

[72] Inventor **Maurice N. Sumner**
1 Chelsea Place, Houston, Tex.
 [21] Appl. No. **649,889**
 [22] Filed **June 29, 1967**
 [45] Patented **Apr. 13, 1971**

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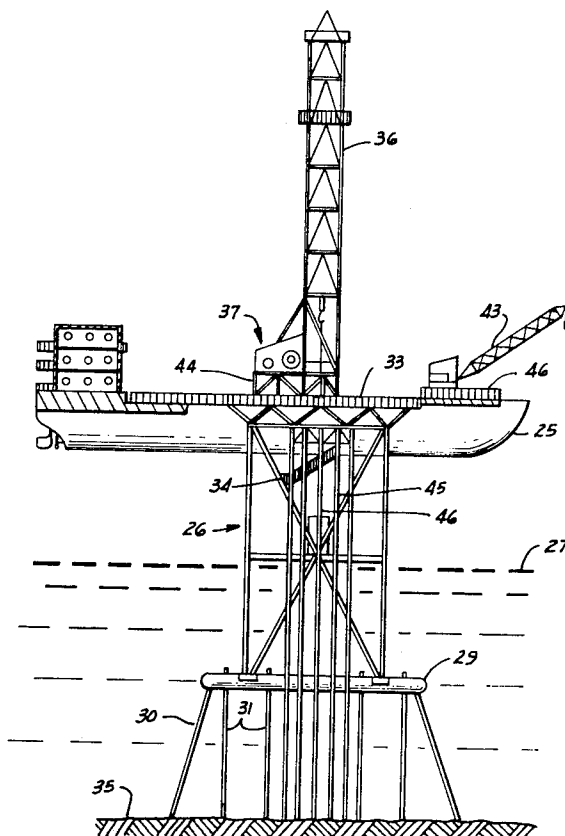
Primary Examiner—Jacob Shapiro
 Attorney—Bernard A. Reiter

[54] **METHOD AND APPARATUS FOR OFFSHORE OPERATIONS**
25 Claims, 105 Drawing Figs.

[52] U.S. Cl. **61/46.5,**
 61/65, 114/5, 114/43.5, 175/7, 175/9
 [51] Int. Cl. **E02b 17/04,**
 E02d 21/00, B63c 7/04
 [50] Field of Search 61/46.5, 46,
 65, 67; 175/5, 6, 7, 8, 9; 114/0.5, 43.5

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ABSTRACT: In the erection of offshore structures, preferred method steps including releasably securing a vessel adapted for water navigation to a structure, said structure being adapted to be stabilized at selected locations of various depths wherein stabilization enables mineral-related, military, and transportation apparatus to function from said structure, altering the elevation of the vessel with respect to the structure whereby the vessel is made more free of wave action at the altered elevation and thereafter restoring the vessel to a navigable relationship to the body of water; said invention including apparatus for supporting a separable structure wherein the support immediately below the structure is designed principally with support of the structure in view and extends downwardly to a footing member, wherein support members below said footing member are founded in the soil beneath the body of water and are designed principally as foundation members.

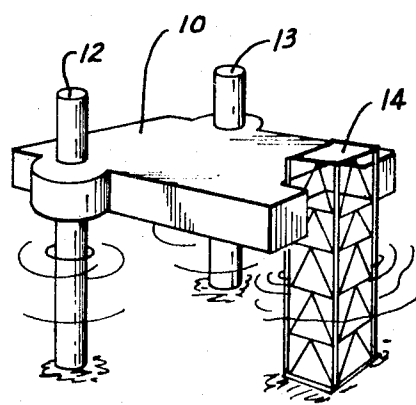
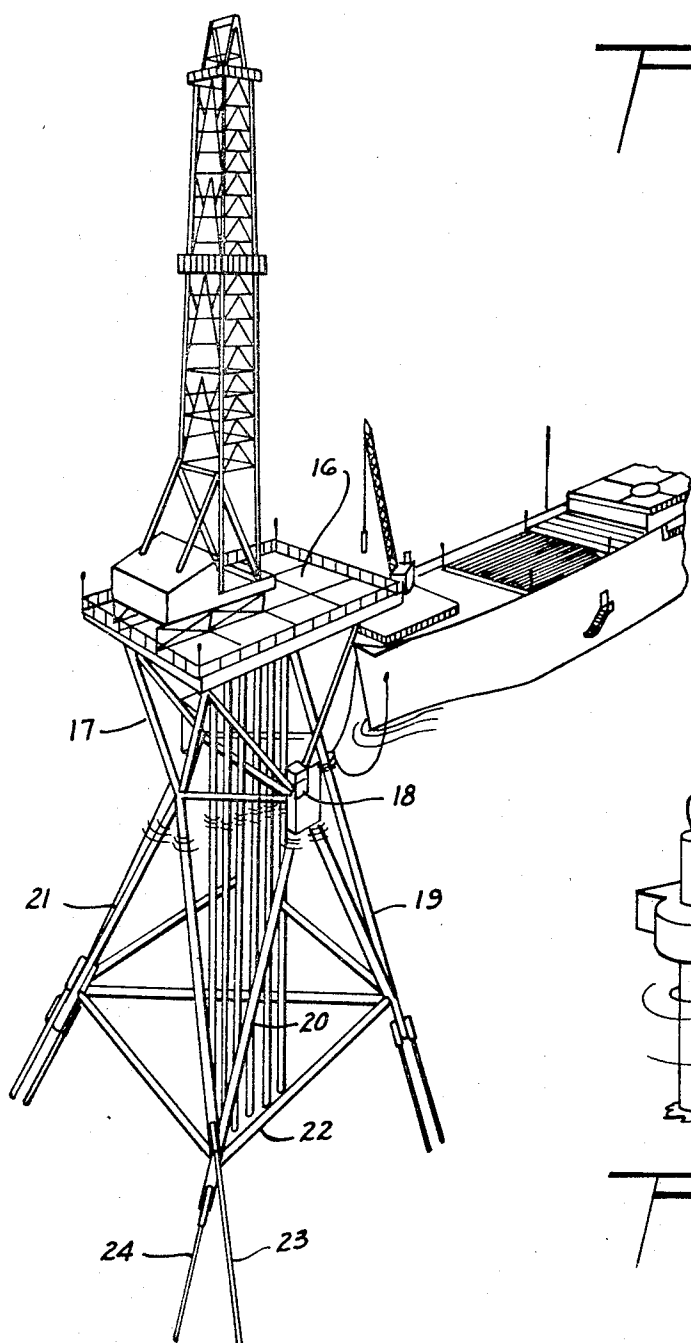


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3,575,005

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F 19-1

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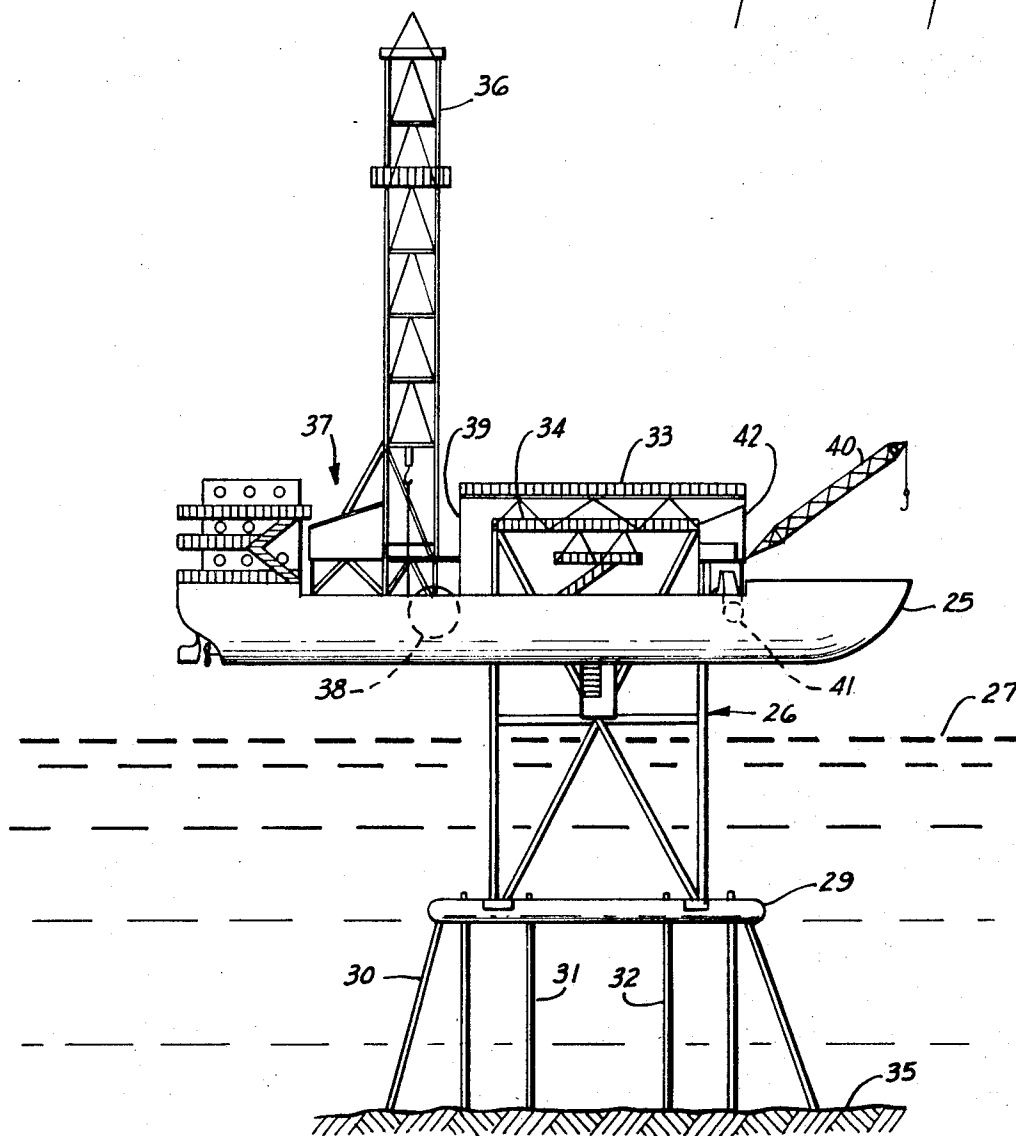
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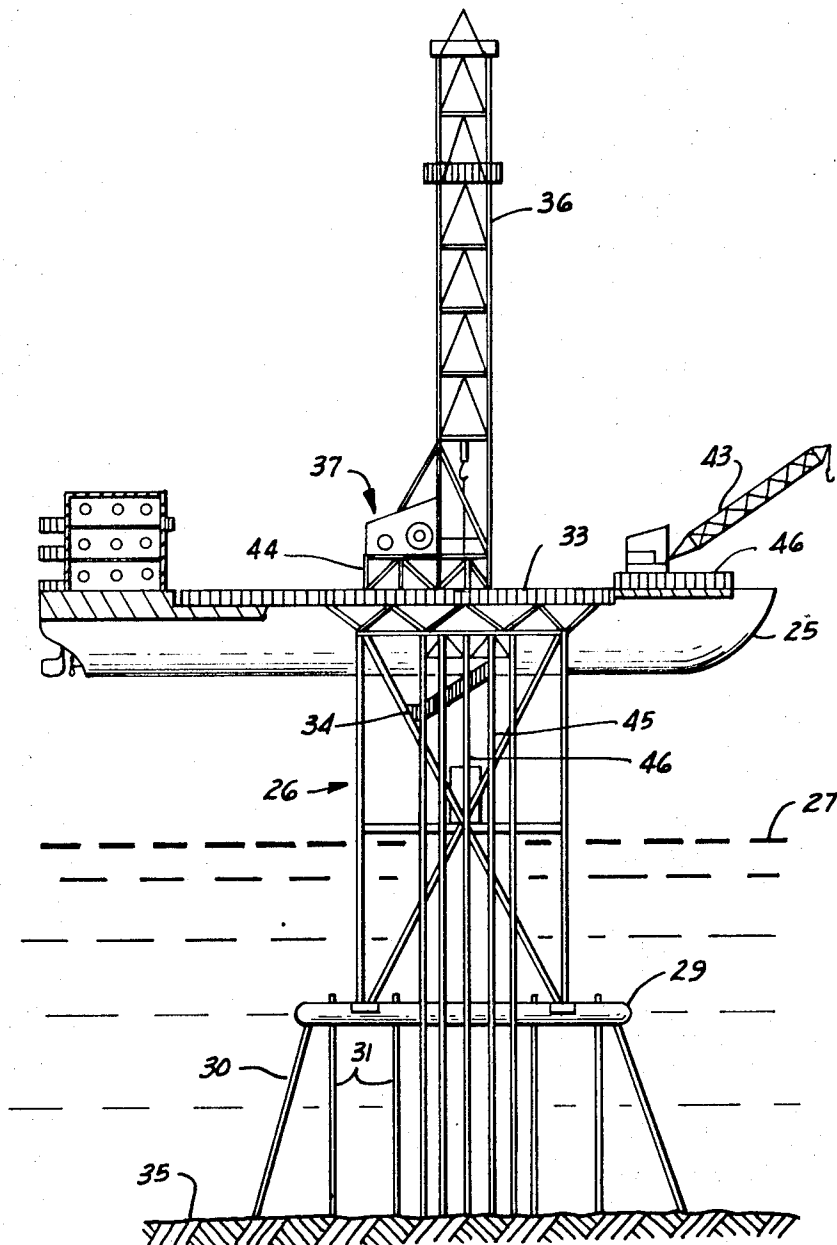
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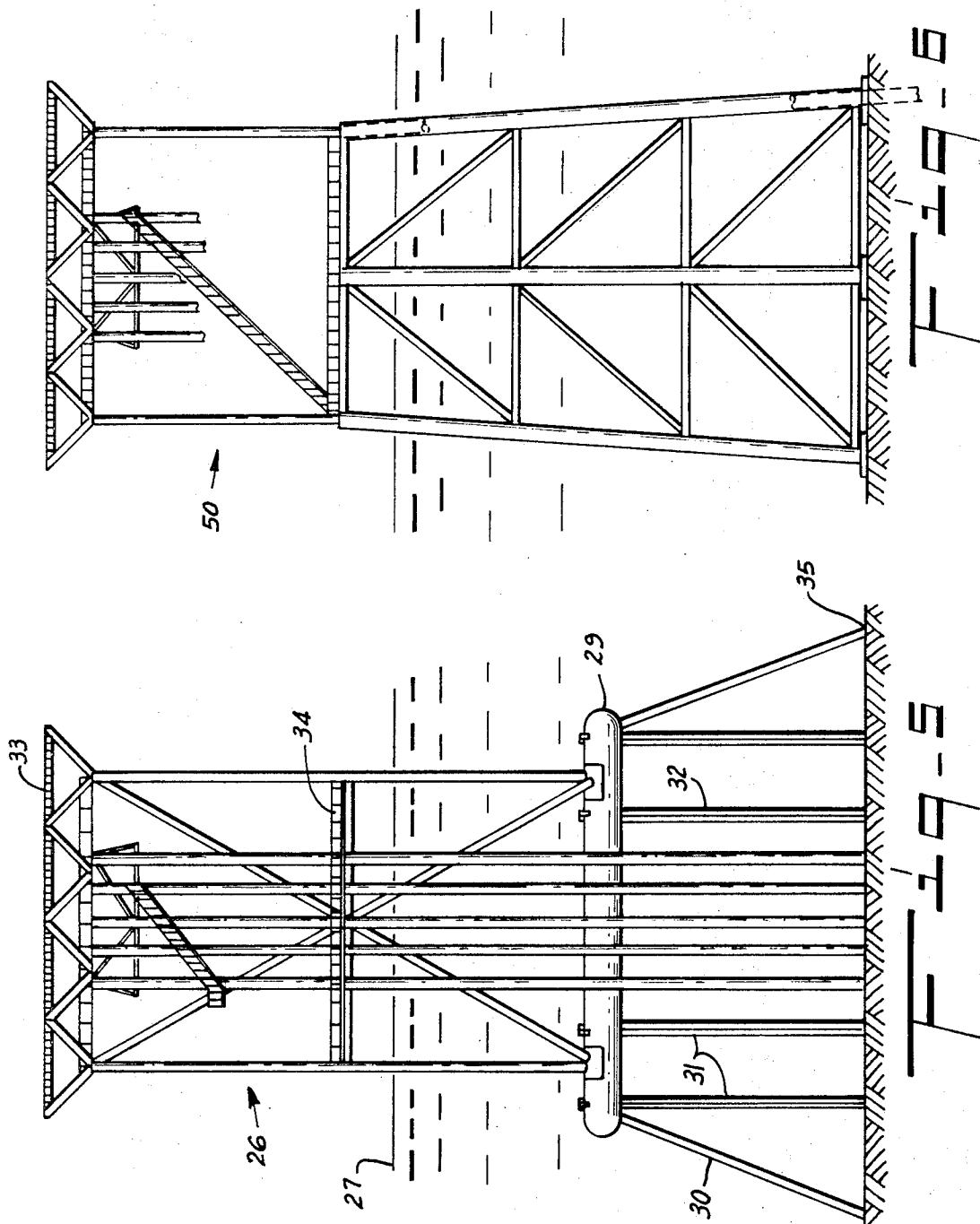
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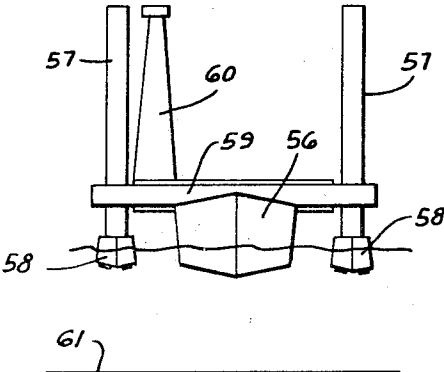


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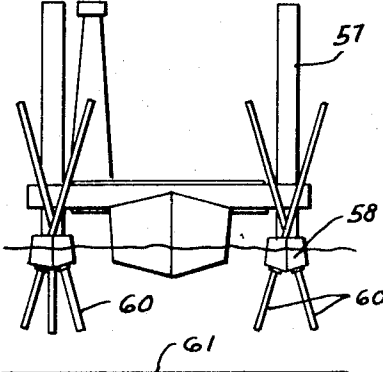


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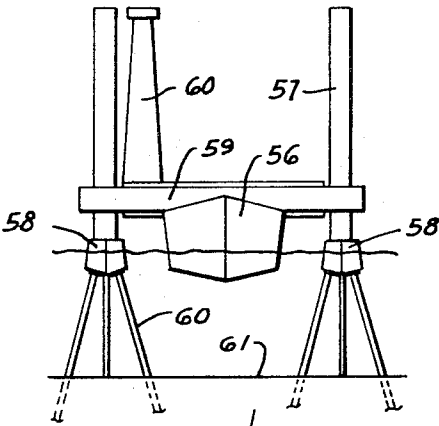


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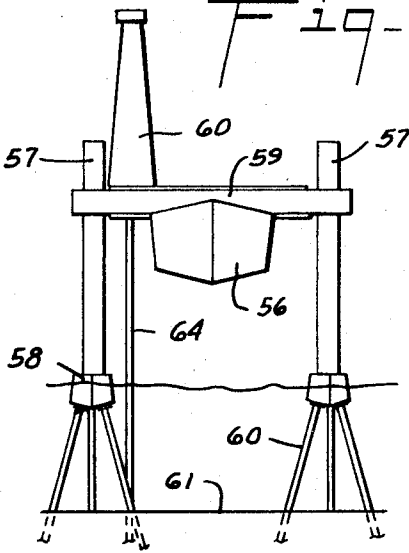


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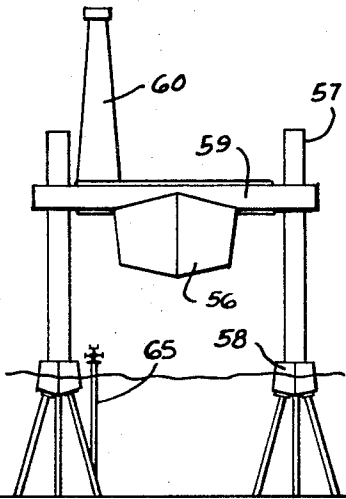


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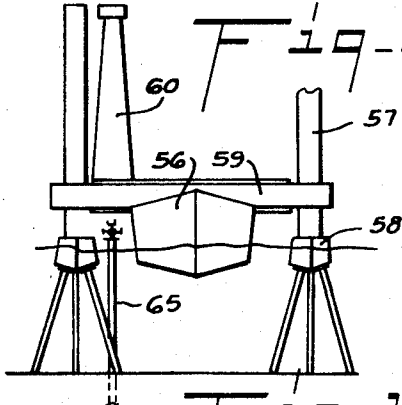


Fig-12

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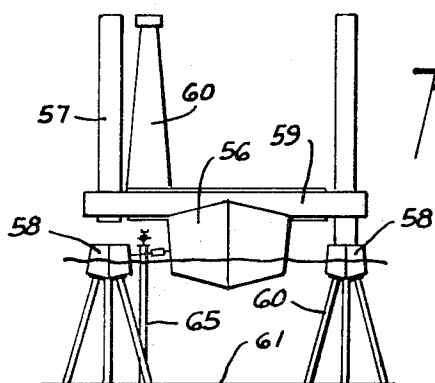


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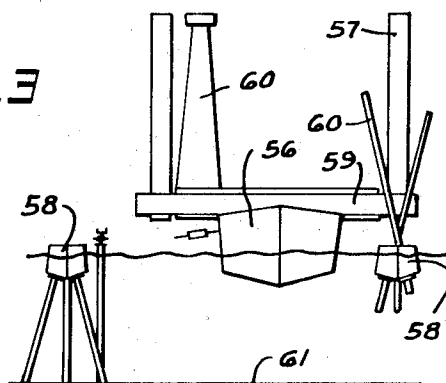


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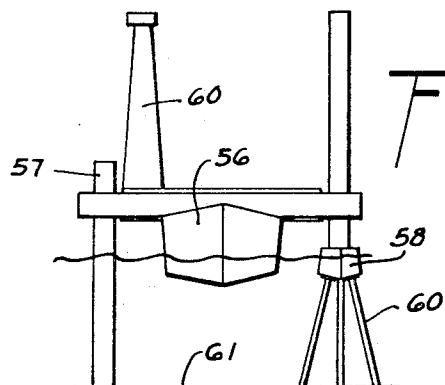


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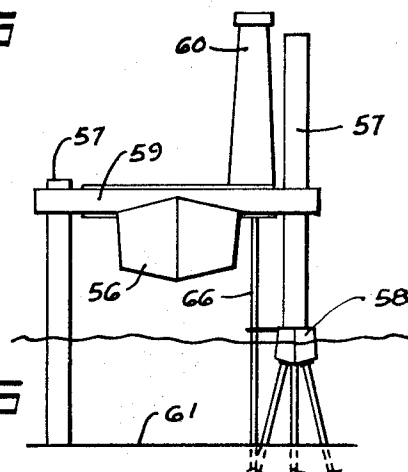


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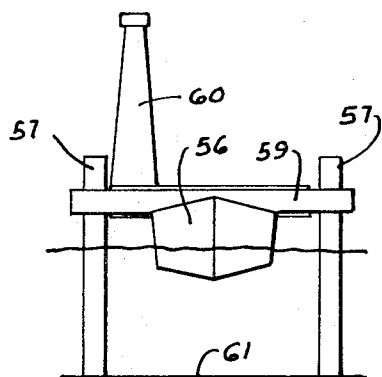


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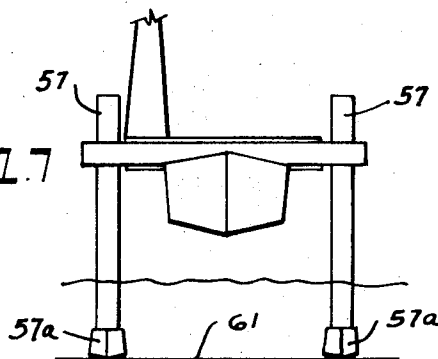


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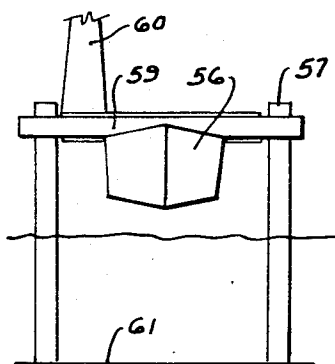
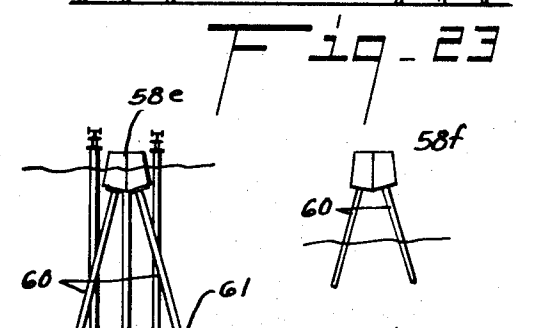
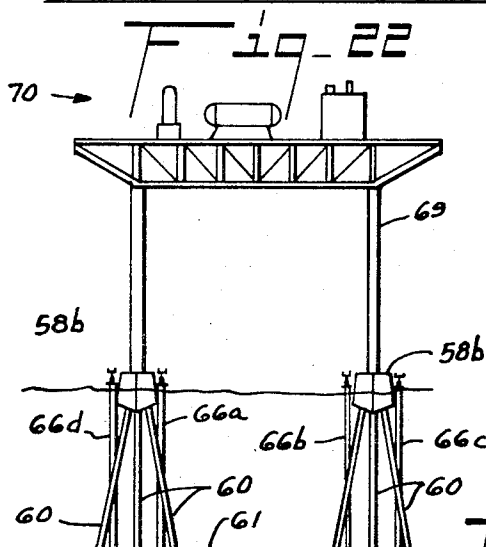
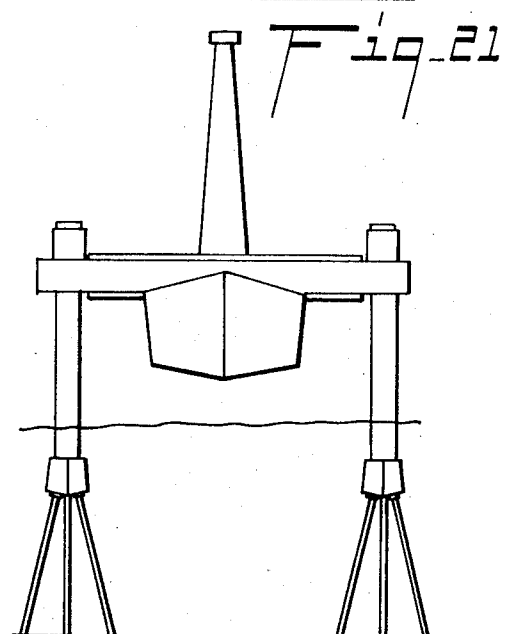
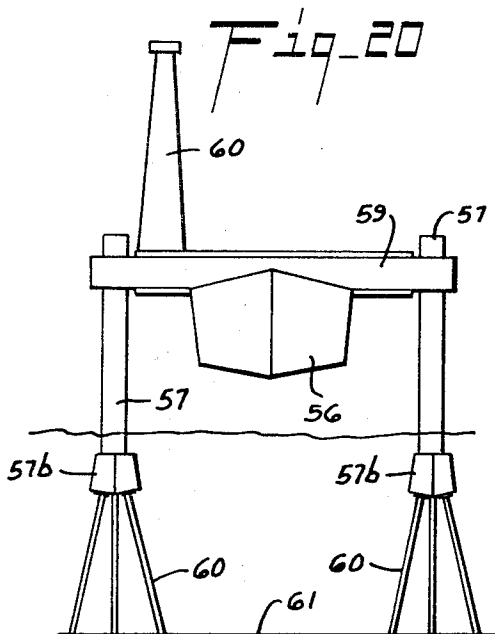
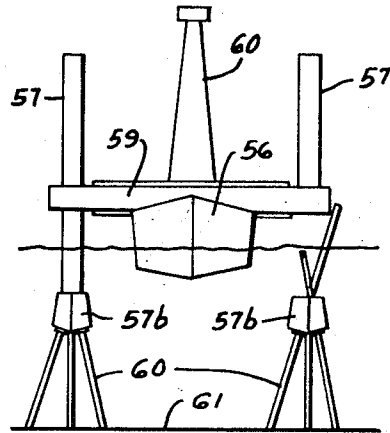
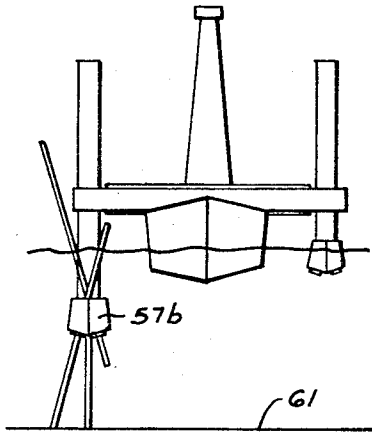


Fig. 19

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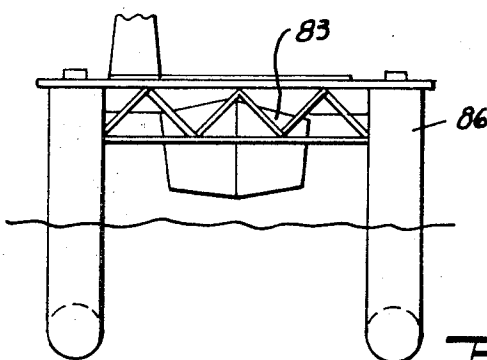
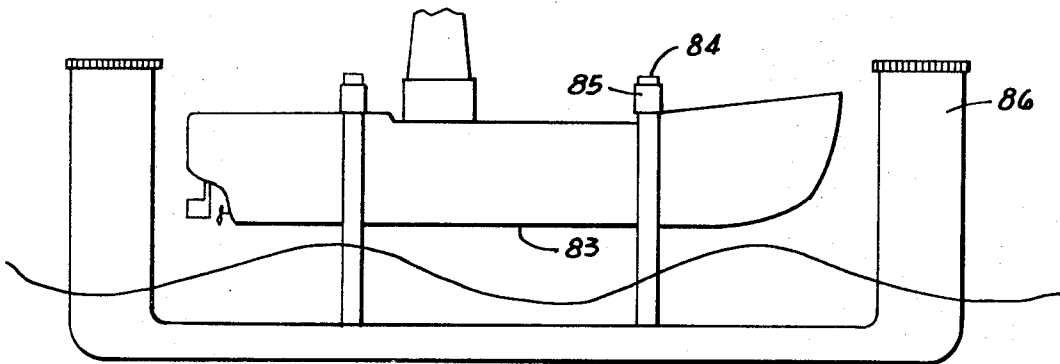
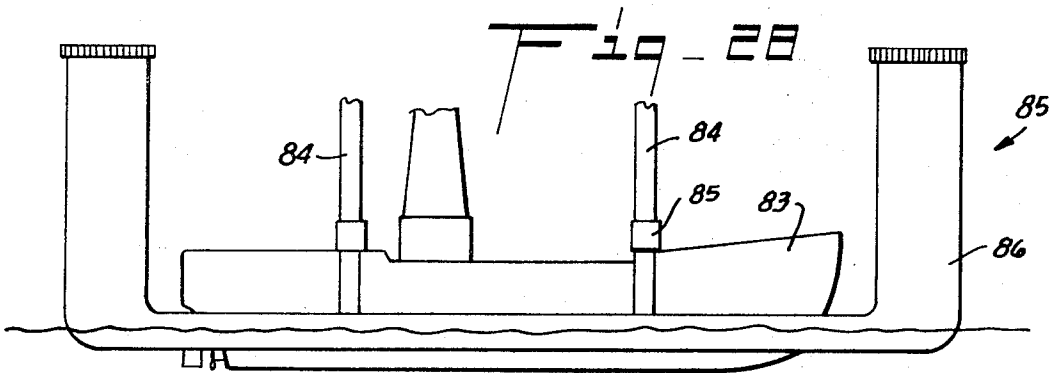
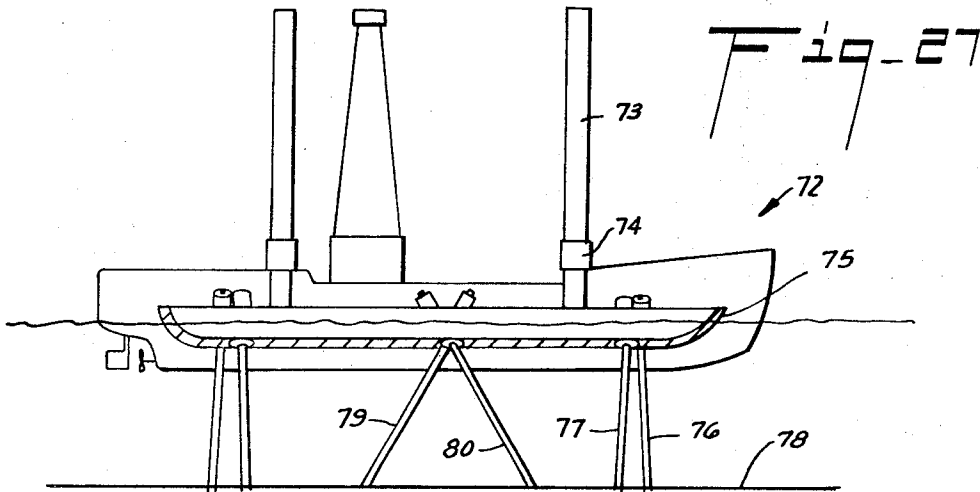


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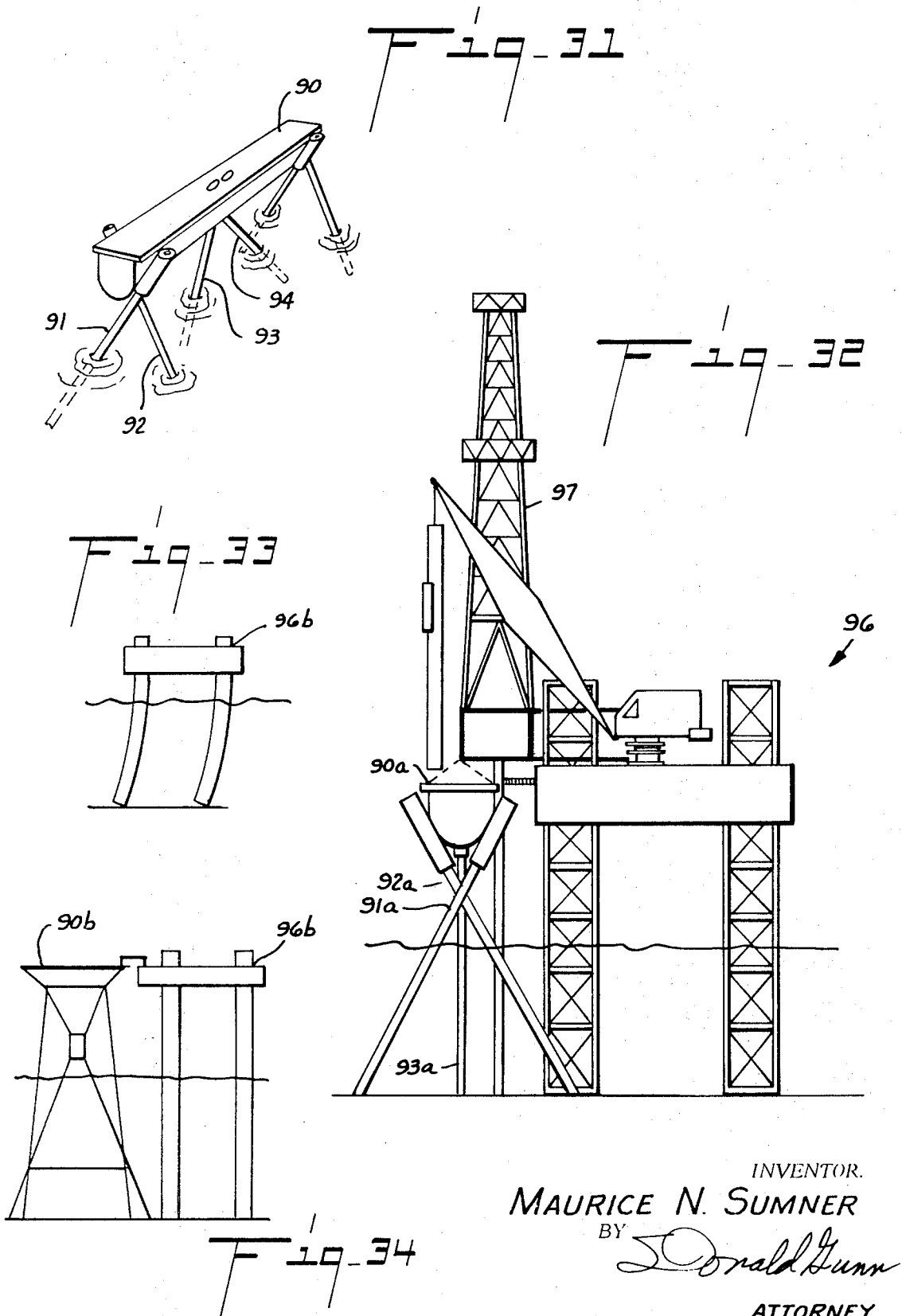


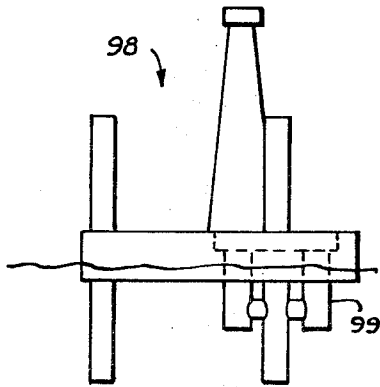
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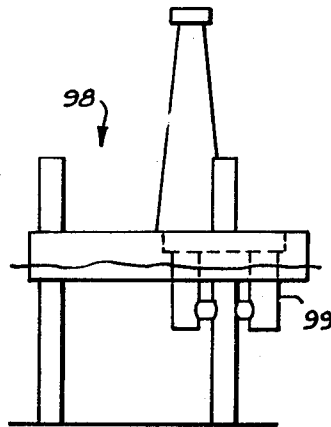
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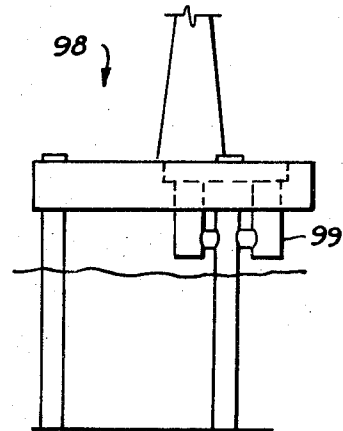




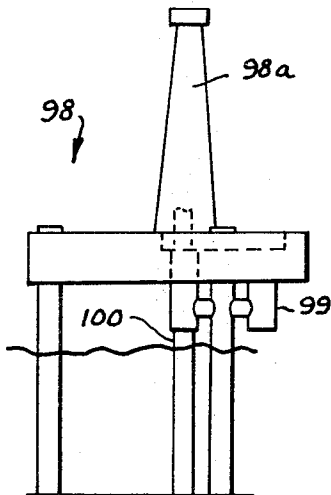
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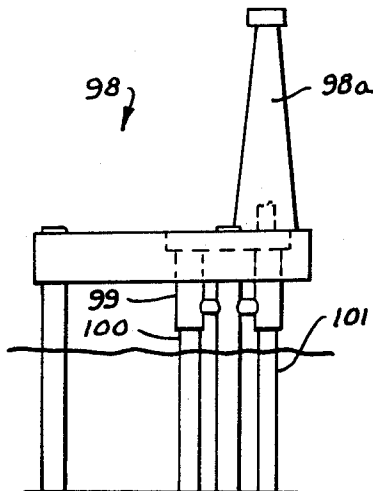
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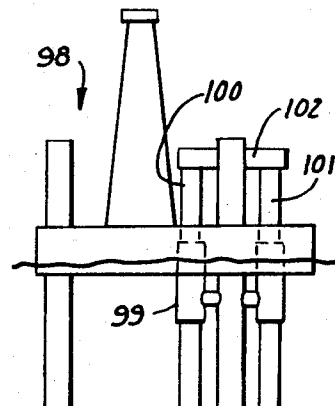
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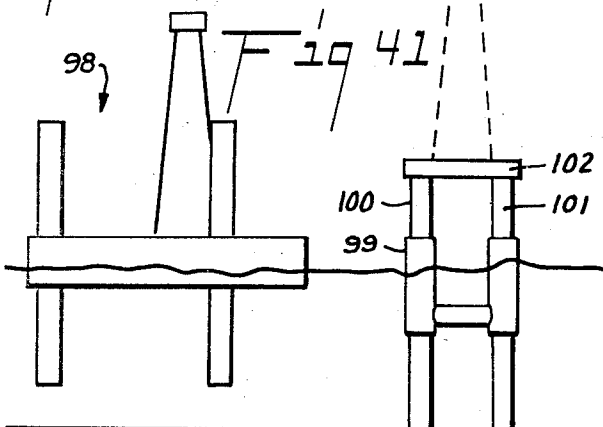
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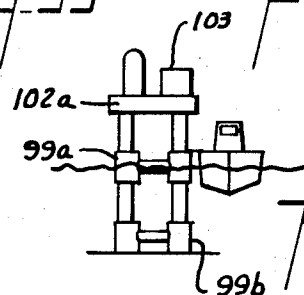
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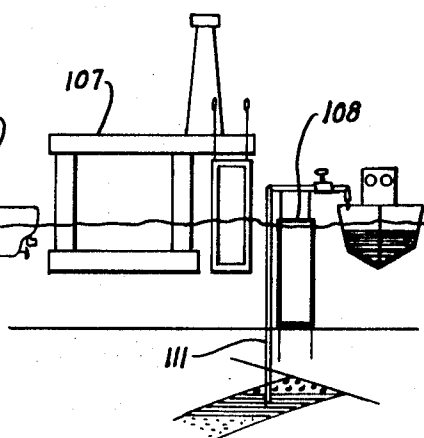
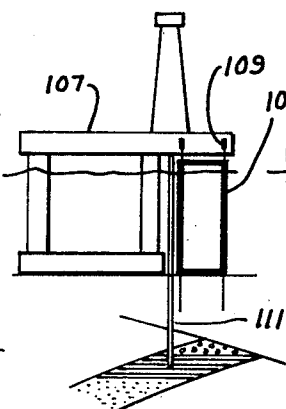
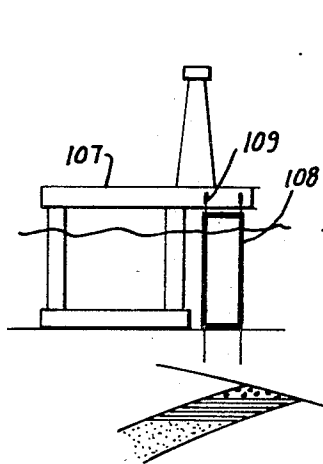
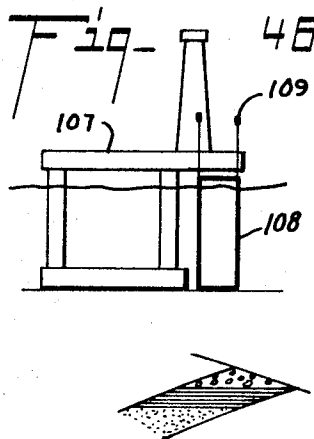
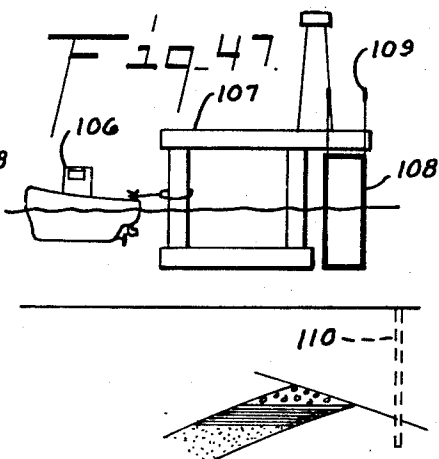
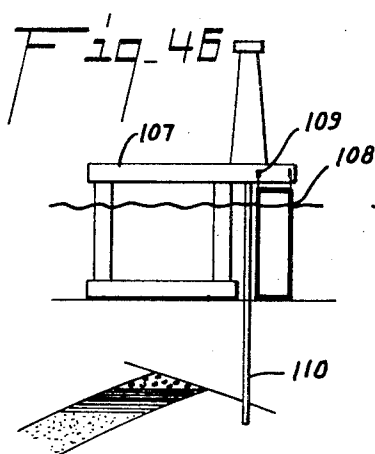
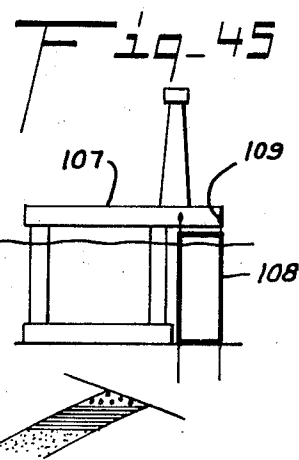
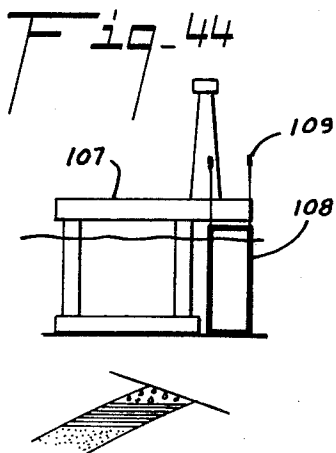
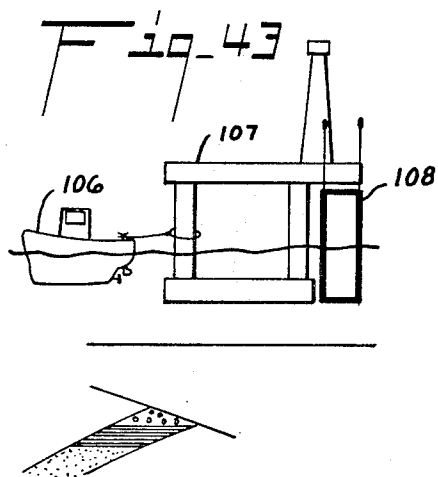
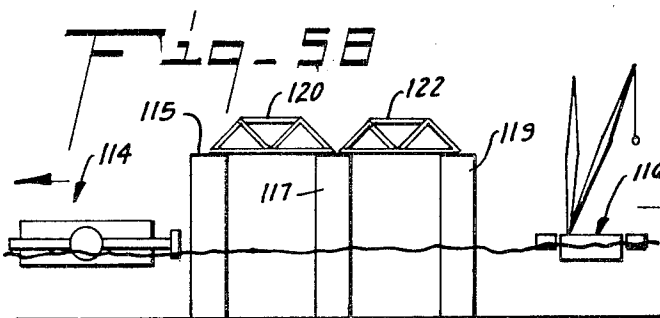
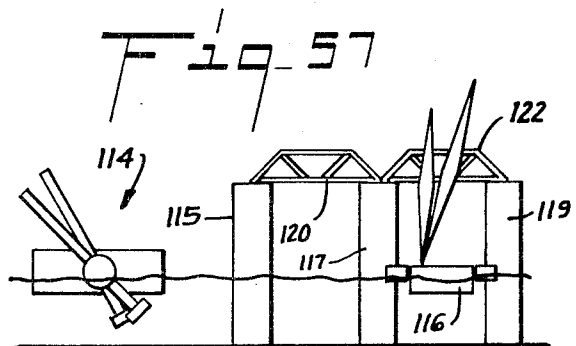
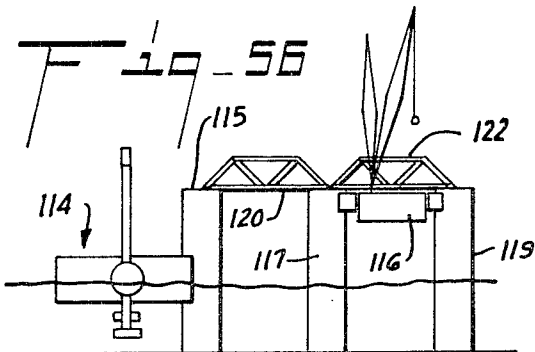
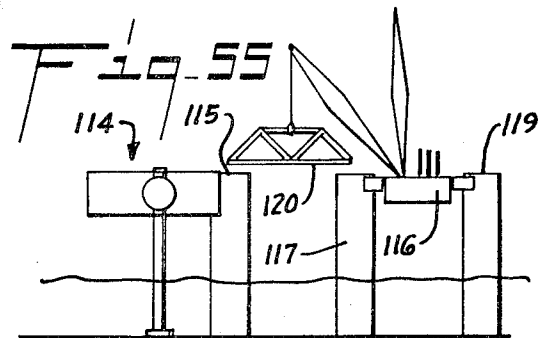
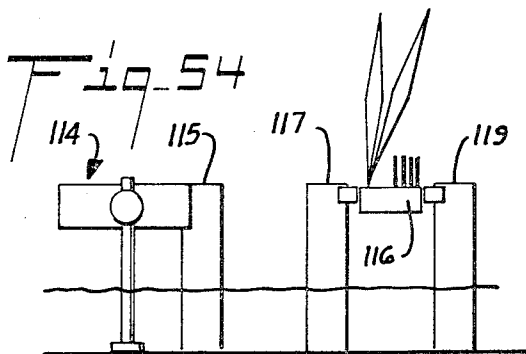
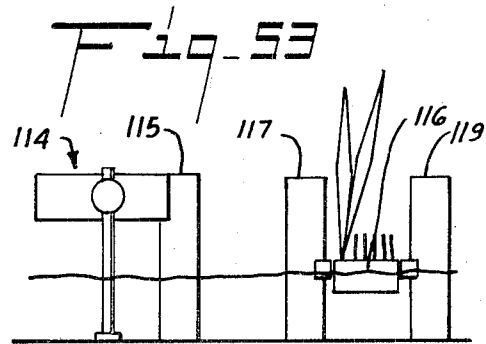
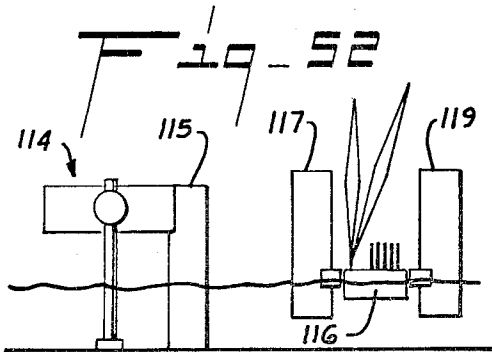


Fig. 49

Fig. 50

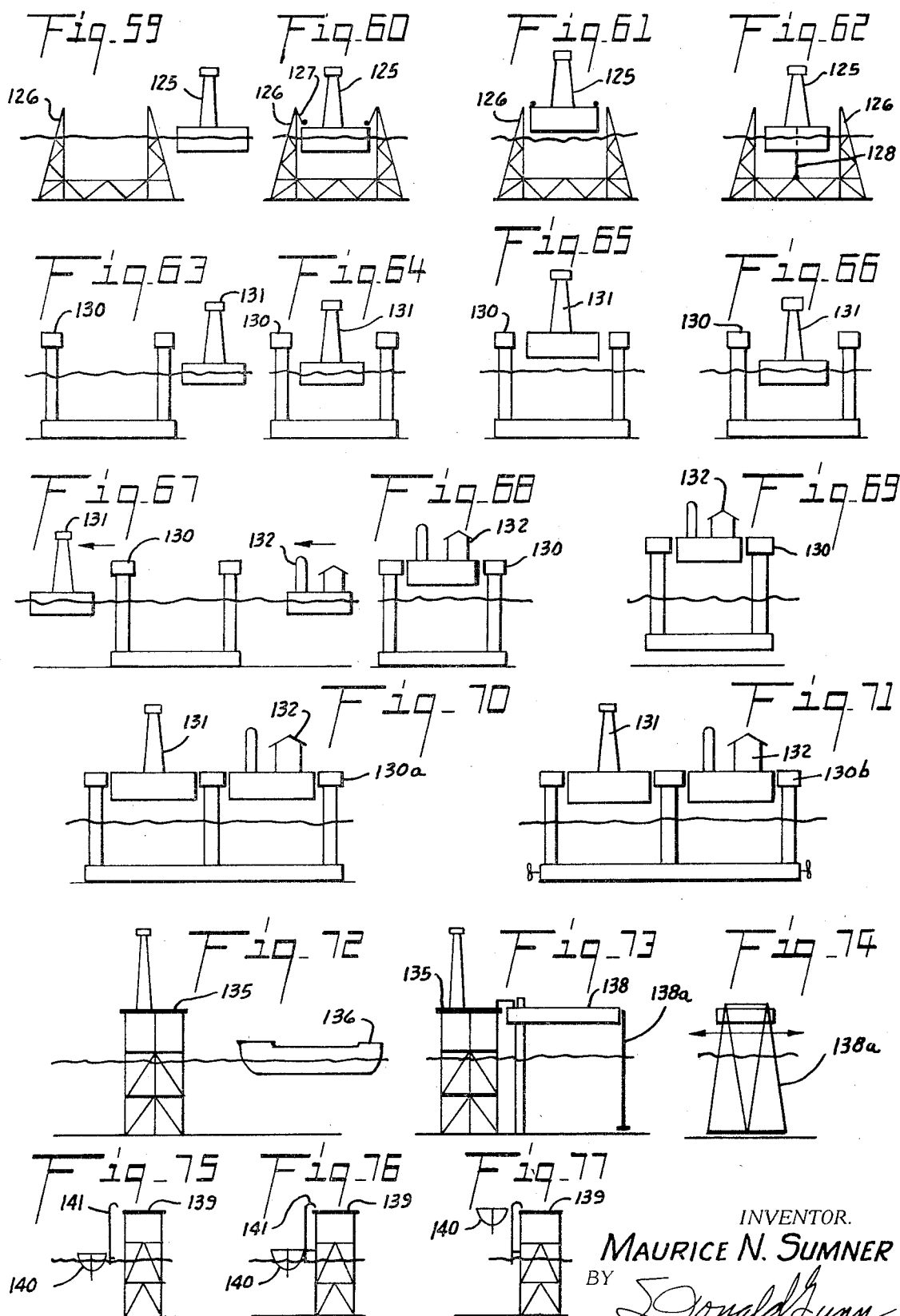
Fig. 51
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MAURICE E. SUMNER
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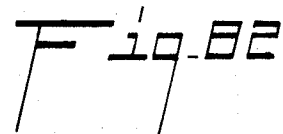
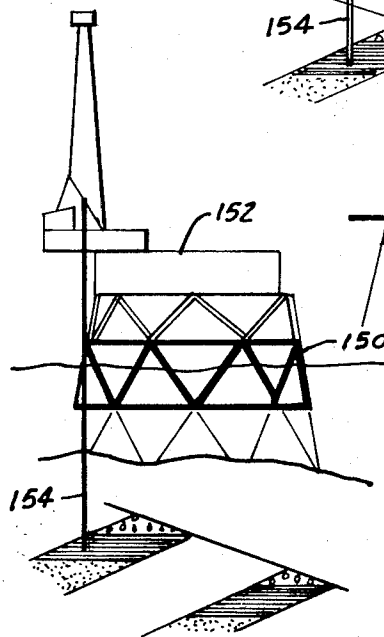
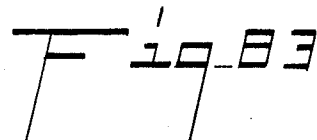
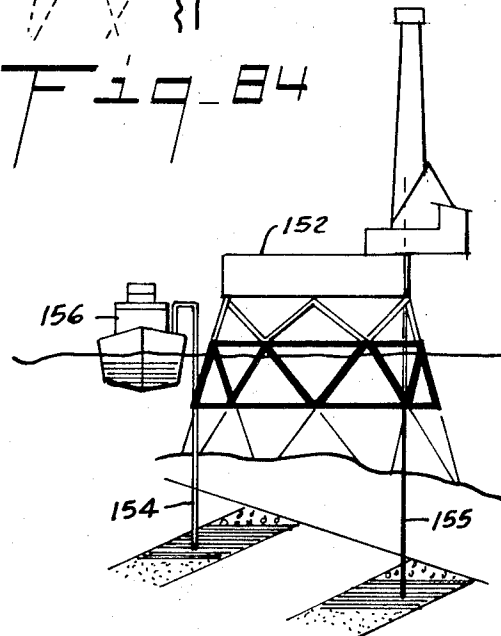
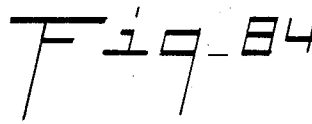
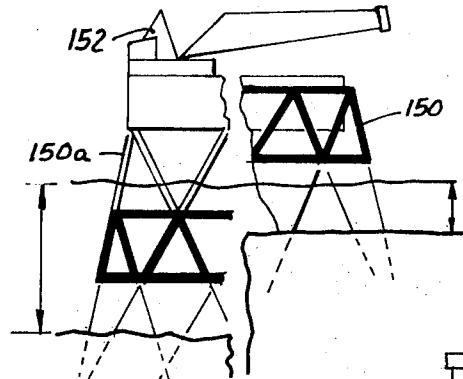
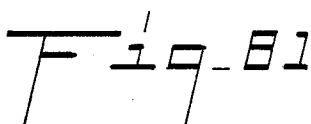
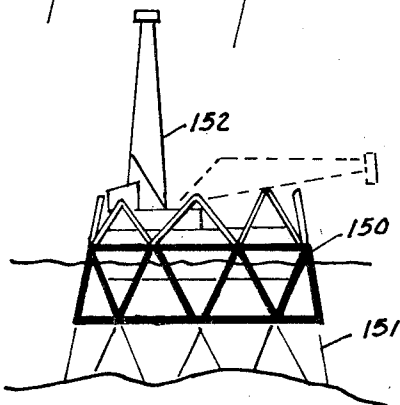
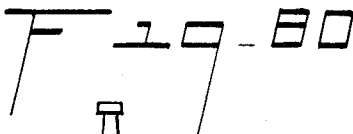
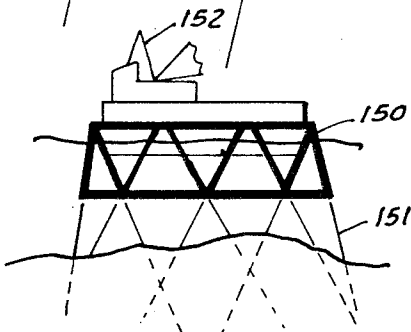
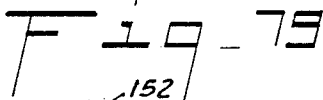
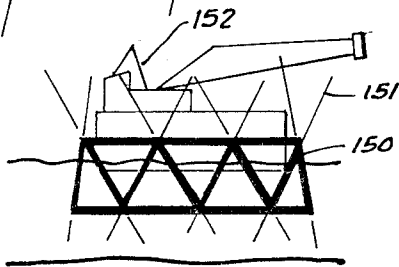
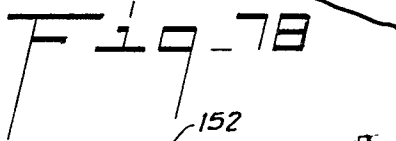
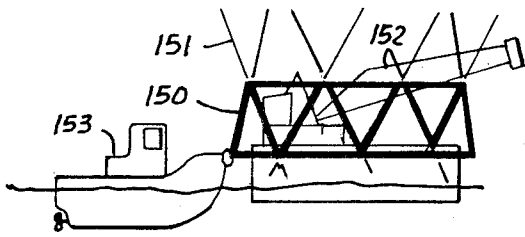
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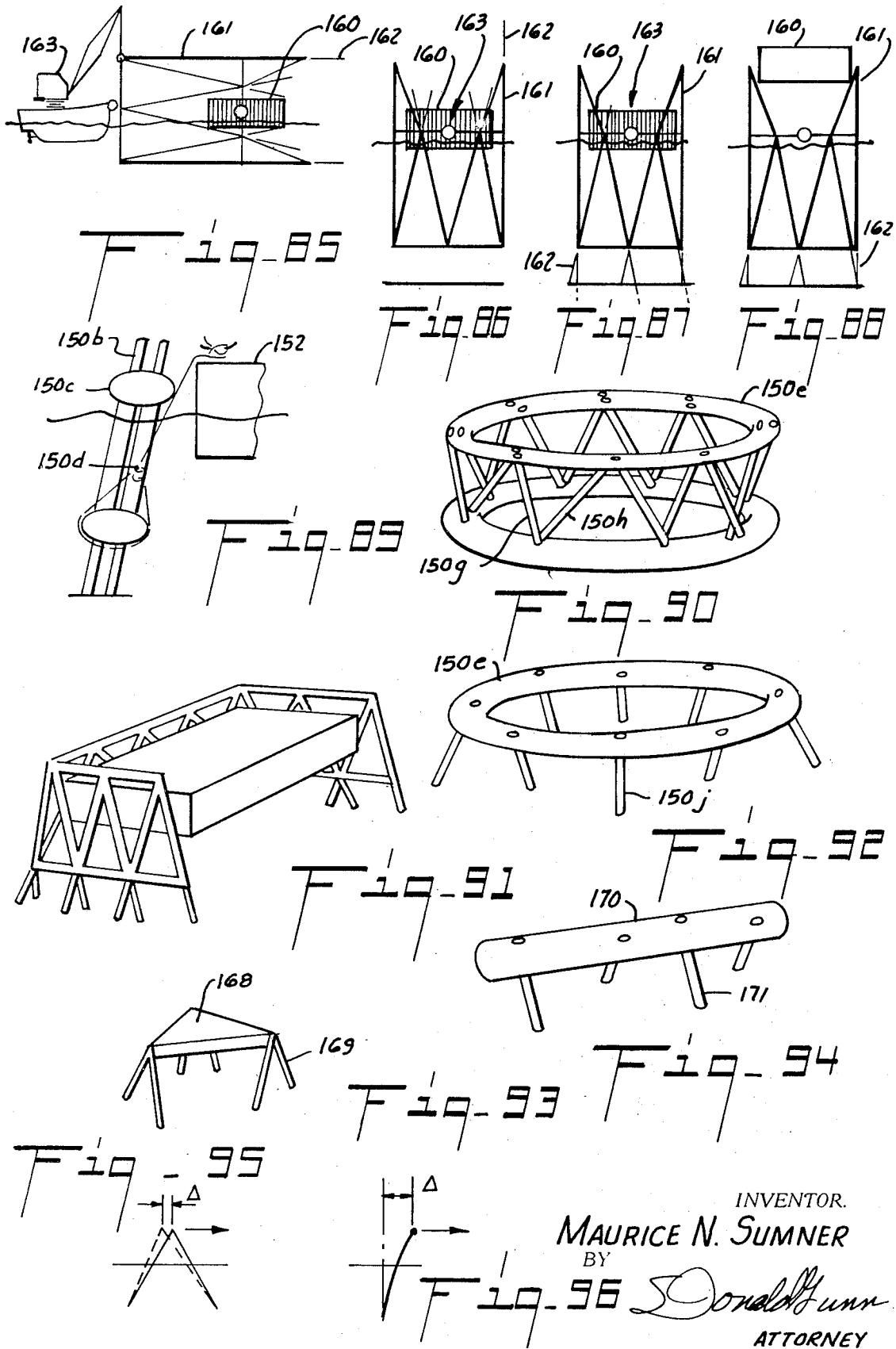
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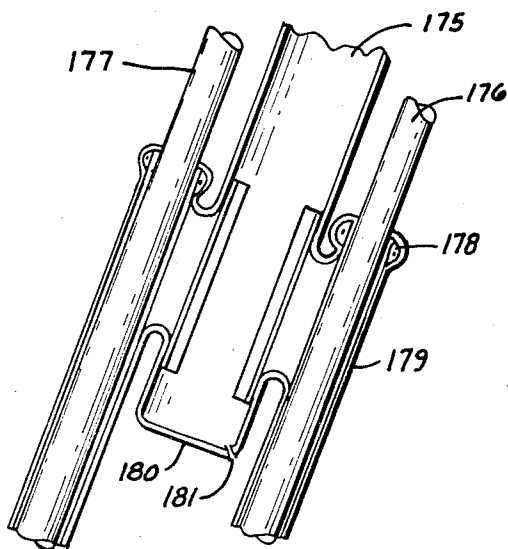


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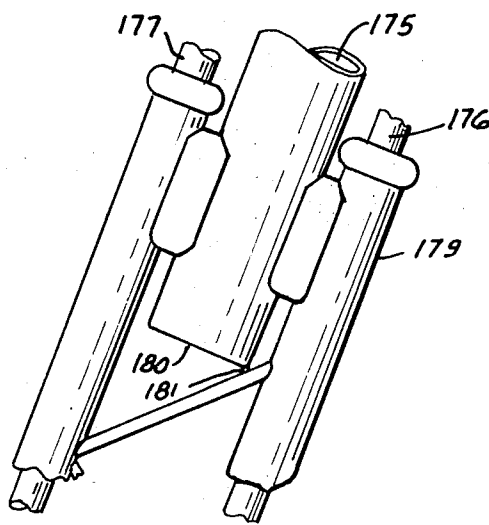


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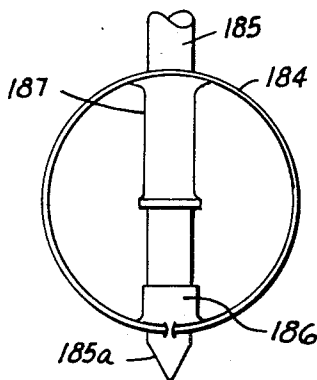


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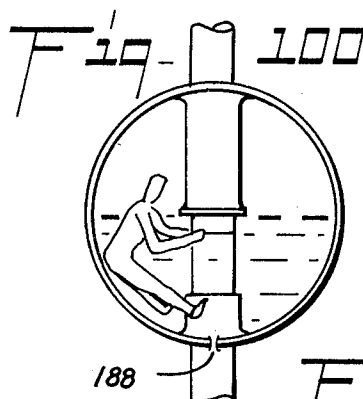


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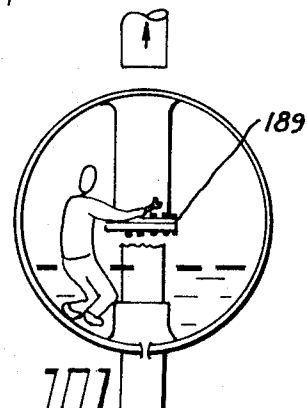


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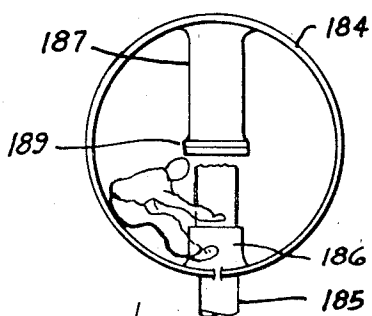


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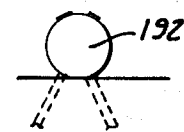


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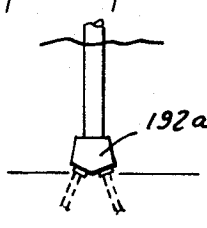


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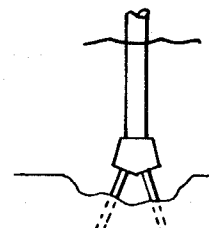


Fig. 105

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METHOD AND APPARATUS FOR OFFSHORE OPERATIONS

SUMMARY OF PROBLEM AND INVENTION

Numerous means are known to those skilled in the art to provide above-water platforms for offshore explorations, the production of minerals, lookouts, and transport stations. They vary in portability from the complete immobility of earth islands to the fixedness of the pile-supported platform, then to much greater mobility of the more expensive units known in the petroleum world as mobile units, which include the submersible bottom-supported unit, the semisubmersible frame, the jackup, and the drill ship.

By far the most common structure known in the art is the pile jacket or pile template, which, when installed, comprises a number of slightly inclined tubular legs, longer than the water depth, braced together into a unitary frame by a number of platform plane frames and portal braces in x 's, y 's, k 's, or diagonals and having mud mats at the base and piling driven through and secured to the legs. Such a structure might be installed by hauling its entirety from the place of assembly to the place of use, settling it to the bottom to rest temporarily on its mud mats, driving the piles through the legs, and securing them thereto. It is plain that the mud mats are necessary to install the structure, since they hold it in place during installation, and it is also true that such a structure will only be well adapted to a single depth of water. If it were to be placed in water of a lesser depth, its top might be inconveniently high above the water, or it might be refabricated to other dimensions to avoid this. If an attempt were made to found it in deeper water, as by holding it in place by other means than its mud mats, keeping its top at a convenient elevation, and letting its piles project down past its bottom, these piles would likely be too limber and weak in bending to support the structure; note that a similar weakness can result if a portion of the mud washes or scours away by motion of the water past a normally-installed platform.

It is also apparent that the number, spacing, and diameter of the legs of a typical pile jacket is determined by the number, spacing, and diameter of the piles required to support the anticipated loads. One skilled in the structural arts might offer many ways to have fewer and smaller legs and braces than are found in pile jackets, but if the concept of the pile jacket of the prior art is retained then the advantages of having fewer and smaller legs and braces cannot be obtained because for every pile there must be a leg and for every leg there must be a brace.

So, in summary, a pile jacket is not well adapted to a wide range of water depths and is therefore not well adapted to be portable because its base is employed in its erection; if new methods were found to omit this employment of the base, and thereby omit the base, and therewith a lower portion of the framework, these new methods could not be employed anyway, because the piling could not withstand the bending effects resulting from their greater exposed substantially parallel length.

Many types of mobile units are found. For a catalog of the bulk of the prior art equipment, reference is made to the publication "The Evolution of Offshore Mobile Drilling Units." Such units are used mostly in exploration drilling, but, for the purpose of this disclosure, no distinction is made between petroleum drilling and production apparatus, and the apparatus described herein is not limited to oil and gas work, but includes other mineral related work, such as sulfur or manganese production, military posts and communications and transport stations, and fishing and agricultural uses.

Basic problems, especially of resistance to marine forces and of adaptability, are to be found in all mobile units; for example:

Submersible bottom-supported units move very slowly through the water, and become prohibitively expensive when adapted to deeper waters. They have structural failings due to wave action, and are easily moved from their location by

heavy seas. In all events, the result is at least a financial disaster.

Submersible bottom-supported units can be adapted at great expense to deeper waters by conversion to a stabilized so-called semisubmersible frame, or such a unit can be designed from scratch, and it will then be adapted to drill in very deep waters or very shallow waters but not to intermediate depths; but it still will move slowly from place to place, and may be even more subject to displacement and destruction by storm.

Other floating rigs are the drill ships, which can move very rapidly to distant seas, but they suffer from high seas during drilling, and cost of operation is high, since the motors and stabilizers must run continuously while they are drilling.

A wide range of sizes and shapes of floating vessels which either float fully on the surface or partly submerged has been provided. These vessels include catamarans such as the "C. P. Baker" of the Reading & Bates Company, outrigger vessels and the like. These primarily have problems of positioning, trimming, towing characteristics and the like.

The jackup units are less expensive than some other mobile units, and are well adapted to intermediate water depths, but they do not move rapidly through the water and there have been grievous losses resulting from the impact of the first engagement of the legs with the marine floor, and from the impact of the waves on the vessel before it is jacked clear of the waves. There have been numerous disastrous losses resulting from scouring of the soil at the footing. The jacks are expensive, and some units with wide footing are not well adapted to an uneven bottom. Solutions to problems of bending have been sought by making the legs an openwork frame, and by the hinging of the legs, as in the LeTourneau three-legged hexagonal units, but the result may be the loss of a part of the safety factor. Further, the prior art jackup rigs include the variety of the "Hustler" of the Offshore Company and the mat-type jackup "Stormdrill III."

Certain more or less hybrid structures are the submersible frame with separately installed platform, exemplified by Mecom's "Mr. Malloy" and by Brown & Root's "Monopod." "Mr. Malloy" was not an open frame, but a dry dock, presenting a wide surface to the wave action, with resultant difficulties. The "Monopod" was difficult to place, and drifted off location during installation.

The principal obvious points of contrast between the fixed units and the mobile units concern mobility, adaptability, and cost, for the fixed platform is cheaper at first, but is difficult or impossible to move, and even when moved is likely to be useful only in a narrow range of water depths and climates. While the mobile-type unit is well adapted to a wider range of water depths, it is in general more expensive at first, but is relatively cheap to move. With particular respect to petroleum, these points converge in an awkward way. If it were known from the start whether a platform would be used at one location or many, it would be easier to balance and choose factors of cost and mobility, but it is never known whether oil will be found. If a fixed platform be used, production can begin promptly upon discovery; if a mobile unit is used, a delay or perhaps a year may ensue, so that the fruits of the endeavor hang just out of reach in point of time, and perhaps in point of cost, for a fixed platform must be built before production can begin. Few wells are so productive that they will amortize the cost of a mobile unit being used as a fixed platform. A vice president of a major oil company has said "A mobile unit is a good dry-hole tool."

It is with the problems of the prior art in view that the present invention is summarized as providing apparatus and method whereby an offshore structure is made adaptable to a range of water depths, is carried to a selected location by a vessel, the vessel is brought to a different elevation where it is at least partly held by the structure, and thereafter is preferably returned to a navigable relationship on the water to depart the installed structure. Moreover, should the structure be temporarily located with a view to moving soon thereafter,

the vessel is then enabled to remove the structure with it to a second location. Further, should the structure be previously located by means of no particular consequence, the present invention enables the vessel to attach to the structure and move it to a second location. The apparatus of the present invention is generally summarized as including a combination of vessel and structure for installation in offshore operations wherein the vessel and structure travel typically from the point of assembly to a predetermined location; said means further including releasable connective means whereby the structure is steadied in the water to be stabilized with respect to the submerged land typically by inserting pilings through a footing structure and into the subsoil, or by the utilization of other techniques to achieve a stable structure. Thereafter, the means of the present invention permits the vessel to be changed in elevation relative to the water to become substantially free of the wave action of the water. For instance, the vessel may be elevated out of the water above the wave action or may be semisubmersible to an intermediate depth whereat exposure to wave action is minimum. Additional apparatus comprising the present invention is summarized as including an offshore structure wherein the support members below the platform deck are mainly designed in accordance with criteria of support members and extend downwardly to a footing member supported above the submerged land by a plurality of pilings and the like, the pilings being designed and located in accordance with design criteria of foundation members as opposed to the structural support design standards. It is axiomatic that the design criteria for the frame below the platform is necessarily different from the criteria for the foundation members themselves. The present invention further provides apparatus wherein the footing member receives a plurality of pilings preferably in bipod relationships extending into the soil and subsoil to prevent collapse due to scouring by the water action. The footing apparatus further including means whereby underwater connections are made by inserting pilings through prealigned openings in the footing member.

The method and the apparatus of the present invention become more readily apparent from consideration of the drawings included herewith wherein:

FIG. 1 is a perspective view illustrating the separable leg concept of the present invention;

FIG. 2 is a perspective of a single leg structure erected in the water in accordance with the present invention;

FIG. 3 illustrates one stage in the method of the present invention of erecting a structure having a novel relationship to the vessel;

FIG. 4 is an additional view illustrating the method partially shown in FIG. 3 wherein the vessel is moved to a second relative elevation whereby it is more free from the wave action;

FIG. 5 is an enlarged detail side view of the single leg concept of the present invention;

FIG. 6 is a view of the pile jacket of the prior art for comparison with FIG. 5;

FIG. 7 illustrates the first step in a method relating to portable drilling structure and associated vessel which is elevated with respect to the water to be more free of the wave action and wherein a well completion is obtained and the drilling apparatus is thereafter removed while leaving a portion of the footing structure to provide a platform for production apparatus;

FIG. 8 is a method step related to the view of FIG. 7 illustrating placement of the pilings through the footing members;

FIG. 9 is similar to FIG. 8 showing the piling drilled or driven into the soil;

FIG. 10 is similar to FIG. 9 showing the drilling platform and vessel elevated to commence drilling operations;

FIG. 11 is similar to the method of step of FIG. 10 showing completion of the oil well;

FIG. 12 is similar to FIG. 11 showing the return of the vessel to the water;

FIG. 13 illustrates the next step in the method wherein the footing member is detached from the jackup leg;

FIG. 14 illustrates the vessel and drilling apparatus, departing from the well head, associated production apparatus and footing member which supports the production apparatus;

FIG. 15 illustrates part of the movable apparatus of FIG. 14 relocated at a subsequent location to engage in additional drilling activities;

FIG. 16 is similar to FIG. 10 in that the apparatus is engaged in drilling activities when elevated above the water level and made more free of the wave action;

FIG. 17 illustrates the same apparatus at even a third location wherein the single remaining footing member shown in FIG. 16 was left at an intermediate location and wherein the present view depicts the drilling apparatus and associated vessel at a third location;

FIG. 18 is similar to FIG. 17 showing the drilling apparatus elevated prior to drilling an additional well;

FIG. 19 is an alternative step in the method wherein additional footing members are installed on the jackup legs after both footing members were left at other drilling sites;

FIG. 20 is a view corresponding to FIG. 8 with the exception of a change in elevation of the footing;

FIG. 21 is a view similar to FIG. 20 illustrating the piles driven through the footing member and into the subsoil;

FIG. 22 is a view similar to FIG. 10 wherein the vessel and associated drilling apparatus are raised to a second relative elevation to be more free of the wave action;

FIG. 23 is a view similar to FIG. 22 illustrating the use of the footing member and pilings with conventional jackup apparatus known in the prior art;

FIG. 24 illustrates installed footing members of the present invention and associated piling members inserted in the subsoil serving as support means for a conventional platform known in the prior art for supporting production apparatus thereon above the water;

FIG. 25 illustrates the footing member of the present invention left installed at the drilling site with a plurality of wells spaced thereabout;

FIG. 26 is a view contrasting with FIG. 25 wherein the footing member is located above the water line;

FIG. 27 is a side view of the structure shown in FIG. 9;

FIG. 28 is a full length view of a vessel having semisubmersible outriggers adjacent to each side of the vessel as a means of obtaining a second relative vertical relationship;

FIG. 29 is a view of the vessel of FIG. 28 showing the vessel elevated above the water to be free of the wave action;

FIG. 30 is a front view of the vessel shown in side view in FIG. 29;

FIG. 31 is a perspective view of a structure similar to the structures of FIGS. 7-27;

FIG. 32 illustrates one method of utilizing a jackup rig to assemble on location the structure shown in FIG. 31;

FIG. 33 illustrates in simplified form the structure of the prior art and its problems relating to lateral loading and resultant bending thereof;

FIG. 34 is a view of the prior art structure shown in FIG. 33 wherein greater leg length is permitted by reinforcement with the structure of the present invention;

FIG. 35 is the first view of a sequence illustrating use of the method of the present invention in installing the drilling apparatus at a selected location;

FIG. 36 is similar to FIG. 35 and shows the jackup legs contacted against the soil beneath the body of water;

FIG. 37 illustrates the drilling platform raised above the level of the water;

FIG. 38 illustrates use of the drilling apparatus to set a first piling;

FIG. 39 illustrates the further use of the drilling apparatus to set additional pilings, the pilings cooperating to support an additional structure temporarily appended to the drilling platform;

FIG. 40 is a view similar to FIG. 39 showing the drilling platform returned to its original relative elevation to float on

the water with the pilings installed by use of the drilling apparatus supporting a structure above the water;

FIG. 41 shows the drilling platform departing from the structure erected in the water;

FIG. 42 shows one variation of the structure for receiving production apparatus assuming completion of a well at the drilling site;

FIG. 43 is the first view of a sequence of views illustrating the method of the present invention and shows a drilling platform during navigation of a body of water;

FIG. 44 is a view similar to FIG. 43 illustrating the drilling platform submersed and resting on the bottom preliminary to drilling a well;

FIG. 45 is a view similar to FIG. 44 illustrating pilings driven through the framework of a separable structure carried by the drilling platform;

FIG. 46 is a view similar to FIG. 45 illustrating the drilling apparatus drilling a dry hole;

FIG. 47 shows the apparatus of the previous views in a buoyant condition being towed by a vessel to an additional location;

FIG. 48 is a view similar to FIG. 44 showing the submersible structure placed at a second or subsequent drilling location;

FIG. 49 is a view similar to FIG. 45 showing the pilings driven through the separable structure;

FIG. 50 is a view similar to FIG. 49 showing the oil well drilled utilizing the drilling apparatus wherein the well penetrates a producing formation;

FIG. 51 shows the vessel moving the drilling platform and associated drilling apparatus while leaving the separable structure at the location of the completed well;

FIG. 52 is the first of a plurality of views illustrating a jackup structure and separable leg of the present invention in location and an additional jackup structure of a new type having separable legs maneuvered to an adjacent position;

FIG. 53 shows the additional structure with the legs positioned at the soil beneath the body of water;

FIG. 54 shows the jackup platform moved to an elevated position to begin construction of a structure on the separable legs;

FIG. 55 shows the construction apparatus carried on the jackup platform erecting a permanent installation between the separable jackup legs;

FIG. 56 shows the constructed facilities wherein the first jackup apparatus at the location is returned to a navigable elevation;

FIG. 57 shows the first navigable vessel leaving and the construction platform returned to the water level after completion of the upper portions of the permanent structure;

FIG. 58 shows the departure of the two vessels from the completed permanent installation utilizing the separable jackup legs of the present invention;

FIG. 59 is the first of a plurality of views somewhat schematic in detail illustrating the method of the present invention wherein the first connection between the vessel and structure is made at sea;

FIG. 60 is a view similar to FIG. 59 showing the vessel utilizing the structure to position itself;

FIG. 61 shows the vessel and associated drilling rig elevated to a level free of water or wave action;

FIG. 62 is a view illustrating the vessel in a buoyant condition in the water to impart at least a portion of its buoyancy to the structure for moving same;

FIG. 63 is the first of a plurality of views somewhat similar to those beginning with FIG. 59 illustrating a structure previously positioned in the water;

FIG. 64 is a view similar to FIG. 63 wherein the vessel is positioned prior to elevating;

FIG. 65 shows the vessel and associated drilling apparatus elevated with respect to the structure;

FIG. 66 shows the vessel returned to the surface of the water;

FIG. 67 is a view similar to FIG. 66 showing the vessel with the drilling apparatus departing from structure and showing arrival of a second vessel with production apparatus thereon;

FIG. 68 is a view similar to FIG. 65 showing the elevated production apparatus and its vessel engaged with the structure;

FIG. 69 shows a submersible structure at a navigable water depth for transporting the production apparatus and associated vessel carried therewith;

FIG. 70 illustrates an alternative to the structure shown in the preceding several views wherein the alternative of a larger submersible structure is utilized;

FIG. 71 is yet another alternative arrangement including a semisubmersible vessel;

FIG. 72 illustrates a conventional pile jacket structure of the prior art;

FIG. 73 shows the utilization of a separate structure to reinforce a jackup structure;

FIG. 74 is a side view of simplified form of the lateral reinforcing provided by the present invention;

FIG. 75 is the first of three views illustrating the method of the present invention having an alternative sequence of steps whereby the structure is stabilized prior to change of elevation of the vessel to make it more free of the wave action;

FIG. 76 shows connection of the vessel to the stabilized structure;

FIG. 77 illustrates change of the relative elevation of the vessel with respect to the structure;

FIG. 78 is the first of a number of views illustrating the method of the present invention applied to a new vessel and structure;

FIG. 79 illustrates the step of preparation for driving the pilings into the subsoil;

FIG. 80 illustrates the pilings driven through the structure and into the subsurface for support;

FIG. 81 illustrates the next step of fabricating additional structure thereabove;

FIG. 82 shows the use of the structure of FIG. 81 to drill a well into a producing formation;

FIG. 83 shows use of the structure for production from the completed well while further drilling is carried on;

FIG. 84 is a view showing a wide range of water depths for which the method of the present invention is adapted;

FIG. 85 is a view illustrating the method of the present invention for use in greater water depths;

FIG. 86 is a view similar to FIG. 85 showing the structure properly oriented in deeper water;

FIG. 87 is a view similar to FIG. 86 wherein the pilings carried in the structure are driven into the subsoil;

FIG. 88 shows the method of the present invention as further elevating the vessel whereby the vessel is more free of wave action;

FIG. 89 illustrates details of a major structural member of the structure shown in FIG. 79;

FIG. 90 is a perspective view of the framing of a platform adapted for use with the present invention;

FIG. 91 illustrates a rectangular platform in perspective for use with the present invention;

FIG. 92 illustrates in perspective view a modified circular platform utilizing the framing of the present invention;

FIG. 93 illustrates a triangular structure supported by the bipod arrangement of the present invention;

FIG. 94 shows an elongated platform supported by a plurality of pilings;

FIG. 95 illustrates the deflection of an elemental bipod arrangement;

FIG. 96 illustrates the deflection of a single support member contrasted with the bipod arrangement of FIG. 95;

FIG. 97 is a section of one means for securing a piling to a leg;

FIG. 98 is the apparatus of FIG. 97 in elevation;

FIG. 99 is the first of a sequence of views illustrating one method for connecting pilings through a footing member;

FIG. 100 shows the footing member of FIG. 99 partially evacuated of water to permit access to the piling members;

FIG. 101 shows the piling after it is cut;

FIG. 102 illustrates the footing member when fully sealed against water entry from above;

FIG. 103 shows a footing member similar to the previous views at the bottom of the body of water with a view of supporting bipod pilings which prevent collapse due to scouring beneath the footing member;

FIG. 104 shows an alternative footing member for use with the leg of a jackup rig or the like wherein pilings are driven at divergent angles to prevent collapse due to scouring; and

FIG. 105 is a view similar to FIG. 104 showing the effect of scouring but wherein the foundation support is continued.

In the drawings, attention is first directed to FIG. 1 which illustrates in perspective view a platform 10 having a pair of conventional support legs 12 and 13 adapted to be at least partly driven to the submerged soil to support the platform 10. The schematic view of FIG. 1 further shows a removable leg 14 in accordance with the teachings of the present invention, wherein the platform 10 is denoted as the vessel and the leg 14 as the structure. The view of FIG. 1 clearly illustrates the adjusted or newly obtained vertical relationship between the structure 14 and the vessel 10 wherein the vessel is elevated safely above the wave action with the structure supported in the water by the land submerged therebelow.

Attention is next directed to FIG. 2 of the drawings which illustrates in perspective a drilling platform 16 above the water and appropriate structure 17 (to be described) which extends to a square frame 18. The square frame 18 coincides with the level of the boat deck as a matter of engineering economy of benefit. From the square frame 18, a plurality of downwardly extending support members indicated by the numerals 18a, 18b, 18c, and so on support the structure thereabove which has the form of an appropriately scaled space frame. At a level substantially below the surface of the water, a rectangle or square formed of members 19, 20, 21, and 22 and having appropriate connections at the corners for several inverted bipods receives the weight of the structure thereabove. Each of the four corners of the structure is supported by a bipod including divergently directed pilings 23 and 24. The pilings are driven into the subsoil to support the structure under vertical loads and against dynamic lateral loads.

To keep perspective of the invention, the structure of FIG. 2 described a single leg "detachable" structure of larger scale than the leg shown in FIG. 1 and is more particularly adapted for use with a plurality of wells in the conductor pipes. The method of constructing the apparatus of FIG. 2 will be noted.

Beginning with FIG. 3 of the drawings, the method of the present invention is illustrated at several stages and is also herein described. Briefly, before attaining the step illustrated in FIG. 3, a vessel 25 and a structure 26 are releasably secured together. The joined vessel is maneuvered by known techniques to a selected or predetermined location in the water. The vessel 25 positions the footing member 29 at a predetermined depth at which the pilings 30, 31, and 32 positioned by the footing member 29 are driven into the subsoil to position, support and brace the footing member in the water. At this point, it should be noted that the structure 26 is adapted for a wide range of water depths wherein great variations in length of the pilings 30, 31, and 32 are permitted. In further particular, the range of piling length is essentially indefinite, especially so when compared with the restrictions on height variations of structures known in the prior art. In summing first steps of the method, the structure is first stabilized at the predetermined location using the footing member 29 as a structural template for setting the pilings in the subsoil.

Of particular interest to the present invention is the fact that the structure below the footing member 29 is constructed and arranged with a view of providing optimum strength and bracing in view of the soil conditions, vertical loads and lateral loads. However, vertical and lateral loading criteria alone are

determinative of the structural design above the foundation footing 29, and there is no requirement that the foundation design pattern be extended for the full length of the structure 26. By way of contrast, consider upright structures such as pile jackets wherein the structural arrangement of the columns, braces and other members is continued repetitively from top to bottom. Also, reference is made to the structure of FIG. 6 wherein the framing is repetitively designed from top to bottom. That is, the full number, diameter and length of the legs are controlled by lateral load, vertical load and foundation considerations. This militates against economy and efficiency in the foundation below and frame above because each compromises the other; the present invention is particularly adapted to incorporate an optimum foundation. The variation of the structure 26 thus permits optimum and efficient design of the upper portions, principally load bearing, and equally efficient design of the lower portions to provide the best possible foundation.

Referring again to the portions of the structure above the water line 27, attention is directed to the upper platform 33 of the structure 26 for receiving the drilling apparatus, and other paraphernalia required for drilling operations such as mud pumps, mud tanks, rotary table, power plant, hoist works, derrick and the like. More will be noted concerning this apparatus hereinafter.

Beneath the platform 33 is located the understructure 34 which includes the boat deck and associated apparatus best shown in the sectional view of FIG. 4. By and large, the apparatus carried beneath the platform deck is of a conventional nature and may include typical storage tanks, crew quarters and the like.

The method of the invention disclosed in FIGS. 3 and 4 entails the above-described step of locating the structure 26 in the body of water. As was described, the next step entails the erection of the foundation members below the footing member 29 and extending into the subsoil to support the structure. A further step in the practice of the present method invention is the charging of elevation of the vessel from a first releasably secured relative elevation to a second releasably secured relative elevation with respect to the structure. In this regard, there is no preferred sequence established in the method for the step of stabilizing the structure at the selected location and the step of altering elevation of the vessel to improve its protection from the wave action. That is to say, the method of the present invention is practiced wherein the two steps are performed alternatively, either step being first, and wherein the two steps can conceivably be performed simultaneously. However, in the embodiment described to this point, only one of many embodiments suitable for this method, the structure is first stabilized with respect to the subsoil and then the elevation of the vessel is altered. At the first elevation, the vessel is on the water as normally expected.

Referring again to the method, once the platform is stabilized (for this embodiment), the vessel is then altered in relative vertical relationship in the following manner. The vessel 25 is lifted upwardly by any one of a number of means. The embodiment shown in FIG. 3 utilizes the draw works of the conventional drilling rig 36, the draw works being indicated generally by the numeral 37. A cable or cables from the draw works engages a large pulley 38 fixed at a selected location whereby the fixed structures 26 is the anchor for a boot strap lift.

Routinely, a crane 40 and a crane 43 are also included as shipboard apparatus. Normally, the cranes 40 and 43 have their own power apparatus which cooperate with a pulley 41 to temporarily divert the function of the power apparatus of the cranes 40 and 43 to assist in lifting the vessel 25. While it may appear that the cabs of the cranes 40 and 43 interfere with the platform 33, this is not the case as the cabs are to one side of the platform 33. Either crane can be skidded onto the platform 33 if one is later needed thereon. By the use of the cable 42 and the cable 39, sufficient lifting force is applied to the vessel 25 to elevate it with respect to the structure 26.

FIG. 3 illustrates partial elevation of the vessel 25. The cables 39 and 42 are drawn in to lift the vessel 25 whereby the optimum elevation is achieved. Attention is next directed to FIG. 4 of the drawings which illustrates the vessel 25 at the maximum height above the water. In FIG. 4, the platform 33 is level with the deck of the vessel 25. Means known to those skilled in the art, including appropriate insert pins, fastening members or the like, then secure the platform 33 at its full elevation. Once locked in position, the cables 39 and 42 are perhaps released and stored, and the vessel is maintained for an indefinite period of time substantially above the water line 27 and substantially free of the detrimental wave action.

In the fully elevated and locked-in position of FIG. 4, the vessel 25 is used to new advantages. More specifically, the vessel provides crew quarters, a power plant, electrical power generation, galley facilities and the like for the benefit of the facilities. The derrick 36 and the draw works 37 are normally mounted on a unitary frame 44 which is skidded to a desired position on the platform 33. The drilling rig is then used in the conventional manner to drill wells through vertically extending conductor pipes 45 extending from the platform 33 into the soil 35. A drill string and conductor pipe 46 indicates the active drilling activities. In any event, routing drilling operations beyond the scope of the present disclosure are pursued with the hope of obtaining production.

The next consideration is the remaining steps of the method of the present invention. It will be appreciated that, after an interval of time, the vessel 25 is lowered to a buoyant position on the water surface 27. The vessel 25 is then freed from the structure 26 and permitted to sail away leaving the structure as a permanent installation. The vessel 25 has a catamaran hull with a forward decking 46 extending between the two hulls which is adapted for temporary removal to enable the structure erected between the hulls to pass therethrough as the ship 25 is maneuvered from the position astraddle the structure.

Attention is next directed to FIGS. 5 and 6 which compare and contrast the preferred embodiment of the erected structure of the present invention with the pile jacket of the prior art. In FIG. 6, the prior art structure 50 is formed with vertical load bearing members at the four corners of the rectangular framework with the indicated bracing at selected levels.

The structure shown in FIG. 5 includes the structure 26 supporting the platform 33 at a level substantially above the water line 27 wherein the structure below the platform 33 is designed and constructed primarily with the requirements of the loading of the platform in view. That is to say, the upper portions of the structure above the footing member 29 are designed in view of the weight acting vertically on the framing members and with further view of the dynamic lateral loading of the wave action. However, from the footing member 29 to the subsurface 35, the divergently directed piles 30, 31, and 32 are designed as to length, strength, quantity, and placement with the foundation characteristics of the soil 35 in view. The design dictated by proper foundation techniques is typically different from the framing and support required by the static loading carried by the platform and the dynamic loading of the wave action.

A side view of the apparatus shown in FIG. 5 would disclose generally symmetric framing members extending downwardly to a pair of preferably elongate, cylindrical footing members 29. Two or more parallel footing members may be used subject to the choice of the designer. Each preferably connects to a plurality of pilings such as the pilings 30, 31, and 32 as determined by the foundation design criteria.

Note should be taken of the boat deck 34 and the ladder extending to platform 33.

In recounting the method of the present invention and exemplary apparatus for use with the method, no limitation is found in the utilization of an offshore structure perhaps best characterized as a footed member taking due note of foundation installation. Moreover, the method of the present

invention is not limited to the apparatus shown. For instance, the method is adaptable for use with semisubmersible vessels, jackup rigs and the like. For greater understanding of the wide range of offshore structures for which the present invention is adapted, reference is next made to FIGS. 7 through 19, inclusive, which relate the method of the present invention to a jackup rig.

In FIG. 7, attention is directed to a vessel 56 and a structure including the jackup legs 57 with the footing members 58 attached thereto. To describe the apparatus generally, the vessel 56 can be a conventionally shaped hull having a platform 59 for receiving appropriate drilling apparatus 59a. The vessel navigates to a predetermined location and utilizes conventional jackup apparatus to lower the legs 57 to a predetermined water depth. In FIGS. 7 and 8, as will be discussed, the jackup legs 57 are not lowered since the foundation footing members are maintained at the water surface. Location of the footing members at or below the water surface is subject to a wide range of variation. The footing members 58 shown in the drawings are similar in function to the footing members 29 shown in FIGS. 3 and 4. However, the end view shows perhaps a slightly different contour of the structure. The footing members 58 are located at the foot of each of the jackup legs 57. If the apparatus shown in FIG. 7 includes four jackup legs, individual footing members can be located at the lower end of each of the legs; each of the footing members would be somewhat larger in diameter than the jackup leg itself and of sufficient size and strength to serve adequately in view of its loading. Alternatively, the footing members 58 can extend between pairs of jackup legs and can be best described as elongate members somewhat similar to the footing members 29 shown in FIGS. 3 and 4. In any event, they are joined at the lower ends of the jackup legs and are adapted to be positioned at a preferred water depth to permit pilings to form a firm foundation.

In FIG. 8, a plurality of pilings indicated generally by the numeral 60 is inserted through appropriate openings in the footing members and positioned somewhat in the manner shown. Utilizing apparatus carried on the platform 59 and omitted for clarity of the drawings, the pilings are driven into the soil 61. The depth to which piles are driven is dependent on the subsoil conditions and a number of other factors which are analyzed to define a substantial footing for the jackup legs 57.

Attention is next directed to FIG. 9 of the drawings which shows the jackup legs in the completed condition. In FIG. 9, the pilings 60 have been driven to an adequate depth and any surplus length above the footing members 58 is cut to avoid interfering with the apparatus. Note should be taken that individual footing members attached to individual jack legs 57 are supported by two or three pilings dependent on the design required for a firm foundation. Alternatively, if the footing member 58 is an elongate member (see FIGS. 3 and 4), several groups of pilings are used. For instance, a group of pilings may be located at each end of the footing member 58 and at intermediate points of the member 58. In either event, FIG. 9 reveals the apparatus firmly founded in the soil 61 and properly prepared to support the load of the apparatus.

In FIG. 10, the vessel 56, the platform 59 and the drilling apparatus 59a are shown elevated substantially above the water level free of the wave action on the body of water. Elevation is achieved by the use of conventional jacking apparatus. A number of systems are known to those skilled in the art; among others, they include pins insertable in openings, rack and pinion, devices which alternately grasp and elongate, and the like. The nature of these devices is beyond the scope of the present disclosure, but they are noted to point out examples of apparatus for elevating the vessel 56 to the altered position wherein the vessel and associated apparatus are made safe from the water action. It should be noted that the weight supported by the buoyancy of the vessel 56 is then shifted to the jackup legs 57 and the footing members 58 of

the present invention which are supported on the appropriate pilings 60 in the subsoil 61.

FIG. 10 also shows the use of the drilling apparatus 59a to support a conductor pipe 64 extending into the soil 61 in conventional drilling operations.

Assuming, for purposes of discussion, that the drilling operation is successful and a well is completed. Attention is directed to FIG. 11 which illustrates a production string 65 and well head production apparatus in the water. In FIG. 11, the jackup legs 57, the foundation support and even the drilling apparatus are in a condition of readiness to be restored with the vessel 56 to the water.

In FIG. 12, the conventional jackup apparatus lowers the vessel to its buoyant position on the water. The view of FIG. 12 clearly indicates that the vessel is returned to the water without interfering with the Christmas tree on the well. In FIG. 13, attention is directed to the fact that the left-hand leg 57 is raised higher than the right-hand leg and is separated from the footing member 58. Without regard to the details of construction, the separation can be achieved in a number of ways. For instance, if the jackup leg 57 is a solid wall member, either an inside or outside reamer may be used to cut the leg 57 from the member 58. On the other hand, cutting torches may cut the member 57 free. Likewise, the apparatus can be joined together initially by rivets, clamps, bolts, or fasteners, said fasteners being severable. In any event, those skilled in the art are familiar with apparatus and techniques for separating the jackup leg 57 from the footing member 58 supported by the piling 60 in the water. The view of FIG. 13 illustrates the releasable connection of the jackup leg 57 from the structure 58 adjacent the producing well 65. Appropriate energy absorbing means is used to push the vessel away from the well.

In FIG. 14, it will be noted that the pilings 60 at the right were pulled from the subsoil 61 and are carried in the footing member 58 as illustrated. Again, appropriate apparatus (not shown) is used to withdraw the pilings 60 from the soil. By way of example and not limitation, a crane carried aboard the work platform 59 is particularly useful at several steps in the method. Without overly belaboring the point, it will be appreciated that the pilings may be withdrawn from the subsoil 61 and to a sufficient height above the soil to be carried during movement on the water. The pilings 60 are locked in position by appropriate means such as stop collars or the like clamped on the pilings to prevent them from sliding through the guides in the footing member 58.

In FIG. 15, the vessel 56 is shown after having navigated to a new location in pursuit of additional drilling operations. The pilings 60 at the right-hand footing member 58 are driven into soil 61 at the new location in the manner previously described. That is, the pilings are driven through the footing member 58 which has guide means for directing the piles in the divergent directions. The pilings 60 are driven to the desired depth and set. However, no pilings are shown at the left-hand side of FIG. 15 which illustrates the left-hand leg 57 without the footing member 58 left at the previous well. The leg 57 is lowered to rest on the soil 61 in the manner now used by jackup rigs. It should be noted that perhaps a second jackup leg 57 is obscured in FIG. 15. This is of no particular consequence since the number of legs on each rig is subject to variation and each leg either has its own footing member 58 or is supported by an elongate footing member (see number 29 in FIGS. 3 and 4). In any event, the footing member left at the first location has no effect on rig erection at a second location.

FIG. 16 of the drawings illustrates the vessel and platform elevated by the jackup apparatus. It will be noted that the right-hand jackup leg 57 stands taller than the left-hand leg. However, this is of no particular import. The drilling apparatus indicated generally at 59a is shifted to the right-hand side of the vessel and the drill string and conductor pipe 66 indicates drilling activities. Preferably, the oil well is drilled adjacent to a remaining footing member 58 although this is not required.

Several views associated with the first producing well 65 are omitted after FIG. 16 which introduces repetition of the method. However, for purposes of discussion, assume that a well is completed and production apparatus is installed.

Assume further that the well is located adjacent to the footing member 58 in FIG. 16. Then, the vessel 56 is lowered to a buoyant position on the water. Then, the jackup leg 57 is separated from the remaining footing member 58 as previously. Again, reamers or cutters, cutting torches, releasably fastening members, and the like are used to separate the jackup leg at its lower end from the footing member. Then, the jackup leg is raised to clear all obstacles and the vessel 56 is moved to a third drilling site. The producing well 66 is adjacent to the footing member 58 which supports the required production apparatus.

In FIG. 17, the vessel is shown after having navigated to even a third location. Both jackup legs are equal in length. The legs are positioned on the soil 61 at the third location and the jackup apparatus raises the vessel in somewhat the conventional method presently used.

Attention is directed to FIG. 19 which shows an alternative to the structure of FIGS. 17 and 18. It may be helpful to replace the footings with a means 57a at the lower ends of the jackup legs 57. The replacement means 57a is installed easily by raising each leg individually and connecting the leg to the member.

The original footing members 58 were each left at wells and the legs had no remaining footing members. New footing members 57b shown in FIG. 20 are added. The ease of disconnection provides instruction for replacement of the footing members on the spuds. As the jackup legs are reequipped with footing members 57b, additional pilings nested in the footing members provide adequate foundation and support.

In FIG. 21, the new pilings 60 are driven into the submerged land and a suitable foundation for the vessel 56 is formed.

In FIG. 22, the vessel is elevated as before. At this point, the vessel is prepared to drill a well utilizing the drilling rig 59a with the assurance that the well will be drilled from a stable platform quite free of the wave action.

Attention is next directed to the view of FIG. 23 which illustrates in schematic detail the adaptation of the footing member and pilings of the present invention for use with conventional jackup apparatus of the prior art.

Attention is next directed to FIG. 24 of the drawings which illustrates a production platform 69 carrying production apparatus indicated generally by the numeral 70. The production apparatus 70 and the platform 69 are shown on footing members 58b left in accordance with the teaching of the foregoing method. A plurality of wells flowing to the well heads 66a, 66b, 66c, and 66d, are located as shown. The footing members 58b left resting on the pilings 60 secured in the subsoil 61 are adapted to support the platform 69 near the wells. Typically, a number of wells are drilled with the vessel at one location. This is a rather common arrangement since a number of wells are drilled from a single location when production is obtained. Slant drilling of deviated wells optimizes production of a formation with all the wells grouped at a single location to simplify gathering and production apparatus. Therefore, the platform 69 is placed on the footing members and pilings with a view of supporting the production apparatus 70 at this single location.

Attention is next directed to FIG. 25 which illustrates the footing member 58e and the pilings 60 in the subsoil 61 which pilings and footing member are left after operation of the method of the present invention. In FIG. 25, two of any number of producing wells are shown adjacent the platform of the footing member 58e. The wells are outside the platform and yet in immediate proximity for convenience of the production and gathering apparatus.

Attention is next directed to FIG. 26 of the drawings which illustrates the foundation member 58f located well above the water line. This is of some significance; the previous views

shown the foundation members located either at or below the water line. In a variety of circumstances, it may be desirable at times to place the foundation member above the water line. Again, the pilings supporting the footing member 58f are fabricated of a desired length and diameter best determined by the requirements of the drilling site.

Attention is next directed to FIG. 27 of the drawings which illustrates a side of the modified jackup rig 72 shown more schematically in the last twenty views. The mobile unit 72 has the jackup legs 73 moved by the conventional jackup apparatus indicated generically at 74. The legs connect to a footing member 58 as noted previously. The footing member 58 is supported by a pair of pilings 60 at the forward end which are embedded in the soil 61. The pilings are extended at angles deviating from the vertical to support the foundation member 58. More particularly, the members 60 achieve a bipod relationship. Amidships, the member 58 rests on a pair of pilings again shown in bipod relationship. The rearward portion of the footing member 58 is likewise supported. The number of bipods may be increased as desired; other suitable arrays of piling might be advantageous in certain conditions. Another example of a good arrangement is one tripod and one bipod; another example is a set of piles arranged as rulings on a conoid. Another is a set of pilings arranged as rulings on a hyperbolic paraboloid.

Attention is next directed to the view of FIG. 28 which illustrates a semisubmersible vessel 82. In FIG. 28, a conventional hull 56 illustrated in side view is connected by means of jackup legs 57 and jackup apparatus 74 to a semisubmersible bottle-type frame 86. More should be noted concerning the semisubmersible frame 86. It is not merely a conventional semisubmersible, but rather is streamlined into a form having characteristics of a catamaran, so that it can be rapidly propelled through the water when at its least-submerged elevation, and is selectively flooded, ballasted, or forced into the water as a means of obtaining a stabilized buoyant position in the water. The end of bow view of the apparatus shown in FIG. 30 illustrates the hull 56 of the vessel centered between a pair of downwardly extending float members which have upward extensions at their ends as a means of stabilizing the vessel 82 in the water.

The tanks 86 are streamlined for minimum water drag during movement from location to location.

Attention is next directed to FIG. 29 which illustrates the vessel 56 lifted on the jack legs 57 above the surface of the water while the semisubmersible tanks 86 to which the jack legs connect are partially submersed to steady the vessel 56 at a smoothly riding position substantially above the wave action.

In FIG. 29, the hull of the vessel 56 is shown raised on the jackup legs 57. The act of elevating the vessel 56 partially sinks the semisubmersible tanks, the customary function of semisubmersible vessels. As needed, the semisubmersible vessel can be stationed by tethering the vessel with multiple anchor lines and the like. Should the vessel drift slightly off station, typically, three or four small propellers aimed in various directions are used to reposition the vessel by continually trimming its location.

The tendency of the semisubmersible vessel to drift is reduced because the side profile best shown in FIG. 29 is substantially wave-transparent. If it were then desired to effect separation between the hull 56, and the stabilized semisubmersible 86, according to the teachings of the present invention, it would be possible, by means of simultaneous ballasting of the semisubmersible 86 and jacking down of the vessel 83, or by other means, to restore the vessel to its afloat elevation while leaving the semisubmersible in its stabilized condition, and then to separate them entirely, so that the vessel can depart while the semisubmersible remains stabilized; alternatively, the two can go away together, just as they came.

Attention is next directed to FIG. 31 of the drawings which illustrates in perspective view a platform erected in accordance with the teachings of the present invention. The

view of FIG. 31 is simplified by omission of the production equipment, drilling apparatus and the like. The platform 90 is secured in position by a plurality of pilings. Attention is particularly directed to a pair of pilings 91 and 92 received in nacelles on opposite sides of the platform 90. The supports are directed at angles to form a bipod. Also, a pair of legs 93 and 94 positioned amidships of the platform 91 lend support to the center portion. In the drawing, it will be noted that the legs 93 and 94 extend again at divergent angles and are best described as providing a bipod in accordance with the teachings of the present invention. Of particular interest is the fact that the legs 91 and 92 are in a plane perpendicular to the length of the platform 91 whereas the intermediate legs 93 and 94 essentially coincide with a vertical plane including the major axis of the platform 91. The rearward portion of the platform 90 is likewise supported as the front portion by a similar bipod arrangement.

Attention is next directed to FIG. 32 of the drawings which relates the structure shown in FIG. 31 of the drawings to the method of the present invention. In FIG. 32, the numeral 96 indicates generally a vessel as will be related to the present method. The vessel 96 is a conventional jackup rig selected for purposes of illustration. The vessel itself includes the platform proper, the erection crane, the jackup legs and jacking apparatus, the drilling rig and other needed paraphernalia. In the view of FIG. 32, the vessel 96 is releasably connected with the platform 90a. The platform 90a is secured at a predetermined elevation above the water by releasable means between the vessel 96 and the platform 90a. The vessel-carried apparatus places pilings 91a and 92a in the bipod relationship noted in FIG. 31. Also, FIG. 32 illustrates the leg 93a which extends at an angle to the plane of the drawing. Relating back to the discussion of the platform 90, it will be recalled that adequate bracing, framing, and support is provided amidships by a central bipod.

Considering now the method and apparatus just described and with a view of relating the method to the apparatus, it should be noted that the platform 90a is releasably secured to the vessel during towing of the vessel 96 and attached platform 90a to the situs, at which elevation the platform rides steadily. On location, the relative elevation is not changed; the vessel and structure remain secured and rise together, within the scope of the method of the present invention. Thereafter, the platform 90a is stabilized with respect to the submerged land. The stabilization is obtained by connecting the pilings at the nacelles for alignment and registration whereby the desired foundation support of the platform is obtained.

Attention is next directed to FIG. 33 which is a schematic drawing of the vessel 96 (or any other jackup rig) showing its tendency to bend during dynamic lateral loading.

As a matter of review, it will be generalized that the vertical loading characteristics of the jackup leg are quite adequate because the vertical load is predictable and designs are readily available for compensating for the generally static vertical forces. However, greater problems arise in accommodating the lateral loading of the moving water.

In FIG. 34, a similar but taller jackup rig is represented as the schematic vessel 96b. Immediately adjacent to the vessel 96b is a platform and undergirding structure 90b erected in accordance with the teaching of FIGS. 31 and 32. Referring back to the dynamic bending shown in FIG. 33, the structure 96b is braced and reinforced by use of the present invention. It will be noted that the structures 96b and 90b are joined together by means suitable to those skilled in the art.

Attention is next directed to FIG. 35 of the drawings which illustrates a conventional jackup rig in transit to a selected location. In FIG. 35, the drilling apparatus, associated jackup gear and platform are identified as a vessel 98 which is releasably secured to a member 99, the significance of which will become more readily apparent hereinafter.

In FIG. 36 the vessel 98 is shown upon arriving at a selected location wherein the jackup legs are lowered to the soil therebelow preliminary to elevating the platform. In FIG. 37,

the platform and joined apparatus is elevated with the framing members 99 and 102 still awaiting use. The platform is elevated to a safe working elevation above the ocean's activities.

Attention is next directed to FIG. 38 of the drawings which illustrates the use of the drilling apparatus 98a to set a piling 100 through the member 99. Other techniques may be used to set the piling 100; however, the motive means of the drilling rig 98a is preferably used in the present method. The piling is set by boring into the subsoil. In any event, and without regard to the means, the method of the present invention teaches placement of the piling 100 centered through the opening in the means 99.

The means 99 preferably has guides for three or four pilings or legs. As will be appreciated, each piling 100 is placed in a guide of a member 99. It should be kept in mind that the objective is to provide a stable structure utilizing the means 99 as will be described.

The drilling rig 98a is suitable for all activities relating to placement of the pilings through the guide means 99. More specifically, the drilling rig 98a is skidded across the platform of the vessel 98 to a point above the location of the piling. As a matter of fact, the rig 98a can set and anchor an indefinite number of pilings.

Attention is next directed to FIG. 39. In this view, the drilling rig 98a has been skidded to a new location to permit drilling and placement of a piling 101 through the guide means 99.

The pilings 100 and 101 both obscure additional pilings which support the structure being erected. Each of the obscured pilings is likewise placed and anchored by the drilling rig in accordance with the present method.

Attention is next directed to FIG. 40 of the drawings. In this view, the jackup rig has been lowered to float on the water and the guide means 99 is lowered with the platform while sliding on the pilings 100 and 101. The upper ends of the pilings 100 and 101 are joined to a horizontal member 102. In further particular, the horizontal member 102 is a platform which is decked over to both receive and support apparatus while resting on the pilings. The member 102 is welded, or clamped, or bolted to the pilings while the guide means 99 is lowered back to a selected midpoint of the pilings to strengthen and brace the assembled structure.

Attention is next directed to FIG. 41 of the drawings which illustrates the vessel 98 departing from the location of the completed structure. In FIG. 41, the guide member 99 is lowered to the intermediate point of the pilings to cross brace the pilings 100 and 101 to maintain an adequate and strong structure.

The dotted line representation of the drilling rig in FIG. 41 indicated that the drilling apparatus of the vessel 98 can optionally be left for drilling from the newly erected platform.

Lastly, attention is directed to FIG. 42 of the drawings which illustrates in schematic detail a completed structure somewhat similar to the one shown in FIG. 41. However, several differences should be noted. For one, production apparatus 103 is placed on the platform deck 102a. In further particular, the guide member 99a is secured at the midpoint as was the case in FIG. 41, but an additional member 99b further braces and supports the means 99a. The need of added braces varies widely, however, and is not limited to the crossbracing members shown in the drawings.

The method of the present invention is taught in the views of FIGS. 35—42, inclusive. As noted many times herein, the method of the present invention includes, among other steps, the steps of releasably securing a structure to a vessel, navigating the vessel to a selected location, adjusting the relative elevation, stabilizing the structure, and releasing the vessel for navigation. In the context of the above described illustrations, it will be appreciated that the method of the present invention is likewise taught for the apparatus shown.

One or two noteworthy factors with respect to the views above described should be considered; attention is directed to

the fact that the drilling rig 98a places the pilings in the subsoil through the guide means carried by the vessel. This is of particular significance due to the speed requirements in offshore operations; moreover, the power plant of the drilling apparatus is preferably used to the fullest extent.

Attention is next directed to FIGS. 43—51, inclusive. In FIG. 43, a vessel 106 is towing a submersible platform 107. For this disclosure, and further for the claims appended hereto, the submersible apparatus 107 is considered the vessel and the carried structure 108 is the structure of interest. In FIG. 44, the submersible platform 107 is located by means such as filling the tanks to settle the apparatus on the bottom. The structure 108, of conventional construction, or the novel structure hereafter disclosed, is positioned by a plurality of pilings 109 in the corner posts. In FIG. 45, the pilings 109 are driven into the soil for erection of the structure 108.

Reference is next made to FIG. 46 of the drawings which illustrates the oil well 110 drilled by the apparatus carried on the submersible rig 107 wherein the oil well misses the producing formation and is considered a dry hole. This failure usually necessitates moving to a new drilling site. This step is shown in FIG. 47 wherein the tug 106 is reattached to the submersible rig 107 and moves the rig to a second location. With regard to the freeing of the structure from the subsoil, pilings 109 are pulled free and stored in the corner posts preferably.

In FIG. 48, the semisubmersible rig is shown at a new location preparatory to drilling a second well. Again, the structure 108 is positioned on the subsoil and the plurality of pilings 109 is made ready. In FIG. 49, the pilings 109 are driven into the subsoil. Then, an oil well 111 is drilled into a producing formation. Since the fundamental purpose is achieved, and since further production apparatus is soon needed and the drilling rig is not needed, change over in the equipment is shown in FIG. 51 wherein the drilling rig 101 is removed by the tow vessel 106. In FIG. 51, the structure 108 is permanently installed with the pilings through the corner post driven well into the subsurface. The oil well 111 is located just outside the structure for reasons to be noted.

Attention is next directed to FIG. 51 of the drawings which illustrates the tug 106 removing the submersible rig 107. The structure 108 supports the production apparatus for the producing well 111. The mobile unit 107 preferably carries additional structures to repeat the foregoing method steps at subsequent locations.

In the foregoing, the structure 108 functions as a separable leg with the separability feature benefitting the production apparatus once the well is obtained.

Attention is next directed to FIG. 52 of the drawings which illustrates a jackup rig 114 having a separable leg 115. Greater detail of one such apparatus is shown in FIG. 1. Also in FIG. 52, a new type of jackup rig 116 having a pair of separable legs 117 and 119 is shown. The jackup rig 116 is shown assuming a position wherein the legs 115, 117, and 119 are prepositioned. In FIG. 53, the legs 117 and 119 are rested on the soil preparing the jackup rig 116 for elevation.

Attention is next directed to FIG. 54 of the drawings which shows the jackup rig 116 at the elevated or raised position. The working deck proper is raised on the separable jackup legs 117 and 119. Some jack means such as rack and pinion elevates the jackup rig 116 on the jackup legs. Without regard to the motive means, such means being left to one skilled in the art, the platform 116 is elevated to the illustrated position to position the construction equipment.

Attention is next directed to FIG. 55 of the drawings wherein the construction apparatus carried on the platform 116 erects a horizontal member 120 between the jackup legs 115 and 117. It will be appreciated that a wide range of horizontal members 120 is adaptable; by way of example and not limitation, the horizontal member 120 is a deck plate or platform formed of trusses and deck plates. The horizontal member spanning the legs is formed utilizing the construction apparatus carried on the platform 116. After completion of

the member 120, attention is next directed to FIG. 56 wherein the construction apparatus carried on the platform 116 is used to build a structure 122 between the legs 117 and 119. Again, the structure 122 fabricated by the construction apparatus is broadly described.

Of particular interest to the view of FIG. 56 is the fact that the jackup rig 114 is lowered and separated from the leg 115. The rig 114 is lowered even before construction of the horizontal member 122 between the legs 117 and 119. The final movement of the rig 114 is shown in FIG. 57. In FIG. 57, the jackup rig 114 moves away from the completed structure.

FIG. 57 reveals the completed structure which includes the upright and previously separable jackup legs 115, 117, and 119. In FIG. 57, the platform 116 is also lowered back to the water level after completing the horizontal member 122. While the schematic form of FIG. 57 is of no limitation, a few features may include an unlimited number of legs, horizontal members 120 and 122 of large dimensions, cooperative decks, continuous platform surfaces, or the like. This is a subject matter of great variation and without inventive limitation.

Lastly, FIG. 58 illustrates both seagoing vessels including the jackup rig 114 and the platform 116 going their separate ways after completion of the structure left in the water.

Note should be taken of two or three practical problems which are of no real consequence to the method of the present invention. For instance, the legs may be equal in length; however, should the bottom be irregular, certainly variations can be tolerated in the length of the legs and the variations can be accommodated either by cutting off the longer legs at the top or extensions on the short legs. Likewise, specifics have been omitted concerning fabrication of the jackup legs. The jackup legs are of known construction including cylindrical bodies, or can be fabricated in accordance with any acceptable engineering standards.

The spacing between the jackup legs shown in FIG. 58 is regular although this is not essential. Moreover, the above technique can be used to place any number of jackup legs at a particular location wherein the number of legs, spacing, strength, length, and individual configurations are subject to a wide range of variation depending on the needs of the completed structure. In any event, these details are acknowledged as being present although of no particular consequence to the present invention.

Attention is next directed to FIGS. 59—62, inclusive, which illustrate a platform on a vessel 125 and a structure 126 resting fully on the bottom. The structure 126 has a pair of upstanding support arms extending well above the surface of the water to carry the full weight of the vessel 125. For the present disclosure, the drilling platform 125 is considered to be the vessel and the framework 126 is considered to be the structure.

In FIG. 60, the numeral 127 indicates symmetrically arranged cables hanging from the structure 126 and secured to the vessel 125 to lift the vessel from the water. As a matter of convenience, the draw works associated normally with the drilling rig lifts the vessel 125 from the water. The actual details of arrangement of the cables 127 are believed within purview of one skilled in the art; as a practical matter, the structure 126 towers perhaps 50 or 60 feet above the water with blocks on the structure 126 sheaved with cables to obtain some mechanical advantage for lifting the vessel 125 from the water. In FIG. 61, the platform 125 is raised to the optimum level. This provides adequate clearance of the vessel 125 and is an altered elevation whereby the wave action does not threaten the vessel. More particularly, the vessel 125 can be left elevated for an indefinite period. If desired, appropriate attaching means of a more permanent nature such as locking members, insertable lock pins, and the like can be used to join the vessel temporarily to the overhead arms 126.

The technique of lowering the vessel 125 to the surface of the water is the reverse of the raising technique. That is, adequate cables connected between the structure 126 and the vessel 125 lower the vessel to the surface. Thereafter, the

vessel is free to sail away as desired. However, attention is directed to FIG. 62 of the drawings which illustrates the vessel 125 utilizing a connector 128 to lift the structure 126 for travel with the vessel 125 to another location.

The vessel 125 can utilize drilling apparatus for one or many wells and movement to a second location permits the drilling of additional wells.

Attention is next directed to FIG. 63 of the drawings in contrast with FIG. 59. A jackup rig 130 and a vessel 131 are shown in the same relationship shown in FIG. 59. One difference between FIGS. 59 and 63 is that the structure 130 is a semisubmersible structure engaged at the site with the vessel 131 in contrast both with the structure 126 and with plain legs known in the prior art. With this in view, it will be noted that the views of FIGS. 63—66, inclusive, are generally analogous to FIGS. 59—62, inclusive.

Attention is next directed to FIG. 67 of the drawings which shows an additional vessel 132 approaching the structure 130. The vessel 132 transports production apparatus typically, to replace the drilling vessel 131. The vessel 132 is raised as described before. This is an improved and novel means to replace drilling equipment with production equipment.

To keep perspective, it should be noted that the structure 130 comprises the separable leg of the present invention. More particularly, though the drawings are schematic in detail, the import of the illustrations is that the separable jackup leg of the present invention can be used in a variety of structures.

Attention is next directed to FIG. 70 of the drawings which illustrates a larger version of the structure 130a, sufficiently large to accommodate both the drilling vessel 131 and the production vessel 132.

By way of further contrast, attention is next directed to FIG. 71 of the drawings which illustrates a semisubmersible vessel 130b stabilized in the water. The semisubmersible vessel 130b is similar or even identical in its structural conformation. Both vessels 130a and 130b display variety in application of the present invention.

Attention is next directed to FIG. 72 of the drawings which illustrates a prior art structure indicated generally by the numeral 135. The structure 135 is a typical pile jacket erected at the drilling site; a tender 136 is tied to the structure 135 to provide services for the drilling work.

Attention is next directed to FIG. 73 of the drawings which illustrates the structure 135 as shown in FIG. 72 joined by bracing 138a to a jackup structure 138. The structure 138 is laterally supported at least in the plane of the drawing by the structure 135 as viewed in FIG. 73 wherein motion to the left or right is countered by the means 138a. However, attention is particularly directed to FIG. 74 which illustrates the rear bracing leg 138b (an end view) wherein the member 138b reinforces the structure in the other dimension. The apparatus of FIG. 73 and FIG. 74 offers several advantages over the prior art. The related prior art comprises a pile jacket with a rig thereon attended by a tender, having auxiliary facilities; tenders are of two types, namely ships and jackups. The jackup is more convenient than the ship because it is more stable, but it may cost more. A very great cost in conventional jackups is in the legs and jacking means, which must be made complex and expensive in order to resist the bending induced by wave action and to resist buckling due to the lack of other lateral support than they are afforded by their own properties. The method of this invention affords means to reduce these costs.

Attention is next directed to FIGS. 75—77, inclusive, which illustrate a conventional offshore structure 139. Alongside the structure 139 is a vessel 140 and a mounted lifting apparatus 141. The view of FIG. 76 illustrates the lifting means 141 connected to the structure 139. In FIG. 77, the vessel 140 is elevated and secured to the structure 139.

One significance of the foregoing operation should be noted. The vessel 140 is a typical small vessel periodically servicing the well. By way of example, the vessel 140 carried

workover apparatus, fracturing pumps, logging apparatus, and wire lines tools. The vessel 140 and the structure 139 cooperate in accordance with the method of the present invention. First, the vessel and structure are releasably secured and a relative change in elevation is achieved between the vessel and structure. The change in elevation makes the vessel more safe from the wave action on the water. The other method steps follow in order as related to the equipment.

Attention is next directed to FIG. 78 of the drawings which illustrates a structure 150 releasably secured to a vessel 152. A plurality of pilings 151 carried in the structure 150 extend through the framing of the structure. The vessel 152 is preferably a buoyant body with drilling rig. Releasable securing such as shock absorbers, fenders, or ropes join the members together. A tug boat 153 propels the vessel 152 and structure 150 to a selected location as shown in FIG. 78; the structure 150 is conveniently carried above the water, and offers no impedance to motion. In FIG. 79, the structure 150 is positioned above the selected location and preparations are made for founding the structure 150. The structure 150 is lowered with respect to the vessel 152 although this need not occur at every location.

In FIG. 80, the pilings 151 are driven into the subsoil and secured to the structure 150. When driven, the pilings constitute a continuation of the structure as shown in FIG. 80; moreover, the vertical extent of the pilings varies widely to accommodate a range of water depths. Attention is next directed to FIG. 81 of the drawings which illustrates erection of increments to the structure 150 to a higher level substantially above the water, although such increments might not be needed in every case.

Attention is next directed to FIG. 82 of the drawings which illustrates the vessel 152 raised above the water even further to the optimum height of the structure 150. The means for raising the vessel 152 to the optimum height are numerous, varied and include, by and large, hoist works to lift the vessel 152 to the framework, and the like. The vessel is raised to the optimum level and the derrick of the drill works is erected and positioned to commence drilling. Note should be taken of the arrangement of paraphernalia on the vessel.

In the optimum arrangement, the vessel 152 is perhaps nonrectangular, preferably even circular. This arrangement results in several efficiencies. For instance, the circular arrangement of the vessel 152 is adapted to the structure 150 therebelow. During high seas, a wave has a linear front which strikes only two of the structural members at the water line at a time. That is to say, the impact of the wave front on the structure is spread over an interval of time. Another result of the circular arrangement of the vessel 152 is the ease with which the derrick is moved from one location on the platform to another prior to drilling another well. For instance, in FIG. 82, a first well is drilled at the left-hand edge. The well 154 is cased and it extends to the producing formation. However, in FIG. 83, the drilling apparatus is shown on the opposite side of the structure. The move is easy on a circular and rotatable platform. Two means are at hand for providing rotatability. The cheaper, but possibly more cumbersome means is to provide for lowering the vessel 152 to its afloat condition, then rotating the vessel as a whole, then rehoisting it to its drilling position. The smoother method entails construction of a carrousel: this uses a lower section of vessel having an encircling rail for bearing the weight of the upper section, having the drilling apparatus in a most convenient relative relationship; the upper section is rotated as a whole on the lower section, permitting the most convenient relative relationship to be preserved.

In the prior art, a rectangular platform is usually used, and the equipment is shuffled about and disarranged, disconnected and connected, which is expensive, slow and even dangerous.

Wells must be reworked to optimize formation production. After drilling several from a platform it is difficult to go back to the oldest well and reopen it for a change in down hole gear.

However, the carrousel returns the derrick to previously drilled wells easily.

Consider, by way of example, the apparatus of FIG. 83 wherein a second well 155 produces. Quite often, the second well will have some effect on the first well, or later analysis of the first well will indicate workover of the first well. Customarily, a derrick is needed. This means, in the ordinary course of events, that the drilling rig must be skidded across the deck and all the apparatus in the way is relocated. However, using the rotatable platform described above, it is possible to return the derrick to the desired position with a minimum of trouble and effort, and without disarranging production equipment which might have been installed in the lower section of the vessel 152 or on the periphery of the structure 150.

In FIG. 83, a vessel 156 is drawn alongside the platform for receiving the production from the first well. In the carrousel platform, this is conveniently possible simultaneously with drilling; it is seldom convenient in the prior art.

Attention is next directed to FIG. 84 of the drawings which illustrates the wide range of water depths for which the structure 150 is adapted. Shallow water is indicated at the right and deeper water at the left.

In the drawings, an embodiment is shown in FIG. 85 which is similar to the embodiment shown beginning with FIG. 78. The floating vessel is indicated by the numeral 160 and is secured to a structure 161 having a plurality of pilings 162 carried therein. A self-propelled derrick barge 163 moves the combination through the water. The buoyance of the vessel 160 tends to lift the forward portions of the structure 161 and the barge 163 lifts the rear of the structure 161. The reason for carrying the structure 161 horizontally and not vertically is that the embodiment shown in FIG. 85 is launched in shallow water for use in substantially deeper waters. A wide range of water depths is accommodated by the structures of FIGS. 78 and 84; a deeper range is accommodated by the structure 161.

The vessel 160 is normally secured to the structure 161 by shock absorbing means to secure the vessel to the structure for safety and protection. In FIG. 86, the structure 161 has been released by the derrick vessel 163 and hangs downwardly toward the submerged land. Thereafter, the various pilings 162 are driven into the subsoil to support the structure. This is shown in FIG. 87. Also, it will be noted that the releasably securing means 163 is kept connected until the structure is founded. Until the structure is founded, it tends to wash to and fro and to bump and jolt against the vessel and cause damage. This problem is prevented by the use of appropriate releasable securing means at two or three points about the vessel. Energy absorbing devices including those operative by hysteresis, possibly of compression and expansion of metal is one alternative means.

Attention is next directed to FIG. 88 which shows the vessel 160 elevated above the water line free of the wave action. The structure carries the vessel 160 at a height of perhaps 50 to 60 feet above the water line. The entirety of the weight of the vessel is then received on the structure which is properly founded and footed with the pilings 162 engaged in the subsoil.

Attention is next directed to FIG. 89 of the drawings which is a detailed view of a water-exposed portion of the structure of the vessel (see FIG. 80). The vessel is represented at least partly at 152 and is secured to the framework as follows. Preferably, a pair of piles 151 form a support of the structure 150. The view of FIG. 89 shows a pair of generally similar toroidal tubular members 150e and 150f having an elliptical cross section. Some efficiency is obtained in terms of metal weight by use of elliptical members. This is particularly true at, above, and below the water line since the force of a wave on a structural member depends on the broadness and streamlining of the structural member. The elliptical arrangement is adapted for use in the present invention. A line 150d is tethered to the vessel 152 to at least partly secure the framework to the vessel. The member 150f is tied to the vessel and released when positioned.

Attention is next directed to FIG. 90 of the drawings which illustrates in perspective the load bearing members of the structure 150 and possibly part of the structure 161. The structure includes preferably an upper ringlike member 150e which is supported above a lower ringlike member 150f. A plurality of evenly-spaced, angled members 150g and 150h are braced between the two ringlike members. Each bracing is connected into a bracket to form a bipod. The bipods are spaced about the structure uniformly to brace the frame. In further particular, the vertical height is increased by stacking the ringlike members 150e with the bipods between levels.

Attention is briefly directed to FIG. 91 which illustrates a conventional rectangular platform adapted for use with the bipod bracing. In FIG. 92, the ring member 150k is supported by piling 150j. Each of the members 150j is directed downwardly at an angle to support the member. The view illustrates the fact that the apparatus of FIG. 92 is adapted for a wide range of uses whereby the bracing members 150j support the structure.

A number of offshore structures in use today are of triangular configuration, particularly jackup rigs. Attention is directed to FIG. 93 of the drawings which illustrates in schematic form a platform 168 supported by a bipod at each corner indicated by the numeral 169. The relationship of the structure 168 to the foregoing is to show the alternative capabilities of the present invention wherein the geometry of the platform varies widely. Of like nature is the view of FIG. 94 which illustrates an extended rectangular platform 170 wherein a plurality of angularly directed support legs 171 support the platform above the water. The platform of FIG. 94 is to be contrasted with the rectangular platform of FIG. 91 and the bipod supports.

Attention is directed to FIGS. 95 and 96 simultaneously which illustrate and contrast the bipod support of the present invention (FIG. 95) and its deflection to a single member and its deflection. This has important meaning when referred to piling. An additional benefit is obtained from the bipod structure. For use in subsoil pilings and foundations, the bipod is more stable than the single member support. In considering lateral loads, each leg of the bipod is either substantially in tension or compression. For the single support member substantial loadings are in shear and moment, as well as tension and compression. If the soil has any inhomogeneities, the single support will likely fail before the bipod because the soil has greater holding ability in resisting the simpler tension or compression of the bipod legs.

Attention is next directed to FIGS. 97 and 98 of the drawings which are a sectional view and an elevational view of means for connecting the pilings 176 and 177 to a leg 175. A surrounding jacket 179 extends fully about the pilings 176 and 177. The lower end of the leg is indicated by the numeral 180. The leg 175 opens through doors into the jacket surrounding the pilings, and at the nacelles for working access. The jacket 179 has a bead about its upper perimeter and a hose or other conduit 178 is placed within the bead of the jacket. The hose communicates fully about the circumference of the pilings 176 and 177 and also about the leg 175. Using available techniques, the hose 178 is inflated to seal against leakage.

Air under pressure and forced down the leg 175 forces water in the leg chamber out through a chamber vent 181. Once the leg chamber is freed of water, a workman is given access to the leg chamber. By the use of sealed opening from the leg chamber to the nacelles formed in the jacket 179, the workman has access to the individual pilings. Each is then fixed to the nacelle by means such as a stop collar welding and the like. On completion, inspection is permitted. Thereafter, the workman may leave the chamber by egressing through the leg and the perhaps temporary seal in the bead may even be released.

Reference is next made to numerous past views wherein a substantially cylindrical footing member or pile cap is shown. For instance, a pair of footing members shown in FIG. 3 have several pilings connected to each footing member; a similar set of members is found in the sequences beginning with FIG.

7. If the platform above the structure is, say, 100 feet or more long, the cylindrical footing member may also range up to 100 feet long. With this in view, attention is directed to FIG. 99 illustrating in sectional view a portion of the cylindrical footing member which receives the pilings members through guide means to be noted. In FIG. 99, a piling 185 having a lower end 185a is urged through the footing member 184. A lower guide 186 and an upper guide 187 direct, align and position the piling 185. The piling is inserted through the guide means before the connection is made between the piling and the footing member.

To fasten a piling to the pile cap, the chamber within the footing member 184 is partially purged of water as shown in FIG. 100. Air is forced into the chamber and both a lower opening 188 and the annular crevice around the pile provide escape for part of the water. The chamber is partially purged to permit entrance of a workman gaining access to the exposed piling 185. The workman enters the chamber and may utilize appropriate means to cut the piling 185. If the piling has excess length, the upper unneeded portion, when cut free above the guide means 186, is removed as shown in FIG. 101. This then permits the workman to attach a cover plate 189 to the upper guide means 187 to seal off the chamber from water entering through the upper guide means 187. Alternatively, other means could be used to seal off the communication to the outside through the upper guide means, perhaps without need to remove the upper part of the piling, sealing the guide means 187; this leaves the chamber air tight at least above and permits the complete purging of water from the chamber. This then permits the workman better access to the lower guide means 186 and the piling 185. The workman is then enabled to place any desired sealant, if sealant is desired between the piling 185 and the inner wall of the guide means 186 to caulk off the chamber. The connection between piling and footing may then be perfected as needed.

Attention is next directed to FIGS. 103—105, inclusive, for further illustration of the use of the present invention. In the drawings, the numeral 192 refers to a footing member actually contacted against the submerged land. The footing member 192 is anchored, perhaps in the foregoing manner, by a number of pilings driven into the soil. In FIG. 104, the footing member 192a is slightly different configuration and is shown at the lower end of a jackup leg. This is not a critical variation as will be appreciated. Footing members on a jackup leg are disclosed often in the present specification. Without regard to the nature of the structure above the footing member shown in the drawings, the footing member can support the structure above by bearing directly on the soil, the use of piling is omitted, at least temporarily. When it becomes clear that more dependable and certain stability and support, which can be offered by the piling, is needed, the pilings are driven and secured to the footing, and the footing member is anchored by the piling in the subsoil.

Attention is directed to FIG. 105 of the drawings which illustrates in greater detail the value of the present invention in counteracting harm from the scouring action of the water beneath the feet of the jackup legs. Erosion beneath a footing member is a real problem and has caused numerous rig failures, especially in the North Sea. In the North Sea, the continual water movement scours the soil, and bearing members seem to accelerate the erosion. When the soil is washed out and the support is destroyed, a structural tragedy occurs without advanced warning. However, in FIG. 105, the effects of scouring action are defeated by the use of divergent pilings. Moreover, the soil about the footing member 192a may wash away without effecting the support of the pilings themselves. This is of critical import in certain environmental circumstances.

I claim:

1. An improved offshore system for multiple and sequential marine operations in which a vessel is navigated to a selected operating site on the water, founded and moved to another operating site on the water, leaving behind at the previous

operating site an operational platform, the operational platform at each site serving as the means for founding the vessel comprising:

- a vessel for carrying operating equipment for offshore operations for operating on the deck thereof;
 - an operational platform means releasably attached to said vessel, said platform means being adapted to be founded on the land beneath the water;
 - oil well drilling drawworks means operatively associated with said vessel and platform means for altering the vessel elevation while the platform is founded so as to thereby remove the vessel from the action of the waves in order to stabilize the vessel and facilitate operation of the equipment thereon; and
 - selectively releasable coupling means securing the vessel to the platform means so that the vessel may, at some specified time, become buoyant again in order to navigate to another operating site whereat the sequence may be repeated.
2. An improved offshore system for marine operations adapted to be positioned at an operating site over water covered land and further adapted to be moved from one such operating site to another such operating site while leaving behind at the prior operating site a support tower means, said system comprising:
- a vessel for transporting a substantially prefabricated support tower means to an operating site, said support tower means being carried and adapted to be positioned by the vessel so as to subsequently be utilized to elevate the vessel; and
 - lift means operatively associated with said support tower means and said vessel for bringing said vessel to an altered elevation free of the wave action of the water, said vessel means including a framework extending from the deck of the vessel and which serves as a draw means for moving the vessel upwardly or downwardly with respect to the support tower means.
3. The system of claim 2 wherein there is further included means for releasably securing said vessel to said support tower means so that the vessel may move away from the support tower means to another operating site upon completion of its work at the first site whereupon another support tower means may be founded on the land beneath the water.
4. The system of claim 2 including, footing means incorporated within said tower support means, said footing means including pile receiving means adapted to receive pile members for extending from said footing means to the land beneath the water so as to found the tower support means on the land and pile members fixedly connected to said pile receiving means of said footing means, said pile members extending downwardly to the land beneath the water and firmly supported thereon so as to found the support means.
5. The system of claim 4 wherein said pile members include a plurality of piles, said piles being divergently disposed with respect to one another so as to enhance stability of the founded footing.
6. The system of claim 4 wherein said pile receiving means provides for passage of piles into the footing member from water above into water below.
7. The system of claim 6 wherein said pile receiving means further includes sealing means for providing a working environment suitable for human endeavor therewithin.
8. An improved offshore system for multiple and sequential marine operations in which a vessel is navigated to a selected operating site on the water, founded and moved to another operating site on the water, leaving behind at the previous operating site an operational support platform, the operational support platform at each site serving as means for founding the vessel comprising:
- a vessel for transporting support platform means to an operating site;
 - support platform means operatively connected to said vessel;

- footing means incorporated in said support platform means so that the footing means may reside optionally at or near the water surface or at a discrete depth;
 - pile receiving means characterizing said footing means for receiving pile members which are to be in contact with the land beneath the water;
 - pile members affixed to said pile receiving means and extending therefrom to the land beneath the water so as to found the footing means on the land;
 - lifting and lowering apparatus means physically connecting the vessel to the support platform means for selectively altering the elevation of the vessel by means of the support platform means while the latter is founded, so as to thereby provide a working platform free of wave action, and which vessel may be returned to a prior elevation upon completion of work activities; and
 - said vessel including release means for releasing the vessel from said support platform means after the latter has returned the vessel to a predetermined elevation to thereby enable the vessel to navigate independently of the support platform means to another worksite whereupon another support platform means is founded and the sequence repeated.
9. The system of claim 8 in which there is provided multiple support platform means and their respective footing means but in which at least only one platform and footing means may, if necessary, be left behind when the vessel departs to a subsequent operating site.
10. An improved offshore system for multiple and sequential marine operations in which a vessel is navigated to a selected operating site on the water, founded and moved to another operating site on the water, leaving behind at the previous operating site an operational platform means, the operational platform means at each site serving as the primary means for founding the vessel comprising:
- a platform means for carrying on offshore drilling operations and for supporting a vessel means;
 - a vessel means for transporting said platform means to an operating site whereupon the vessel deposits the platform means at such site;
 - footing means incorporated into the platform means, said footing means being adapted to receive pile members so as to found the footing means securely;
 - pile members provided for receipt by the footing means and for contacting the land beneath the water so as to found the platform means and the vessel when the vessel is supported by the platform means;
 - means releasably connecting said vessel to said platform means for founding said vessel on the land beneath the water after the platform is founded so that at some later predetermined time the vessel may release from the platform means and navigate to another worksite while leaving the founded platform means behind to serve as an automated work station or to receive service vessels; and
 - said vessel means constituting a submersible rig and said operational platform means constituting a supporting leg for said rig when founded on the land beneath the water.
- 11 The system of claim 10 in which said submersible rig may be supported by two or more separable legs which constitute platform means that remain in place after the vessel is made buoyant and navigated to another worksite.
12. The system of claim 10 wherein said operational platform means constitutes a separable leg, said leg being rotatably connected to said vessel so as to permit its movement about an axis in the horizontal plane, thereby allowing the leg to be carried in a variety of positions by the vessel.
13. The system of claim 10 wherein the founded operational platform means left by the vessel is provided with elevating changing means for receiving and changing the elevation of a subsequent vessel so as to move said vessel to an elevation free of the wave action and thereby provide a relatively calm operating station.

14. The system of claim 8 wherein said support platform means includes removable means for increasing the height thereof after the tower is founded to thereby enable higher elevation of the vessel if necessary.

15. The system of claim 14 wherein the vessel is adapted to reside interiorly of the support platform means when the former is being navigated to a worksite, with the support platform means uniformly distributed about the vessel so as to enhance stability during movement and so as to enable direct descent of the support platform means upon reaching the worksite.

16. The system of claim 14 wherein the vessel is characterized by a circular deck which is rotatable with respect to the vessel hull so that said deck may operate as a moving platform when the vessel is elevated on the structure thereby significantly enhancing operations such as well reworking by a derrick on the platform.

17. An improved offshore system for multiple and sequential marine operations in which a vessel is navigated to a selected work operating site at an afloat elevation, brought to a different working elevation whereat it is stably supported free of wave action by a stabilized marine structure, brought back to its afloat elevation while the stabilized marine structure remains stabilized at the selected operating site and wherein the vessel is brought again to its different elevation whereat it is stably supported as before, but repositioned, comprising:

a vessel, for carrying equipment and operational platform means, at an elevation substantially free of surface wave action;

an operational platform means stabilized at an operating site supporting the said vessel, said operational platform means being adapted to carry on offshore operations and to be moved from one site to another by said vessel;

releasable elevating and lowering means operatively extending from said vessel and connected to said platform means for altering the vessel elevation while the platform is stabilized; and

selectively releasable coupling means for releasing the said vessel to float while the said platform means is stabilized at an operating site, so as to allow the vessel to move to a new location while the said platform means remains stabilized at the operating site.

18. The system of claim 17 wherein the said vessel is a drilling barge, and the said platform means is a semisubmersible wave transparent frame stabilized by thrusters, structure, brought back to its afloat elevation while the stabilized marine structure

19. The system of claim 17 wherein the said vessel is a drilling barge and the said platform means is a pile jacket.

20. The system of claim 17 wherein the said vessel is a jackup rig and the said platform means is a pile jacket.

21. The system of claim 17 wherein the said vessel is a round barge and the said platform means is a ringlike frame surrounding the vessel.

22. The system of claim 17 wherein the said vessel is a catamaran and the said platform means is a pile-supported space frame.

23. The system of claim 17 wherein the said vessel is a trimmed center hull and the said platform means is an outrigger pontoon.

24. The system of claim 17 wherein the said vessel is a submersible and the said platform means is a pile jacket.

25. The system of claim 17 wherein the said vessel is a jackup rig and the said platform means is a submerged pile-supported vessel having a sealed space for human endeavor therein.

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