Sept. 26, 1961 J. E. LUCAS 3,001,592

WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

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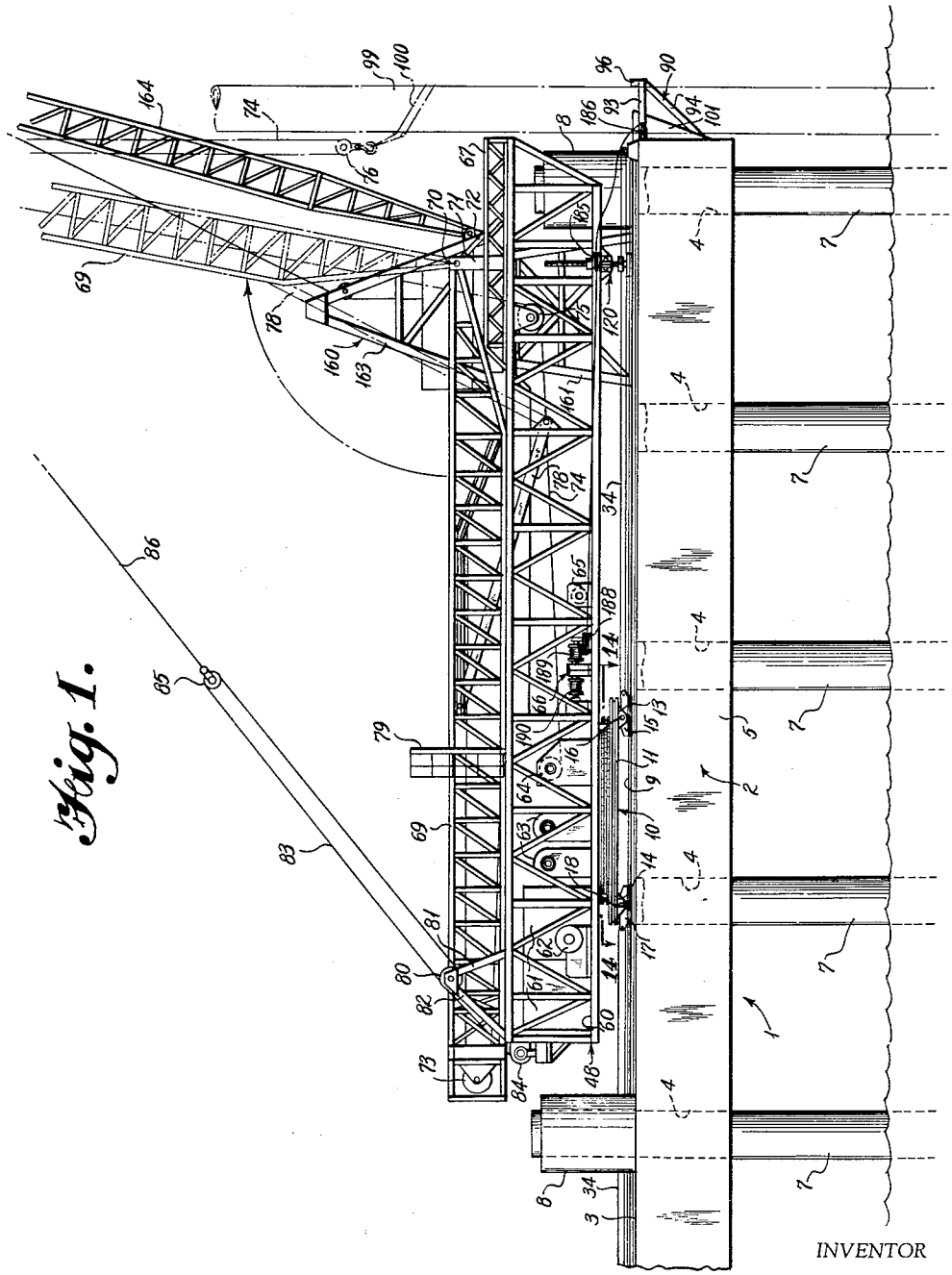


Fig. 1.

INVENTOR

Joseph E. Lucas

BY Bacon & Thomas

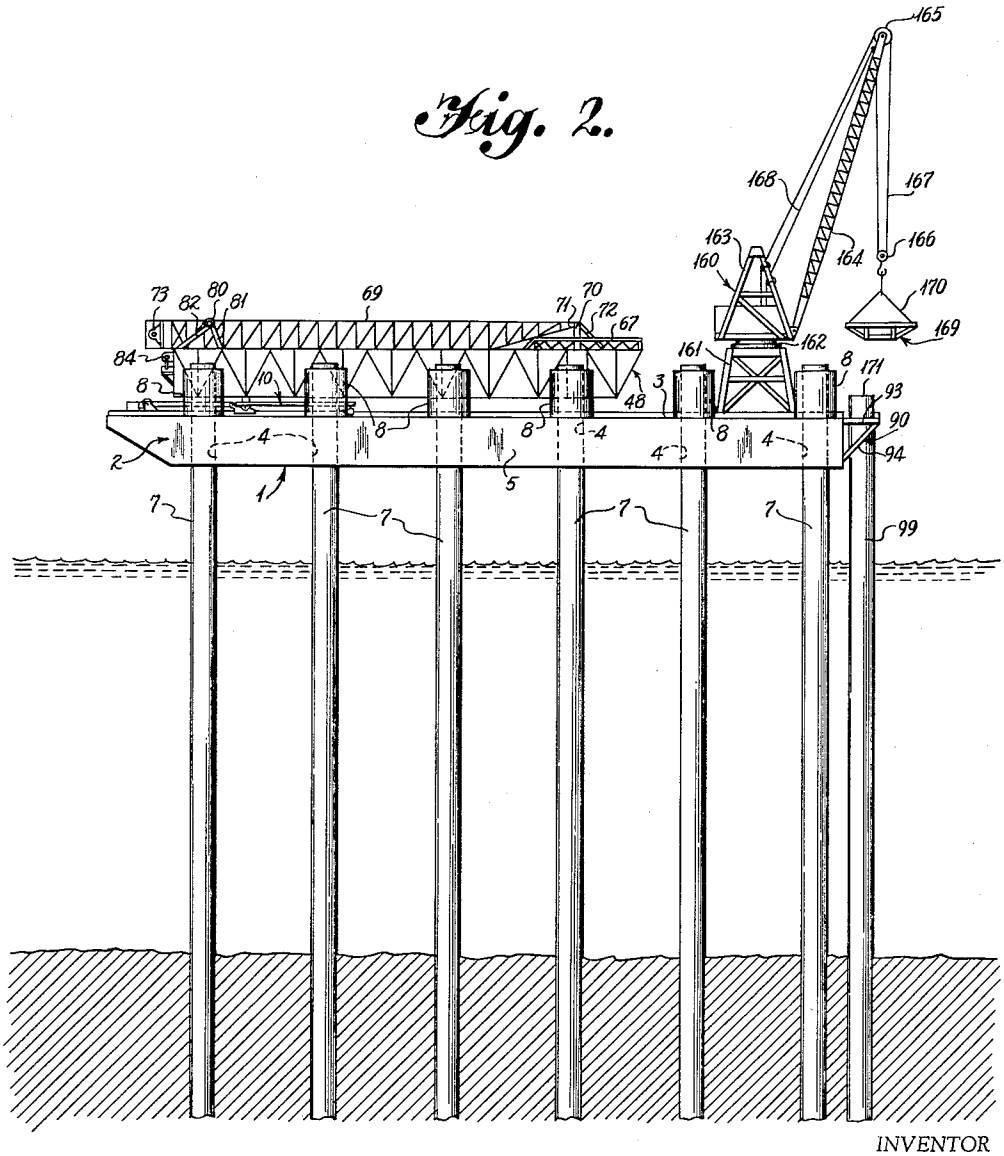
ATTORNEYS

Sept. 26, 1961 J. E. LUCAS 3,001,592

WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

Filed Sept. 3, 1954 17 Sheets-Sheet 2

Fig. 2.



INVENTOR

Joseph E. Lucas

BY Bacon & Thomas

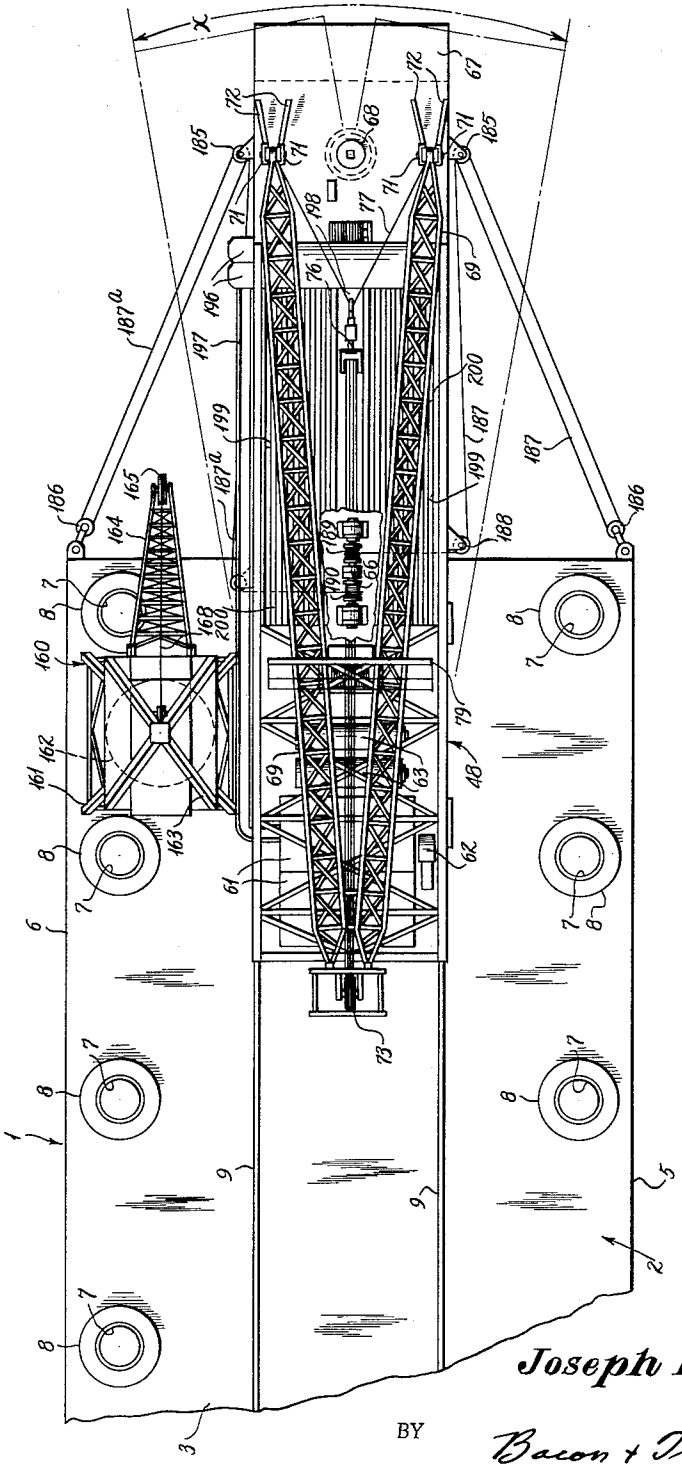
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Sept. 26, 1961 J. E. LUCAS 3,001,592

WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

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Fig. 3.



INVENTOR

Joseph E. Lucas

BY

Bacon & Thomas

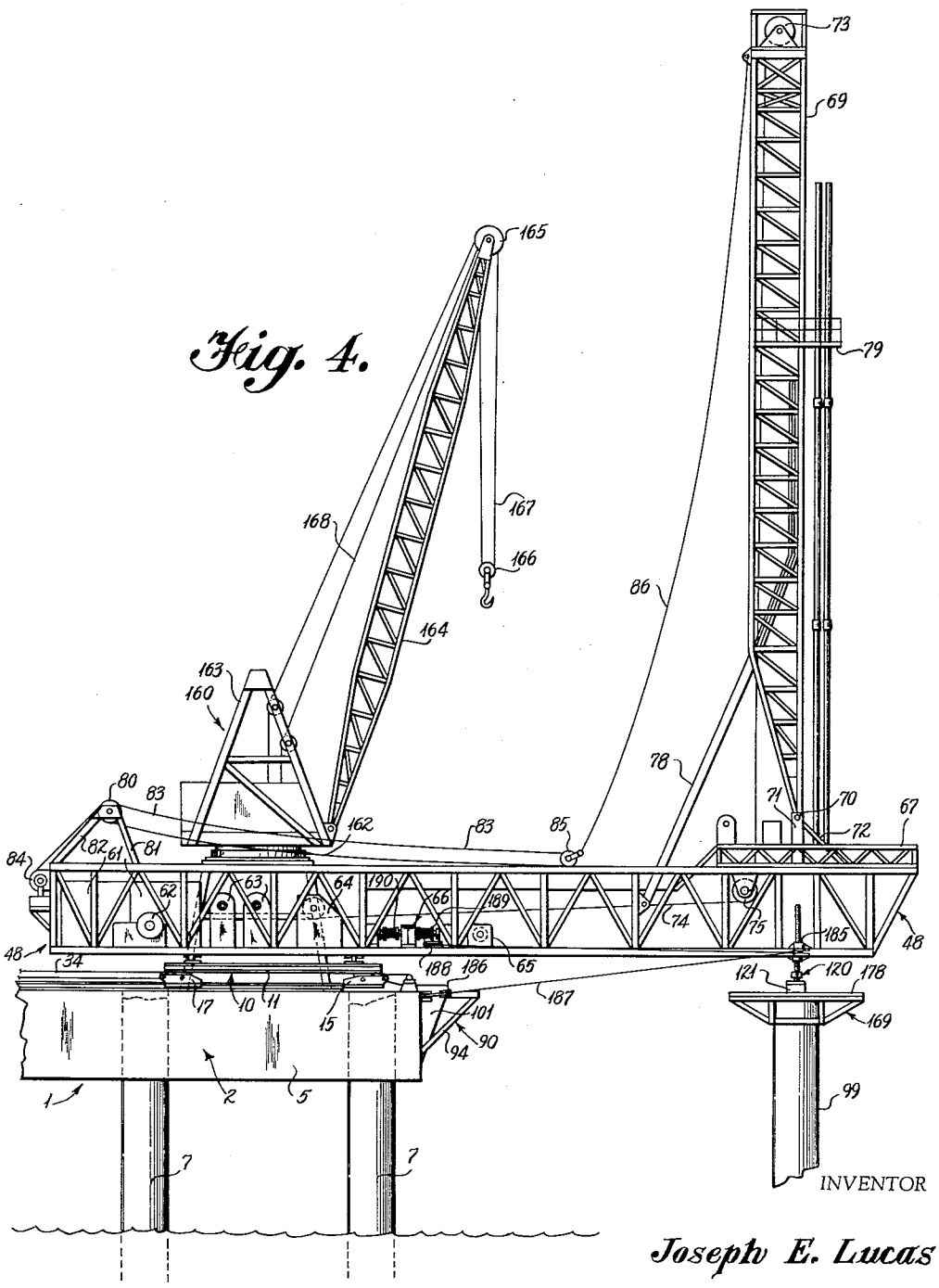
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WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

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Fig. 4.



INVENTOR

Joseph E. Lucas

BY

Bacon + Thomas

ATTORNEYS

Sept. 26, 1961 J. E. LUCAS 3,001,592

WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

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Fig. 6.

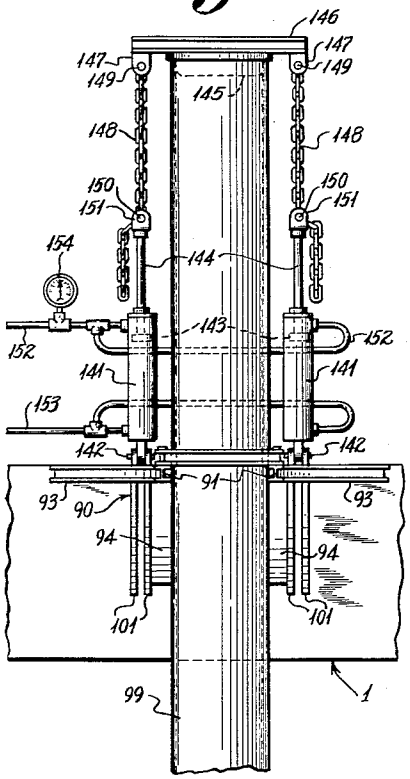


Fig. 5.

INVENTOR

Joseph E. Lucas

BY Bacon & Thomas

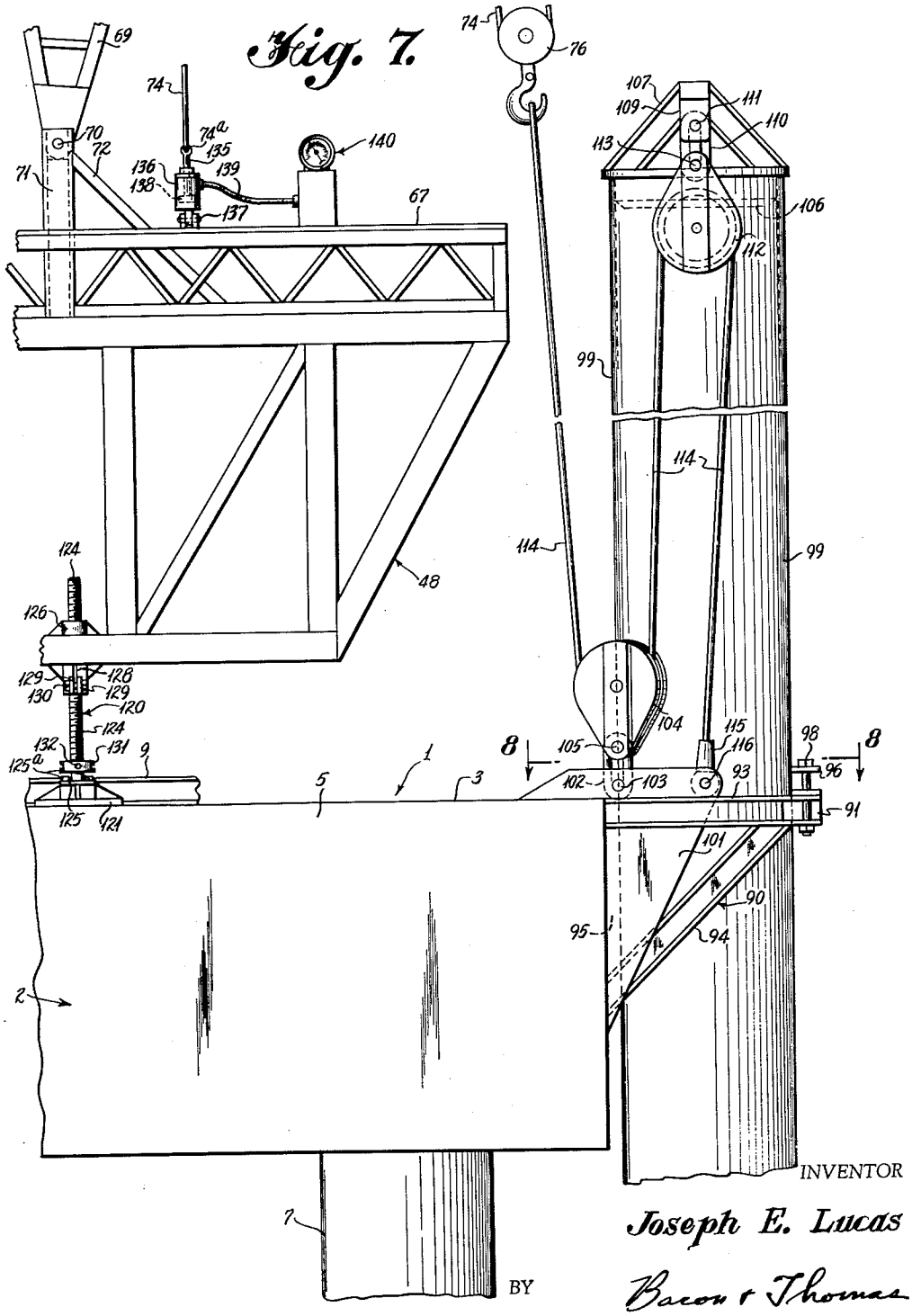
ATTORNEYS

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WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

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Fig. 7.



INVENTOR

Joseph E. Lucas

BY Bacon & Thomas

ATTORNEYS

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WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

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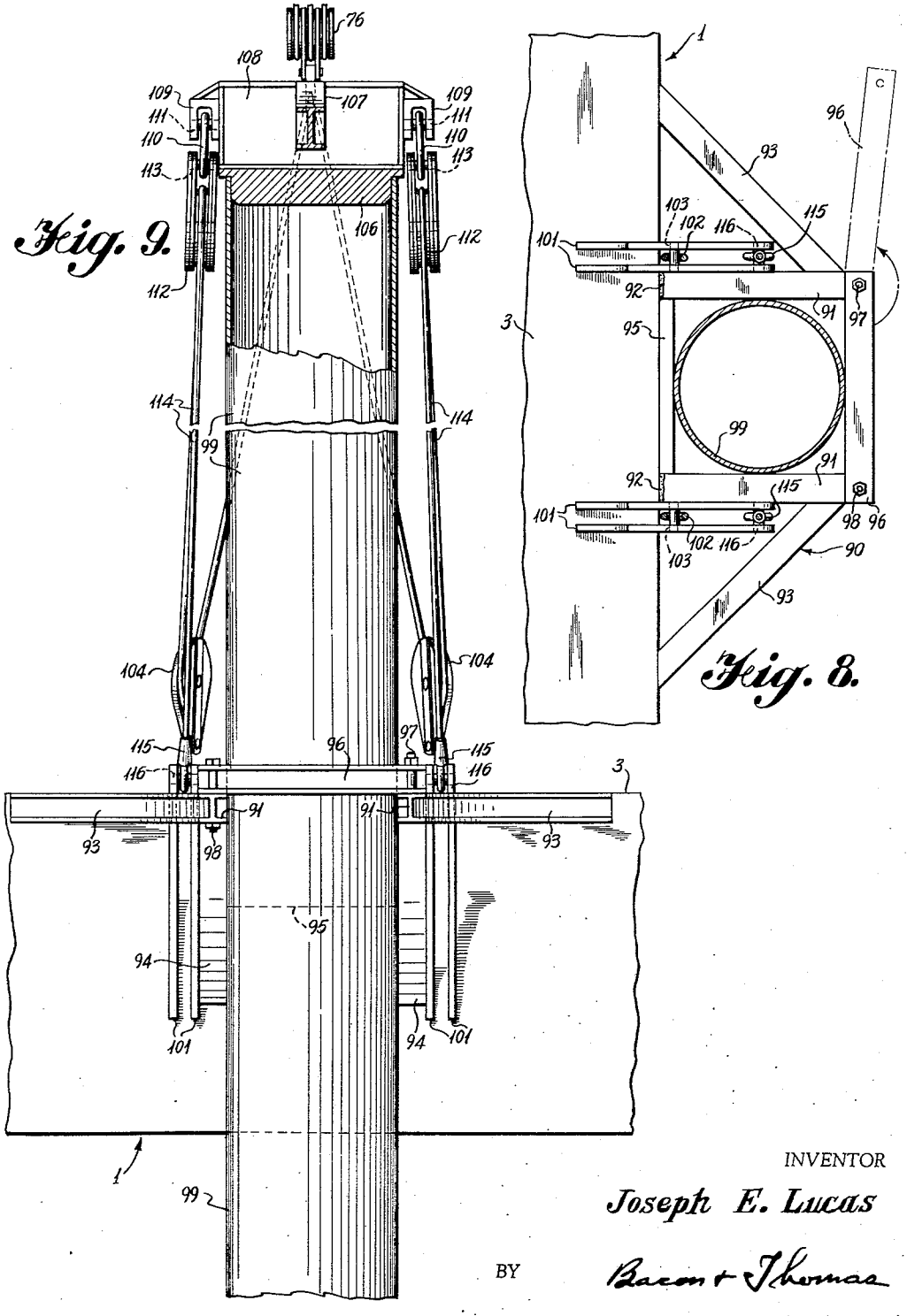


Fig. 9.

Fig. 8.

INVENTOR

Joseph E. Lucas

BY Bacon & Thomas

ATTORNEYS

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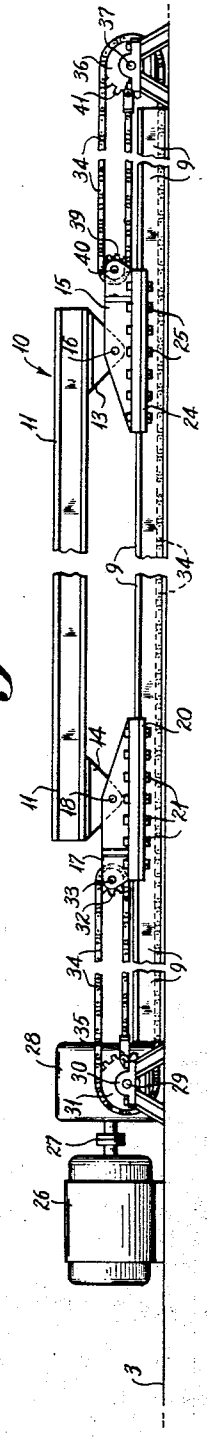


Fig. 10.

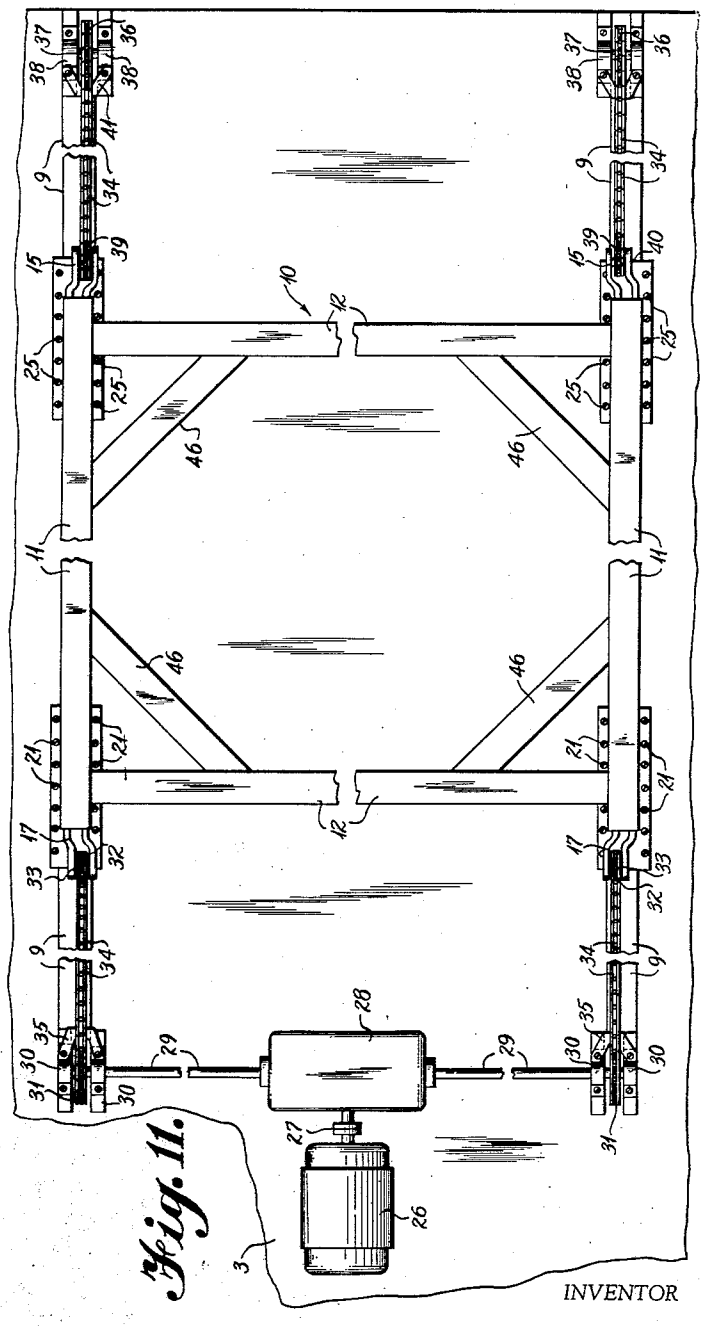


Fig. 11.

INVENTOR

Joseph E. Lucas

BY Bacon & Thomas

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WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

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Fig. 12.

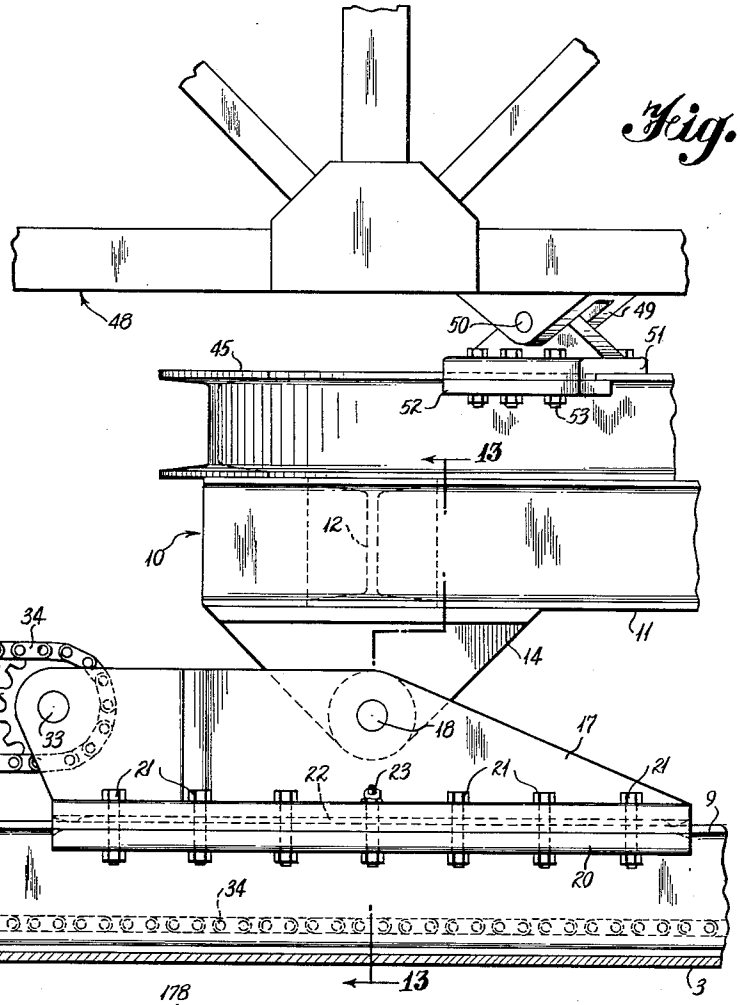


Fig. 13.

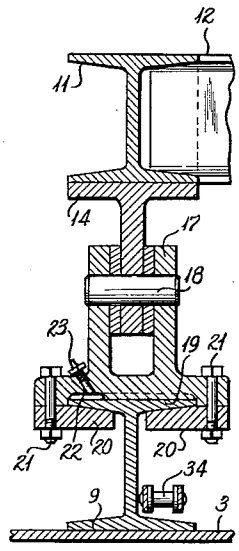
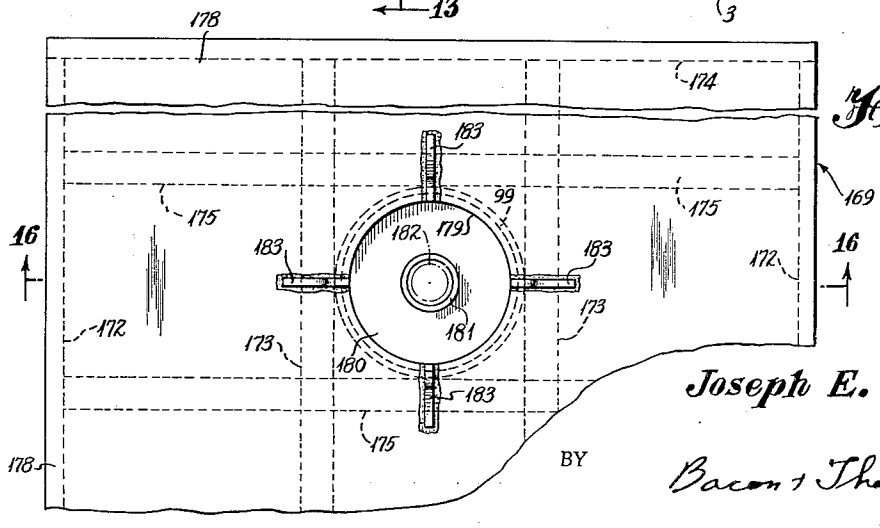


Fig. 15.



INVENTOR

Joseph E. Lucas

BY

Bacon & Thomas

ATTORNEYS

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WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

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Fig. 14.

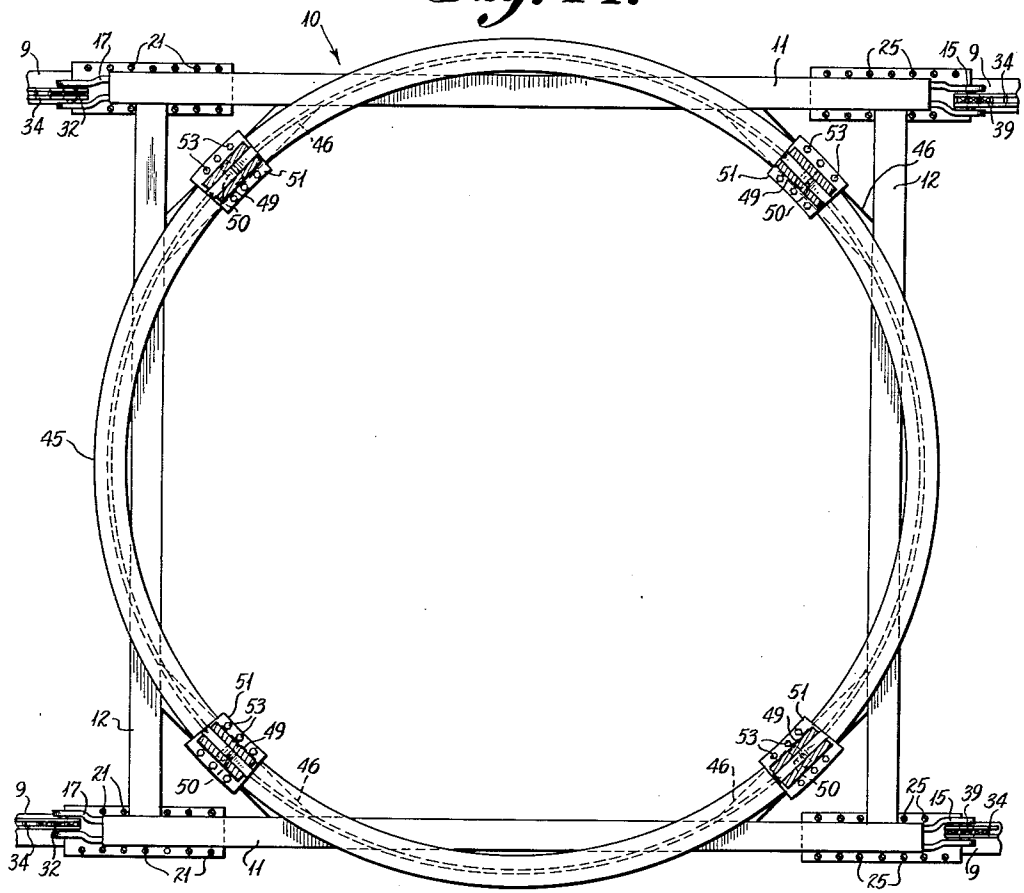
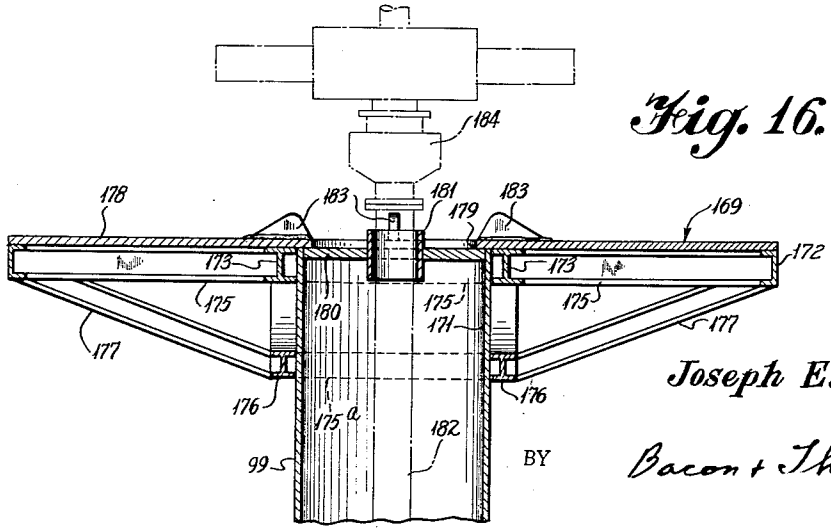


Fig. 16.



INVENTOR

Joseph E. Lucas

BY Bacon & Thomas

ATTORNEYS

Sept. 26, 1961 J. E. LUCAS 3,001,592

WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

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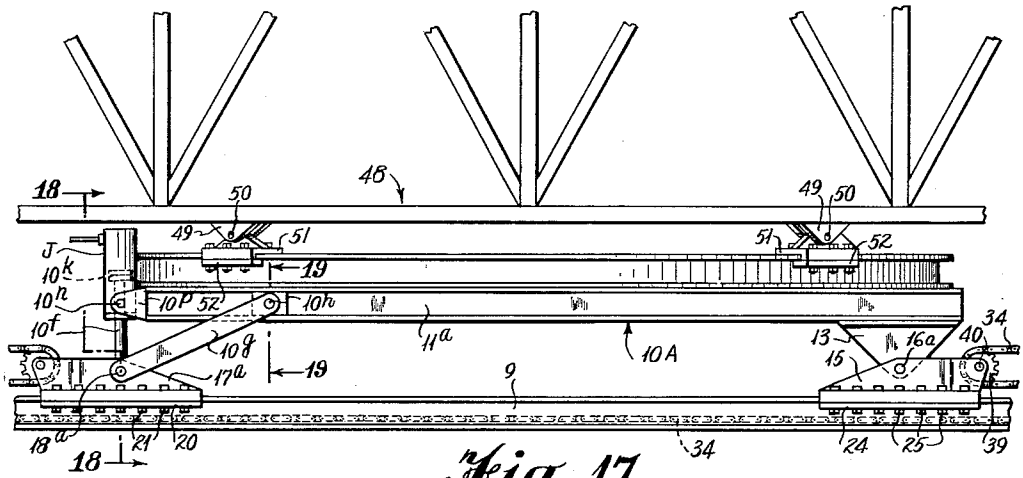


Fig. 17.

Fig. 18.

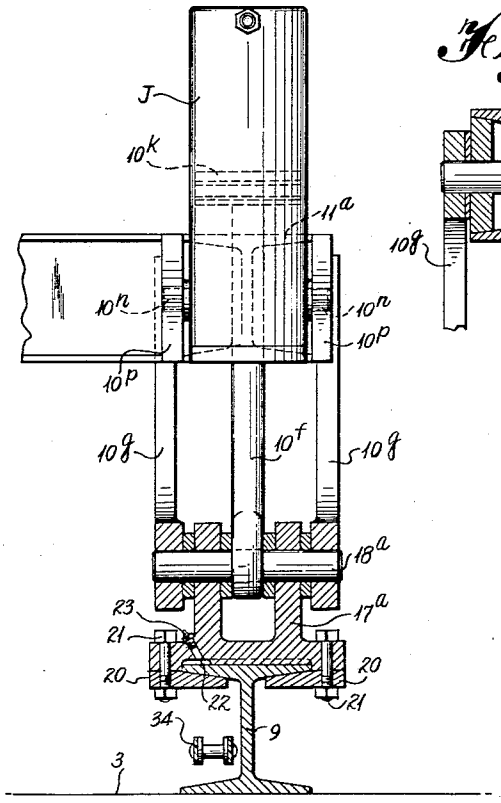
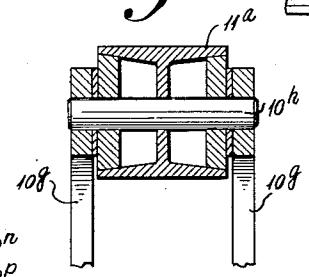


Fig. 19.



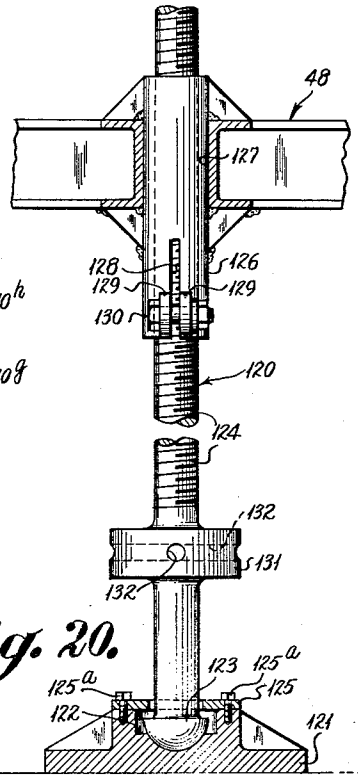


Fig. 20.

INVENTOR

Joseph E. Lucas

BY Baron & Thomas

ATTORNEYS

Sept. 26, 1961 J. E. LUCAS 3,001,592

WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

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Fig. 21.

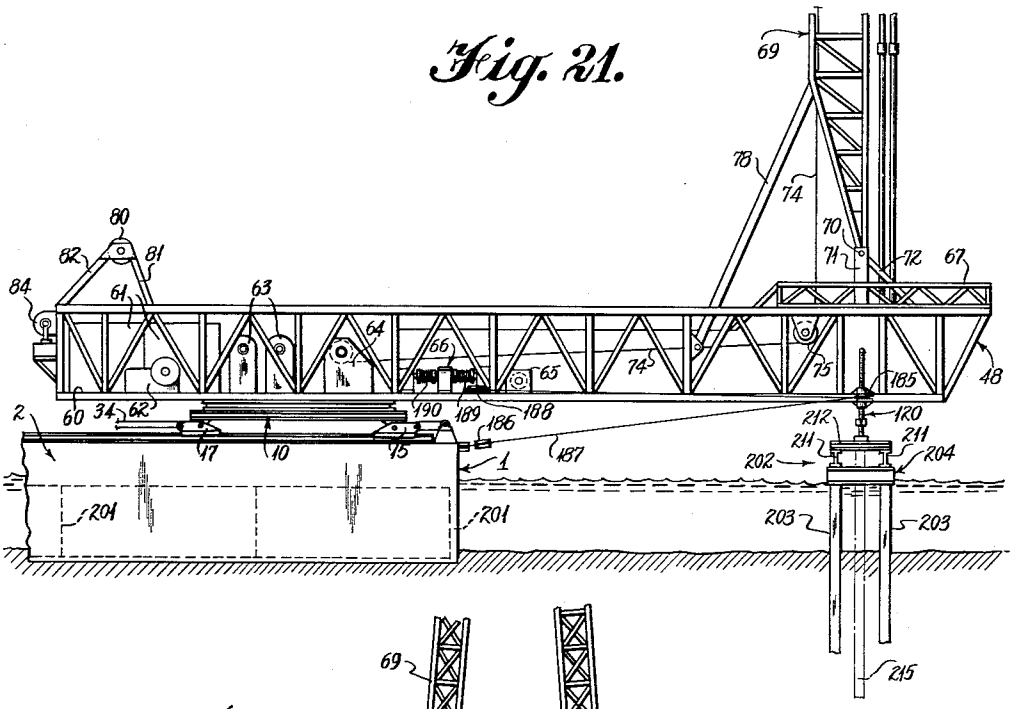
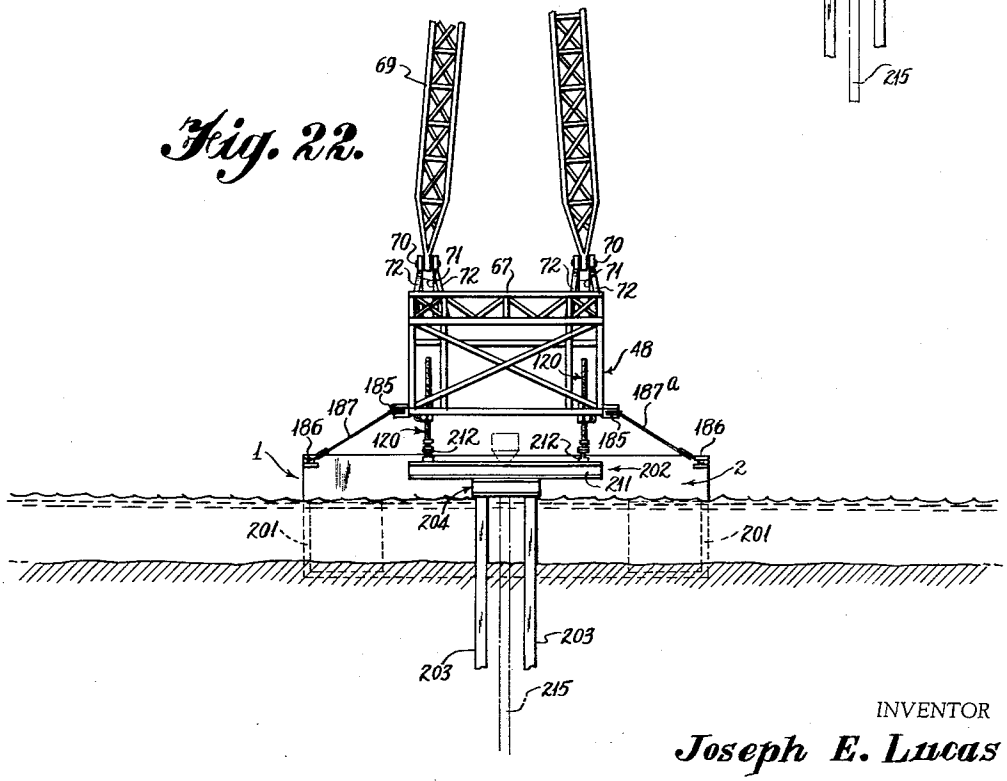


Fig. 22.



INVENTOR

Joseph E. Lucas

BY Bacon & Thomas

ATTORNEYS

Sept. 26, 1961 J. E. LUCAS 3,001,592

WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

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Fig. 23.

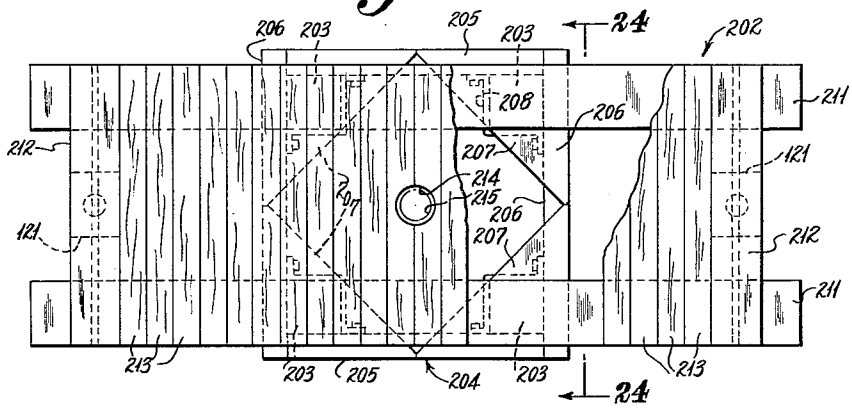


Fig. 24.

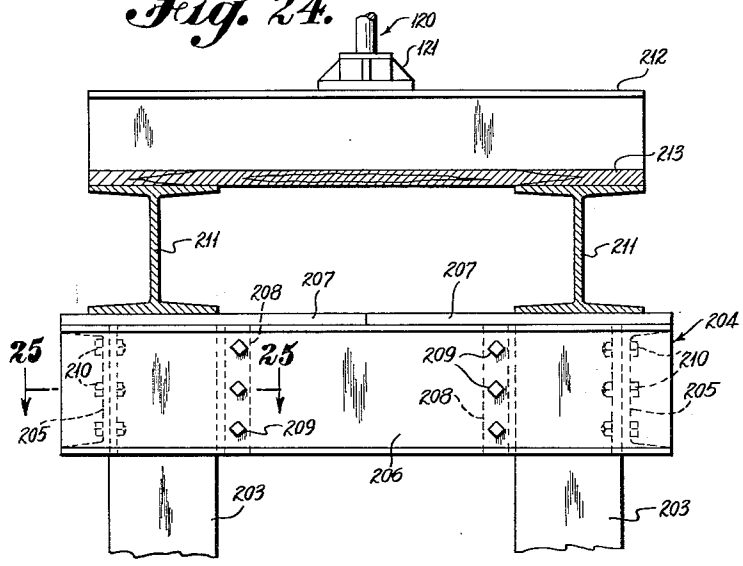
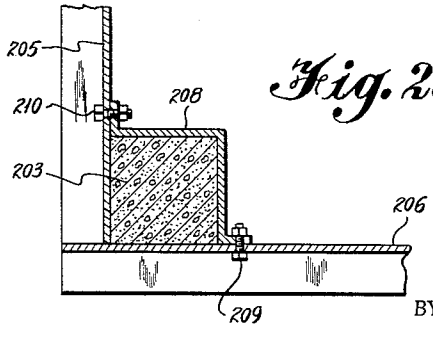


Fig. 25.



INVENTOR

Joseph E. Lucas

BY Bacon & Thomas

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Sept. 26, 1961 J. E. LUCAS 3,001,592

WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

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Fig. 26.

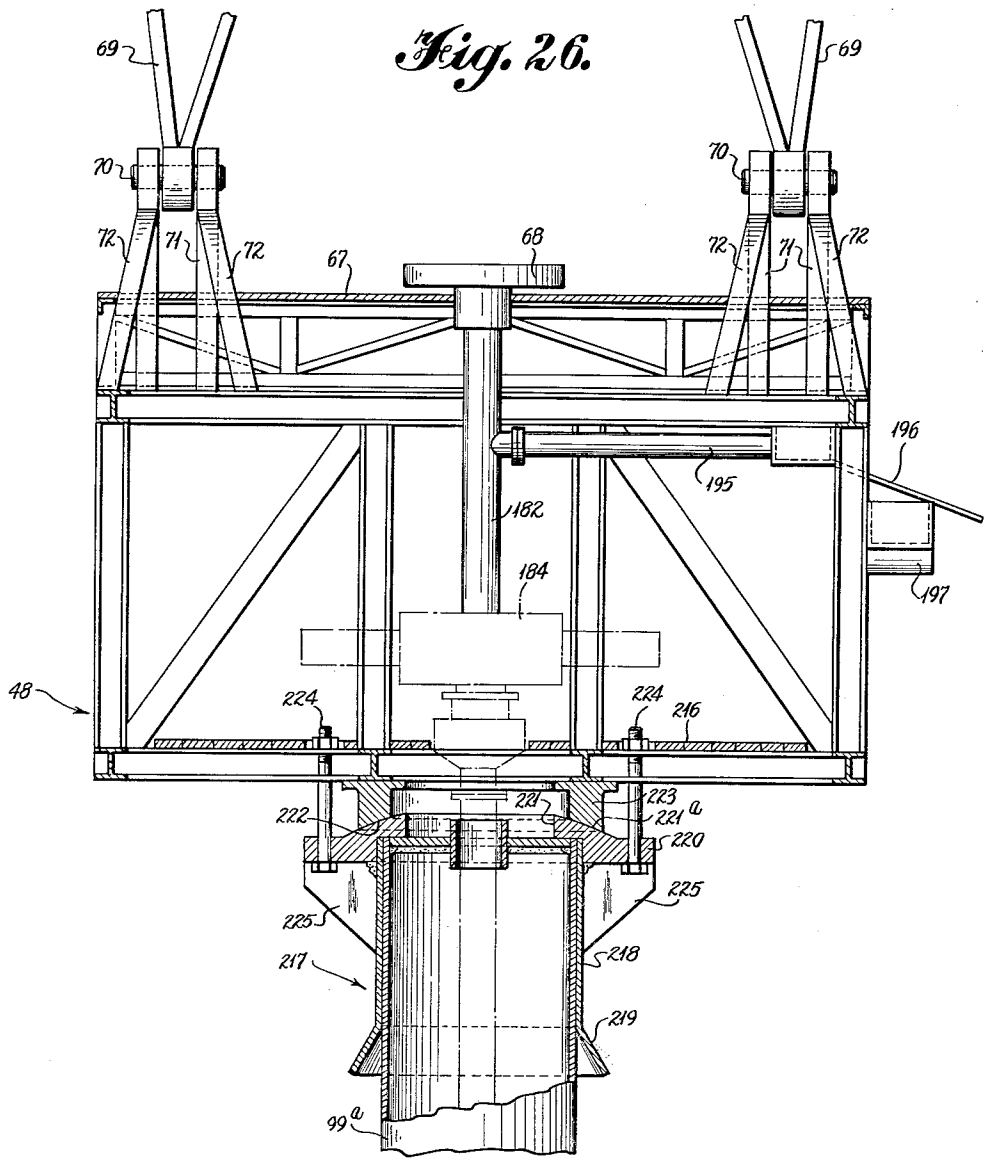
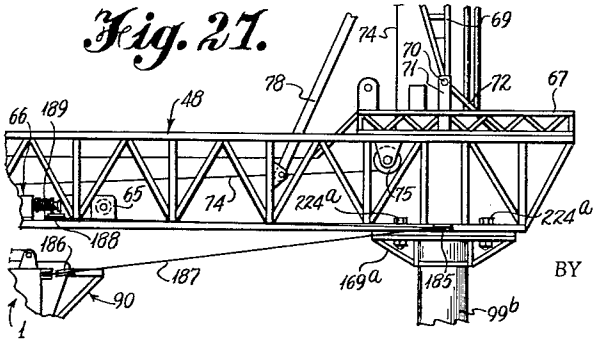


Fig. 27.



INVENTOR

Joseph E. Lucas

BY

Bacon + Thomas

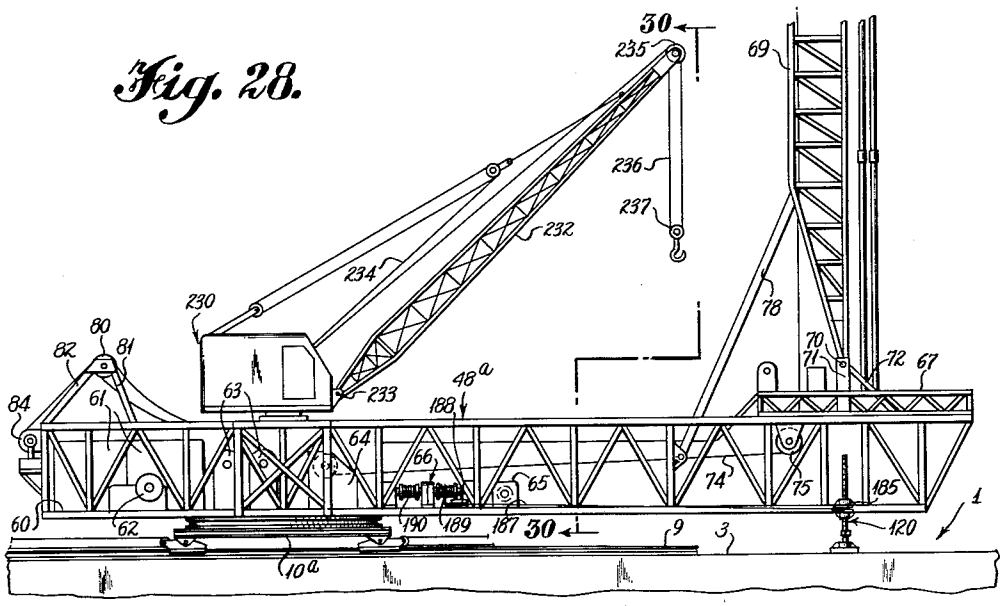
ATTORNEYS

Sept. 26, 1961 J. E. LUCAS 3,001,592

WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

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Fig. 28.



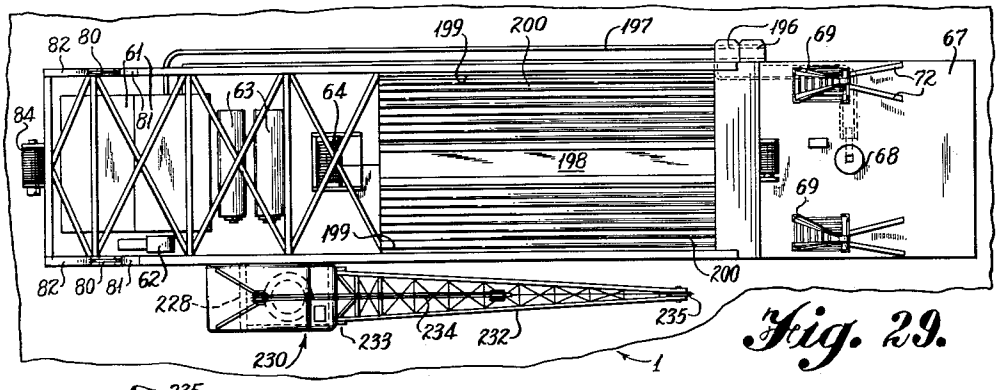


Fig. 29.

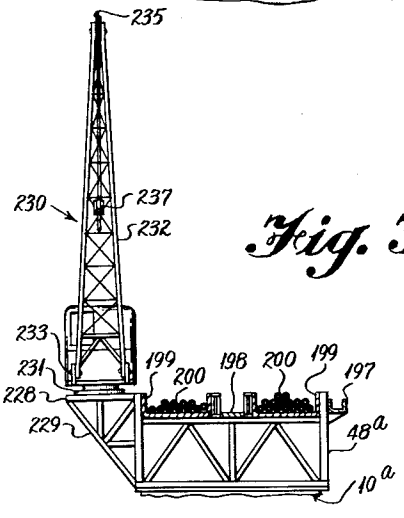


Fig. 30.

INVENTOR

Joseph E. Lucas

BY Bacon & Thomas

ATTORNEYS

Sept. 26, 1961 J. E. LUCAS 3,001,592

WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

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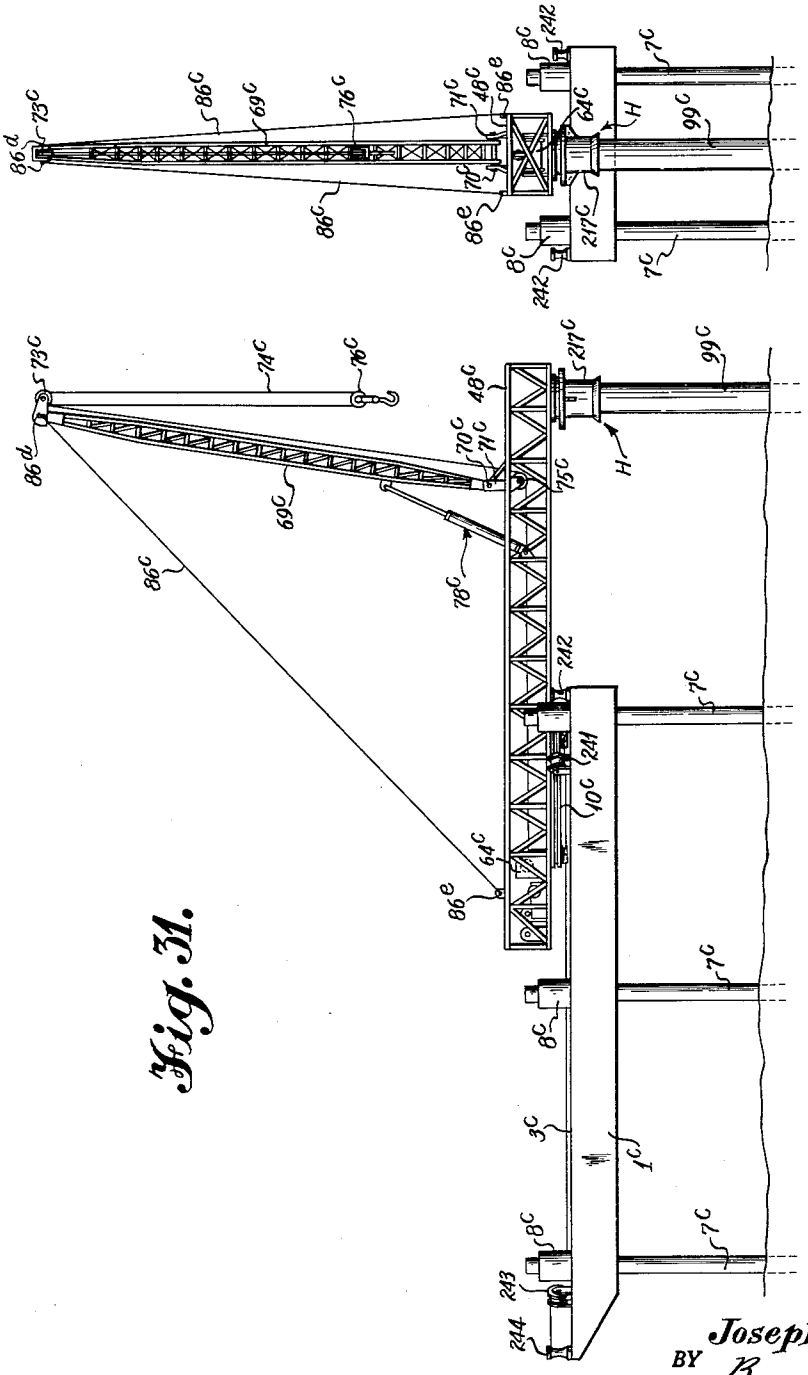


Fig. 31.

Fig. 32.

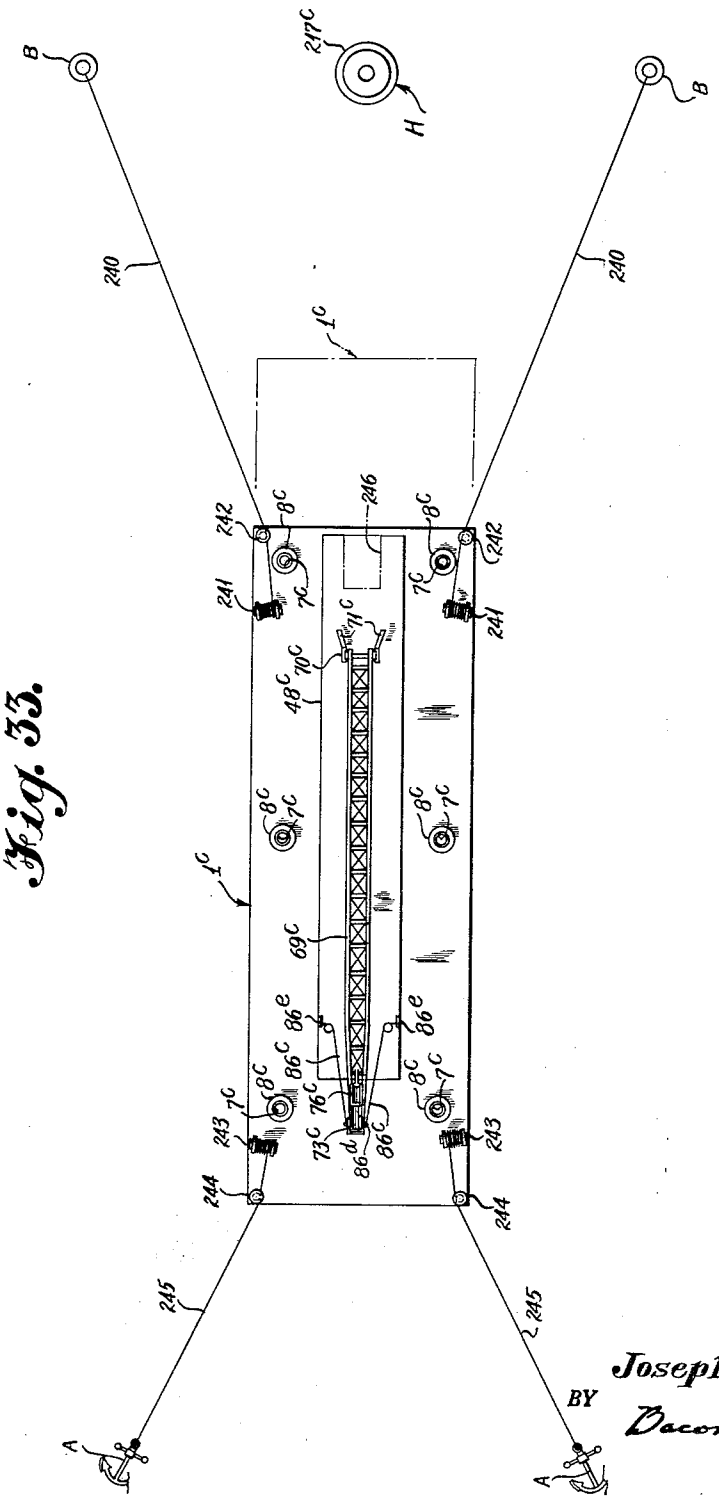
INVENTOR.
Joseph E. Lucas
BY Bacon & Thomas
ATTORNEYS

Sept. 26, 1961 J. E. LUCAS 3,001,592

WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

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Fig. 33.



INVENTOR.
Joseph E. Lucas
BY
Bacon & Thomas
ATTORNEYS

United States Patent Office 3,001,592
Patented Sept. 26, 1961

3,001,592

WELL DRILLING AND SERVICING BARGE INCLUDING BRIDGE AND RIG STRUCTURE AND METHODS

Joseph E. Lucas, Caracas, Venezuela, assignor to De Long Corporation, New York, N.Y., a corporation of Delaware

Filed Sept. 3, 1954, Ser. No. 454,093
19 Claims. (Cl. 175—8)

The present invention relates to apparatus and methods for use in over-water well drilling and/or servicing operations, including the installation, removal, etc. of caissons, platforms or other well head supporting structures.

More particularly, the invention relates to a barge or other marine structure adapted for use in erecting a platform or other well head supporting structure in either deep or shallow water and which barge includes equipment for drilling and/or servicing a well after the well head supporting structure has been installed. The barge is constructed so that it can be raised above the water at a well site or, if desired, sunk in shallow water. In either case, a caisson or well head supporting structure is sunk beyond one edge of the barge by the equipment mounted on the barge, as hereinafter explained. A relatively small platform can be mounted upon the caisson, if desired. The caisson may be sunk and the platform erected close to the barge and then the barge may be moved to a safe working distance, for example, about 50 feet, from the platform in order to minimize damage or loss by fire, blow-out, etc.

In order to accomplish this, the barge is provided with a novel movable bridge unit, or combination bridge, derrick floor and derrick mast structure, serving as a mounting for a substantially complete drill or servicing rig. The derrick mast is pivoted over the derrick floor at the forward end of the bridge unit in such a way that it can be raised from a horizontal position resting on top of the bridge into a vertical operating position by a cable, conventional jacks, and/or boomer legs interconnecting the derrick and the bridge. The bridge unit simplifies the derrick raising and lowering operations at an over-water well site, by providing a long stable base.

One of the features of the invention is that the drilling mast can be converted to install a caisson or other well head supporting structure by connecting a boom topping line to the upper end of the mast and leaning the mast forward to bring the crown block into vertical alignment with the structure to be handled. In the same manner, the mast can be used for structure salvaging operations in the event that the well is abandoned.

Another feature of the invention is that the mast and the rig components can also be used to preload the caisson where bottom soil conditions due to grain size or coarseness and other factors preclude developing a substantial load-bearing capacity through "skin friction." The preloading of the caisson is accomplished by transferring a measured portion of the weight of the barge to the caisson, substantially in excess of the caisson design load. In this way it is possible to test the caisson's load carrying ability, to make certain it will not settle in use.

The load-bearing ability of structural foundations in areas having a deep, fine-grained soil bottom is greatly affected by the "skin friction" that develops over a period of time. Recent test data indicates that such areas may develop "skin friction" and mud "shear strength" values, ranging from 0 lb. per sq. ft. at the mud line to as high as 1,000 lbs. per sq. ft. at a 100-ft. depth of mud penetration. These values vary with the area, depth of mud and the coarse grain stratas that may be penetrated, as well as with the time period of setting up or gelling.

In an area where advantage can be taken of this "skin friction" characteristic, it is possible to sink a caisson to a less depth for a given bearing load if the mud is allowed a period of time to "set up" or "gell" before application of the full design load. Thus, a caisson or piling forced into mud and subjected to a certain load, will, after a certain time interval, be able to support a much greater load than when it was first forced into the mud.

The present invention takes advantage of this phenomenon by providing apparatus and methods whereby a load bearing factor for any given area can be determined for use in accurately designing well head supporting structures of minimum dimensions. It will be apparent that, with knowledge of the load bearing factor of a particular area, a caisson of shorter length and smaller diameter may be designed to support a given load, than would be the case of a caisson where driven to the necessary depth to provide the desired bearing capacity, without taking advantage of the gelling property of the mud.

To develop such a factor, a caisson or the like is forced downwardly into the mud by applying a predetermined measured load thereto. The load is removed and the caisson permitted to stand while the mud sets up or gells about the same, say for a period of about 24 hours. Then a measured load is applied to the caisson to determine its load carrying ability before further penetration starts. The ratio between the two measured forces represents the load bearing factor of the particular area, for a given setting up or gelling time, the depth of penetration, and the caisson used. With this information, it is possible to determine in advance how deep the caisson should be sunk in the particular area in order to safely support a given working load after a certain length of time. This avoids the uncertainty attached to prior well head support installations, making it possible to design a caisson of minimum length for supporting a given load in a particular soft bottom soil area.

Another feature of the invention is the method of relieving a caisson installed as above described, of the static or equipment load. This makes it possible to start drilling operations immediately after sinking the caisson and without waiting for the mud to set up or gell, since the working loads are very light during the initial stages of well drilling. Under ordinary circumstances the mud would be completely set up by the time that the heavy working loads are applied.

A typical example of the "gelling" phenomenon is the case of an off-shore drilling installation in which 24" pipe piles were driven to a depth of about 200 feet into the mud without reaching "refusal." When the platform was salvaged, some months later, a lift of about 350 tons was applied to the piles without being able to move them. If a load bearing factor had been determined for this area, it is probable that piles one-half the length would have been adequate and salvagable.

The installation of the well head supporting structure, the salvaging, and other heavy lift operations are preferably carried out with the forward end of the bridge unit supported on the deck near the end of the barge.

The bridge is made long enough to span any desired gap between the barge and platform or well head. The bridge preferably has all major rig components necessary for well drilling or servicing operations permanently mounted thereon. The equipment mounted on the bridge comprises conventional drilling or servicing components so arranged as to locate the center of gravity of the bridge unit towards its aft end. A movable support is disposed beneath the center of gravity so that the bridge unit is balanced on said support.

The bridge support is mounted upon shoes that slide

along tracks secured to the barge deck. As a safety measure, the shoes are designed so that they permit movement of the support only in a direction longitudinally of the tracks. The shoes are connected to chains arranged so that the support and bridge can be moved to and held in any desired position on the tracks.

The bridge unit is preferably mounted upon its support in such manner as to enable the forward end of the bridge to be moved up or down or shifted sidewise relative to the barge. This makes it possible to project the bridge over the well head in a raised position and then lower the bridge to contact the well head supporting structure under exact control. It also makes it possible to "spot" the bridge end over a well head supporting structure that is not in true alignment with the tracks on the barge.

Assuming the well head supporting structure has been erected, and the barge repositioned at the desired distance away, the bridge is moved into a position spanning the gap between the barge and such structure with the forward end of the bridge above such structure. This end of the bridge may carry adjustable connecting jacks or an adapter for connecting the bridge to the platform or caisson. This connection serves to transfer the vertical reaction of the working load from the bridge to the platform or caisson, and also causes the bridge to brace the caisson and the derrick against lateral forces from any direction during drilling or servicing operations.

As an alternative, the bridge may carry a separable platform below the derrick floor that can be set down on the well head supporting structure by the bridge. This platform may be left on the well head structure or retracted with the bridge at the conclusion of operations, as desired.

In another modification of the invention, a platform structure may be built into the bridge to serve as a subderrick floor, and to similarly connect the bridge with the upper end of a caisson or well head supporting structure.

Another feature of the invention is the provision of a caisson guide at one end of the barge for guiding a caisson or similar structure while it is being driven or installed.

Another feature is that the barge includes crew's quarters (not shown) together with all facilities for carrying on machine shop and repair work in remote areas. The barge is also equipped to salvage the well head supporting structure for reuse, if the well is non-productive.

A further feature of the invention is that, after a producing well has been drilled or serviced, the drilling or servicing equipment can be easily and quickly removed for use at another well site. This is safely and quickly accomplished in a matter of minutes by retracting the bridge from the well head, jacking the barge down onto the water, and moving the barge away.

Another important feature is to provide a quick and safe method to get back over the well head for servicing even in rough water.

The principal object of this invention is to provide overwater well drilling and servicing apparatus and methods that will greatly speed up drilling and servicing operations and reduce their costs.

Another important object is to reduce the current hazards of over water drilling and servicing operations and to eliminate the costs and loss of time occasioned by unfavorable weather and water conditions.

More specifically, the objectives of this invention are to provide apparatus and methods for:

(1) Reducing the over-all operation cost by utilizing the drilling or servicing apparatus to quickly install or remove overwater well head supporting structures, thereby eliminating the auxiliary derrick barges presently used for this purpose.

(2) Reducing the "rigging up" and "rigging down" time and costs by providing a novel arrangement of major well drilling or servicing components permanently assembled into one mobile counterbalanced bridge unit with the components always ready to be quickly positioned in working alignment with a well head.

(3) Quickly setting up a rig for drilling or servicing operations by projecting or retracting the bridge unit over water into or out of operative engagement with a well head, under exact control, in a matter of minutes, even in rough water, thereby saving many days of rigging time.

(4) Making it possible to reduce the size and lower the cost of a well head supporting structure by:

(*a*) Laterally bracing such structure by the well servicing or drilling apparatus through its bridge unit against the working loads imposed during the well drilling or servicing operations;

(*b*) Relieving the well head supporting structure of the major static weight of the bridge unit and its components during drilling or servicing operations;

(*c*) Eliminating the need for leaving a permanent derrick on the well head structure for well servicing or recompletion purposes, whereby the well head supporting structure may be designed for less than half the load such structures usually carry with prior methods and equipment; and

(*d*) Determining a load bearing factor in water covered soft bottom areas for use in accurately designing well head supporting structures of minimum dimensions.

(5) Transferring the vertical drilling or servicing working loads from the derrick to a well head supporting structure, thereby eliminating a heavy cantilever load on the rig support and making it possible to locate such support a substantial and safe working distance from the well head.

(6) Reducing operational hazards by preloading a well head supporting structure to test its load carrying ability to make certain the structure will not settle in use.

(7) Quickly salvaging the well head supporting structure for use at another site in case the well drilled turns out to be non-productive.

(8) Quickly and safely positioning well drilling and/or servicing apparatus in an operative relation within safe working distance of a well head, even in rough water.

(9) Reducing the current hazards of overwater oil well operations by making available a stable platform at a safe distance away from the well head from which to carry out remedial operations if the well should get out of control due to fire, blow-out, collision or other causes.

FIG. 1 is a side view of one form of caisson-equipped barge raised above the water, and showing in dot-and-dash lines, the derrick mast leaning forward to lower a well head caisson through a caisson guide;

FIG. 2 is a view similar to FIG. 1 but showing the caisson sunk and a platform being moved by an auxiliary crane into position over the caisson;

FIG. 3 is a fragmentary plan view showing the barge spaced from the platform and the bridge unit extended over the water from the barge to the platform and with the derrick mast in its lowered position;

FIG. 4 is a left side view corresponding to FIG. 3, but showing the derrick in its normal vertical position;

FIG. 5 is a right end view of the apparatus shown in FIG. 4;

FIG. 6 is a diagrammatic, fragmentary view illustrating one form of apparatus that may be employed to preload or force a caisson downwardly;

FIG. 7 is a fragmentary view of another form of apparatus that can be used to force a caisson downwardly;

FIG. 8 is a sectional view taken on the line 8—8 of FIGS. 1 and 7, respectively, illustrating details of the caisson guide;

FIG. 9 is a right end view partly in section of the apparatus shown in FIG. 7;

FIG. 10 is a diagrammatic side view showing the tracks, support and shoe assembly for the bridge unit

and the mechanism for moving the shoes along their tracks;

FIG. 11 is a plan view of the structure shown in FIG. 10;

FIG. 12 is a fragmentary elevational view of one of the shoes and the frame for supporting the turntable of the bridge unit;

FIG. 13 is a vertical sectional view taken on the line 13—13 of FIG. 12;

FIG. 14 is a sectional plan view of the turntable taken on the line 14—14 of FIG. 1;

FIG. 15 is a fragmentary plan view of the platform;

FIG. 16 is a sectional view taken on the line 16—16 of FIG. 15;

FIG. 17 is a fragmentary view of a modification embodying a pivotally mounted turntable for the bridge unit;

FIG. 18 is a sectional view taken on the line 18—18 of FIG. 17;

FIG. 19 is a sectional view taken on the line 19—19 of FIG. 17;

FIG. 20 is a fragmentary view partly in section of one of the two screw jacks at the forward end of the bridge unit;

FIG. 21 is a side view showing the use of the present apparatus in connection with a barge sunk in shallow water and a platform mounted on a plurality of pilings;

FIG. 22 is a right end view of the platform and apparatus shown in FIG. 21;

FIG. 23 is a plan view of the platform shown in FIGS. 21 and 22;

FIG. 24 is a sectional view taken on the line 24—24 of FIG. 23;

FIG. 25 is a fragmentary sectional view taken on the line 25—25 of FIG. 24, illustrating the manner in which the platform is clamped to the piling;

FIG. 26 is a sectional view through a modified form of bridge structure including a derrick subfloor and an adapter that can be positioned on the top of a caisson to transmit the working load to a well head supporting structure;

FIG. 27 is a fragmentary view illustrating still another modification in which a platform structure is detachably secured to one end of the bridge unit;

FIG. 28 is a side view of a modification in which an auxiliary crane is mounted at one side of the bridge unit;

FIG. 29 is a fragmentary plan view of the apparatus shown in FIG. 28;

FIG. 30 is a sectional view taken on the line 30—30 of FIG. 28;

FIG. 31 is a side view of a relatively lighter form of apparatus particularly adapted for well servicing;

FIG. 32 is a right end view of the apparatus shown in FIG. 31; and

FIG. 33 is a diagrammatic view illustrating the manner in which the servicing barge may be manipulated to make a safe approach to a well head.

Referring now to FIGS. 1 to 5 of the drawings, a barge that may be used for either well drilling or servicing operations is generally identified by the numeral 1. The barge comprises a hull 2 having a working deck 3. The hull 2 has openings 4 extending therethrough in spaced relation adjacent its opposite sides 5 and 6. A cylindrical caisson 7 of substantial length, depending upon the depth of the water and bottom characteristics, is mounted in each opening 4 and may be held in a raised position by a caisson jack 8 of any known or suitable construction while the barge is moved to a well site. The jacks 8 may be actuated by equipment (not shown) contained on the barge 1.

After the barge 1 has been moved to the well location, the jacks 8 are operated to lower the caissons 7 into the water. As is well known, the jacks 8 include elements for successively gripping and releasing the caissons 7 in a manner to force the caissons downwardly, such action being reversible when it is desired to raise the caissons. The jacks 8 are operated to raise the barge 1 relative to the caissons 7 until the barge is lifted to the desired height above the water, as illustrated in FIGS. 1, 2, 4 and 5. The caissons 7 are then locked against movement relative to the barge 1 by the jacks 8, or by clamping the caissons by any suitable means to hold the barge raised for drilling or servicing operations.

A pair of rails or tracks 9 extends lengthwise along the central portion of the barge 1, as best shown in FIG. 3. Each of the tracks 9 may consist of beam sections of generally H-shaped configuration (see FIG. 13). A support 10 is mounted upon the tracks 9 and is movable to any desired position lengthwise of the barge 1. The support 10 is illustrtated in detail in FIGS. 10 to 14, and includes a rectangular frame consisting of side members 11 positioned above the tracks 9 and connected adjacent their ends by cross members 12. The side members 11 and the cross members 12 are preferably made of I-beam sections welded or otherwise secured together. With more particular reference to FIG. 10, a bracket 13 is welded to the underside of the side members 11 at the forward end (right end) thereof and a bracket 14 is similarly welded to the aft or left end of said members. A pair of forward shoes 15 is pivotally connected to the bracket 13 by pins 16. A pair of aft shoes 17 is similarly connected to the brackets 14 by pins 18. The shoes 17 have a recess 19 (FIG. 13) to receive the upper flange of the tracks 9. The shoes 17 are held to the tracks 9 by gibs 20 connected to the shoes by bolts 21. The recess 19 is provided with lubricant grooves 22 and a grease fitting 23 communicates with said grooves. The forward shoes 15 are of similar construction and are held on the tracks 9 by similar gibs 24 and bolts 25. Thus, the support 10 is mounted on the tracks 9 so that it can be moved to any position along the tracks 9 and held in such position by mechanism which will now be described.

Referring particularly to FIGS. 10 and 11, a reversible electric motor 26 is secured to the deck 3 and is connected by a coupling 27 to a conventional, non-coasting, gear reduction unit 28. A shaft 29 extends from opposite sides of the gear unit 28 and each of its ends is mounted in a pair of bearings 30 fixed to the deck 3 at the aft end of the tracks 9. A drive sprocket 31 is mounted on the shaft 29 between each pair of bearings 30. A relatively small sprocket 32 is rotatably mounted upon a shaft 33 carried by each of the shoes 17. Separate chains 34 extend over the sprocket 32 of each shoe 17 and one end of each chain is anchored to the bearings 30 as indicated at 35. Each chain 34 extends around one of the large sprockets 31 and then forwardly around similar sprockets 36 mounted upon shafts 37 journaled in spaced bearings 38. The bearings 38 are fixed to the deck 3 at the forward end of the tracks 9. The chains 34 further extend around small sprockets 39, similar to the sprockets 32, rotatably mounted upon shafts 40 carried by the forward shoes 15. The opposite ends of the chains 34 are anchored to the bearings 38 as indicated at 41.

When the motor 26 is operated to cause the drive sprockets 31 to rotate clockwise, the support 10 will be moved to the right, as viewed in FIG. 10, and when the direction of rotation of the driving sprockets 31 is reversed, support 10 will be moved along the tracks 9 toward the left. Since the gear reduction unit 28 is non-coasting the support 10 will be locked by the chains 34 in any position along the tracks 9 to which it has been moved, upon stopping of the motor 26.

Referring to FIGS. 12 and 14, a circular track or turn table 45 is disposed above the side members 11 and cross members 12 of the support 10 and is preferably welded thereto. The track 45 is I-shaped in cross section, as shown in FIG. 12. Diagonal braces 46 underlie the track 45 and connect the side members 11 with the

cross members 12. These braces are also welded in place.

A truss type of bridge structure 48, FIGS. 1 and 2, is disposed above the support 10 and has four brackets 49 (FIG. 14) welded to the underside thereof. The brackets 49 are located on radii 90° apart. A pin 50 connects each bracket 49 with a shoe 51 that is slidably mounted upon the upper flange of the circular track 45. Gibs 52 secured to the shoes 51 by bolts 53 retain the shoes in place upon the track 45. Thus, the bridge 48 is mounted upon the support 10 for movement about the vertical axis of the circular track or turn table 45. The mechanism for turning the bridge 48 through an arc at least as great as the arc X in FIG. 3 will be described later.

FIGS. 17, 18 and 19 illustrate a modified form of bridge support 10A in which the aft shoes 17*a* are connected by pins 18*a* to piston rods 10*f* and to pairs of links 10*g*. The links 10*g* are connected by pins 10*h* to side frame members 11*a*. The rods 10*f* are connected to pistons 10*k* in cylinders J pivoted at 10*n* to brackets 10*p* on the members 11*a*. The cylinders J are operable to tilt the bridge 48 about a horizontal axis provided by the pins 16*a* to raise or lower the forward end of the bridge 48, as desired.

The bridge 48, FIG. 1, includes a main floor 60 upon which is mounted conventional mud tanks 61 and a mud pump 62. Engines 63 and a cable drum 64 of a conventional draw works, and an additional drum 65 and a double drum winch 66 are also mounted upon the floor 60. A derrick floor 67 is provided at the forward end of the bridge 48. A conventional rotary table 68, FIG. 3, is mounted in the derrick floor 67. A two-legged derrick mast 69 is pivotally mounted at one end upon pins 70 adjacent the forward end of the bridge 48. The pins 70 are mounted in brackets 71 connected with braces 72. A crown block 73 is mounted on the opposite end of the mast 69. A cable 74 extends from the drum 64 under a sheave 75 mounted on the bridge 48, and then over the crown block 73 and through a conventional traveling block 76.

In FIG. 1, the mast 69 is shown in full lines in its down position resting upon the top of the bridge 48 and is shown in dot-and-dash lines in its raised position. The mast 69 is moved from its down position to its raised position with the aid of a cable 77 (FIG. 3) in a conventional manner. The mast 69 is held in a vertical position by boomer legs 78. The mast 69 has a pipe rack 79 pre-assembled therewith. A sheave 80 is mounted upon frame members 81 and 82, extending upwardly from the bridge 49, and a boom topping cable 83 extends from a motor driven drum 84 around a sheave 85 and also around the sheave 80. A connecting cable 86 has one end thereof connected with the sheave 85 and its other end connected with the upper end of the mast 69, FIG. 4.

Referring now to FIGS. 7 and 8, a caisson guide, generally identified by the number 90, is mounted upon one end of the barge 1. The caisson guide 90 is positioned in alignment with the bridge 48 and comprises parallel arms 91 welded to the end of the barge as indicated at 92. Diagonal braces 93 connect arms 91 with the barge 1 and are welded to both to brace the arms against lateral forces. Additional braces 94 connect the arms 91 with the barge in a manner to resist downward forces on said arms. A spacer 95 is disposed between the inner ends of the arms 91. A gate 96 is pivoted on a pin 97 fixed to one of the arms 91, and a bolt 98 secures the gate to the other arm 91 in its closed position. A hollow caisson 99 is shown positioned in the guide 91 with the spacer 95 serving to prevent the caisson from rubbing the end of the barge 1. The caisson 99 may be of any desired diameter and may serve as the sole support for a well head structure or structures under certain conditions.

Assuming that the barge 1 has been moved to a selected well site and has been raised above the water by the jacks 8, the mast 69 is raised to the forwardly inclined position shown in dot-and-dash lines in FIG. 1 and used to position the caisson 99 in the guide 90. This is readily accomplished by attaching a conventional sling 100 to the caisson 99 and connecting it with the hook of the traveling block 76. The cable 83 controlling the connecting line 86 is now used to brace the derrick 69 while it is leaning forward. The caisson 99 is lowered by gravity to the bottom and thereafter may be sunk to the desired depth by driving or jetting. It is preferred, however, to apply a measured predetermined load to the upper end thereof to force the caisson 99 downwardly to the desired depth, as will be explained in further detail later.

One form of apparatus for forcing the caisson 99 downwardly is illustrated in FIGS. 7, 8 and 9. A pair of spaced brackets 101 is welded to the end of the barge adjacent each of the arms 91. A link 102 is disposed between each pair of brackets and pivotally connected thereto by a pin 103. A sheave 104 is also pivotally connected to each of the links 102 by a pin 105. A flanged cap 106, adapted to seat upon the upper end of the caisson 99, is reinforced by an inverted V member 107 generally I-shaped in cross section, as shown in FIG. 9. Members 108 extend laterally from the member 107 and carry brackets 109. A link 110 is pivotally connected to each of the brackets 109 by a pin 111. A sheave 112 is connected with each of the links 110 by a pin 113. A cable 114 of a suitable length extends through the sheaves 104 and 112 and has a socket 115 secured to each of its ends. The sockets 115 are pivotally connected with the brackets 101 by a pin 116, on a diametrical line passing through the axis of the caisson 99.

The links 102 and 110 are mounted in their respective brackets 101 and 109 with sufficient freedom to permit the sheaves 104 and 112 to properly align themselves when the cable 114 is connected with the hook of the traveling block 76 and a pull is applied to said cable, as shown in FIG. 9. As the traveling block 76 is raised by the cable 74, the cable 114 will apply a downward force to the cap 106 to force the caisson 99 downwardly. The caisson 99 may be sunk to any desired depth, but preferably is only sunk to the depth necessary to support a given load, as determined by the load bearing capacity of the particular area, as will be explained in further detail later.

During the time that the caisson 99 is being positioned in the guide 90 and while it is being forced downwardly by the preloading device, the derrick load on the forward end of the bridge 48 is transmitted to the barge deck 2 by screw jacks 120, positioned on opposite sides of the bridge. One of the jacks 120 is shown in detail in FIG. 20 and comprises a self-aligning base 121. The base 121 has a recess 122 containing a concave seat for a rounded head 123 at the lower end of the jack screw 124. The head 123 is retained in the recess 122 by a split ring 125 secured to the base by cap screws 125*a*. The screw 124 extends through a threaded sleeve 126 mounted in an opening 127 in the frame work of the bridge 48. The lower end of the sleeve 126 has a slot 128 and clamping lugs 129 at opposite sides of the slot. A bolt 130 extends through the clamping lugs for tightening the split ends of the sleeve 126 on the jack screw 124 to lock the screw against turning. An enlargement 131 is provided with intersecting passages 132 for receiving a screw turning bar, not shown.

The bridge structure 48 includes conventional means for measuring the force applied to the caisson 99. The dead end 74*a*, FIG. 7, of the cable 74 is connected to a piston rod 135 extending from a cylinder 136. The cylinder 136 is pivotally connected to the bridge 48 by a pin 137. The piston rod 135 is connected to a piston 138 in the cylinder 136. The conduit 139 connects the upper portion of the cylinder 136 with a conventional weight indicator 140. The pull exerted on the piston rod

135 by the cable 74 will be proportional to the load on the hook of the traveling block 76, and, therefore, the weight indicator 140 will furnish an accurate reading of the load applied.

FIG. 6 illustrates an alternative form of apparatus that may be used to force the caisson 99 downwardly. This apparatus comprises a pair of hydraulic cylinders 141 pivotally connected to brackets 101 by pins 142, which replace the pins 116. Thus, the cylinders 141 are positioned upon a diametrical line passing through the axis of the caisson 99. Each of the cylinders 141 contains a piston 143 having a piston rod 144 connected thereto. A cap 145, similar to the cap 106, has a bar 146 of I-beam shape welded thereto. The ends of the bar 146 project beyond the cap 145 and carry brackets 147. A chain 148 is pivotally connected by a pin 149 to each of the brackets 147. The chains 148 are adjustably connectable by a pin 150 to a bracket 151 at the upper end of each of the piston rods 144.

Conduit means 152 is connected with the upper end of the cylinders 141 and similar conduit means 153 is connected with the lower end of said cylinders. The conduit means 152 and 153 are connected with a source of pressure fluid or vented by conventional valve means, not shown. When pressure fluid is connected with the conduit means 153 and the conduit means 152 is vented, the piston 143 will be raised in the cylinders 141 so that any slack in the chains 148 can be taken up by adjusting the pins 150. When the conduit means 152 is connected with pressure fluid and conduit means 152 is vented, the pistons 143 will move downwardly and cause the chains 148 to apply force to the upper end of the caisson 99 to move said caisson downwardly. A conventional weight indicating gauge 154 is connected in the conduit means 152 to indicate the load or force being applied to the caisson 99.

In sinking the caisson 99, particularly in areas having a soft or mud bottom of substantial depth, it is difficult to determine to what depth the caisson should be sunk in order to support the loads that will be imposed during the well drilling operation. One method of obtaining an answer, is to force the caisson into the bottom by apparatus such as disclosed in FIG. 6 or FIGS. 7, 8 and 9, and sinking the caisson to a depth at which it will support a given load without further penetration. This method works satisfactorily except that a caisson must often be sunk to a very great depth before the "refusal" or resistance to penetration is equal to the calculated load the caisson will be required to support.

Another and more economical method is to force the caisson downwardly into the mud by applying a measured load thereto. The load is then removed and the caisson permitted to stand while the mud gells about the same, say for a period of 24 hours. Then a measured load is again applied to the caisson to determine the load that it will support before further penetration starts. The ratio between the two measured forces will then represent the load bearing factor of the particular area, for a given setting up or gelling time, depth of penetration and the caisson used.

In actual practice, this factor is quite important. For instance, it has been found experimentally in a certain area where test piles were comparatively easily driven to various penetrations up to 100 feet into the mud that the mud developed a skin friction or shear strength ranging from zero pounds per square foot at the mud line to about 1000 pounds per square foot at a 100 foot depth, after setting up for about 24 hours. This increase was in a nearly straight line function. Based on the foregoing, assuming a pile of 4 square foot per lineal foot and a mud penetration of 50 feet, the pile would have a load carrying capacity of 25 tons

$$\left[\frac{4\times 50\times 500}{2}=50{,}000 \text{ lbs.}\right]$$

while a similar pile with a mud penetration of 100 feet would have a load carrying capacity of 100 tons

$$\left[\frac{4\times 100\times 1000}{2}=200{,}000 \text{ lbs.}\right]$$

In another area, a force of about 7 tons was required to force a 12 inch pipe test pile 100 feet into the mud. After about a 24 hour gelling period it required a force of about 70 tons to move the pile. The load bearing factor for this area, under the conditions specified, would be $70/7=10$.

With knowledge of such a factor in the design of well head supporting structures, the usual "over-design" can be avoided and important savings over present practice can be made in development drilling where many wells are drilled in the same area.

After the caisson 99 has been sunk to the desired depth, the mast 69 is lowered and the bridge structure 48 is moved back to the position shown in FIG. 2. A conventional material handling rotary crane 160 is mounted on the deck near the guide 90. The crane 160 includes a base 161, a turn table 162, a super structure 163 mounted on the turn table, and a boom 164 pivoted on the super structure. The boom 164 has the usual crown pulley 165 and traveling block 166 with which a main cable 167 is associated. A boom topping line 168 is connected with the upper end of the mast 164. A prefabricated platform 169 is adapted to be lifted from the deck 3 by a sling 170 connected with the hook of the traveling block 166 and set down on the top of the caisson.

The platform 169 is shown in detail in FIGS. 15 and 16 and comprises a framework of standard structural elements rigidly welded together. Thus, the frame includes channel-shaped sides 172 and intermediate, heavier, longitudinal I-beams 173. The sides 172 are connected by end channels 174 and transverse I-beam sections 175. Additional transverse beams 175*a* and longitudinal beams 176 are connected by braces 177 to the beams 173 and transverse members 175. A heavy steel plate is welded on top of the framework and serves as a floor 178 for the platform 169.

The platform floor 178 has a central opening 179 that is smaller in diameter than the inside diameter of the caisson 99. The portions of the longitudinal beams 173 and 176 and the transverse beams 175 and 175*a* at the center of the platform 169 form aligned square openings of a size to snugly receive the upper end 171 of the caisson 99. A ring 180 partially closes the caisson end 171 and has a sleeve 181 welded therein through which the conductor pipe 182 is adapted to be subsequently inserted. Reinforcing webs 183 are welded to the floor 178 at the edge of the opening 179 to stiffen the floor in this region, since the entire weight of the platform 169 is borne by the floor 178 which rests upon the upper end of the caisson 99. It will be understood that blowout preventer equipment 184, etc. may be mounted upon the conductor pipe 182 in the usual manner.

After the platform 169 has been mounted upon the caisson 99, the barge 1 may be lowered onto the water by the jacks 8 and the caissons 7 raised. The barge 1 may be then moved to a safe working distance, say of about 50 feet, from the platform 169 and again raised above the water to a height where the bridge 48 is higher than the platform 169. The bridge 48 is then moved along the tracks 9 until its forward end overlies the platform 169, as illustrated in FIG. 4. If the platform 169 is not in accurate alignment with the tracks 9, then the forward end of the bridge 48 is moved sidewise until the rotary table 68 is vertically aligned with the axis of the caisson 99. This sidewise movement of the projecting end of the bridge is effected through sheaves 185 mounted at opposite sides of the bridge unit and sheaves 186 mounted upon the end of the barge. Separate cables 187 and 187*a* extend through the sheaves 185 and 186 and around an additional sheave

188 mounted on the bridge. The cable 187 is wound upon a drum 189 and the cable 187*a* is wound upon a similar drum 190 which constitute elements of the two drum winch 66, previously referred to. It will be clear from FIGS. 3 and 5 that the forward end of the bridge 48 can be moved clockwise or to the left by taking up on the cable 187 and slackening cable 187*a*, or moved in the opposite direction by taking up on cable 187*a* and slackening cable 187. In either event, after the rotary table 68 has been properly aligned with the caisson 99, both cables 187 and 187*a* are pulled up tightly to brace the bridge and the caisson against lateral movement relative to the barge 1.

After the bridge 48 has been properly aligned with the caisson 99, the jacks 120 are adjusted so that their base 121 rests upon the platform floor 178. Since the bridge 48 is substantially counterbalanced upon the support 10, little or none of the static weight of the bridge 48 is transferred to the platform 169 through the jacks 120. The derrick mast 69 is then raised to its vertical position and held in such position by the boomer legs 78. The boom topping line 83 is slacked off, as shown, since it is not required during drilling.

Referring to FIGS. 3, 26 and 29, a mud discharge pipe 195 extends laterally from the conductor pipe 182 to conventional shale shakers 196. A mud "ditch" 197 is fastened to the side of the bridge 48 and returns the mud to the tanks 61 by gravity. The bridge 48 also has a walkway 198 extending centrally thereof at a region between the derrick floor 67 and the draw works. Pipe racks 199 are disposed upon either side of the walkway 198 and provide storage space for drill pipe or well casing 200 so that it can be readily raised by the cat line (not shown) for delivery to the derrick floor 67 when needed. Additional pipe and casing (not shown) can be stored on suitable racks on the barge deck 3 and readily delivered to the walk way pipe racks 199 by the auxiliary crane 160 as needed.

If the well is a producer, the bridge 48 is retracted, leaving the producing platform 169 behind. The barge 1 is then jacked down onto the water again and moved to a new site. If, on the other hand, the well happens to be dry, the barge 1 is jacked down onto the water and is then moved up to the caisson 99 close to the forward end of the retracted bridge so the caisson will be directly under the crown block when the derrick is raised into operating position. In this position the barge is then jacked up into the air. The derrick 69 is then raised into operating position with the crown block 73 approximately directly over the caisson 99. The hook of the traveling block 76 is then used to remove the platform 169 from the caisson 99, and the platform is stowed.

Next, suitable gear (not shown) is attached to the caisson 99 permitting the traveling block hook to be connected to the caisson. The draw works 64 are then operated to pull the caisson 99 up. In this way, the caisson 99 can be salvaged for reuse at another well site. Upon completion of salvage operations, the barge 1 is again lowered onto the water and moved to a new site.

FIGS. 21 and 22 illustrate the use of the barge 1 in shallow water. In this connection, the hull 2 is provided with a plurality of tanks 201. Sufficient water is pumped into these tanks to sink the barge. The barge 1 is shown positioned a substantial distance from a platform 202, with the bridge 48 spanning the gap between the barge and the platform. The platform 202 may be lifted onto a plurality of square piles 203 by the crane 160, if desired. The piles 203 may be sunk into the mud by any suitable means.

The details of the platform 202 are best shown in FIGS. 23 to 25. Thus, a framework 204 comprising channel-shaped side members 205 and end members 206 are welded together and braced by generally triangular plates 207 which rest upon the upper end of the piles 203. The framework 204 is secured to the respective piles 203 by a clamp 208 fastened to the side members 205 by bolts 209 and to the end members 206 by bolts 210. Heavy I-beams 211 are disposed directly above the piles 203 and project a substantial distance beyond each end of the frame 204. Relatively short I-beams 212 extend transversely of the beams 211 and are spaced the proper distance apart to receive the base 121 of the screw jacks 120. Wooden planks 213 are secured to the I-beams 211 and form a floor between the I-beams 212. The flooring 213 is provided with an opening 214 in registration with a conductor pipe 215. Here again, the screw jacks 120 serve primarily to transmit the live load on the derrick 69 to the piles 203, rather than to transmit the weight of the bridge 48 to the piles.

FIG. 26 illustrates a modification of the invention in which the bridge 48 is provided with a sub-floor 216 below the derrick floor 67 and an adapter 217 is secured to the bridge 48 below the sub-floor 216. The adapter 217 comprises a cylindrical shell 218 which is flared or bell-mouthed at its lower end, as indicated at 219. A heavy plate 220 is welded to the upper end of the shell 218 and has a central opening 221 aligned with the caisson 99*a*. The plate 220 has a convex surface 221*a* that is engaged by a complementary concave surface 222 formed on a ring 223. Bolts 224 hold plate 220 and ring 223 to the lower side of the frame work of the bridge 28. Webs 225 serve as reinforcement for the adapter 217.

After the caisson 99*a* has been installed, and the barge repositioned at the desired distance away from the caisson the forward end of the bridge 48 is tilted upwardly by the cylinders J on the support 10A. The bridge with the adapter 217 secured thereto, is then projected outwardly to a position where the adapter is above the caisson 99*a*. The forward end of the bridge is then lowered by the cylinders J to position the adapter 217 on the caisson. The bolts 224 are loose at this time to accommodate any misalignment. When the bridge 48 is in final position on the caisson 99*a* the bolts 224 are tightened so that the bridge 48 braces the upper end of the caisson 99*a* against lateral wind and wave forces. The live load on the derrick 69 during drilling operations is transmitted through the bridge 48 directly to the caisson 99*a* through the adapter 217. After the well is completed, the bolts 224 are loosened, and the bridge 48 is raised and retracted, removing the adapter 217 from the caisson 99*a*.

FIG. 27 illustrates another modification of the invention in which a platform 169*a* similar to the platform 169 as secured to the underside of the frame work of the bridge 48 by bolts 224*a* and is adapted to be set down on the upper end of a caisson 99*b* by manipulation of the bridge structure itself. Here again, the live load on the derrick 69 is transmitted through the platform 169*a* directly to the caisson 99*b* when the apparatus is in use. Likewise, the bridge 48 braces the caisson 99*b* against lateral forces. After the well drilling operation has been completed, the platform 169*a* is detached from the bridge by removing the bolts 224*a*. The derrick 69 is then lowered and the bridge 48 retracted, leaving the platform 169*a* to serve as a well head support.

FIGS. 28, 29 and 30 illustrate another modification of the invention in which a bridge 48*a* has a platform 228 erected at one side thereof and braced by a framework 229 connected with one side of the framework of the bridge 48*a*, as best shown in FIG. 30. A conventional crane 230 is rotatably supported upon a turntable 231 mounted upon the platform 228. The crane 230 includes the usual derrick boom 232 pivoted at 233, a boom topping cable 234, a crown block 235, a main cable 236 and a traveling block 237. It will be noted from FIGS. 28 and 29 that the axis of the turntable is approximately in lateral alignment with the middle of the movable support 10*a* for the bridge 48*a*. FIG. 29 particularly illustrates

the convenient location of the boom **232** for handling the pipe or casing **200** stored on the racks **199** mounted on the bridge **48***a*. Such pipe or casing can be readily delivered by the traveling block **237** to the cat line (not shown).

FIGS. 31, 32 and 33 illustrate a relatively lighter form of barge construction embodying the principles of the present invention and particularly adapted for well servicing use. Thus, a barge **1***c* is provided with six caisson jacks **8***c* and supported above the water by a corresponding number of caissons **7***c*. A counterbalanced bridge structure **48***c* is mounted upon the barge deck **3***c* upon a movable support **10***c*. A derrick mast **69***c* is mounted upon the bridge **48***c* by a pin **70***c* and brackets **71***c*. The mast **69***c* is raised and lowered by a conventional hydraulic cylinder and rod assembly **78***c*. A main cable **74***c* extends from a draw works **64***c* around a sheave **75***c* to a crown block **73***c* and around a traveling block **76***c*. A pair of guy lines **86***c* is connected to the upper end of the mast as indicated at **86***d* and to the bridge **48***c* as indicated at **86***e*. The forward end of the bridge **48***c* is shown resting upon an adapter **217***c* mounted upon the upper end of a caisson **99***c*. The adapter **217***c* being similar to the adapter **217** shown in FIG. 26.

In well servicing operations it is extremely important that the well servicing apparatus make a safe approach to the well head H. Such approach is made with the present apparatus by anchoring two buoys B on opposite sides of the well head H so that lines **240** extending from winches **241** mounted on the barge can be connected thereto. The lines **240** extend past the caisson jacks **8***c* and fairleads **242** mounted on the barge. Additional winches **243** and fairleads **244** are mounted at the opposite end of the barge **1***c* and lines **245** extend from the winches **243** and are connected to anchors A.

In making an approach to the well head H, the barge **1***c* is moved into a position in which the bridge **48***c* is approximately in alignment with the well head. The anchors A are then dropped to prevent the barge **1***c* from moving toward the well head H. The lines **240** are then connected with the buoys B. This can be done by men working from a relatively small boat. Assuming that the barge **1***c* is to be moved from its full line position into a final position indicated by the dot-and-dash lines in FIG. 33, the anchor lines **245** are payed out while the lines **240** are taken in. After the barge **1***c* has reached its desired position, the jacks **8***c* are operated to lower the caissons **7***c* and to raise the barge above the water to the desired height. While the barge **1***c* is being raised, the lines **240** and **245** are slacked off. The bridge **48***c* is then projected from the barge **1***c* over the well head H under precise control. In this connection, the forward end of the bridge **48***c* is provided with an opening **246** to accommodate the well head equipment (not shown) extending above the structure **217***c*. The derrick mast **69***c* is then raised by the hydraulic cylinder assembly **78***c* and well servicing operations can then be started. After the well servicing operations have been completed, the derrick **69***c* is lowered, the bridge **48***c* is retracted, the barge **1***c* is lowered onto the water and the caissons **7***c* are raised. Meanwhile, the barge **1***c* is held against movement toward the well head H by properly controlling the lines **240** and **245**. After the barge **1***c* has been lowered onto the water, the lines **240** are detached from the buoys B, the anchors A raised, and the barge moved to another site.

The load bearing factor of the area around a site may also be used in designing the caissons **7** that hold the barge above the water. Those caissons can then be made in the most economical dimensions. In use the barge may be lifted only enough to load the lowered caissons a measured amount and left so until the mud gells. After the mud bells the entire weight of the barge can be transferred to the caissons.

Various changes may be made in the details of construction of the several embodiments of the invention disclosed herein without departing from the principles of the invention or the scope of the annexed claims.

I claim:

1. A method of erecting an over-water platform comprising: raising a barge above the water at a well site; sinking at least one platform caisson while guiding the same from said barge; positioning a platform upon said caisson; lowering said barge back onto the water; moving said barge a safe working distance away from said platform; again raising said barge above the water; and extending a bridge over the water from and outboard of said barge to a position wherein one end thereof overlies said platform and the center of gravity of said bridge is inboard of said barge.

2. The method of providing an over water structure for drilling an under-water well, comprising: supporting on one over-water platform a movable bridge unit having at least a draw works, a derrick mast adjacent one end of said unit and having a crown block at its upper end, and a cable extending from the draw works and over said crown block for suspending a live load; providing a second over-water platform spaced a substantial distance from said first over-water platform; positioning said bridge unit across the gap between said platforms with the upper end of said mast above said second platform and the center of gravity of said bridge unit inboard of said one platform; and supporting the weight of said bridge unit on said one platform while transmitting the downward thrust of said live load on said derrick mast to said second platform.

3. In a method of providing an over water structure for drilling an under-water well in deep water, the steps, comprising: positioning a well drilling barge at the desired well location, said barge having a movable bridge mounted thereon provided adjacent one end of said bridge with a rotary table, a derrick mast and a traveling block; elevating said barge to a desired height above the water; utilizing said derrick mast and traveling block at least in part to install a caisson and a well head supporting structure beyond one edge of said barge; lowering said barge onto the water; moving said barge a substantial distance away from said well head supporting structure; again raising said barge above the water; and positioning said bridge across the gap between said barge and said well head supporting structure with the rotary table substantially vertically aligned with said well head supporting structure and the center of gravity of said bridge inboard of said barge.

4. The method defined in claim 3, wherein the bridge is utilized to brace the caisson and well head supporting structure and the derrick mast against lateral forces.

5. In a method of providing an over water structure for drilling a well under water, the steps, comprising: installing a relatively small platform over the water at the desired well location; positioning a well drilling barge adjacent but spaced from said platform; elevating said barge to a desired height above the water; placing a bridge unit, including a derrick mast, a traveling block for suspending a live drilling load, and a derrick floor provided with a rotary table, in a position to bridge the space between the barge and the platform with the rotary table disposed in a position overlying the platform and the center of gravity of said unit inboard of the barge; and supporting the weight of said bridge unit on said barge while transmitting the downward thrust of the live drilling load on said derrick mast to said platform.

6. The method of drilling an under-water well in an area having a soft-deep, mud bottom, comprising: installing a well head supporting structure by forcing a caisson or the like into the mud until the resistance to penetration reaches a predetermined amount that will produce the required load carrying ability after the mud has gelled; positioning a drilling barge a desired distance from said caisson; raising said barge above the water;

positioning a bridge carrying drilling mechanisms across the gap between said barge and caisson with the center of gravity of the bridge inboard of the barge; commencing drilling operations through said caisson while supporting the static load of the bridge and drilling equipment from the barge, whereby the caisson is relieved of said static load, and drilling operations can be started before the mud gells around the caisson, and whereby only the low load of the initial drilling operations may be imposed upon the caisson during the mud gelling period.

7. Over-water well drilling and servicing apparatus, comprising: a barge having a working deck; means for at least partly supporting said barge on the marine bottom at a well site with said working deck above water; a movable bridge on said barge for spanning a gap between said barge and a well head; a movable support on said barge disposed beneath and intermediate the ends of said bridge; means on said barge for moving said support to a position wherein one end of said bridge projects beyond one edge of said barge; and mechanisms mounted on said bridge in working alignment and constituting a well drilling-servicing rig, said mechanisms being positioned on the bridge so that said bridge is substantially balanced on its support.

8. Over-water well drilling and servicing apparatus, comprising: a barge having a working deck; means for at least partly supporting said barge on the marine bottom at a well site with said working deck above water; a generally horizontally movable bridge on said barge adapted to span a gap between said barge and a well head; well drilling and servicing mechanisms carried by said bridge and distributed thereon to maintain the center of gravity of said bridge inboard of said barge when said bridge is in said spanning position; a movable support intermediate the ends of said bridge supporting said bridge in vertically spaced relation to said barge, said support including horizontal pivot means; means on said barge for moving said support horizontally relative to said barge; and means for moving said bridge about said horizontal pivot.

9. Over-water well drilling and servicing apparatus, comprising: a barge, a movable bridge on said barge adapted to span a gap between said barge and a well head; a support intermediate the ends of said bridge supporting said bridge in vertically spaced relation to said barge; a pair of tracks on said barge; two pairs of shoes mounted upon said tracks; means pivotally connecting said support with one pair of said shoes for movement about a horizontal axis; means connecting said support with said other pair of shoes and including power operated means on said barge for raising and lowering said support and bridge with respect to said other pair of shoes; and means on said barge connected with said shoes for moving the support and bridge along said tracks.

10. In combination, a marine well head supporting structure; a barge having a working deck spaced from said well head supporting structure; means at least partly supporting said barge on the marine bottom with said working deck above water; a movable bridge on said barge for spanning the gap between said barge and well head supporting structure, said well head supporting structure including a platform having an opening; a rotary table at one end of said bridge; means on said barge for extending the bridge from said barge, while supporting the static weight of said bridge and elements carried thereon on said barge, to a position in which said rotary table is in vertical alignment with the opening in said platform; a derrick mast mounted on said one end of said bridge; and adjustable means disposed between said bridge and said platform for transmitting the live load on the derrick mast to said platform.

11. Over-water well drilling-servicing apparatus, comprising: a barge having a working deck; means for at least partly supporting said barge on the marine bottom at a well site with said working deck above water; a bridge on said barge for spanning a gap between said barge and a well head; well drilling and servicing mechanisms carried on said bridge and distributed thereon to maintain the center of gravity of said bridge inboard of said barge when said bridge is in said spanning position; a support on said barge for said bridge disposed intermediate the ends of said bridge, said support including means mounting said bridge for up and down, and sidewise movement of its forward end relative to said barge; means for moving the forward end of said bridge up and down; means for moving the forward end of said bridge sidewise; and means for moving said support and bridge to a desired position on said barge.

12. In combination, an over-water well head support; an over-water marine structure spaced from said well head support; a movable bridge on said marine structure for spanning the gap between said marine structure and said well head support; a movable under-carriage for said bridge mounted upon said marine structure and disposed intermediate the ends of the bridge; means for moving said under-carriage and bridge to a position on said marine structure wherein one end of said bridge overlies said well head support; and mechanisms mounted on said bridge constituting a well drilling-servicing rig, said mechanisms being distributed on said bridge so that the weight of the bridge and mechanisms is counter-balanced relative to said undercarriage, whereby the well head support is relieved of the weight of the overhanging portion of said bridge.

13. Mobile apparatus for the drilling and servicing of offshore wells comprising: a floatable structure adapted to be towed to and from a marine well site and provided with means for support on the marine bottom at the site to provide a stable working platform elevated above wave action, said structure having a generally rectangular horizontal outline; an elongated drilling substructure; well drilling and servicing mechanisms carried on said substructure including, adjacent one end thereof, a drilling derrick and a rotary, said mechanisms being distributed on said substructure to maintain the center of gravity thereof intermediate its ends and said substructure being mounted on said platform for horizontal shiftable adjustment into overhanging relation wih an edge of said platform without overbalancing to position said derrick and rotary in a limited range of distances outboard of said outline; and means pivotally connecting the other end of said substructure to said platform for pivotal adjustment of said substructure about a horizontally-shiftable vertical axis, when in said overhanging relation, whereby said derrick and rotary can be moved in a limited arc outboard of said outline.

14. The structure defined in claim 13 including power-operated means for effecting the shiftable and pivotal adjustments.

15. A mobile structure for drilling and servicing wells in a marine bottom comprising: a buoyant body; a plurality of elongated body-supporting legs mounted in upright position on said body for vertical movement relative thereto; power-operated means mounted on said body for selectively restraining or effecting said movement in order to elevate said legs off the marine bottom when the structure is floated from one marine site to another, move said legs down into engagement with the marine bottom at a selected site and there raise said body out of the water on said legs for stable support thereon during well drilling or servicing operations, and lower said body on said legs back down into the water preparatory to floating the structure to another marine site; an elongated drilling substructure; well drilling and servicing mechanisms carried on said substructure including, at one end thereof, a drilling derrick and a rotary, said mechanisms being distributed on said substructure to maintain the

center of gravity thereof intermediate its ends and said substructure being mounted for horizontal movement on said body; and means pivotally connecting the other end of said substructure to said body for swinging movement about a horizontally-shiftable vertical axis, whereby said substructure can be moved linearly into overhanging relation with a peripheral edge of said body without overbalancing to position said derrick and rotary in a limited range of distances outboard of said body for drilling or servicing operations on a well and can be moved back inboard of said edge for increased stability of the structure when said body is being raised or lowered and when the structure is afloat, and said substructure can be pivoted about said connecting means to move said derrick and rotary in a limited arc outboard of said body, thereby enabling said derrick and rotary to be adjusted into a plurality of operative positions relative to said body.

16. The structure defined in claim 15 including power-operated means for moving the substructure linearly toward and away from the body edge.

17. The structure defined in claim 15 including power-operated means for pivoting the substructure about the connecting means.

18. The structure defined in claim 15 including power-operated means for moving the substructure linearly toward and away from the body edge and for pivoting said substructure about the connecting means.

19. The structure defined in claim 12 in which the under-carriage includes means connecting the bridge thereto for swinging movement about a vertical axis.

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