United States Patent

[11] 3,540,396

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[54] **OFFSHORE WELL APPARATUS AND SYSTEM**
13 Claims, 11 Drawing Figs.

[52] **U.S. Cl.** **114/0.5,** 144/206, 114/230
[51] **Int. Cl.** **B63b 35/44,** B63b 21/24, B63b 21/00
[50] **Field of Search** 114/0.5, 0.5D, 206; 61/46.5

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ABSTRACT: An offshore deepwater well apparatus and system for exploration, drilling, working, maintaining and production operations at and over an ocean floor well site and comprising an anchor and mooring system for connection with a composite floatable platform means including a lower submersible support section and an upper working platform section, both sections being buoyant and the support section carrying support columns slidably associated with said platform section and lockable therewith for supporting the platform in selected spaced relation above the water surface, together with tensioning means for the mooring and anchor system to maintain a uniform balanced tension force on the platform means for maintaining stability of the platform means under varying load conditions and adverse wind, wave and weather conditions.

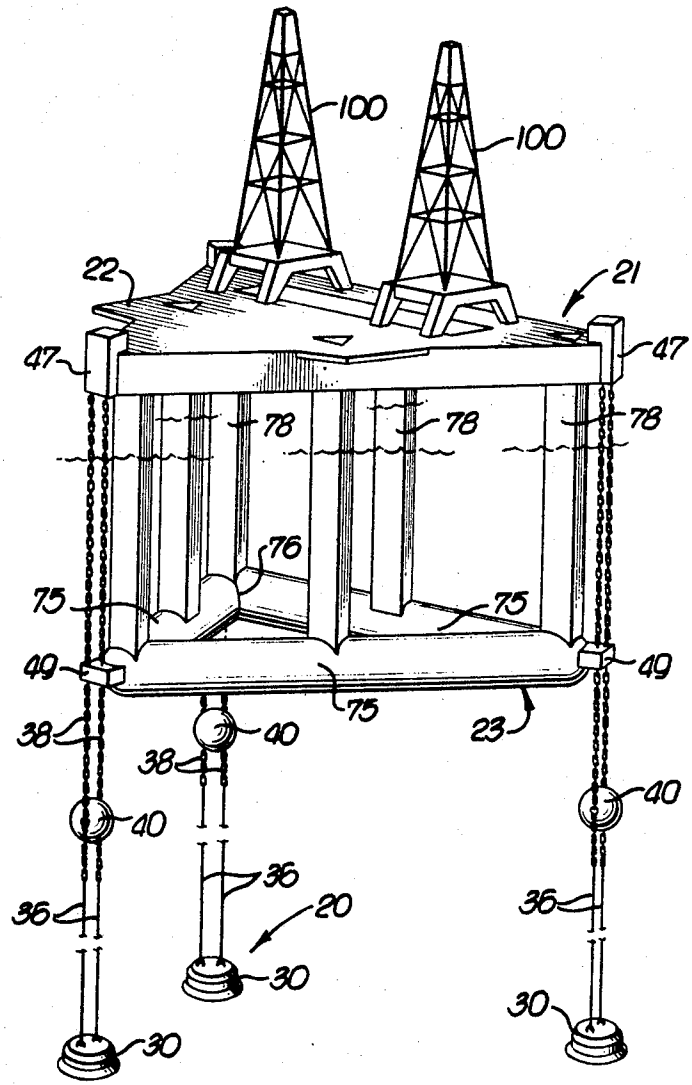


FIG. 1.

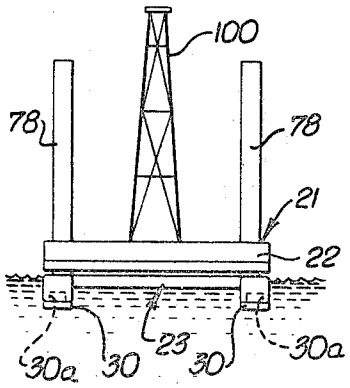


FIG. 2.

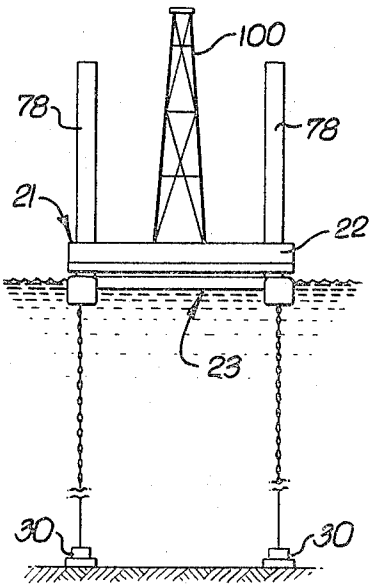


FIG. 3.

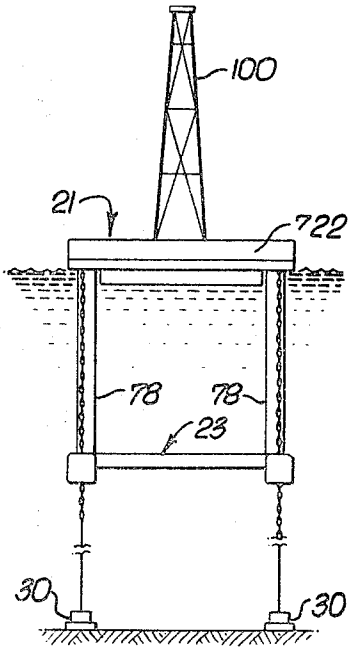


FIG. 5.

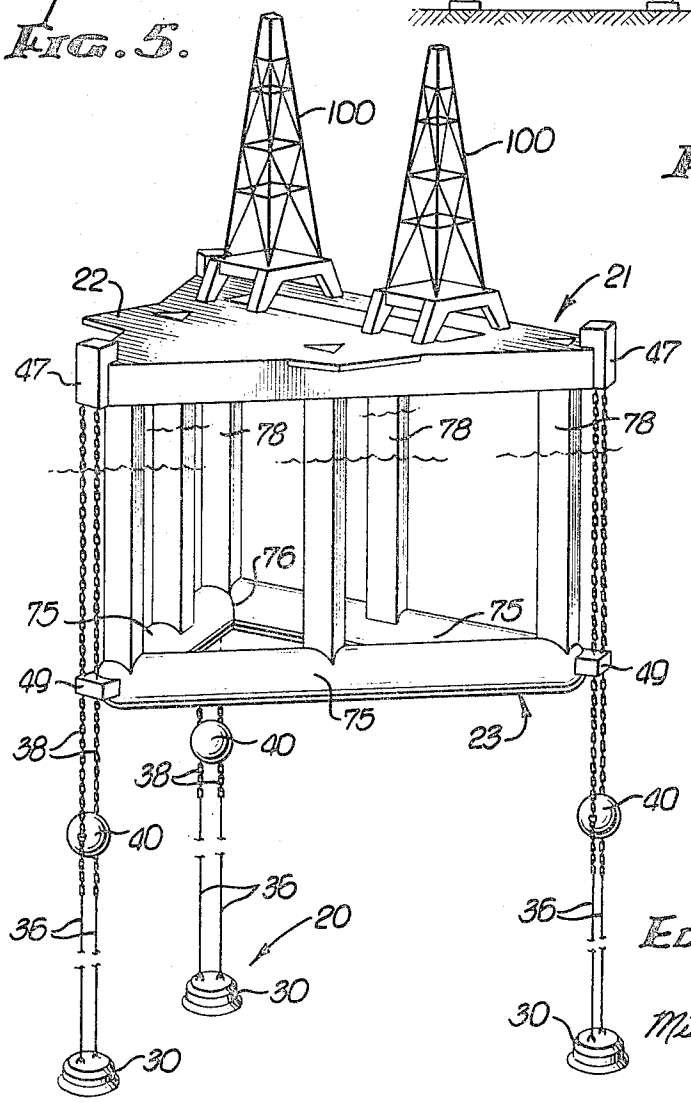
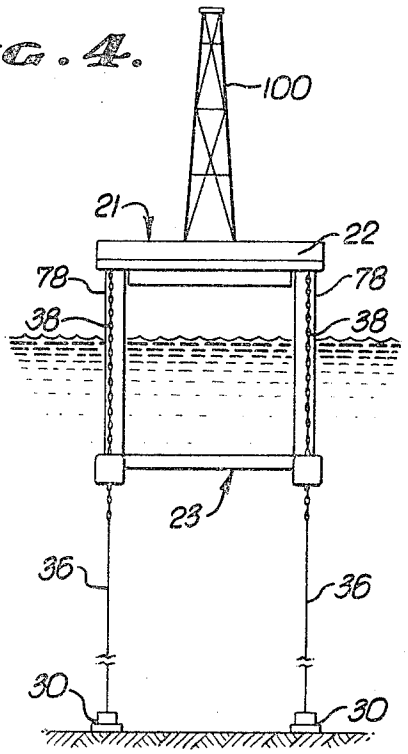


FIG. 4.



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FIG. 6.

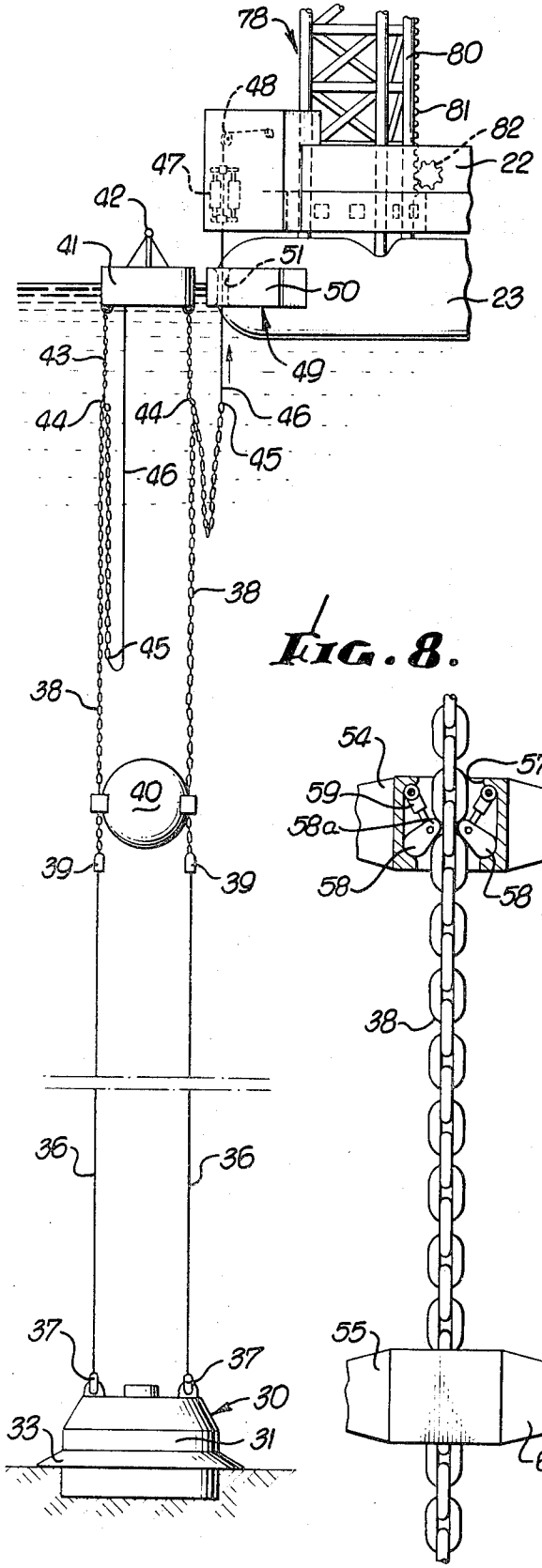


FIG. 7.

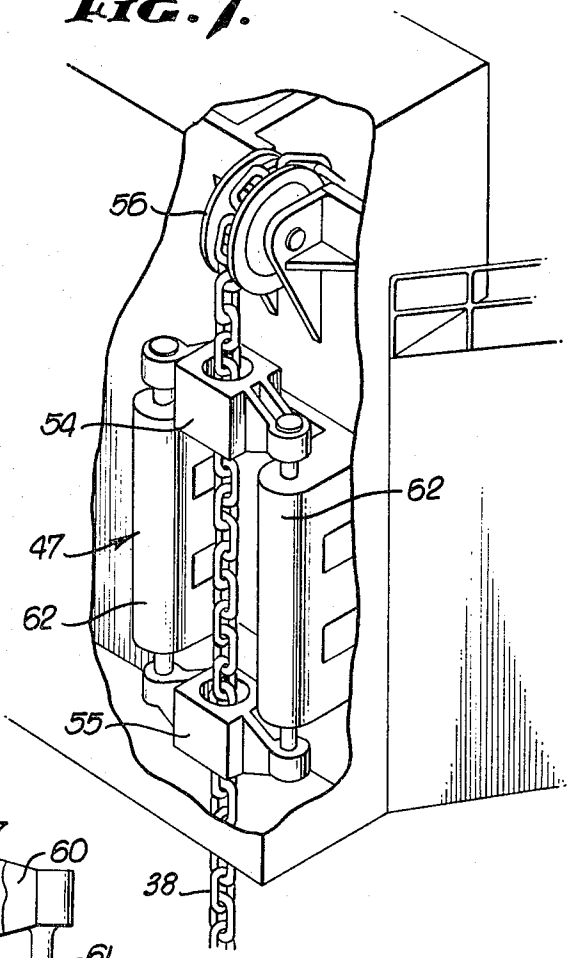
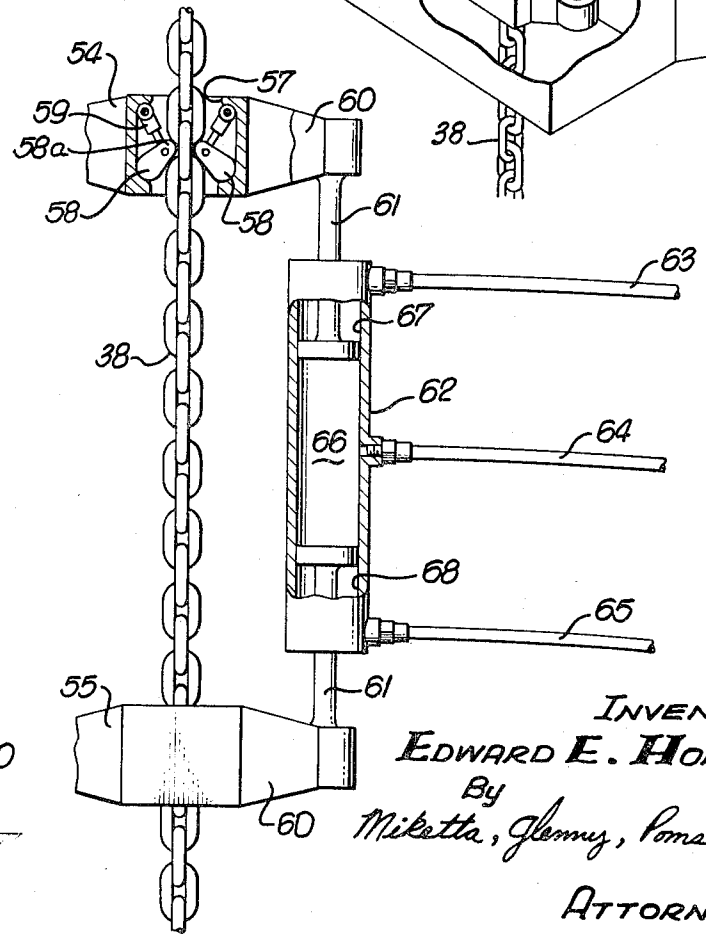


FIG. 8.



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FIG. 9.

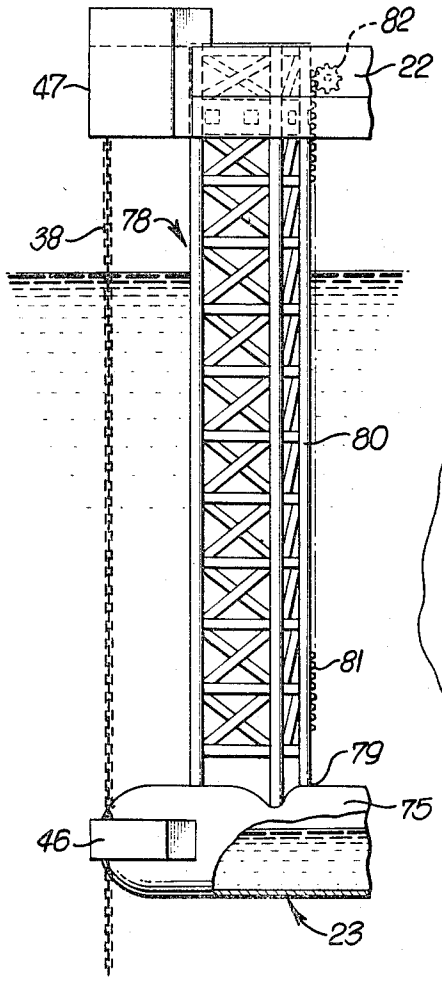


FIG. 10.

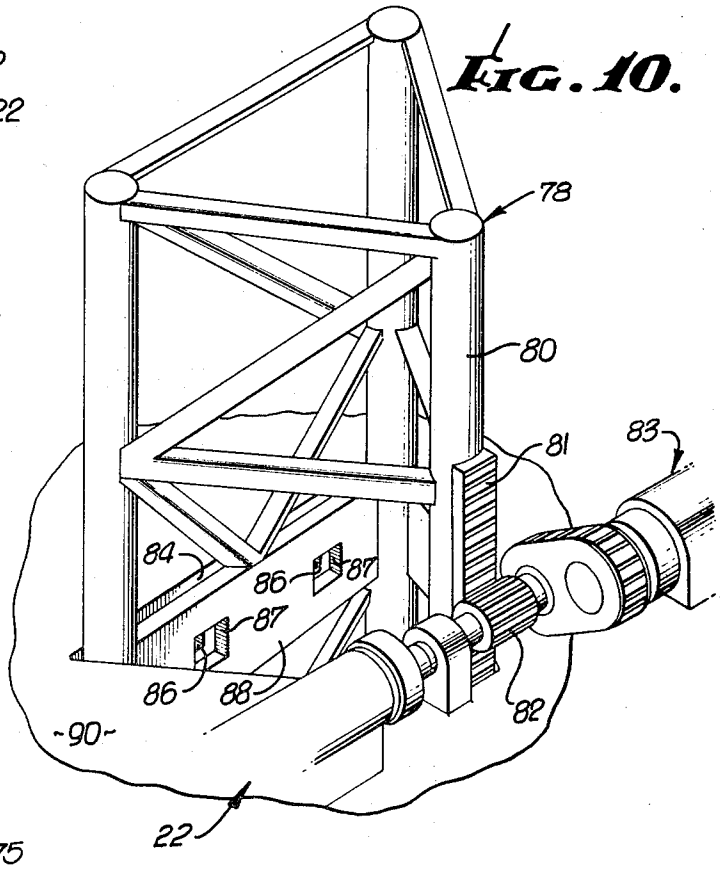
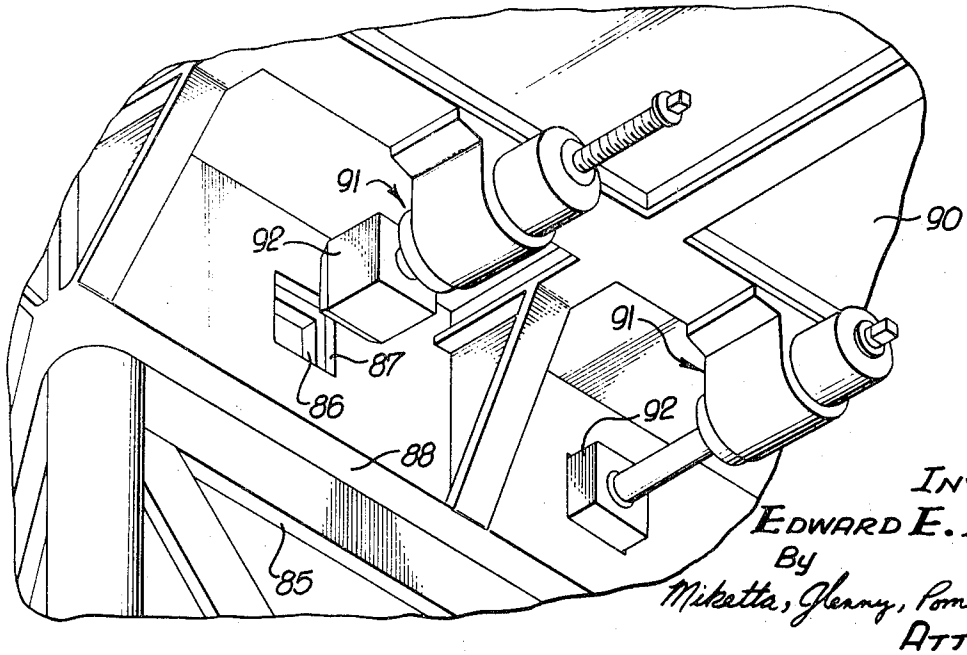


FIG. 11.



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OFFSHORE WELL APPARATUS AND SYSTEM

Prior proposed offshore drilling apparatus have generally included platforms supported by columns having their lower ends resting upon the ocean floor, for example, Armstrong, U.S. Pat. No. 2,248,051; floating elevated platforms supported by columns from a floating pontoon, Le Tourneau, U.S. Pat. No. 3,011,467, and Collipp, U.S. Pat. No. 3,163,147, a permanent floating platform employing counterweights for adjustment to vertical oscillations and reduction of roll, Khelstovsky, U.S. Pat. No. 3,294,051, and floating platforms provided with anchors with parallel anchor lines, Armstrong, U.S. Pat. No. 2,399,611; Knapp, U.S. Pat. No. 3,154,039. The prior proposed permanent apparatus which employed fixed columns to rest on the ocean floor are limited to relatively shallow water because of the expense and high costs involved in extending support columns to the ocean floor in deep water. Moreover, the depth of the water in which such structure is to operate increases costs roughly in proportions to the square of the water depth. Such prior proposed apparatus when considered for deep water (greater than 350 to 400 feet) is not only more expensive but all other related costs involved such as maintenance, equipment, labor, etc., are increased so that when deep water exploration and drilling is involved such increased costs make the project uneconomical and not feasible.

In the prior proposed floating systems of the type mentioned above, the construction of the support columns, supporting pontoons and counterweights or other means become relatively complex and may be difficult to transport to a well site because of the peculiar construction involved.

Such floating platforms have been considered as semipermanent, are subject to rolling and heaving caused by wind and wave action and such platform motion increases difficulty of drilling and other well operations, are generally designed for supporting only one drilling rig, are provided with relatively complex anchoring systems which require excessive time to set and secure, and require heading into prevailing seas to reduce motion of the platform means.

Generally speaking, such prior proposed offshore well apparatus included constructions and a method of operation which were suitable for shallow waters but which become unsuitable in terms of cost, construction, stability, and flexibility of operation in deep water well operations.

The present invention contemplates an apparatus and a system wherein the apparatus may be readily adapted for use in relatively shallow water and into relatively deep water. The present invention contemplates an apparatus which is competitive costwise with conventional prior proposed platforms in depths of water in order of 350 to 400 feet and which when used in deepwater projects the costs are not materially affected by the increase in depth. Moreover, it is contemplated that the system of the present invention is correlated with an entire well operation commencing with exploration for oil to the final depletion of an oil reservoir.

It is therefore the primary object of the present invention to provide a novel apparatus, system and method for offshore well operations.

An object of the present invention is to design and provide an offshore well-drilling and production apparatus which may be readily floated and transported to a proposed ocean floor well site and readily moored or secured at the site and which includes a platform section elevated a suitable distance above the water surface and supported from a submerged support section in a relatively very short period of time as compared to the erection of such a platform in prior proposed systems.

Another object of the present invention is to design and provide an offshore well-drilling system wherein a novel relationship is provided between anchor means, mooring lines and a composite floatable platform means whereby the platform means may be readily and quickly located and secured at a proposed well site.

A still further object of the present invention is to design and provide a novel mooring system including anchor means (either permanent or temporary) connected with anchor lines readily slidably externally associated with a support pontoon section of the platform means and connected to the platform means for securement and selective tensioning of the anchor lines.

Another object of the present invention is to disclose and provide a novel method of installing an offshore well platform system in which installation time is reduced to a minimum without effecting stability and operation of the platform means.

A further object of the present invention is to provide a floating platform means which is anchored in location by anchor means at the ocean floor and in which the anchor lines are maintained under predetermined selected tension forces virtually equivalent to upwardly directed buoyant forces less gravity forces provided by a submerged support section whereby the platform means will be supported above the surface of the water in a stable position.

A further important object of the invention is to disclose and provide a floating platform means of separable buoyant sections and wherein the combined buoyancy of the buoyant sections permits carrying installation or setting, and retrieval of weighted anchor means.

Various other objects and advantages of the present invention will be readily apparent from the following description of the drawings in which an exemplary embodiment of this invention is shown.

IN THE DRAWINGS:

FIG. 1 is a schematic view of a floatable platform means embodying this invention in towing or transport condition;

FIG. 2 is a schematic view of the platform means shown in FIG. 1 secured to anchor means;

FIG. 3 is a fragmentary view similar to FIG. 2 showing a lower buoyant submersible support section separated from an upper work platform section of the platform means;

FIG. 4 shows a schematic view of the platform means anchored and elevated above the water surface in final position;

FIG. 5 is a more detailed schematic view showing an exemplary anchor array and the floatable platform means in final position;

FIG. 6 is an enlarged fragmentary elevational view showing anchor and mooring means for the platform means;

FIG. 7 is an enlarged perspective view of an exemplary anchor chain jack means useable in the present system;

FIG. 8 is an enlarged elevational view, partly in section, of the anchor chain jack means shown in FIG. 7;

FIG. 9 is an enlarged elevational view showing the floating platform section, the submersible support section and the support columns interconnecting the same;

FIG. 10 is an enlarged perspective fragmentary view of the support column and rack-and-pinion means shown in FIG. 9; and

FIG. 11 is an enlarged fragmentary view showing means for locking the support column with respect to the work platform section.

The offshore deepwater well-drilling system shown in the drawings embodies in general an anchor means **20** (FIG. 5), a composite floatable platform means **21** which includes an upper buoyant working platform section **22**, a lower buoyant submersible support section **23**, and means for connecting the anchor means to the upper platform section and to the lower support section in such a manner that the anchor means may be selectively tensioned against buoyant forces of the support section so as to maintain the upper platform section in a desired stable position. The exemplary platform means may be provided with selected well tools and equipment for purposes of drilling and operating a subsurface or offshore oil well field, as the two drilling rigs shown in FIG. 5. A workover platform means for repairing and maintaining such a field may embody similar features as the platform means **21** so that various necessary service operations can be readily and conveniently accomplished.

The anchor means generally indicated at **20** may comprise a plurality of permanent (or temporary) deadweight anchor

bodies 30 arranged in a selected array. Each permanent anchor body 30 may be of any suitable construction and as indicated in FIG. 6 an anchor body 30 may include a generally cylindrical shell 31 which may be filled after setting, as by a tremie pipe, with a very heavy material such as a cementitious material containing hematite or taconite. The shell 31 may be provided with an outwardly and downwardly directed skirt 33 providing a suitable bearing area for reducing unit bearing load and for limiting sinking and embedment of the anchor body 30 into the ocean floor.

In a permanent anchor system the anchor bodies 30 may be selectively located on the ocean floor at a proposed well-drilling site and in a particular arrangement whereby anchor bodies 30 will provide a pattern related to the configuration of floatable platform means 21. Exemplary platform means 21 is triangular in configuration and anchor bodies 30 are located and embedded in the ocean floor in a corresponding triangular configuration. In the event the platform means is of rectangular, octagonal, or other polygonal configuration a suitable number of anchor bodies 30 may be employed likewise in a corresponding polygonal pattern and located on the ocean floor. The total array of deadweight anchor bodies 30 develop a downward force sufficient to overcome buoyancy and varying loading conditions acting on the platform means. Thus, in an exemplary permanent installation where shells 31 may be filled with a cementitious body including hematite or taconite and depending upon anticipated buoyancy conditions the total weight of each anchor body may be in the order of one thousand tons.

It will be readily understood that placement of anchor bodies 30 in a selected pattern is a first step in providing an offshore drilling system. Anchor bodies may be installed by special equipment carried on the platform means, or by an anchor barge. After a first anchor body 30 is set in place then each of the other anchor bodies are referenced for positioning to the first anchor. The position of the successive anchor bodies being installed may be determined by either surface navigation means or underwater object-sensing systems, *i.e.*, acoustic means, or the like.

Anchor bodies 30 may be carried by platform means 21 in various ways. When a platform means embodying this invention is equipped with work over or service facilities and is employed to service several wellheads, the support section 23 of the platform means may be provided with downwardly facing recesses 30*a* for receiving anchor bodies for transport from one site to another. In service operation, anchor bodies 30 are retrievable and are not completely filled with nonremovable ballast.

The anchor means generally indicated at 20 also includes a mooring system for connecting anchor bodies 30 to the platform means 21, such mooring system including anchor lines 36 which may be made of steel cable such as bridge cable, pipe, bar, or chain. Each anchor line 36 may be coated with a suitable corrosion-resistant compound such as a bitumen to protect the cable and prevent ultimate weakening of cable strength. In the example shown in FIG. 6 each anchor body 30 is provided with two cables 36 connected at 37 to the anchor body as by well known means such as an eye and pin connection. Cables 36 may be of any selected length depending upon the depth of the ocean at the proposed well site. At their upper ends cables 36 are connected to anchor chains 38 which are preferably of at least the same strength as cable 36 and which may be cable or other suitable tension member. Anchor chain 38 may be of any flexible cable, etc. Just above connection 39 between the chains 38 and cables 36 a subsurface buoy 40 may be provided in order to maintain cables 36 in extended condition. Subsurface buoy 40 may be located approximately 75 to 200 feet below the water surface. The use of a chain facilitates the connection of subsurface buoy 40 thereto. Each buoy 40 has a buoyancy which exceeds the weight of the associated cable so as to minimize lateral motion thereof caused by ocean currents and also the weight of the chain thereabove to maintain the anchor mooring system in the event the chain is dropped.

Anchor chain 38 as best seen in FIG. 6 is provided with a length greater than the distance between the subsurface buoy 40 and the height to which the upper platform section 22 is to be located above the sea surface. Chains 38 are supported initially from a surface buoy 41 of suitable construction and having sufficient buoyancy to exceed the weight of chain 38. Surface buoy 41 may be provided with a warning light 42. A relatively short buoy chain section 43 may be connected by suitable means to anchor chain 38 at 44 and the length of chain 38 beyond connection 44 may normally loosely extend along its main portion and at its end may be connected as at 45 to a messenger cable 46 which may be secured in and carried by the buoy 41. When a floatable platform means is positioned for mooring at such mooring system the messenger cable 46 is detached from surface buoy 41, fed through an external guide means 49 on the submersible support section 23 and through a chain jack means 47 over a sheave system 48 to a suitable winch drum (not shown). Thus, when messenger cable 46 is pulled through the guide means 49 and the chain jack means 47 the anchor chain 38 is drawn therethrough for securing the platform section to the anchor system as described in detail hereinafter. Surface buoy 41 may have its connecting chains 43 disconnected from anchor chain 38 and buoy 41 may be secured alongside the floatable platform in well known manner.

Thus when each of the anchor bodies 30 has been connected through the anchor line mooring system above described, under normal conditions, the floatable platform means 21 will be positioned above the array of anchor bodies 30 and in general alignment therewith.

Guide means 49 carried on submersible support section 23 may comprise a suitable projecting member 50 secured to the surface of support section 23 and provided with a vertical through passageway 51 of sufficient diameter to freely pass anchor chain 38. Such a guide means may be provided with a side opening (not shown) if desired in order to facilitate placement of the messenger cable in passageway 51 at the time the support section 23 is secured to the mooring system. Such side opening may be closed by a pivoted gate means or a slidable closure lock actuated by a fluid cylinder means from a remote control.

The anchor chain jack means 47 provides step by step raising or lowering of the chain as fully described in my copending U.S. Pat. application Ser. No. 714,289, filed Mar. 19, 1968, entitled "Constant Tension Chain Jack Assembly". FIGS. 7 and 8 schematically illustrate the operation of such a chain jack assembly and briefly the assembly comprises top and bottom chain stopping devices 54 and 55 through which chain 38 passes and then extends over a sheave 56 carried on the platform means in suitable manner. The chain stopping devices include pivoted or rockably mounted pairs of dogs 58 on each side of through passageway 57 and on opposite sides of the chain 38 so that inner ends 58*a* of said dogs may interengage with links of chain 38 to hold the chain 38 against movement in one direction. Each dog 56 may be biased toward chain 38 under a selected pressure by biasing means 59. In FIG. 8 the dogs of top device 54 are indicated as upwardly directed so as to permit drawing in of chain 38. Dogs 58 in bottom stopper device 55 are similarly rockably mounted and are downwardly directed to permit downward paying out movement of chain 38. In operation one of the sets of dogs may be fully retracted by biasing means 59 so as to permit movement of chain 38 in one direction.

The stopper devices 54 and 55 are carried on a yoke means 60 which includes piston rods 61 which extend into cylinder means 62. Pressure fluid is supplied through line 64 to chamber 66 to cause the yoke means 60 to expand. Lines 63 and 65 are connected to end chambers 67 and 68 to relieve fluid from said chambers during the expansion stroke. Since one set of dogs is engaged and the other set of dogs is disengaged from the chain, the chain may be raised or lowered in a step by step fashion.

The actuation of the chain jack means 47 at each chain 38 may be correlated by a fluid pressure system (not shown) so

that the anchor lines may be uniformly selectively tensioned or may be uniformly selectively payed out. Other chain-tensioning systems may be employed if desired.

The composite floatable platform means **21** comprises the lower buoyant submersible support section **23** which in this example includes triangularly arranged pontoon bodies **75** connected together at their ends at **76** by any suitable means so as to form a rigid triangular pontoon section. Each pontoon body **75** may comprise a hollow shell suitably compartmented and provided with means for introducing and discharging ballast therefrom (not shown) so that the buoyancy of the support section **23** may be readily changed as desired. The support section **23** includes a plurality of upstanding support columns **78**; in this example, provided at each corner of the triangular section and also intermediate the length of each pontoon body. Support columns **78** are best shown in FIGS. **9**, **10** and **11** and may include any suitable structural steel column in order to provide necessary strength and rigidity. Each support column **78** is fixed at **79** by suitable base plates and welding to the pontoon bodies **75**. Each support column **78** includes along one of its column members, such as **80**, a rack bar **81** extending for substantially the entire length of the column **78**. Rack bar **81** engages a drive pinion gear **82** carried by platform section **22**. The drive gear **82** may be driven by a suitable drive and motor means generally indicated at **83**. The drive and motor means **83** are not designed to raise or lower the platform section **22** but are employed as a control means for regulating the movement of the platform.

Platform section **22** includes a generally polygonal shaped opening **84** of corresponding polygonal pattern as that of support column **78** so that the support column **78** may slidably move therethrough when the support section and platform section are moved relative to each other. The platform section **22** at opening **84** includes locking plates **85** provided with ports **86** for alignment with ports **87** in a companion plate **88** on column **78**. Mounted beneath deck **90** of the platform section and opposite each of the aligned ports **86**, **87** may be provided a suitable locking member **91** having a locking head **92** of the same configuration as ports **86**, **87** and adapted to be inserted into said ports for locking the platform section in selected relationship with support columns **78**. The locking means **91** may be pneumatically actuated. The support column **78** may include vertically spaced locking plates **88** with ports therein so that the platform section may be locked at other selected spacing from support section **23**.

The upper platform section **22** may be of selected area and in a well drilling operation may include a pair of drilling rigs indicated at **100**. The deck area of the platform section **22** may carry the usual drilling equipment and accessories necessary to perform an offshore drilling operation. It will be apparent that the platform section may be equipped for different purposes such as exploratory, development, workover, and maintenance situations and may be varied in size.

In the system of establishing or installing an offshore drilling and production system embodying this invention reference is made to FIGS. **1**—**4** which schematically shows the method of installation of the platform means. In the event permanent anchors have been installed by an anchor barge or other means, anchors **30** shown on the support section **23** would not be employed. In FIG. **1** the platform section **22** and support section **23** are in close spaced relationship with the support columns **78** extending upwardly above the deck of the platform section **22**. In this position the floatable platform means is stable and readily towed to a proposed well site.

When the platform means reaches the proposed well site the messenger cable of the already established mooring system may be disconnected from surface buoys **41** and fed through guide means **46** on support section **33**, through the chain jack means **47** and to a takeup winch. When all of the chains have been connected to respective chain jack means a selected tension may be uniformly placed on each of the chain means so that the anchor lines are taut and are guided through the guide means **46**.

The support section **23** including each pontoon **75** may then be flooded uniformly so that the support section **23** will gradually submerge and be guided downwardly not only by the slidable passage of support columns **78** through openings **84** but also by the passage of the anchor lines and anchor chain **38** through guide means **46** on the support section. The support section **23** is thus maintained in alignment within the projected pattern of the anchor means on the ocean floor. During submerging of the support section **23**, the gear **82** of the motor control means may be in neutral position or idle so as to permit the support columns **78** to freely slide through opening **84**. In some instances to assist in controlling the accurate descent of the support section **23**, the pinion gears **82** may be driven so as to exert necessary downward or upward pressures on a support column to keep it in synchronism with the other columns.

After support section **23** has reached a predetermined submerged depth, (*e.g.*, 130 feet) and normally the lowest position of the columns, support columns **75** may be locked with respect to the platform section **22** by locking means **91**. In such spaced relationship of platform means **22** and support section **23** the platform section with its buoyancy may be floating on the water surface as indicated in FIG. **3**. Thus support section **23** is provided with negative buoyancy in order to submerge the support section along a controlled path with respect to the anchor pattern. The platform section, which is buoyant, floats on the water surface as in FIG. **3**.

After the platform and support sections have been locked in separated relation support section **23** may be relieved of its ballast by any suitable means such as pressure air until there is sufficient buoyancy in the support section to cause the support section with the locked platform section to be raised a preselected space above the water surface, such as 30 feet. As the sections ascend the anchor lines are payed out through the chain jack means to maintain substantially uniform tension and to permit the platform section to be elevated at a uniform even stable rate.

When the platform section **22** has been raised to a selected height above the water surface it will be apparent from FIG. **4** that the support section **23** is located a selected distance (such as 100 feet) beneath the water surface. Such depth is below the effect of wind and waves on the upper portion of an ocean body and wave amplitude is thereby small. Thus the submerged support section **23** is located in a relatively stable portion of the water body.

Buoyancy imparted to support section **23** is made great enough so as to not only support the platform section **22** in desired position above the water surface but to also sufficiently tension anchor lines **36** so that any changes in loading of the platform section **22** caused by atmospheric conditions, waves or addition of equipment to the platform will maintain the anchor lines under a minimum selected tension so as to maintain the platform stable. Buoyancy forces of support section **23** are sufficient to maintain the anchor lines under tension and to prevent a slack condition therein under the most severe adverse conditions. In addition the buoyant forces must be great enough to keep lateral position of the support section within selected limits when subjected to ocean currents. In an exemplary design having 1500 long tons of positive buoyancy the platform will remain within a circle having a radius of 10 percent of the water depth when subjected to a current of two knots and a wind of 85 miles per hour. In 1 knot currents and 30 knot winds, such lateral excursion is less than 2½ percent of the depth.

In the above described exemplary embodiment of this invention it is important to note that the buoyant support section **23** is a substantial distance below the water surface and is designed as a long period vessel having in the horizontal plane a natural period in the order of 14 seconds or more. Such a period is longer than that of high energy ocean waves and therefore the support section does not respond significantly in normal sea conditions. The platform means is a short period structure in a vertical direction and may have a natural period in the order of between one and two seconds depending upon

water depth. Thus, with respect to the vertical axis of the platform means, the platform will remain at an almost constant distance from the sea floor regardless of changes in water level. Since the platform means is imparted very little vertical movement, drilling and completion operations may be accomplished with greater facility, more quickly and more safely. Riser support equipment becomes more simplified because vertical compensation requirements become minimal.

It will be noted that the anchor and mooring lines include redundant tension members so as to eliminate dangers occurring in the event a tension member should break. The platform means of this invention utilizing the anchor system described can be readily and safely installed in areas where ocean bottom soil conditions are unfavorable because the soil bearing strength is not an important factor for the stability of the platform means.

It will be understood by those skilled in the art that the method of establishing the offshore well system is facilitated by the provision of the subsurface and surface buoys whereby the anchor chain is readily available and the provision of the guide means on the support section **23** which establishes a guiding relationship between the mooring system and the platform means which not only facilitates relative movement between the platform section and the support section when the platform means is being installed but also provides externally disposed tension members which contribute to the stability of the platform means.

The features described above with respect to the platform means **20** may be embodied in a smaller work over platform which may perform a service function and which is not expected to remain on site for long periods of time. Such a work over platform would be provided with chain jack means compatible in pattern and arrangement to the anchor and mooring system at the well site.

When anchor means are carried by the floating platform means, such as shown in FIG. **1**, and the operations to be performed include moving the platform to a well site, performing a well operation, and then moving to another well site, it should be noted that the combined buoyancy of both upper and lower section is capable of supporting and carrying fully weighted anchor means. Thus setup time at a well site is reduced because the anchor means may be lowered to the ocean floor and the support section then submerged without adding weight or ballasting the anchor.

It will be understood that various changes and modifications may be made in the embodiments of the invention described above and which come within the spirit of the present invention.

I claim:

1. In an offshore deepwater well-drilling and production system the provision of:

a plurality of anchor means in spaced preselected arrangement in an ocean floor;

each anchor means including an anchor line extending to the water surface;

a composite floatable platform means including an upper buoyant working platform section and a lower buoyant submersible support section;

means including a plurality of upstanding column means fixed to said lower support section and slidably guidable and lockable in said upper platform section for connecting said buoyant sections for relative movement therebetween;

said anchor lines being slidably connected and laterally restrained on said lower section;

and means for connecting the upper ends of said anchor lines to said upper platform section for selectively tensioning said lines against buoyant forces of said support section to maintain a selected elevation of said upper platform section above the water surface under varying load conditions;

whereby said platform and support sections are closely spaced for floatable transport at the water surface to a well site and whereby said sections are separated to submerge the lower support section and to then provide the lower section with positive buoyancy to support from beneath the water surface the upper platform section above the water surface.

upstanding nonbuoyant structural column members secured at their bottom ends to said lower support section;

opening means in said working platform section slidably receiving and guiding said column members for permitting relative vertical movement between said working platform section and said support section;

means on said support section for slidably guiding and laterally restraining the upper portion of said anchor lines; and

adjustable means connecting the upper chain portions of said anchor lines to said working platform section for tensioning said anchor lines;

whereby said anchor chain portions are virtually parallel to said column members and said anchor line means are maintained under tension by upward thrust of the buoyant support section.

2. In a system as stated in claim **1** wherein each anchor line includes a subsurface buoy supporting the major length of said anchor line and a surface buoy supporting the length of the anchor line above said subsurface buoy.

3. A system as stated in claim **1** wherein said lower buoyant support section includes means for carrying said anchor means.

4. A system as stated in claim **1** including means for submerging said lower section along said anchor lines to a selected depth while said upper section floats on said water; and means for locking said column means at said upper section at a fixed predetermined distance above said lower support section.

5. In an offshore well system for use in well drilling, worktower, and production operations the combination of:

a plurality of anchor means in selected preselected arrangement secured in an ocean floor;

anchor line means fastened at one end to said anchor means and extending upwardly to about the water surface;

each anchor line means including a lower portion and a subsurface buoy supporting said lower portion;

and an upper chain portion and an upper buoy supporting said chain portion;

a floatable platform means including a buoyant upper working platform section and a lower buoyant support section connected thereto; and

simultaneously tensioning said mooring lines to maintain a selected force differential between the upward thrust forces of the submersed positive buoyant support section and the holding force of the mooring lines.

6. In a method of establishing a working platform at an offshore well site, the steps of:

setting a plurality of anchor means in the ocean floor with mooring lines extending to the surface of the water;

attaching said mooring lines to a composite platform means having a submersible support section and a working platform section;

separating the support section from the platform section by imparting negative buoyancy to the support section;

securing the platform section and the support section in selected spaced relation;

raising the spaced platform and support sections by imparting selected positive buoyancy to the support section.

7. A method as stated in claim **6** including the step of guiding the separation of the platform section from the support section by said mooring lines.

8. In a method as stated in claim **6** including the steps of:

locking said platform section in selected spaced relation to said support section; and

said support section carrying upstanding columns slidably guided in openings in said platform section.

9. A method as stated in claim 6 including the step of retrieving said anchor means for transport by said support section.

10. In a method of establishing a working platform at an offshore well site the steps of:

providing an anchor arrangement of virtually the same external configuration as a platform;

attaching mooring lines to such a platform by extending each line through a guide on a support means connected with the platform;

submerging the support means along said mooring lines until a selected depth is reached;

locking said platform to column members carried by said submerged support means;

imparting positive buoyancy to said support means for raising said support means, platform and columns as a unit with the platform a selected space above water surface; and

imparting a selected tension to said mooring lines whereby the buoyant thrust of the submersible support means will exceed loads imparted to said platform for maintaining said mooring lines under a selected minimum tension.

11. A system as stated in claim 1 wherein the combined buoyancy of the buoyant sections is capable of carrying said anchor means.

12. In an offshore well system, the provision of:

a plurality of anchor means at an ocean floor;

said anchor means including an anchor line;

a platform means including an upper platform section and a lower platform support section;

means interconnecting said platform sections for vertical relative movement therebetween;

said anchor line being connected to at least one of said platform sections;

means for imparting negative buoyancy to said lower platform support section for separating said sections while said upper section remains at the surface of the water;

means for securing said platform sections in spaced apart relation;

means for imparting positive buoyancy to said platform support section to raise said interconnected platform sections until said top platform section has a selected height above the surface of the water; and

means for tensioning said anchor lines for imposing a vertical force differential between said positive buoyant forces and said tension forces whereby selected loads on said platform means will not overcome said force differential.

13. In an offshore well system including a platform means adapted to be positioned and anchored over a subsea well site; the provision of:

a plurality of anchor means in spaced arrangement at the ocean floor for holding said platform means in relation to said well site;

anchor line means fastened at one end to each of said anchor means and extending substantially vertically upwardly therefrom and providing a connection at their other end to said platform means;

said anchor line means being under selected tension by buoyancy of said platform means for vertically positioning and holding said platform means at a selected height and location over said anchor means;

said anchor line means including a lower portion and an upper portion, both being under said selected tension when operatively connected to said platform means;

a subsurface buoy of positive buoyancy connected to and between said upper and lower anchor line portions;

the tension imparted to said lower anchor line portion by said subsurface buoy being at least great enough to support said lower and upper anchor line portions when said upper anchor line portion is not connected to said platform means;

said subsurface buoy being located at a depth below a selected submerged depth of a platform means; and

a surface buoy for connection to said upper anchor line portion to support said upper anchor line portion when disconnected from said platform means whereby a platform means is readily movable into or off operating position with respect to a well site.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,540,396 Dated November 17, 1970

Inventor(s) Edward E. Horton

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 7, line 45, after "anchor" insert -- means --. Colum 8, line 6, beginning with "upstanding nonbuoyant" cancel all t and including "section." in line 22, same column 8, and insert the same after "thereto;" in line 49, same column 8; line 38, "tower" should read -- over --; line 49, cancel "and"; line 5(beginning with "simultaneously" cancel all to and including "lines." in line 54, and insert the same after line 67; same column 8, line 67, "." should read -- ; and --.

Signed and sealed this 15th day of June 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR
Commissioner of Patents