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[54] **OFF SHORE DRILLING PLATFORM CONSTRUCTION**

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[52] **U.S. Cl.**.....**61/46.5,** 61/48, 114/.5 D

[51] **Int. Cl.**.....**E02b 17/00,** B63b 35/44

[58] **Field of Search**.....61/46.5, 46, 63, 61/69, 48; 114/.5 D

[56] **References Cited**

UNITED STATES PATENTS

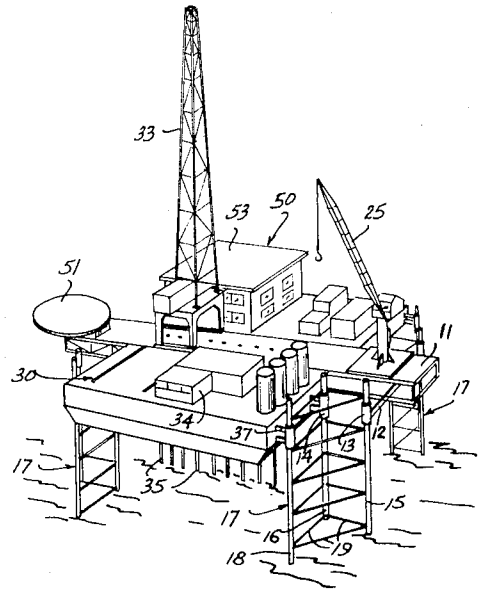
3,014,346	12/1961	Small	61/46.5
3,011,318	12/1961	Ashton	61/46.5
3,007,316	11/1961	Higgins, jr.	61/46.5

Primary Examiner—Jacob Shapiro
Attorney—Peter Kirby

[57] **ABSTRACT**

Four legs or spuds engaging the sea bed support an elevated, alongated platform above the water to form an I configuration defining a pair of barge-receiving slots into which different barges can be moved and raised to the platform level by jacking mechanisms. The arrangement permits "unit chassis" type operation by which first a drilling barge with a derrick can be introduced and then, after drilling, this barge can be removed and the slot occupied by a production barge, leaving a servicing slot vacant for future work.

7 Claims, 12 Drawing Figures



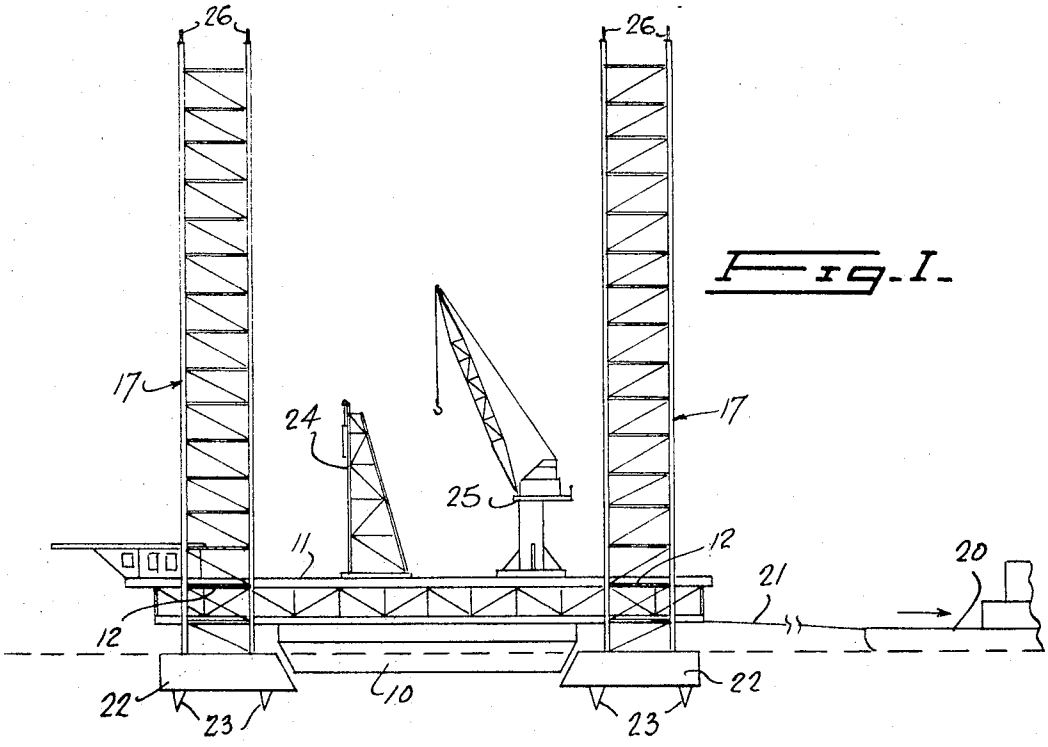

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Fig. 1.

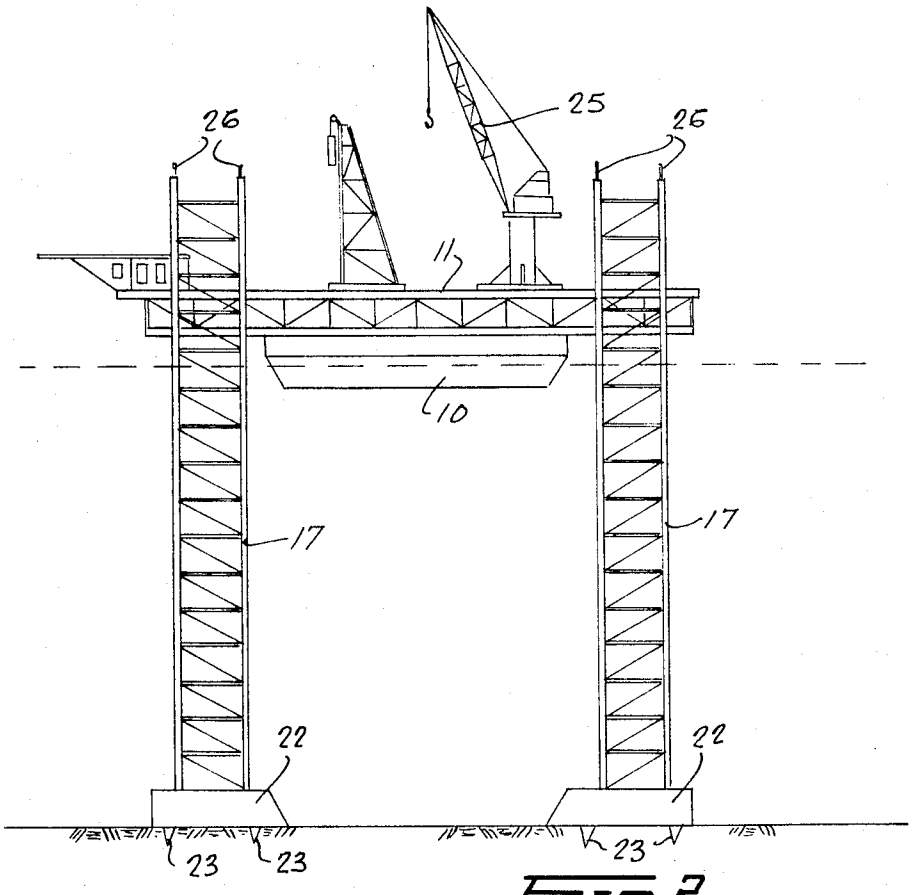

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Fig. 2.

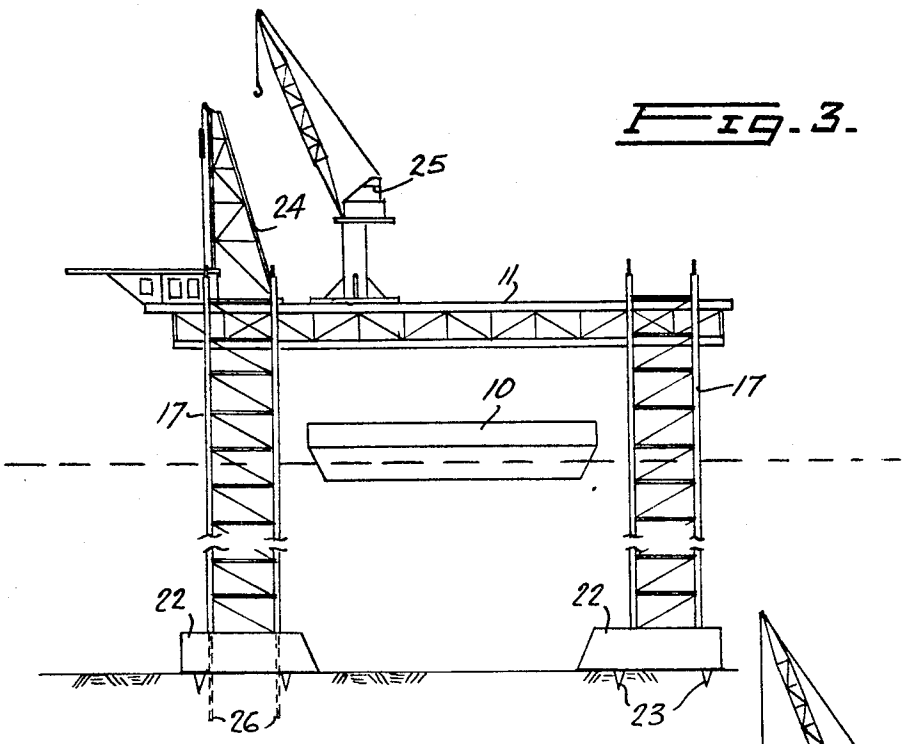


Fig. 3.

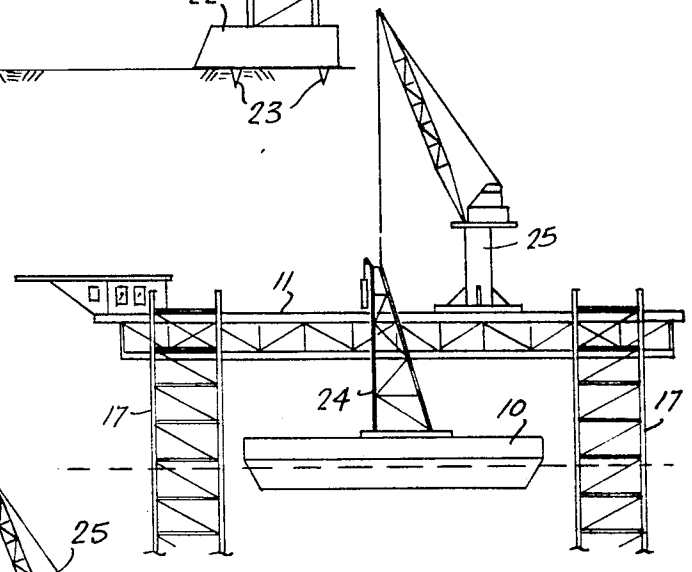


Fig. 4.

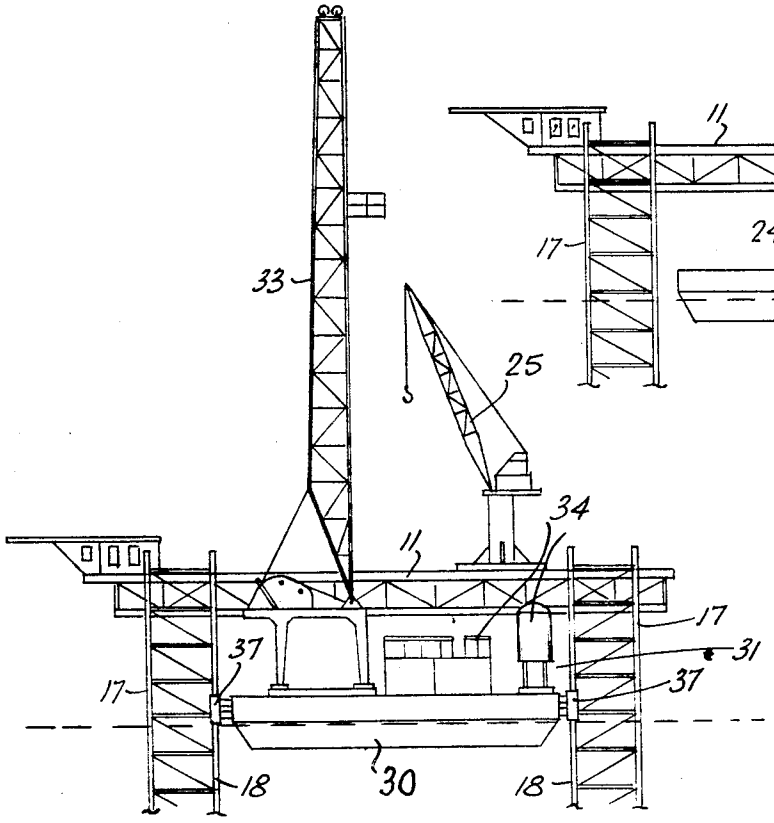
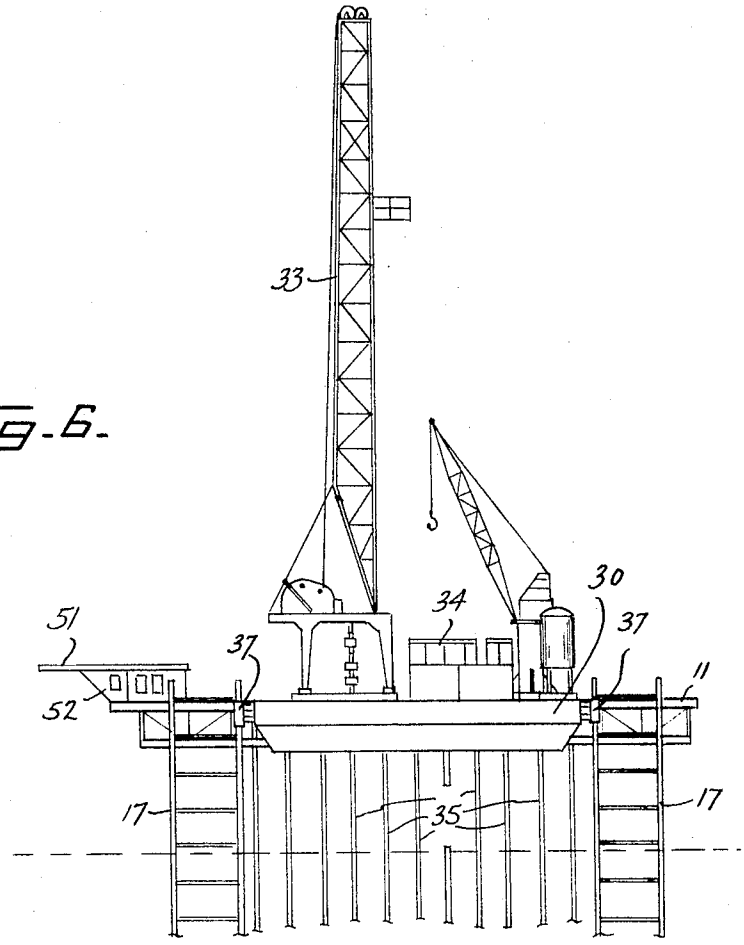


Fig. 5.

Fig. 6.


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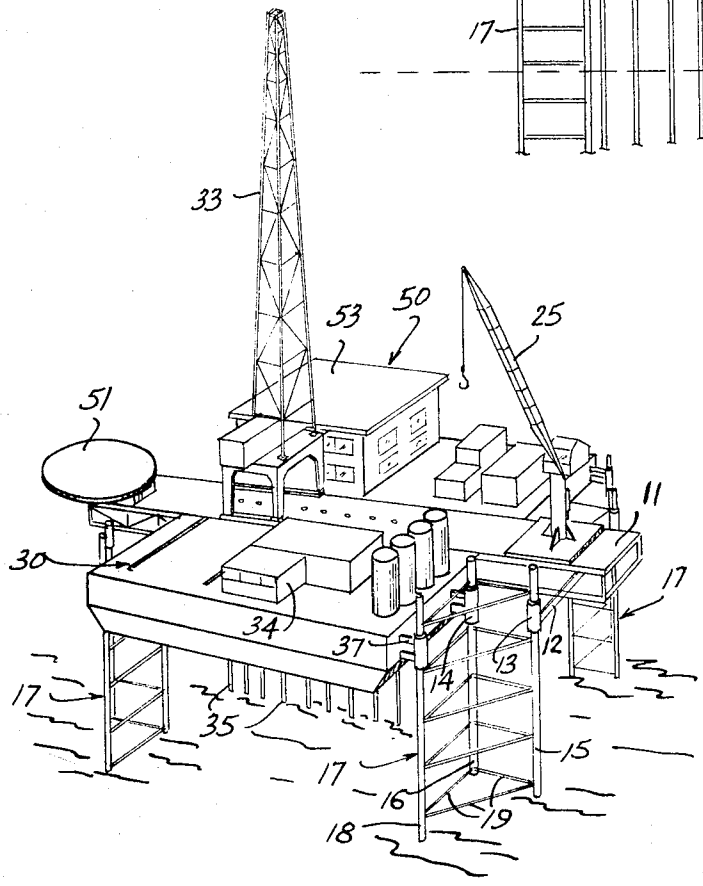

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Fig. 8.

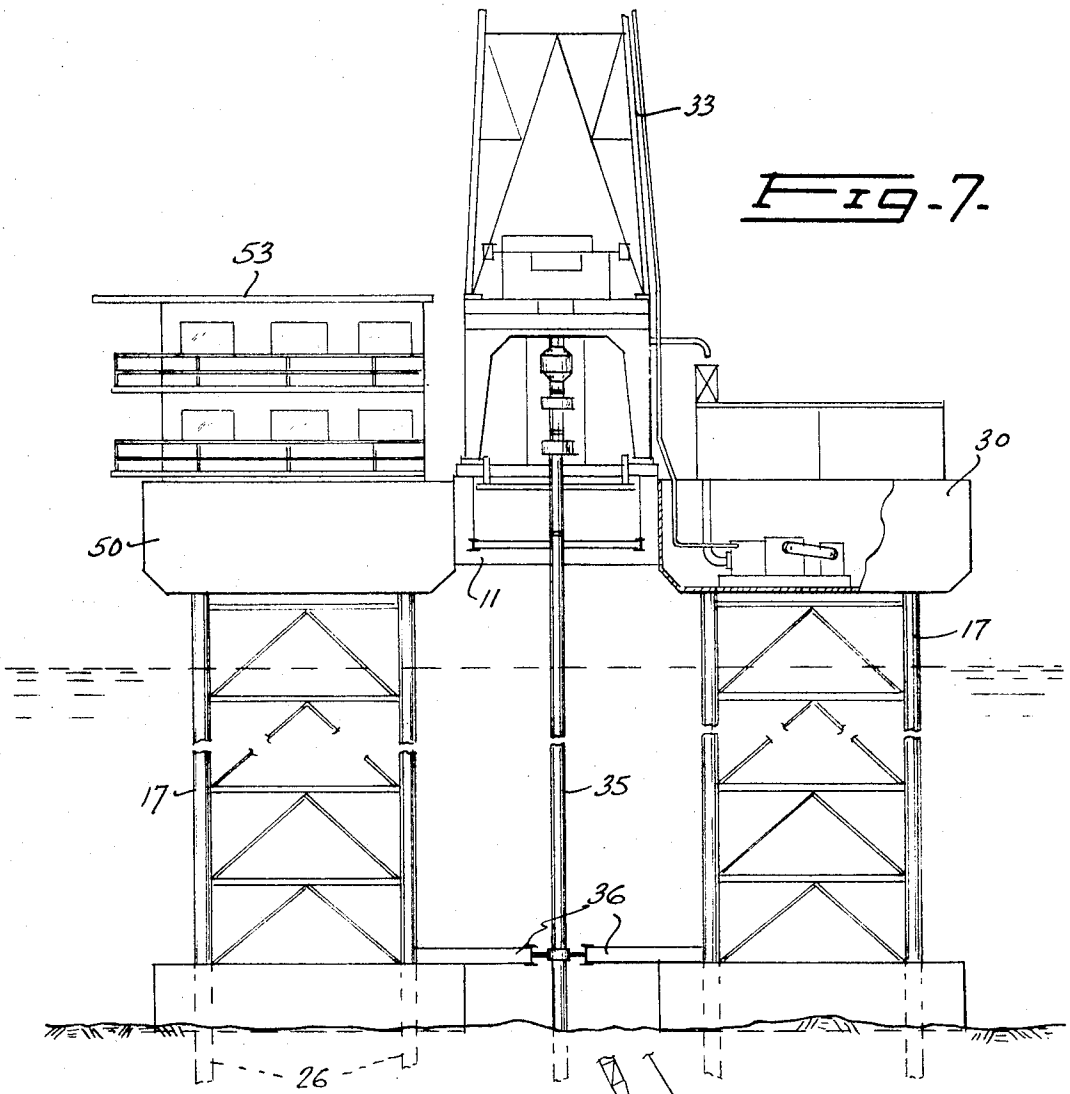


Fig. 7.

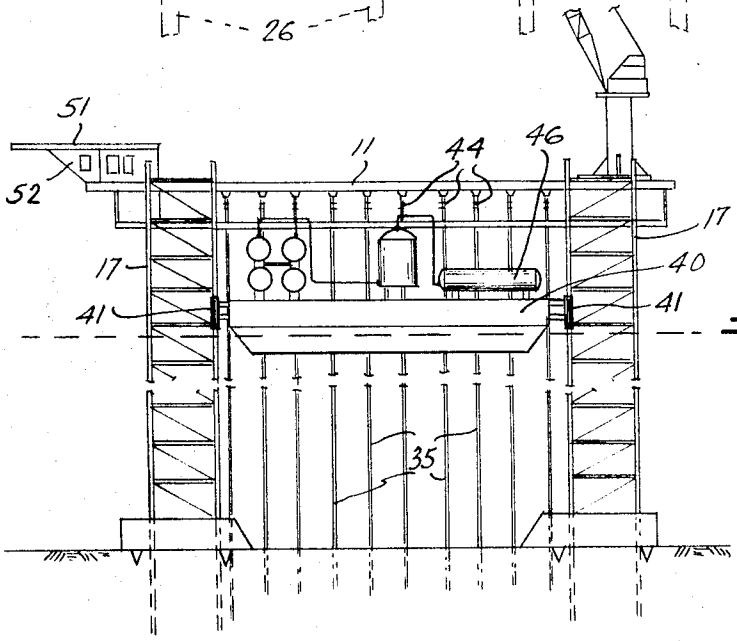


Fig. 9.

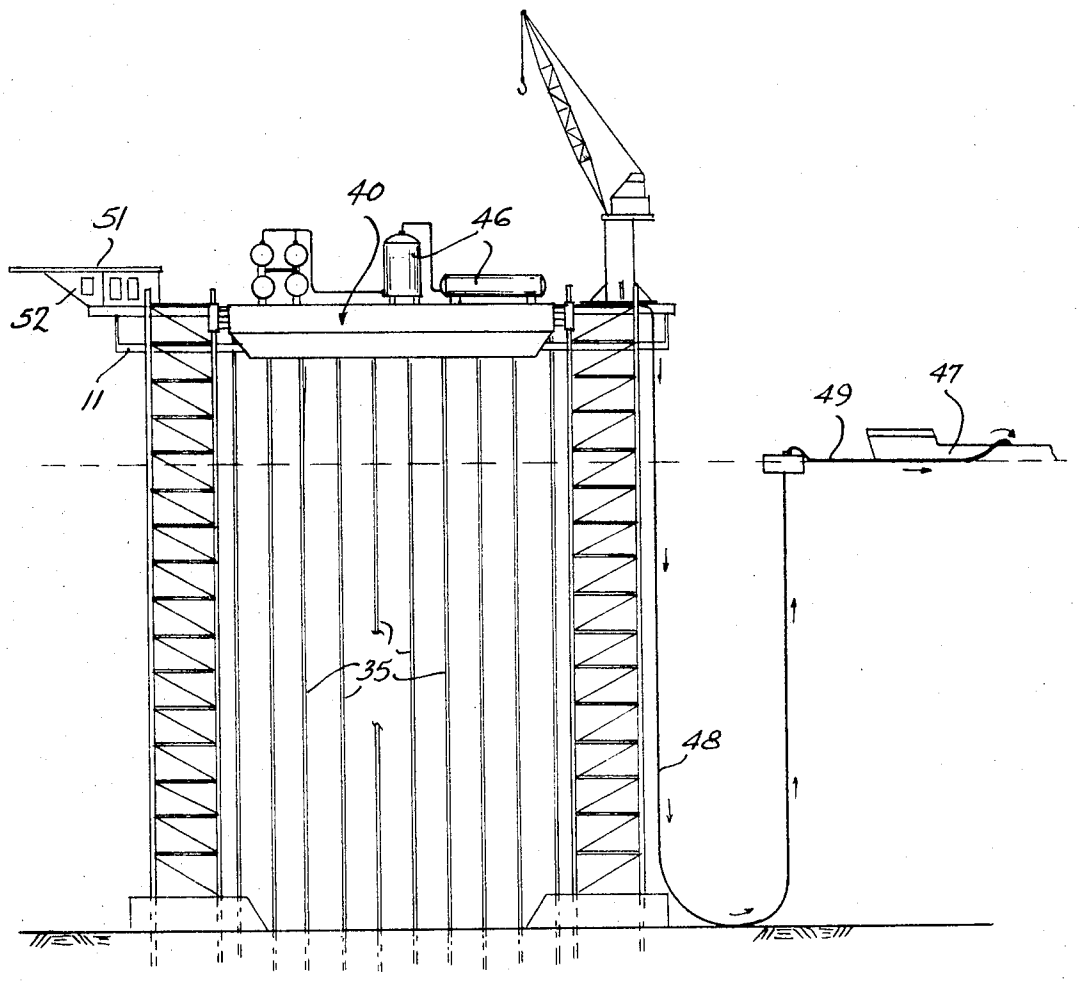


Fig. 10.

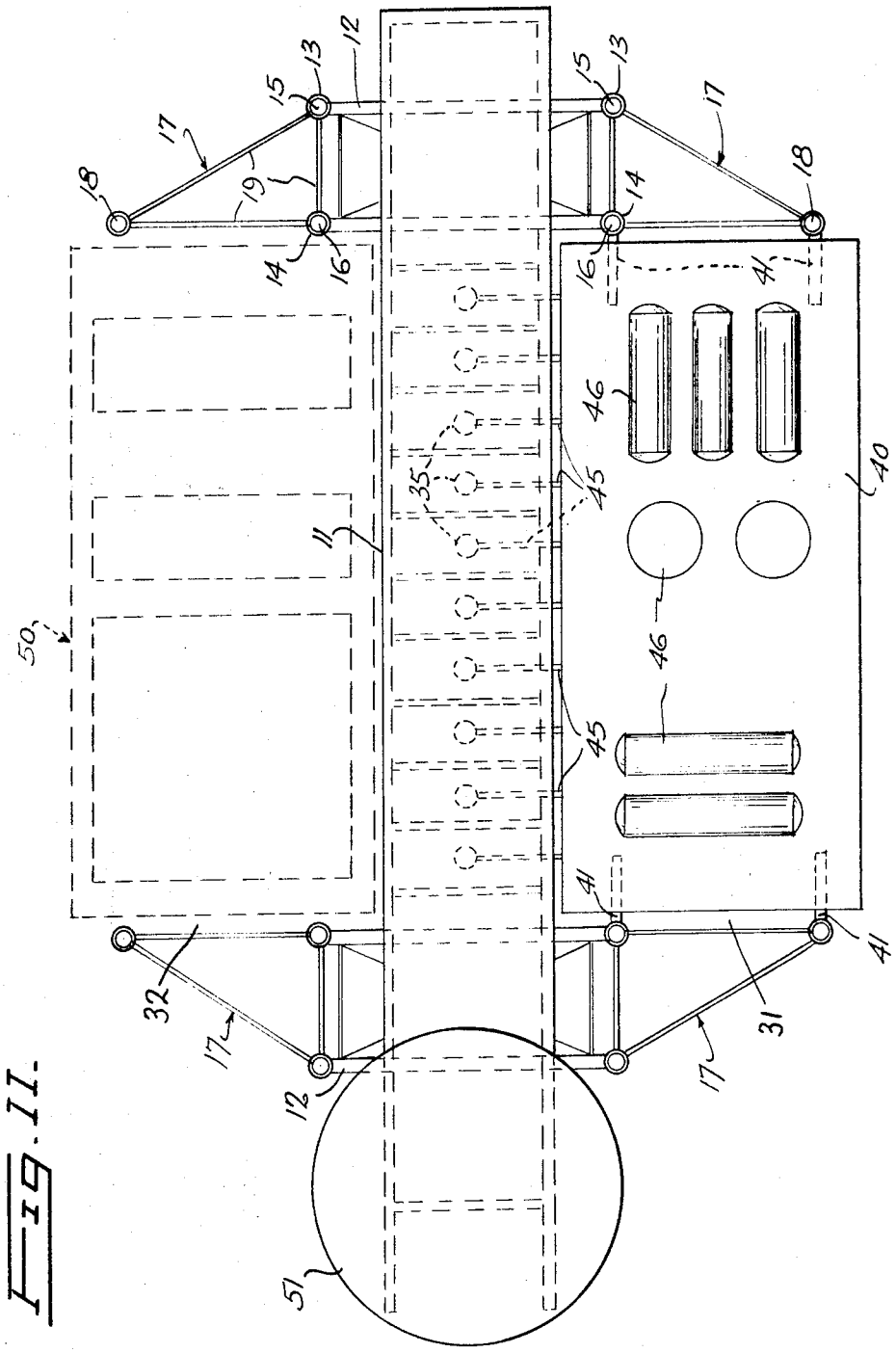


Fig. 11.

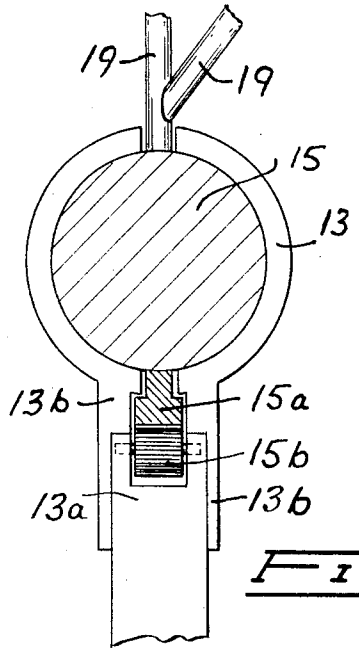


Fig. 12.

OFF SHORE DRILLING PLATFORM CONSTRUCTION

This invention relates to improvements in the structure and erection of an off shore drilling platform construction.

The invention is directed primarily towards a platform construction adapted for production and service operations over a known oil (or gas) field, but the principles of the invention can also be applied to platform constructions intended for exploration.

The object of the present invention is to provide improvements in the structure of the platform construction and particularly to provide simplification in the manner of erecting and operating the same.

Further features of the invention will appear from the specific example of a platform construction assembled according to the present invention, that is described below in association with the accompanying drawings. It is to be understood, however, that this description is provided by way of example only, and not be way of limitation of the broad scope of the present invention, which latter is defined in the appended claims.

In the drawings:

FIG. 1 is a side view of a first step in the erection of the platform structure and spuds that form basic parts of the construction;

FIGS. 2 to 4 show similar side views of the same construction at successive stages in the erection thereof;

FIG. 5 is a view similar to FIG. 4, showing a drilling barge being placed in position;

FIG. 6 is a view similar to FIG. 5, at a later stage in the operation;

FIGS. 7 and 8 are respectively end and perspective views corresponding generally to FIG. 6 but at a somewhat later stage in the operation;

FIG. 9 is a side view at a subsequent stage with a production barge being placed in position;

FIG. 10 is a further side view at a still later stage, showing the construction in final operation; and

FIG. 11 is a plan view of FIG. 10.

FIG. 12 is a horizontal section taken through a conventional jacking arrangement.

Referring first to FIG. 1, the basic components of the construction will be seen to comprise a flotation barge 10, directly on top of which there is mounted an elongated platform 11. At each end of the platform 11 there is rigidly connected thereto a projecting cross member 12. While FIGS. 8 and 11 show the apparatus at a later stage in its erection, these figures are useful at this time to obtain a clear understanding of the manner in which the cross members 12 project laterally from each end (or substantially the end) of the elongated platform 11. The outer ends of the cross members 12 engage by means of sleeves 13, 14 two vertical members 15, 16 of each of four legs or so-called spuds 17. The spuds 17 are vertically extending and of triangular form in cross-section, each comprising three vertical tubular members 15, 16 and 18, as well as a series of cross struts 19.

Each of the sleeves 13, 14 incorporates an elevating or jacking mechanism, by which each spud can be moved up and down relatively to the platform structure that is composed of the respective cross members 12 and the main platform 11. The particular form of spud shown and the jacking mechanisms are well known.

Numerous different jacking mechanisms for rigs of this character have been developed and are available on the market. Accordingly no detailed illustration or description thereof is considered necessary in this specification, the particular jacking system adopted being in no way germane to the inventive advance with which the present description is concerned.

However to facilitate a general understanding FIG. 12 shows a somewhat diagrammatic horizontal section through a conventional jacking arrangement. The vertical tubular member 15 shown in FIG. 12 is typical of the members 15, 16 and 18, and is shown connected to cross struts 19. The sleeve 13, which is also typical of the sleeves 13 and 14, partially surrounds the member 15 in sliding relationship thereto. Extending vertically along and secured to the member 15 is a rack 15a with which a pinion 15*b* meshes. The pinion 15*b* is journalled in and supported by a member 13*a* secured to arms 13*b* extending from the sleeve 13. Rotation of the pinion 15*b* by a motor (not shown) will thus cause the entire assembly of parts 13, 13*a* and 13*b* to move up or down on the member 15, or alternatively to move the member 15 up or down in relation to the assembly 13, 13*a* and 13*b* which assembly will be connected either to a cross member 12 or to an extension arm 37 or 41 from one of the barges as is more fully explained below.

In the initial position shown in FIG. 1, the assembly, floating primarily on the barge 10 located beneath the platform 11, is towed to the required off shore site by a tug 20 and cable 21. At this time the spuds 17 are in their fully elevated position. During this towing operation, some additional buoyancy can be obtained from air in tanks 22 forming feet at the bottom ends of the spuds 17.

As shown in FIG. 2, once the desired site has been reached, the jacking meachanisms are operated to lower the spuds 17 until their feet (tanks 22) rest on the sea bed. Spikes 23 provided on the under-surfaces of the tanks 22 achieve an initial stabilising penetration of a few feet into the material of the sea bed. During this operation the tanks 22 will be flooded to assist the jacking mechanisms.

Operation of the jacking mechanisms is then continued to elevate the platform structure in the manner shown in FIG. 3 and raise it above the water, leaving the barge 10 still floating. The jacking mechanisms can then conveniently be removed in favour of permanent welded connections of the cross members 12 to the spuds 17 in this elevated position. Alternatively, in addition to the jacking mechanisms extending from the cross members 12 to engage the spuds 17, the barge 10 may have arms (not shown) extending outwardly from its ends and including jacking mechanisms, to engage the four vertical members 16. Raising of the platform structure to the FIG. 3 position can then be achieved by first jacking up the barge 10 to elevate the whole assembly, then welding the cross members 12 to the vertical spud members 15, 16 at the elevated location, and finally lowering the barge 10 again by means of its jacking mechanisms.

A pile driver 24 and crane 25 are then moved into appropriate positions on the platform 11 for driving piles 26 down through the insides of the vertical members 15, 16 and 18 of the spuds 17. These piles 26 are initially positioned within such members. As the piles

are driven down through the feet 22 of the spuds 17 and deep into the sea bed, additional sections are added at their upper ends. In this manner a very firm anchoring of the construction is eventually achieved, the piles 26 being driven typically 100 or 200 feet into the sea bed. The piles normally take the form of hollow steel tubes and, if desired, they can be more firmly fixed in place after driving by being filled with concrete poured in from the upper ends.

As shown in FIG. 4, after this securing operation has been completed, the pile driver 24 is lowered onto the barge 10 which is then used to transport the pile driver away from the site.

The construction is now ready for commencement of drilling operations. FIG. 5 shows a drilling barge 30 that has been towed into position by a tug (not shown) and inserted in a slot 31 which is one of two barge-receiving slots 31 and 32 (see FIG. 11) formed on each side of the platform 11. It will be appreciated that the platform 11 forms with its end cross members 12 and the spuds 17 an assembly that in plan view has the general shape of a capital I, the two side cavities of which define the so-called slots 31 and 32. In FIGS. 7, 8 and 11, each of these slots is shown occupied, but this will not always be the case, as will be explained below. The arrangement permits the introduction and removal of different barges into and out of the respective slots as the operation proceeds. This arrangement and the facility that it provides is an important feature of the present invention.

Returning to a consideration of FIG. 5, the drilling barge 30 will be seen to carry a drilling derrick 33, in addition to the usual ancillary drilling equipment shown generally at 34. Arms 37 at the ends of the barge 30, which include jacking mechanisms similar to those carried on the cross members 12, or on the work barge 10, are then extended to engage the vertical members 16, 18 of each of the pair of spuds 17 that help define the slot 31. While the barge 40 shown in position in the slot 31 in FIG. 11 is a production barge to be described below, rather than the drilling barge 30, it is elevated in a similar manner and this figure is a convenient one to consider. The barge 40 has similar extension arms 41 that include jacking mechanisms and are employed to project outwardly and engage the vertical members 16, 18. The arms 37 of the barge 30 operate similarly.

The drilling barge 30 is thus elevated to the position shown in FIG. 6, i.e. level with the platform 11, whereupon the derrick 33 is skidded off the barge 30 onto the platform 11 and drilling operations are commenced. Before or after this operation, or at approximately the same time if preferred, a quarters and supply barge 50 (FIGS. 7 and 8) is brought into position in the other slot 32, similarly connected by extension arms with jacking mechanisms to the vertical members 16, 18 of the spuds defining this slot, and also elevated into position in alignement with the platform 11. The roof of quarters 53 on this barge acts as a landing pad for large helicopters.

The derrick 33 will be moved along the platform 11, as successive drilling operations are carried out. FIGS. 6, 7 and 8 show this operation at a partially completed stage, the usual drilling conductors 35 (previously set by the pile driver) extending down through the sea bed to the oil and/or gas field to form a series of wells. As shown in FIG. 7, these conductors 35 may be supported near the sea bed by conventional devices 36 extending from the spud feet and put in place by divers or previously installed during construction. As far as the wells themselves are concerned, these again will be conventional in construction. Cementing of the conductors 35 into the sea bed, for the avoidance of spills, will be carried out in the normal manner and no further description or illustration of this aspect of the operation is deemed necessary, since it is conventional.

One of the important advantages of the present invention is that, while it provides simplification of the construction in many respects, it does not sacrifice the facilities that more complex constructions afford. A number of wells can be formed and both directional and slant drilling can be carried out. While the drawings illustrate only a single line of conductors 35 extending along the center line of the platform 11, it will be appreciated that additional rows of wells can be drilled, if desired. As indicated above, the present construction can also be used for exploration purposes, although in this case perhaps with a less permanent fixing of the spuds 17 into the sea bed.

Once the well drilling operation has been completed, the derrick 33 is skidded back onto the drilling barge 30 and the latter is jacked down again along the spuds 17 until it floats, whereupon the arms 37 are retracted. The drilling barge 30 is then towed out of the slot 31 so that the production barge 40 can be placed in position therein, as shown in FIG. 9. Similarly, the quarters and supply barge 50 is lowered and removed from the slot 32 at approximately the same time, leaving the slot 32 vacant. Conventional well terminal equipment 44 (so-called Christmas Tree), including valves and associated gear, will have been set up along the platform 11 at the termination of each of the conduits 35 as part of the well forming operation.

The production barge 40 is now elevated into position by the jacking mechanisms in its extension arms 41, so that the barge 40 is level with the platform 11 and the terminal equipment 44. Permanent connections 45 are then established with this equipment 44 so that the ancillary equipment 46 on the production barge 40 (e.g. pumps, pressure air supply etc.) can be brought into operation and the production of the wells fed to a tanker 47 which is shown in FIG. 10 connected to the construction by pipelines 48 and 49. If preferred, the production pipeline 48 can run directly along the sea bed to storage on shore.

Assuming that the platform construction as now set up will be in production for a year or more before changes or major maintenance operations are required, the barge 40 can conveniently be welded into position in its elevated locations, so that the jacking mechanisms can be removed for use elsewhere, such mechanisms representing a large investment in expensive equipment. The smaller crew required during production then occupies quarters 52 beneath a smaller helicopter landing pad 51 at an end of the platform 11.

When the time eventually comes for overhaul or redrilling of the wells, the procedures described above can be reversed (subject, of course, to reinstatement of jacking mechanisms in place of welded connections).

Important features of this platform construction and its method of erection are as follows:

The configuration of the spuds with a relatively narrow, elongated platform extending between them forms the two barge-receiving slots **31** and **32** into and from which the various barges can be moved and removed as required, and jacked up into position level with the platform **11**. The initial flotation barge **10** will be mounted directly beneath the platform **11**, but subsequently, once the platform has been firmly secured to the sea bed, all barges will occupy one or other of the slots **31**, **32** whereby to leave free the space directly under the platform **11** for the oil well conductors.

During production the slot **32** will normally be vacant, which permits it to be used to receive any barge required, for example a barge fitted with equipment for well servicing, well sand off and/or for dealing with other production problems.

The slot-forming configuration has the important feature that it enables each of the barges to be prerigged on land and merely floated and jacked into position, thus avoiding the need for rigging at the site. This facility enables the production equipment, or any of the other equipement, to be replaced for maintenance purposes on a "unit chassis" basis. Faulty equipment on the production barge, for example, need not be repaired at the site. A substitute production barge can be towed out to the site, the faulty barge being lowered and towed away and the replacement barge inserted in its slot and raised into position for immediate use. The faulty equipment can then be repaired on land. Since one of the slots will normally be vacant, the replacement barge can be located in position before the faulty one is removed.

The layout also facilitates moving of the derrick and crane longitudinally along the platform to position either of these pieces of equipment directly over a well during drilling, or during production, or for maintenance purposes.

It will be noted that while the application of dead loads, i.e. the barge elevating loads, will be applied to four of the vertical spud members, i.e. the members **16** in the case of the barge **10** and those members **16**, **18** at each end of a barge-receiving slot in the case of the other barges, the application of live loads (i.e. drilling loads) will always be applied to eight such vertical members, namely the members **15** and **16** of each of the four spuds **17**, such loads being transmitted through the platform structure **11** and **12** to the spud members.

As mentioned above, these simplifications are achieved without the loss of any of the normal facilities of a conventional off shore platform construction.

Throughout the foregoing description and in the claims that follow reference is made to the use of four spuds. It should be made clear, however, that additional spuds may be used, if desired, either to render the entire construction more stable, or to provide a more complex configuration affording two, or more than two, barge- receiving slots.

As an alternative to the arrangement shown in which the spuds extend truly vertically, these may be angled out in the known manner to provide a wider and hence firmer support for the platform. Thus, in referring throughout the description and claims to "vertically" extending spuds, it is intended to include spuds that extend generally vertically in the sense that they include some horizontal component in their direction of extent.

I claim:

1. An off shore drilling platform construction comprising an elongated, horizontal platform structure, four vertically extending spuds and means including elevating mechanisms located on each side of each end of said platform structure and connected to a respective one of said spuds for lowering said spuds to the sea bed and for subsequently elevating the platform structure above the water to be supported on said spuds; said platform structure and spuds together constituting an I-shape configuration forming a pair of barge-receiving slots each defined along one side by the platform structure and at its ends by a pair of said spuds, the other side of each slot being open for receiving a barge with the ends of said barge located adjacent respective ones of said pair of spuds for elevation of said barge to the level of the platform structure by further elevating mechanisms.

2. A construction according to claim **1**, wherein said platform structure includes an elongated platform and cross members projecting to each side of the platform from each end thereof, and wherein each of said spuds is formed of at least three vertical members, the first and second ones of which are connected to said cross members, and the first and third ones of which are located for engagement by said further elevating mechanisms for elevating the barges in said slots.

3. The combination of a barge and an off shore drilling platform construction comprising an elongated, horizontal platform structure, four vertically extending spuds and means including elevating mechanisms located on each side of each end of said platform structure and connected to a respective one of said spuds for lowering said spuds to the sea bed and for subsequently elevating the platform structure above the water to be supported on said spuds; said platform structure and spuds together constituting an I-shape configuration forming a pair of barge-receiving slots each defined along one side by the platform structure and at its ends by a pair of said spuds, the other side of each slot being open for receiving said barge with the ends of said barge located adjacent respective ones of said pair of spuds, said combination including further elevating mechanisms for connecting said barge ends to said pair of spuds for elevation of said barge to the level of the platform structure.

4. A method of erecting an off shore drilling platform construction comprising an elongated, horizontal platform structure and four vertically extending spuds for supporting said structure from the sea bed, said platform structure and spuds together constituting an I-shape configuration forming a pair of barge-receiving slots on each side thereof; said method comprising

a. transporting said construction to a required site by means of a flotation barge located symmetrically beneath said platform structure with the spuds in an elevated position,

b. lowering the spuds to rest on the sea bed, then elevating the platform structure above the water supporting on said spuds, and removing the barge,

c. introducing a drilling barge having a drilling derrick into a first of said barge-receiving slots defined on one side by the platform structure and at its ends by a pair of the spuds, and then elevating the drilling barge in said slot above the water to the level of the platform structure,

d. while maintaining said drilling barge level with the platform structure transferring the derrick laterally from the drilling barge to the platform structure, and then drilling wells into the sea bed by means of such derrick.

5. The method of claim **4** including the additional step of

e. introducing a quarters and supply barge into a second of said barge-receiving slots defined on the other side of the platform structure between the other pair of spuds, and then elevating the quarters and supply barge to the level of the platform structure.

6. The method of claim **5**, including the subsequent steps, after completion of the drilling of said wells and of terminal equipment therefor on the platform structure, of

f. removing said derrick and drilling barge by reversal of the procedures of steps c and d,

g. introducing into the first barge-receiving slot vacated by the drilling barge a production barge having production equipment thereon, and then elevating the production barge to the level of the platform structure,

h. and finally connecting said production equipment to the well terminal equipment on the platform structure for the transportation of the production of said wells through a pipeline to storage.

7. The method of claim **6**, including the further step of

i. removing said quarters and supply barge by reversal of the procedure of step e whereby to render said second slot vacant for subsequent use as a servicing slot by other barges.

* * * * *