by said barge for limiting tilting in each direction of said pivoted supporting structure and latch means engageable with said barge and pivoted supporting structure for retaining the latter in tilted position against said stop means.

8. A barge construction for offshore installation including a plurality of supporting hollow caissons each being movable relative to said barge, a pair of spaced vertically aligned caisson guides each rigidly fixed with respect to the barge carrying each caisson, a plurality of vertically extending hydraulic cylinders spaced about each caisson, each of said hydraulic cylinders including an extensible vertical piston rod, a first gripping jaw assembly for selectively locking said caisson to said barge and to release said caisson therefrom, a second movable gripping jaw assembly secured to and movable vertically with said piston rods, said piston rods each being connected to one of said gripping jaw assemblies, said second assembly receiving the associated caisson for movement therethrough, each caisson having longitudinally spaced annular bands thereon extending entirely thereabout defining recesses therebetween, complementary laterally movable jaws mounted upon said first and second assemblies, each set of complementary jaws being laterally movable for extending into said recesses for interlocking engagement with the annular bands of said caisson, said annular bands slidingly engaging said guides for movably supporting the caisson therein and maintaining the caisson free of engagement with the guides, each of said assemblies including a pair of vertically spaced upper and lower horizontal guide elements, each set of complementary jaws being slidably disposed between and retained against relative vertical movement by the associated pair of guide elements, and means connecting said jaws on opposite sides of the associated caisson to thereby permit sliding movement of said jaws and said means as a unit within said guide elements, and driving means connected to said means connecting said jaws for selectively effecting movement of said jaws toward and away from each other, whereby the jaws are self-centering and capable of limited free sliding movement within said guide elements.

9. The combination of claim 8, wherein each of said driving means each includes an element operatively connected thereto for movement with its respective complementary jaws when said respective complementary jaws of each asesmbly are moved to positions for engaging and releasing an associated caisson, means interconnecting the element of each one of the driving means to the other driving means for rendering inoperative said other driving means and for preventing movement of its associated complementary jaws to prevent disengagement of said last-mentioned complementary jaws from their associated caisson when the complementary jaws of the other assembly are disengaged from said caisson.

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