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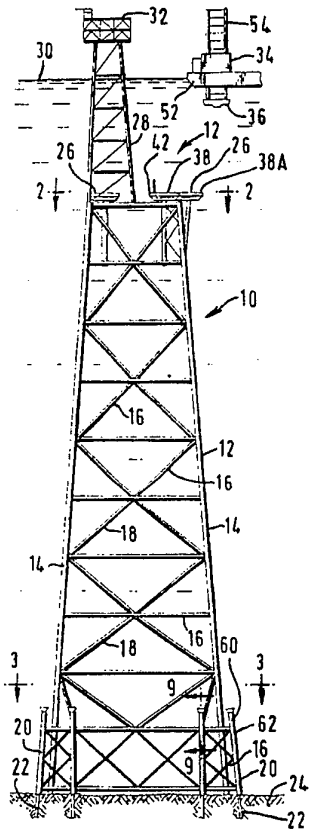
(57) Abstract

An offshore platform structure for well operations in deep water areas comprises: a bottom founded jacket base (12); a surface tower (28) and platform deck (32) supported by the jacket base (12) and extending above the water surface (30); and a subsea rig support interface (26) presented at the top of the jacket base (12) and adapted to receive a jack-up rig (34) for well operations. Preferably the structure is equipped with two stage pile sleeves (20) that are connected at the foot of the structure such that after removal of the second stage the first stage of each sleeve is preserved for re-deployment, thereby facilitating reuse of the structure. The removable mounting of a jack-up rig (34) on a reusable structure increases the flexibility of field development in deep water areas.



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OFFSHORE PLATFORM STRUCTURE AND REUSABLE FOUNDATION PILE SLEEVE FOR USE WITH SUCH A STRUCTURE

The present invention relates to a platform structure for conducting offshore hydrocarbon recovery operations and to a reusable foundation pile sleeve for use with such a structure. An object of the present invention is to provide an offshore platform structure which increases flexibility and reduces costs of field development in deep water areas.

In shallow water jack-up rigs are often used to provide a derrick and associated equipment for drilling, completing or working over a well. This equipment is mounted to a combined hull\deck which is capable of floating these facilities to site. A plurality of retractable legs are provided which renders the jack-up rig conveniently portable. Once floated into position for conventional operations, the legs are jacked-down until they engage the water bottom. Further jacking transfers the load from the buoyant hull to the legs, then lifts the hull/deck out of the water and above the splash zone to produce a stable, bottom founded offshore platform for conducting well operations.

A consideration of this design is that to best take advantage of the mobile nature of the facilities provided on the jack-up rig, the rig is removed after drilling is complete and does not remain deployed at the development during the production phase except, possibly, for temporary workover operations. The considerable investment in drilling, completion and workover equipment is best utilized by redeploying the jack-up rig to another location as soon as these operations are complete. Thus, surface completions for production are not accommodated on the jack-up rig itself. A small structure called a "well jacket" can be used with the jack-up rig to provide the benefits of a surface completion with the convenience of a jack-up rig. However, well jackets and jack-up rig combinations are limited to shallow water deployment. Further, practical

limitations on the length of the retractable legs more directly restrict the depth in which jack-up rigs can be traditionally deployed.

The requirements of deeper water depths have most often been answered by the continued use of traditional bottom founded platform structures. Topside facilities provide convenient well access for production operations. However, such structures must dedicate a significant amount of their structural strength to supporting drilling facilities that are only required for a relatively short period of time in the life of the overall operations from the platform in recovering oil and gas from a reservoir. Further, the structure must be able to withstand the maximum design environmental conditions, the design hurricane criteria, with these drilling facilities in place.

Of course, recovery operations lead to depletion of the hydrocarbon reservoir and, in time, the platform loses its usefulness at a site. Nevertheless, the well jacket that forms the tower supporting the deck of the platform may be structural sound and capable of an extended useful life. However, salvage operations are difficult and another constraint of traditional well jackets is that they are design specific for a given water depth. This tends to substantially limit redeployment opportunities.

Certain designs have been proposed for "piggyback" deployment of a jack-up rig onto a subsea structure, yet these designs have carried forward many of the limitations of each structure producing a result that, although it increases water depth for the jack-up rig, otherwise remains the sum of the limitations of its constituent parts.

Thus, there continues to be a need for economically accommodating and even enhancing the benefits of surface completions and the convenience and economies of jack-up rig operations in deeper water.

Toward the fulfilment of this need, the present invention provides an offshore platform structure for temporarily using a jack-up rig for well operations in deep water applications. The

structure has a bottom foundable jacket base and a surface tower supported by the jacket base and extending after installation above the water surface. A platform deck is supported by the surface tower and a subsea rig support interface is presented at the top of the jacket base and is adapted to receive the jack-up rig for well operations.

In a suitable embodiment of the present invention the bottom foundable jacket base comprises a plurality of legs and interconnecting framework. Well operations equipment is provided on the jack-up rig having a plurality of legs which extend from a combination hull/deck member and engage the jacket base at the rig support interface below the water surface. The well operations equipment provided centers around a withdrawable derrick, either on a sliding bridge in a slot-style jack-up rig or on a cantilever deck in a cantilever deck style jack-up rig. Either withdrawable derrick system permits deployment of the jack-up rig upon the jacket base without interference with the surface tower, but then allows drilling operations after the derrick is brought into substantial vertical alignment with the surface tower.

Yet another aspect of the present invention is a method for providing a deep water offshore platform in which an offshore platform structure having a surface tower supported by a bottom founded jacket base is installed and a jack-up rig is mated on an underwater rig support interface presented at the top of the jacket base to establish a combined offshore platform system for conducting well operations during calm weather periods. The jack-up rig is demobilized and withdrawn from the jacket base before a storm. This permits the combined offshore platform system to be designed on the less extreme basis of calm weather criteria and greatly reduces the loads of the offshore platform structure itself which is still designed to meet severe storm and/or hurricane criteria.

A further object of the present invention is to provide a reusable pile sleeve for a bottom-founded offshore platform structure, of the type pinned to the water bottom with piles.

Pile sleeves are connected to the base of the platform

structure and piles are inserted through the pile sleeves and secured into the water bottom during installation of the platform. Platform installation continues by securing the piles within the pile sleeves to complete a stable foundation for the platform.

However, the platform structure often has a useful life exceeding the duration of profitable oil and gas production at the original site. It may then be desired to salvage the platform structure for relocation. At this point, a secure pile-to-pile sleeve connection becomes a detriment, often requiring expensive underwater operations or transportation of the platform to onshore facilities to completely remove and then replace the pile sleeves.

It is known from US patent 5,028,171 to provide a pile sleeve with an insert which is welded co-axially inside the sleeve and which is after installation of the platform structure secured to and around a foundation pile by a grout packer or a swedge connection. Disadvantages of the known sleeve are that disconnection of the welds at both ends of the sleeve is a time consuming underwater operation and that, if upon re-positioning of the platform structure piles are used which have the same diameter as those at the first location, new inserts have to be welded within the sleeves.

There is thus a need for a means to facilitate platform structure salvage and re-deployment that provides secure pile-to-pile sleeve connection, but also provides for easy separation from piles and reusable pile sleeves, even if at the various sites where the platform structure is deployed piles of the same diameter are used to pin the structure to the water bottom.

Toward the fulfilment of this need, the present invention provides a pile sleeve which has after installation of the offshore platform structure on the water bottom a substantially vertically extended, open-ended cylindrical member having a second stage sleeve which is connectable to the platform structure at a location near the water bottom and a first stage sleeve projecting co-axially from the second stage sleeve. First and second stage locking profiles are presented inside the first and second stage sleeves, respectively. The first stage sleeve is thus accessible for cutting

operations, severing both the first stage sleeve with the pile-to-pile sleeve connection inside and the top of the pile within. This allows retrieval of the platform structure, but preserves the second stage pile sleeve for re-deployment.

In a suitable embodiment of the invention the pile sleeve is adapted to receive piles in a hydraulically swaged locking relationship and having an extending cylindrical member and a first locking profile on the interior wall of the cylindrical member. In that case a first pile may be hydraulically extruded into the first locking profile upon a first deployment of the offshore platform structure. A portion of the pile sleeve and concentric pile is accessible at this first locking profile for removal to conveniently retrieve the offshore platform structure for re-deployment to another location using the second locking profile.

The brief description above, as well as further objects and advantages of the present invention, will be more fully appreciated by reference to the following detailed description of the preferred embodiments which should be read in conjunction with the accompanying drawings in which:

FIG. 1 is a side-elevational view of an offshore platform structure in accordance with one embodiment of the present invention.

FIG. 2 is a cross-sectional view of the offshore platform structure of FIG. 1 taken at line 2-2 in FIG. 1.

FIG. 3 is a cross-sectional view of the offshore platform structure of FIG. 1 taken at line 3-3 in FIG. 1.

FIG. 4 is a side-elevational view of an offshore platform system in accordance with one embodiment of the present invention, as viewed from the vantage of line 4-4 in FIG. 2, but including a deployed jack-up rig.

FIG. 5 is an alternate embodiment of a subsea rig support interface applicable to a practice of the present invention.

FIG. 6 is a side-elevational view of an offshore platform structure in accordance with an alternate embodiment of the present invention.

FIG. 7 is a cross-sectional view of the offshore platform structure of FIG. 6 taken at line 7-7 in FIG. 6.

FIG. 8 is a cross-sectional view of the offshore platform structure of FIG. 6 taken at line 8-8 in FIG. 6.

FIG. 9 is a cross-sectional view of a pile deployed through a multi-stage pile sleeve in accordance with the present invention taken from the vantage of line 9-9 in FIG. 1, but taken during installation.

FIG. 10 is a cross-sectional view of a locking tool securing the pile of FIG. 9 within the uppermost stage of the pile sleeve.

FIG. 11 is a cross-sectional view of the withdrawal of the locking tool of FIG. 10 following swaging operations.

FIG. 12 is a cross-sectional view of a first stage of the pile sleeve severed from latter stages to facilitate salvage and reuse of the jacket base.

FIG. 13 is a cross-sectional view of an alternate embodiment of the present invention taken from the vantage of line 9-9 in FIG. 1, but taken during installation.

FIG. 14 is a cross-sectional view of an embodiment of the present invention during grout injection.

FIGS. 9-14 illustrate the use of a multiple stage pile-to-pile sleeve connection in accordance with the present invention.

FIGS. 1-8 illustrate two suitable embodiments of an offshore platform structure according to the invention. FIGS. 1-4 illustrate one application of the present invention with an offshore platform structure 10, and FIGS. 6-8 illustrate another embodiment of this application. In both instances, the structure has a jacket base 12 that is directly reusable across a range of water depths and the present invention facilitates salvage and re-deployment. Structure 10 (in FIG. 1) has a bottom-founded jacket base 12 having legs 14 with an interconnecting framework 16 of braces 18. Piles 22 are installed into the water bottom 24 through pile sleeves 20 by drilling and grouting or driving procedures known in the art. The piles are then secured within the pile sleeves by hydraulic locking or grouting operations.

The top of jacket base 12 is provided with a plurality of subsea rig support interfaces 26 and further supports surface tower 28 which extends above ocean surface 30 to support platform deck 32. Rig support interfaces 26 and surface tower 28 are arranged to accommodate reception of jack-up rig 34, here shown approaching offshore platform structure 10.

FIG. 2 is a cross section of offshore platform structure 10 illustrating a layout of subsea rig support interfaces 26 and surface tower 28 to accommodate a particular class of three leg jack-up rig (not shown). In this application, the rig support interfaces are positioned to receive feet 36 of jack-up rig 34 and efficiently transfer the load of offshore platform structure 10 to legs 14. The rig support interfaces should be below the wave zone, but well within the range of jack-up rigs, e.g., 60 metres or so below the water surface.

In one embodiment of this application, rig support interfaces 26 are provided by a load cushion 38A which is provided in FIGS. 1-4 by spud buckets 38 partially filled with a granular substance or other means to cushion the impact at touchdown and to disperse the load across the rig interface. The granular material must not only meet these load transfer characteristics, but also weather the environmental conditions and challenges such as scouring effects which tend to wash the granular material out of the open-top spud bucket even though it is positioned below the wave zone. Thus, sand, gravel or other granular material must be selected to accommodate these requirements. In one variation, cement or grout is placed in the spud bucket and sets after touchdown. Such a material may be selected to provide structural benefits to the system by resisting a moment applied across the jack-up rig to jacket base interface, yet to provide a limited adherence that is easily broken during de-mobilization of the jack-up rig for transfer to another site.

FIG. 5 illustrates another embodiment of subsea rig support interface 26 in which load cushion 38A is provided by a layer of cushioning material such as rubber or elastomeric cushion 38B over a

steel lattice structure 38D. The lattice structure has a hole or receptacle 39 which receives a pin 37 on foot 36 for an advantage of more exact load placement and resistance to lateral loads. Further, if desired, hydraulically driven gripping arms 41 may be deployed to engage the edges of foot 36 to provide resistance to a moment applied across the jack-up rig to jacket base interface.

FIG. 2 also illustrates a plurality of conductors 40 arranged through surface tower 28. Drilling may be undertaken through each of the conductors using the jack-up rig which may also complete the well and sets production risers through conductors 40. Alternatively, platform deck 32 may accommodate surface completions with a workover rig installed thereon. The platform deck of the surface tower also facilitates production while drilling ("PWD") operations by supplying deck space for production facilities not easily accommodated on jack-up rigs designed for drilling alone.

FIG. 4 illustrates jack-up rig 34 in place on jacket base 12 of offshore platform structure 10. Together these comprise offshore platform system 50. In this embodiment, jack-up rig 34 has three retractable legs 54 depending from a hull /deck member 52. Drilling and other facilities are provided by the jack-up rig, including a derrick 56, which is conveniently provided on a cantilever deck 58.

Deployment of jack-up rig 34 (see FIG. 1) is facilitated by means for aligning the jack-up rig with subsea rig support interfaces 26. This means may, for example, be provided in a cooperation between the hull/deck 52 of the jack-up rig as it floats in an alignment through a bumper engagement with a vertical face of surface tower 28 prior to jacking operations. Alternatively, at least one installation guide 42 may project substantially vertically above the periphery of one or more of spud buckets 38 to engage feet 36 on descending legs 54 during jacking operations (see FIGS. 1 and 2). Further, these and other means for alignment may be combined.

After touchdown of feet 36 within rig support interfaces 26, further jacking operation transfers the load of the jack-up rig from buoyant hull /deck 52 to jacket base 12, ultimately raising the hull/deck from the water, above the splash zone, and in position to

extend retractable cantilevered deck 58 so as to position derrick 56 over surface tower 28. Well operations may then be shifted among the conductors by skidding the derrick on the cantilever deck without moving hull/deck 52 of the jack-up rig.

A comparison of the cross sections of FIGS. 2 and 3 illustrates another aspect of this application. The cross section of FIG. 2 at the top of the jacket base is skewed to a diamond shape to provide support for the subsea rig support interfaces 26 in substantial alignment with legs 14 of the jacket base. However, this quadrilateral cross section does not extend outwardly the leg 14 which is associated with surface tower 28 at the first corner of the jacket base. Thus, the first corner is a shorter distance "a" from an intersection of lines diagonally bisecting the cross section at this level than distances "b" or "c" with respect to the other corners. This relationship contributes to providing a wide spread at subsea rig support interface 26 to accept the feet of jack-up rig 34, yet maintains surface tower 28 adjacent the jack-up rig for convenient access with a cantilevered deck.

By contrast, the cross section of FIG. 3 at the base of the offshore platform is a more conventional square or rectangular shape in this embodiment which facilitates traditional transport and deployment. FIG. 3 also illustrates the connection of pile sleeves 20 to legs 14.

FIGS. 6-8 illustrate another application well suited to the present invention in which jacket base 12 has three legs 14 arranged with braces 18 of framework 16 in a triangular cross section. Here surface tower 28 is supported by interconnecting framework 16A to the jacket base in a parallel, overlapping relation. This affords a minimal footprint to jacket base 12, thereby reducing material requirements. The structural requirements for surface tower 28 to support a facilities deck, workover rig, risers and riser conductors, are much less than that required to support a jack-up rig 34. Separating these support requirements may allow an overall reduction in steel despite the overlap of surface tower 28 to jacket base 12.

This application of the present invention addresses reducing costs not only by providing support only where it is needed but by designing a platform system 50 that matches structural capabilities to meet relevant design criteria on a seasonally adjusted basis. The ease of jack-up rig deployment and demobilization as a self-contained mobile unit facilitates employing a method of conducting platform operations that can further reduce platform costs.

Thus, offshore platform structure 10 is installed and jack-up rig 34 is mated thereon to establish an offshore platform system 50 for conducting well operations during calm weather periods. However, the jack-up rig is demobilized and withdrawn from the offshore platform structure for hurricane season. This permits the combined offshore platform system 50 to be designed on the less extreme basis of winter storm criteria and greatly reduces the weight, wind and wave loads of the offshore platform structure 10 itself (absent the jack-up rig) which is still designed to meet hurricane criteria. This relation can even continue for embodiments of the offshore platform structure which include a workover rig on the platform deck.

Returning to an embodiment of a reusable pile sleeve according to the present invention, FIG. 9 is a longitudinal cross section of pile 22 which has been secured to the water bottom through pile sleeve 20. This cross section is taken from the vantage point of line 9-9 in FIG. 1, but illustrates an installation step in one embodiment of the present invention which facilitates reuse of offshore platform structure 10 after depletion of a reservoir.

In this embodiment, pile sleeve 20 is an open-ended cylindrical member having extended multiple stages, here illustrated by first and second stage sleeves 60 and 62. First stage sleeve 60 projects co-axially from second stage sleeve 62 to facilitate access for salvage operations (see also FIG. 1). Both the first and second stage sleeves have locking profiles 64, here provided by an annular groove 66 on the interior surface of the cylindrical member 68.

Offshore platform structure 10 is launched and placed and piles 22 are secured into the water bottom through pile sleeves 20 by

driving or by drill and grout operations. At that point a locking tool 70 is run inside the pile which is held concentrically within the pile sleeve (see FIG. 9). Seals or packers 72 are activated to secure a hydraulic seal above and below the first locking profile 64A and to isolate the second locking profile 64B.

Hydraulic pressure is introduced to the interior of pile 22 through locking tool 70 to the annular region bounded by the locking tool and the pile between seals 72. The pressure extrudes or swages the pile into locking profile 64A to form a secure connection (see FIG. 10). Thereafter, seals 72 are deactivated and locking tool 70 is removed from the pile and is used for succeeding pile-to-pile sleeve connections as installation operations continue. Alternatively, mechanical swaging operations may be isolated to the first locking profile causing the pile to conform to the shape of the first locking profile in a secure engagement.

Another embodiment of the multiple stage pile-to-foundation connection of the present invention is illustrated in FIGS. 13 and 14 in which the pile-to-pile sleeve connection is secured by grout. In FIG. 13, remotely operated vehicle ("ROV") 76 is attaching to a nipple 78 presented on the exterior of the pile sleeve for hydraulically inflating packer 80 through a fluid conduit 81. Upon actuation, packer 80 expands from recess 82 to seal across the pile-to-pile sleeve annulus and isolate first stage 60 from second stage 62. If it is desired to keep the grout from open contact with seawater, a second packer 80 is deployed on the upper bounds of the first stage and a grout return valve is provided immediately adjacent thereto. The length of the annular first stage locking profile is dependent upon the friction of the grouted zone necessary to manage the design loads.

In FIG. 14, packers 80 have deployed with hydraulic pressure supplied by ROV 76 and the ROV is in communication with a source of grout. The ROV attaches to grout placement valve 84 and injects grout, displacing the seawater and filling the annulus until grout reaches grout return valve 86. The ROV is removed and the grout sets in the first stage locking profile. Note, that packers 80,

valves and nipples of second stage 62 may be omitted in the initial installation and conveniently installed in minimal offshore operations after salvage of the jacket.

Offshore platform structure 10 may have a useful life exceeding the life of profitable production from the hydrocarbon reserves at the initial site of deployment. It may then be desired to salvage the offshore platform structure 10 for relocation. At this point surface facilities are removed to prepare the jacket base for recovery.

Returning to FIGS. 9-12, placing the initial extruded locking engagement in an accessible location facilitates simple cutting operations, through both pile sleeves 20 and piles 22, around the base of the offshore platform structure. In the illustrated embodiment, first stage pile sleeve 60 is accessible as an extension projecting upwardly from the bracing which connects pile sleeve 20 to jacket legs 14 (see FIG. 1). However, other configurations may be employed, e.g., a downwardly projecting extension in which the first stage is presented on the bottom. In this latter embodiment, explosive cutting from inside the pile may be preferable to traditional cutting methods.

The first stage extension and the pile section therein is separated from the cylindrical members (see FIG. 12). This permits the jacket base to be floated or lifted by crane, readied for transport and carried to a new site. Second locking profile 64B remains available for a re-deployment of the offshore platform structure. The embodiment of FIGS 13 and 14 would be similarly salvaged and re-deployed. Further, these salvage operations may be aided by providing additional ballast chambers within the platform jacket into which air may be pumped for a reserve buoyancy that facilitates one-piece retrieval.

The multi-stage locking profile arrangement of the present invention facilitates successive deployments of an offshore platform structure. This presents particular advantages with a jacket base having flexibility for re-deployment throughout a range of water depths, e.g., in combination with a jack-up rig that may adjust to

differences in water depths. However, the present invention will be seen by those having ordinary skill in the art as applicable to a full range of offshore foundations on other jacket or gravity structures which are pinned to the water bottom with piles.

Other modifications, changes and substitutions are intended in the foregoing disclosure and in some instances some features of the invention will be employed without a corresponding use of other features. Thus it will be understood by those skilled in the art of petroleum engineering that instead of a two stage pile sleeve a multiple stage pile sleeve may be used and that the first, third and any further stages of the pile sleeve may be mounted either all co-axially above the second stage sleeve, or all co-axially below the second stage sleeve, or co-axially both above and below the second stage sleeve.

Accordingly, it is to be understood that the foregoing detailed description and accompanying drawings only illustrate the invention and are not to be construed as limitations of the following claims.

C L A I M S

1. An offshore platform structure for temporarily using a jack-up rig for well operations in deep water applications, comprising:

a bottom foundable jacket base;

a surface tower supported by the jacket base and extending after installation above the water surface;

a platform deck supported by the surface tower; and

a subsea rig support interface presented at the top of the jacket base and adapted to receive the jack-up rig for well operations.

2. An offshore platform structure in accordance with claim 1 wherein the surface tower is supported at a first corner of the top of the jacket base.

3. An offshore platform structure in accordance with claim 2 wherein the jacket base has a quadrilateral horizontal cross section.

4. An offshore platform structure in accordance with claim 3 wherein a horizontal cross section at the bottom of the jacket base is substantially square and the cross section at the top of the platform base is characterized in that it is diamond shaped such that the first corner supporting the surface tower is a shorter distance from an intersection of lines diagonally bisecting the cross section than are the other corners, whereby a wide spread is accommodated at the rig support interface to accept the feet of the jack-up rig which is then closely adjacent the surface tower.

5. An offshore platform structure in accordance with claim 1 wherein the jacket base has a triangular horizontal cross section.

6. An offshore platform structure in accordance with claim 5 wherein the surface tower is supported by the jacket base in a parallel, overlapping relation joined to a side of the jacket base by interconnecting framework.

7. An offshore platform in accordance with claim 1 further

comprising a mating guide for aligning and maintaining the jack-up rig in position for deployment onto the jacket base through the rig support interface.

8. An offshore platform in accordance with claim 7 wherein the mating guide comprises a guide surface on the surface tower.

9. The offshore platform structure in accordance with claim 1 wherein

the jacket base has a plurality of legs and interconnecting framework and is founded on the water bottom;

the surface tower extends above the water surface;

the subsea rig support interface is presented at the top of the jacket base and below the water surface; and

a jack-up rig is removably installed upon the jacket base, the jack-up rig comprising;

a plurality of extendable legs, each engaging the rig support interface;

a combination hull and deck structure supporting well operations equipment; and

a cantilever deck extending from the combination hull and deck structure presenting a derrick of the well operations equipment in substantial vertical alignment with the surface tower.

10. An offshore platform structure in accordance with claim 9 wherein the subsea rig support interface further comprises a load cushion.

11. An offshore platform structure in accordance with claim 10 wherein the feet of the jack-up rig present a pin and the subsea rig support interface comprises:

a lattice structure;

wherein the load is a layer of cushioning material, such as rubber, over the lattice structure; and

a receptacle defined by the lattice structure to accept the pin.

12. An offshore platform structure in accordance with claim 10 wherein the subsea rig support interface comprises:

a plurality of spud buckets supported by the jacket base and

both substantially aligned with the legs of the jacket base and positioned to receive the feet of the jack-up rig; and

wherein the load cushion is a layer of granular material, such as sand or gravel, in the spud buckets; and

wherein each spud bucket is provided with a mating guide for aligning and maintaining the jack-up rig in position for deployment onto the jacket base through the rig support interface, the mating guide comprising at least one installation guide extending substantially vertically above the periphery of one of the spud buckets.

13. A method of providing a deep water offshore platform comprising:

installing an offshore platform structure having a bottom founded jacket base, a surface tower supported by the jacket base and extending above the water surface, a platform deck supported by the surface tower, and an underwater rig support interface presented at the top of the jacket base;

mating a jack-up rig onto the rig support interface of the offshore platform structure to establish an offshore platform system for conducting well operations during calm weather periods; and

demobilizing the jack-up rig and withdrawing the jack-up rig from the offshore platform structure before a storm;

whereby the offshore platform system need only be designed on the basis of calm weather criteria and the offshore platform structure which is designed to meet storm criteria need not be sized to accommodate the jack-up rig in this extreme event.

14. A reusable pile sleeve for securing an offshore platform structure to the water bottom, comprising:

a tubular member having a second stage sleeve which is connectable to the platform structure and a first stage sleeve projecting co-axially from the second stage sleeve;

a first stage locking profile inside the first stage sleeve; and

a second stage locking profile inside the second stage sleeve.

15. A reusable pile sleeve in accordance with claim 14 wherein the

first and second stage locking profiles are each at least one annular groove in the interior wall of the cylindrical member whereby the first and second stage locking profiles are configured to receive an extrusion from the pile inserted therethrough at installation to form a secure connection.

16. A reusable pile sleeve in accordance with claim 14 wherein the first and second stage locking profiles are annular surfaces capable of sustaining a secure, grouted pile sleeve-to-pile sleeve connection, the pile sleeve further comprising:

an annular recess in the cylindrical member separating the first and second stage sleeves;

a packer installed in the annular recess disposed to selectively deploy a seal between the cylindrical member of the pile sleeves and the pile to isolate the first stage sleeve from the second stage sleeve during initial deployment of the jacket section;

an actuating fluid conduit in communication with the packer; and

a grout placement valve providing access to the interior of the first stage pile sleeve.

17. An offshore platform structure provided with at least one pile sleeve according to claim 14, wherein the second stage sleeve of each pile sleeve is connected to the platform structure at a position which is, after installation of the platform structure at an offshore location, located near the water bottom and such that the tubular member of each pile sleeve has a substantially vertical orientation.

18. The offshore platform structure in accordance with claim 17 wherein the structure is a structure as claimed in claim 1 and having a plurality of legs that are interconnected by a framework and each leg is provided with at least one pile sleeve of which the second stage sleeve is welded to the leg such that, after installation of the platform structure at an offshore location, the first stage sleeve is mounted on top of the second stage sleeve.

19. A method for connecting a pile to a pile sleeve in the foundation of an offshore platform structure according to claim 17,

comprising:

setting the pile into a water bottom through the pile sleeve; and

securing the pile to the pile sleeve at the first stage.

20. A method in accordance with claim 19 wherein the pile is secured to the pile sleeve at said first stage by:

inserting a locking tool into the pile; and

securing hydraulic seals in the pile above and below the level of a first locking profile in the first stage of the pile sleeve, but at a level not aligned with a second stage locking profile; and

extruding the walls of the pile into the first locking profile with hydraulic pressure provided by the locking tool.

21. A method in accordance with claim 20 wherein the pile is secured to the pile sleeve at said first stage by:

setting a packer in the annulus between pile and the pile sleeve at a level between the first and second stage sleeves; and

injecting and setting grout in the annulus of the first stage sleeve between the pile and the pile sleeve.

22. A method for reusing an offshore platform structure according to claim 17, comprising:

a) initially installing the offshore platform structure at a first site by:

lowering the offshore platform structure onto the water bottom at said first site;

setting a pile into the water bottom through each pile sleeve; and

securing each pile to the second stage sleeve of each pile sleeve;

b) retrieving the offshore platform structure upon depletion of hydrocarbon reserves at the first site by:

retrieving topside facilities from the offshore platform structure;

cutting each concentric pile and pile sleeve at a location between the first and second stage sleeve and removing each second stage sleeve and concentric pile section which is still secured

thereto from the platform structure; and

raising the offshore platform structure and rigging for transport; and

c) redeploying the offshore platform structure, comprising:

lowering the offshore platform structure onto the water bottom at a second site;

setting a pile into the water bottom through each pile sleeve; and

securing each pile to the first stage sleeve of each pile sleeve.

23. An offshore platform structure substantially as described with reference to the accompanying drawings.

24. A method of installing and reusing a platform structure substantially as described with reference to the accompanying drawings.

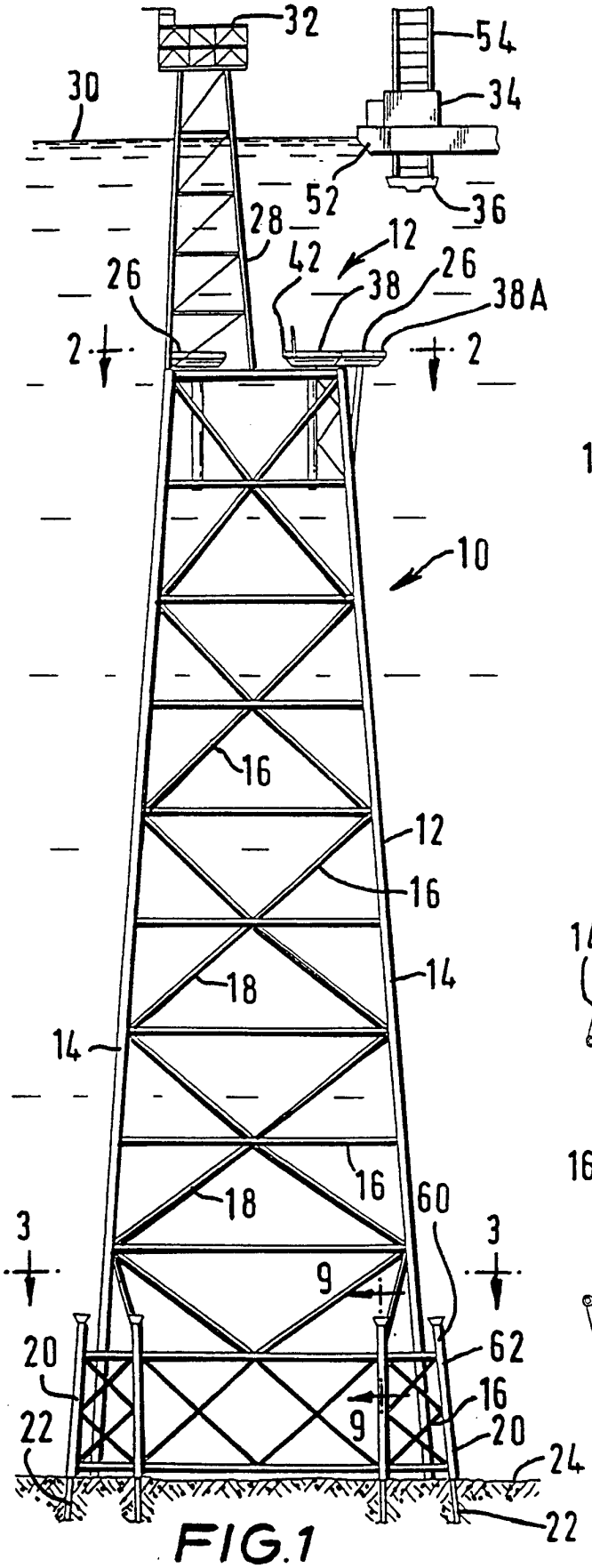

FIG.1

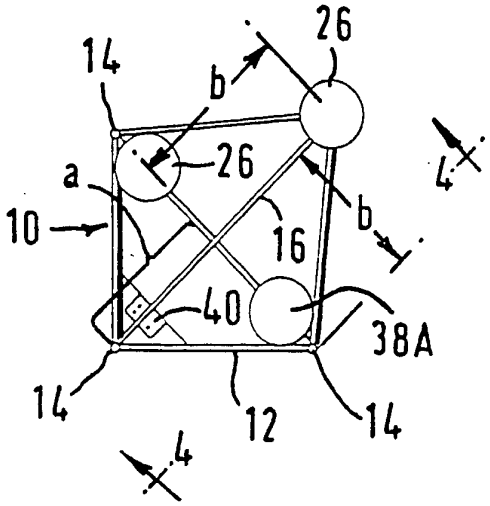

FIG.2

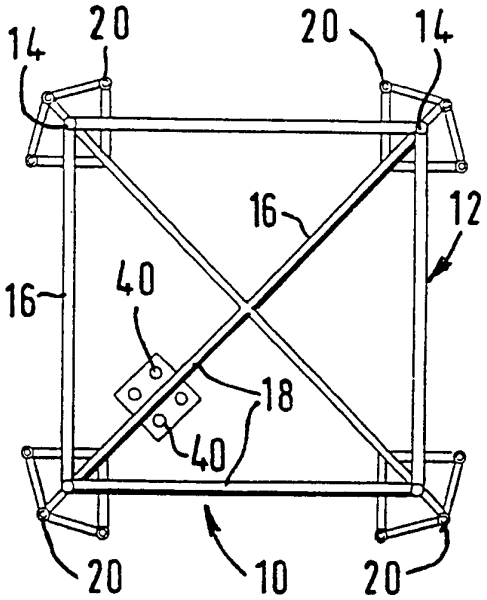

FIG.3

FIG. 4

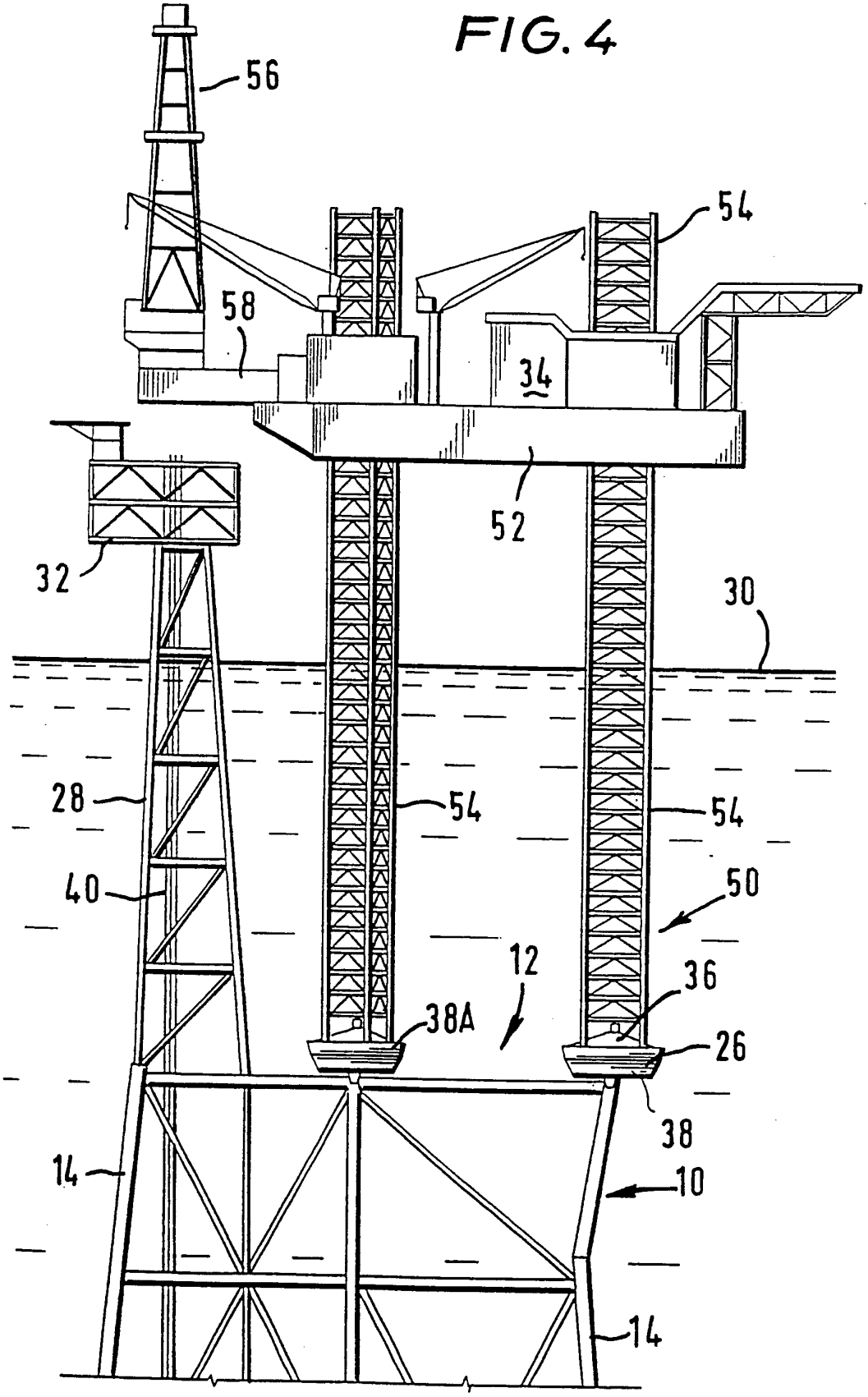

FIG.5

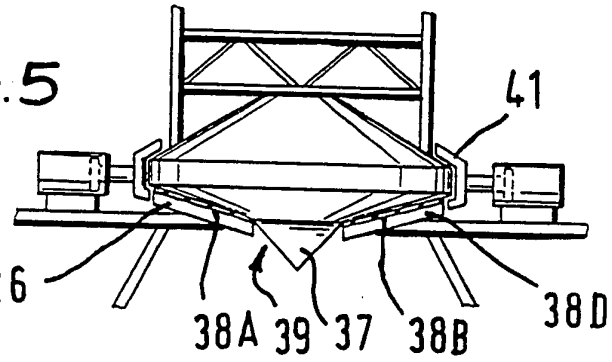

FIG.7

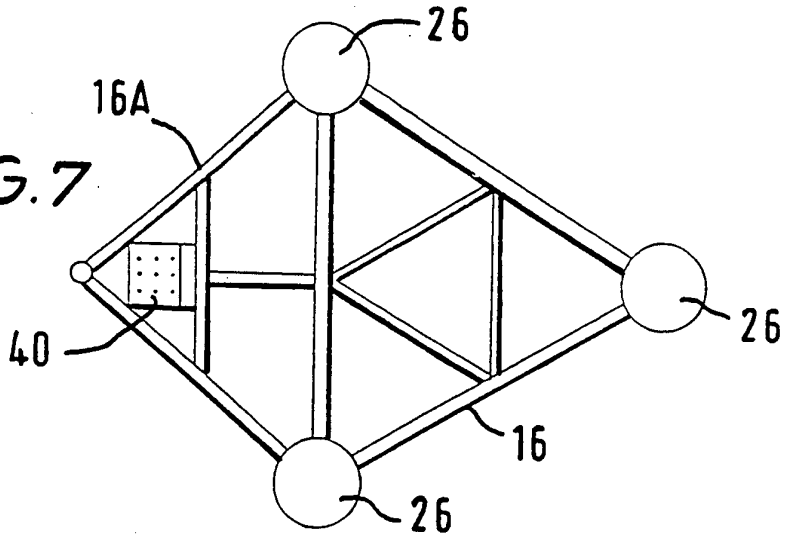

FIG.8

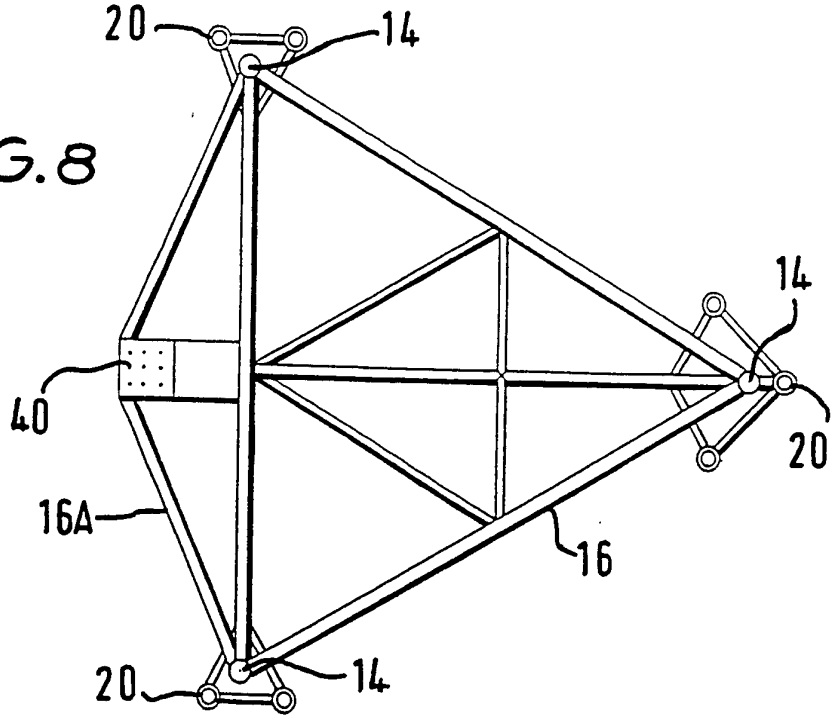

FIG.6

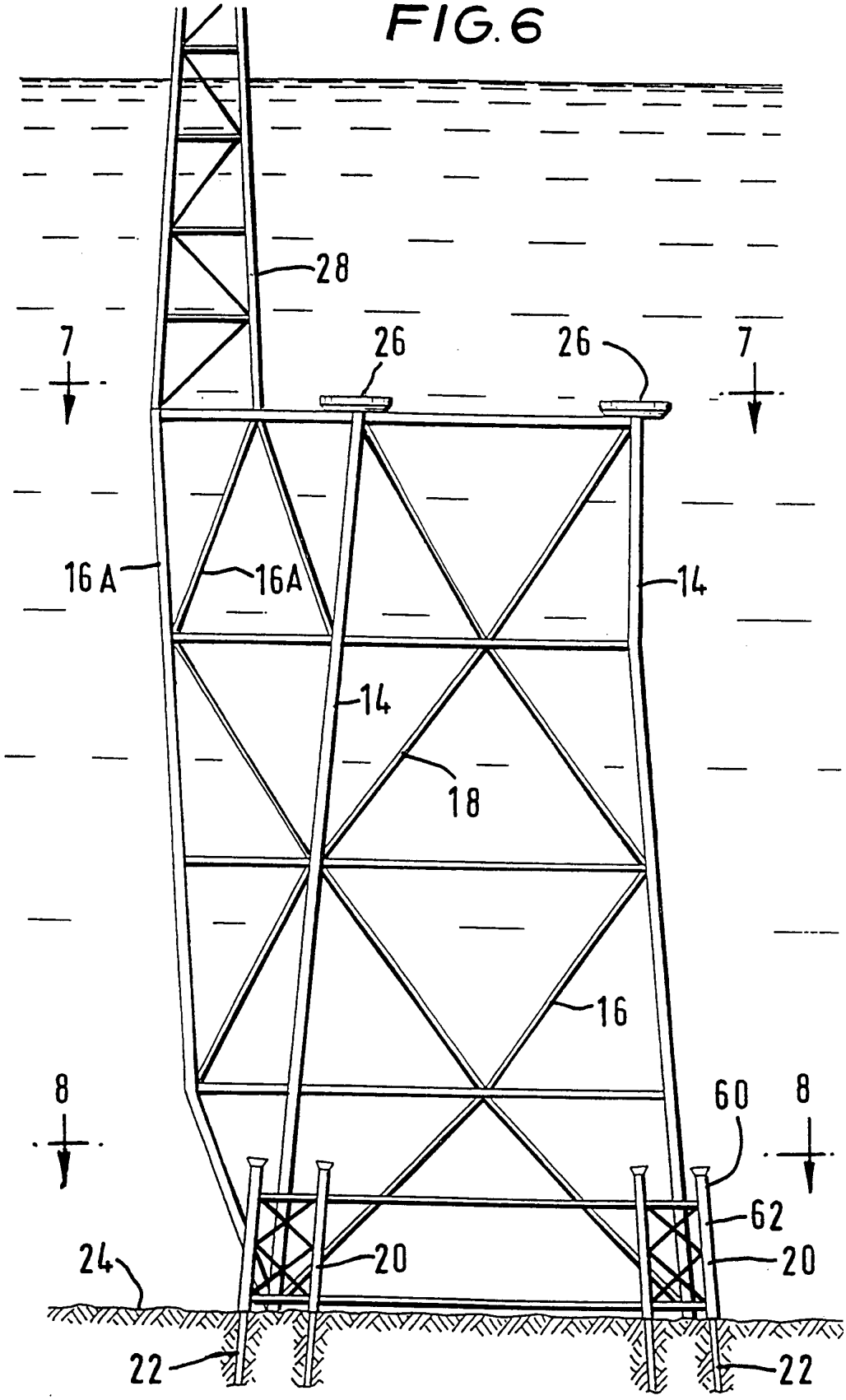

FIG.9

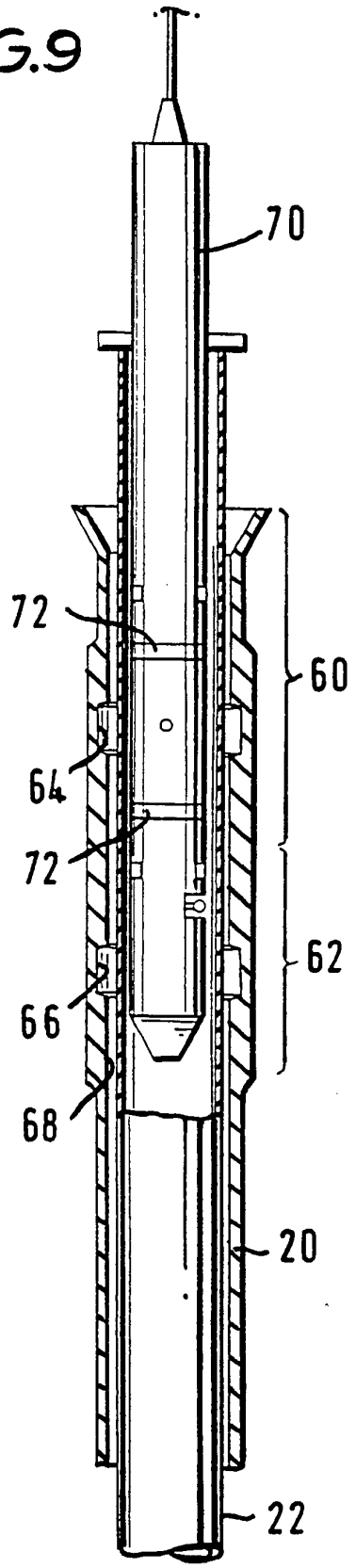

FIG.10

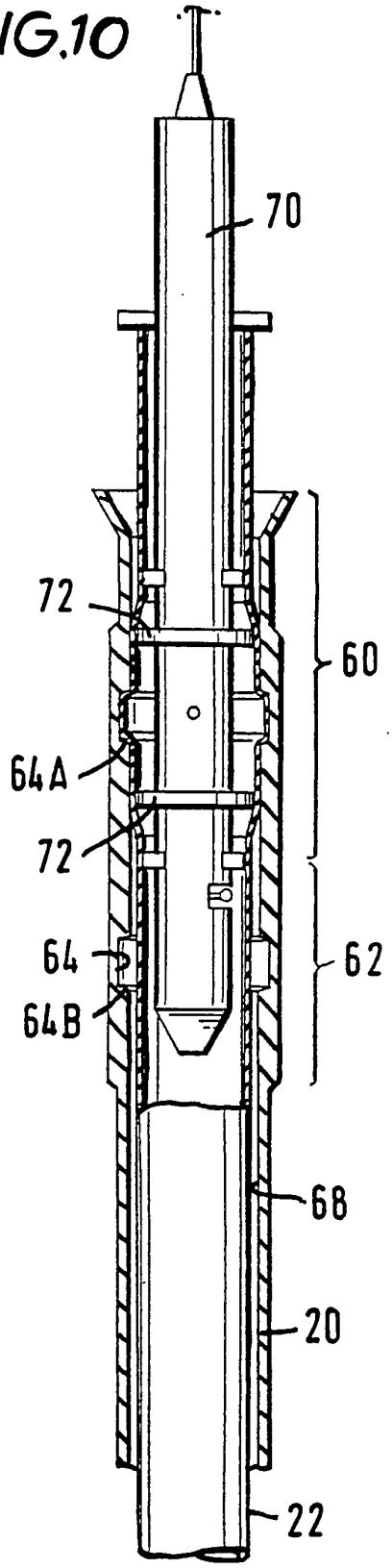

FIG.11

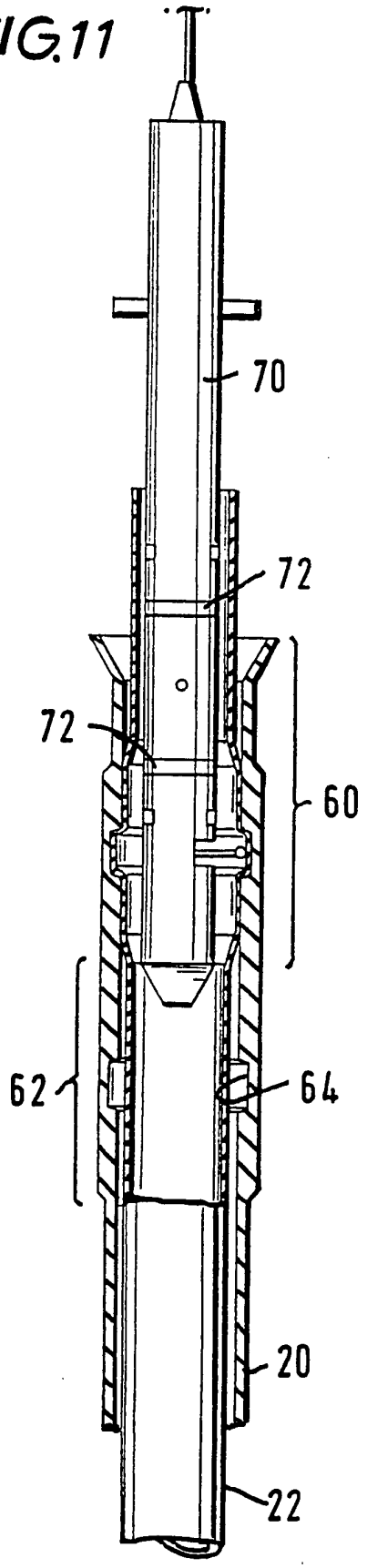

FIG.12

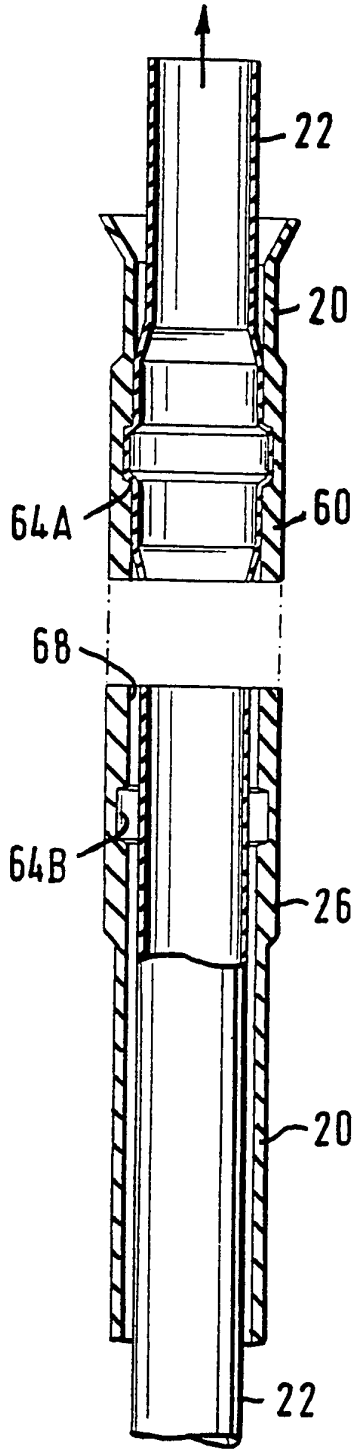

FIG. 13

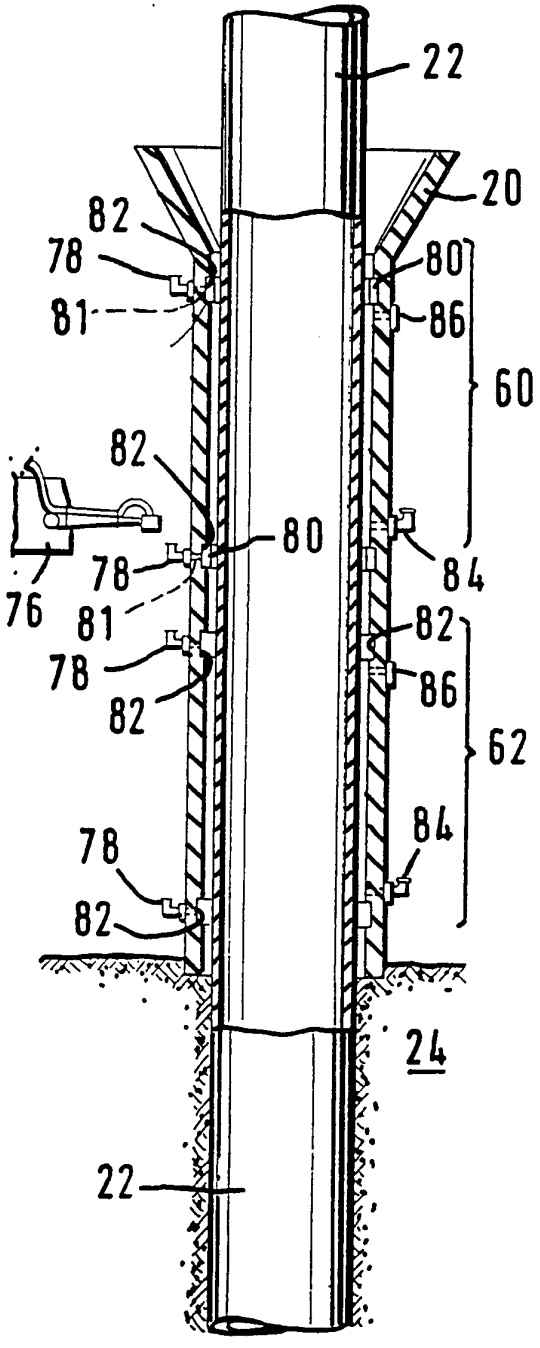
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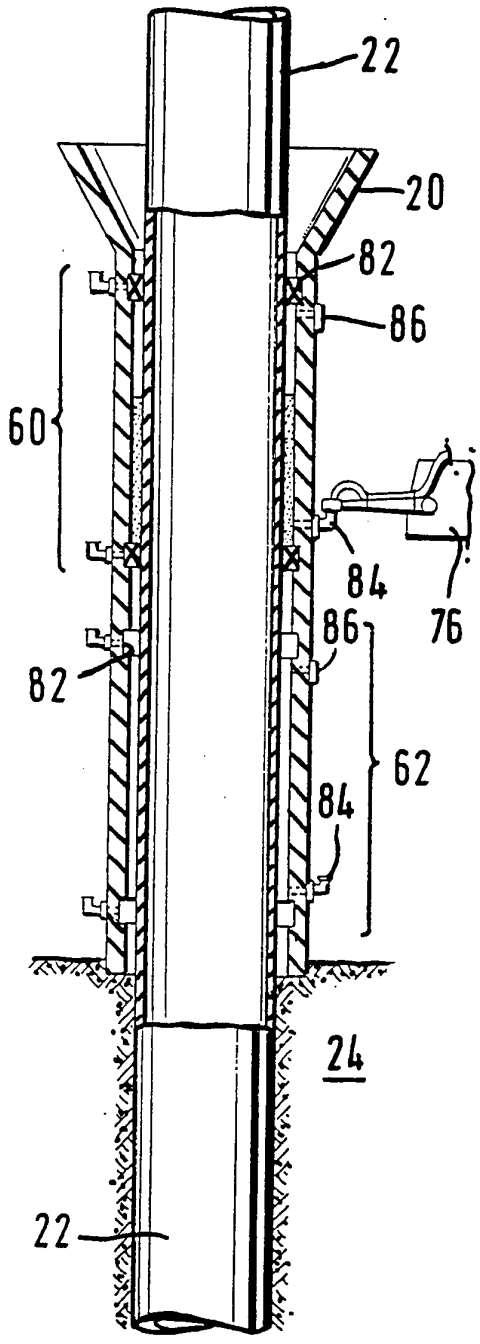
FIG. 14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