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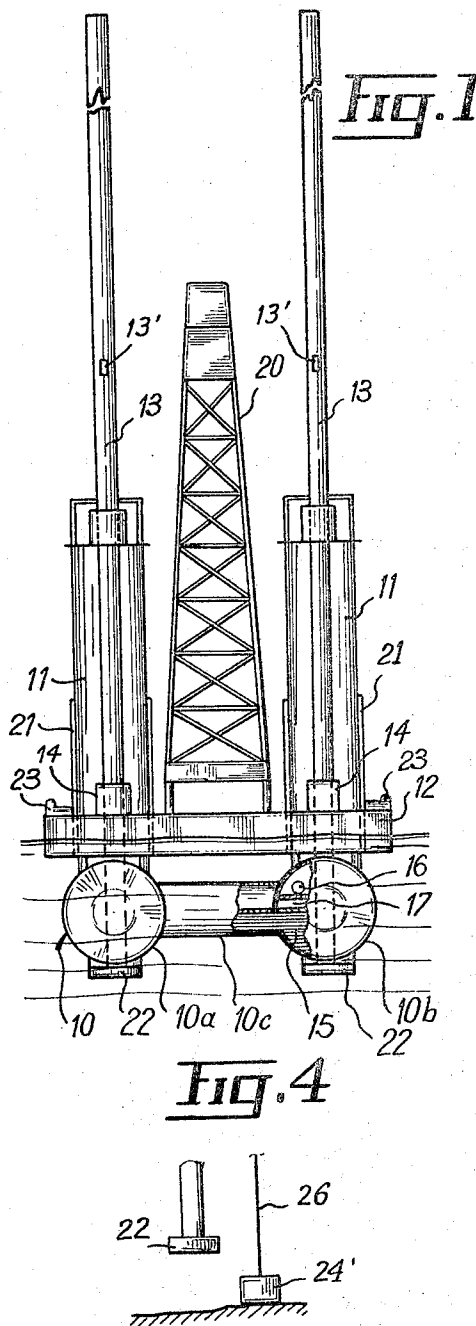
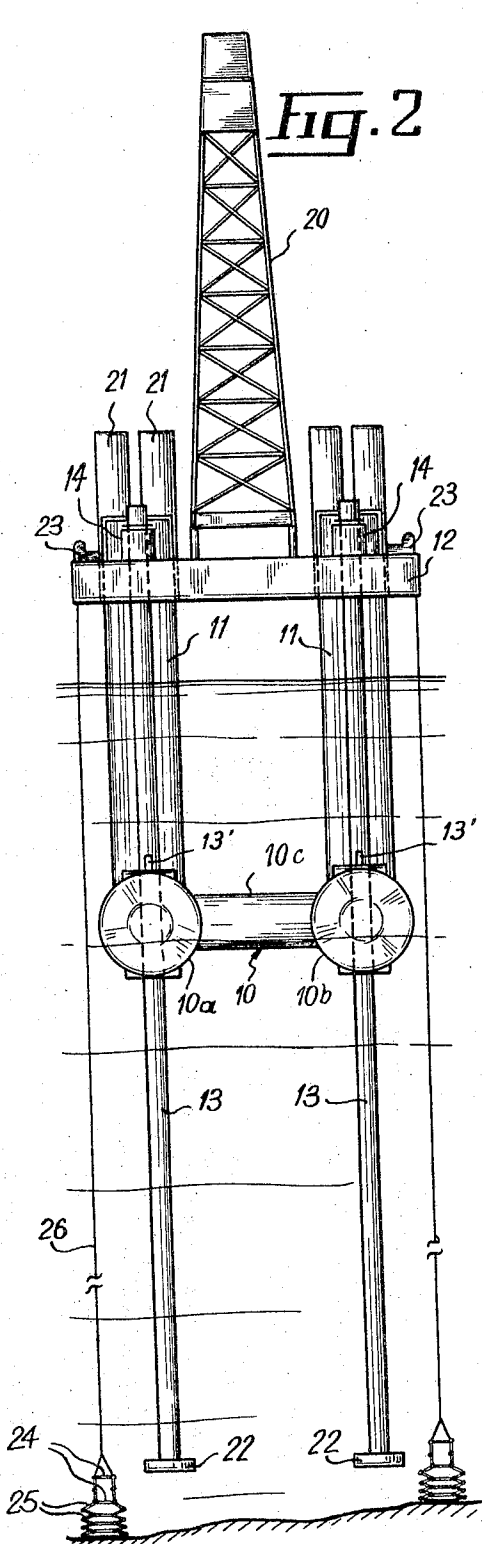
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APPARATUS FOR DRILLING IN DEEP WATER

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2 Sheets-Sheet 1



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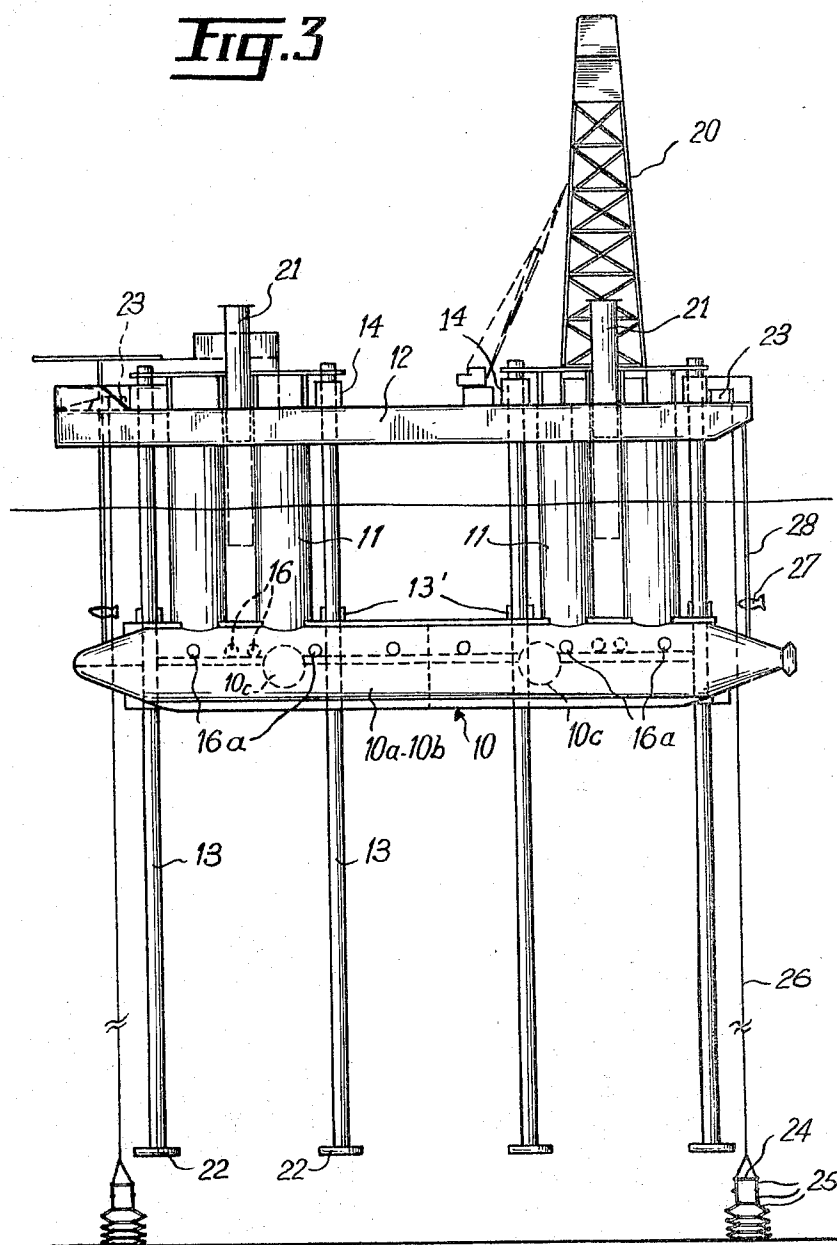
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APPARATUS FOR DRILLING IN DEEP WATER

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Fig. 3



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APPARATUS FOR DRILLING IN DEEP WATER
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10 Claims. (Cl. 114—5)

This invention relates generally to deep-water drilling and, more particularly, it relates to an improved apparatus for carrying out drilling operations in deep water (i.e. greater than 60 meters).

It is known that at present drilling in deep water, and especially at sea, is generally carried out from platforms supported on the bottom of the sea.

For this purpose utilization is made either of structures fixed by construction, or of floating, possibly self-elevating platforms, which move by floating to the utilization site. These latter devices, such as that described in U.S.A. Patent No. 2,837,897 or in U.S.A. Patent No. 3,001,370, are utilizable to depths of up to 60 metres at maximum. When the appliance has arrived at the drilling site, the shell supporting the platform is filled with water and immersed until it rests on the bottom. The platform can then be raised along columns fixed to the shell, until it is at a suitable distance from the sea surface.

However such devices possess two serious drawbacks. First of all it is practically impossible to utilize them when the sea bottom is deeper than 60 metres. Secondly the necessity of filling with water the shell which supports the platform prevents placing any apparatus in this shell, such as the pumps or reserves of mud which will be utilized in the course of the drilling.

Moreover for very deep drillings special ships have been used, which all possess the drawback of vertical instability and significant roll by reason of the swell which always exists in the region where the drilling is effected.

The present invention has for an object the provision of an improved device or apparatus for drilling in deep water comprising a sealed shell which is always immersed, above which there is disposed a platform sliding along vertical columns fixed to the shell. This platform is partially immersed, that is to say effects the flotation of the appliance during its transport, but is capable of being fixed on the columns at any desired height.

According to the invention, when the device is situated at the drilling site, the platform is raised along the floating stabilizing columns until it has emerged completely and is situated at a suitable distance from the water surface, the shell and the columns always remaining in flotation.

Thus the positioning of the device can be very rapid, the only manoeuvre to be effected consisting in raising the platform along the stabilizing columns with the aid of entirely conventional means, without it being necessary to fill and possibly empty the shell, as was provided in most of the present-day appliances.

Moreover it should be noted that the devices described in the aforementioned U.S.A. patents must be equipped with columns of very great height, for example of the order of 80 metres, since the lower shell must rest upon the bottom.

These prior art columns, which do not participate in the flotation of the assembly, have however a very slight cross-section, just sufficient to avoid deformation under the weight of the platform. Contrary to the prior art, the apparatus of the present invention permits use of columns of relatively short height. Moreover in accordance with the invention the sum of the cross-sections of

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the various stabilizing columns must be at least equal to 6% and preferably close to 8 or 10% of the flotation area of the platform. Thus when the device is in the position for use, the sealed shell is situated at a quite significant depth beneath the sea level. The center of gravity of the device is thus itself quite low, so that the platform is very stable.

The invention will be better understood and various other characteristics and its advantages will appear in the course of the description of a form of embodiment given solely by way of example, with reference to the accompanying drawings, wherein:

FIGURE 1 is a front elevation of the device in its position for navigation,

FIGURE 2 is a view similar to FIGURE 1, the device being in its position for utilization in deep water,

FIGURE 3 is a side view of the device in its utilization position,

FIGURE 4 is a detailed view of a variant of FIGURE 3.

Referring to the drawings, it is seen that the device comprises essentially a sealed shell 10 upon which there are fixed eight vertical floating stabilizing columns 11 constituting slideways for a platform 12. The sealed shell 10 can be constituted, as represented in the drawings, by two cylindrical caissons 10a and 10b connected to one another by two or more strong tubes 10c.

This sealed shell is arranged in such manner as to contain the major part of the effective load, namely: the drilling water, drinking water, the fuels, muds and cement, that is to say about 85 to 90% of the useful load. In this manner the load to be foreseen on the platform is minimised, permitting operation as an unassisted independent unit, and of reducing the size of the platform. More precisely, about the lower half of the submersible shell 10 will advantageously be partitioned into compartments 15 containing the liquid materials or fluids necessary for the drilling. In the upper part there will be disposed the electric pumps 16 permitting the raising of the liquid materials to the platform by means of pipes (not shown) placed in the columns 11. The compartments when emptied, will generally be filled with sea water in order to keep the total weight of the appliance substantially constant. To this end a series of water-gates 16a (FIG. 3) are provided for the admission of sea water into these compartments. The pumps 16 and water gates 16a will be accessible through the columns 11 but controlled automatically from the platform.

As regards the solid materials, especially the cement, these will also be placed in the upper part of the shell 10 above the liquid materials. Water ballast 17 for compensating for the weight of these solid materials can also be provided inside the shell and will preferably be disposed in its central part.

The platform 12, through which there pass the columns 11 serving as slideways for the platform, is supported either directly on these columns by means of jacks, for example of the hydraulic type, or preferably upon the shell 10 through the intermediary of shafts 13 of suitable dimensions situated outside the columns 11 and also sliding through the platform 12 and supporting it by means of jacks 14. Lifting means, for example the jacks 14, also effect the displacement of the platform along the columns 11.

It is however quite apparent that the lifting means mentioned above could be of a different type from those described here, without however thereby departing from the scope of the invention. More particularly for this purpose it would be possible to utilize hydraulic or pneumatic jack mechanisms, or entirely mechanical devices.

As already indicated, the internal space of the columns 11 communicate with the interior of the shell 10. Lifts

and load hoists will be provided in one of the columns, permitting access to shell 10 and lifting of the solid materials to the level of the platform. Moreover the tubes and reserve pipes can also be housed in these columns. During navigation (FIGURE 1) the platform is completely lowered into contact with the submersible shell which is always completely immersed, the buoyancy of the platform itself, which is then partially immersed, adding to the total buoyancy of the device. Thus it is understood that the stability in navigation is clearly improved in comparison with that of known devices and that furthermore it is possible either to increase the load on the platform or to reduce the width of the latter.

When the device has arrived at the utilization site, the raising of the platform 12 along the columns 11 is effected for example by means of jacks 14 or with the aid of the other elements provided for this purpose. The decrease of water displacement of the platform causes the progressive depression of the shell 10. When the platform has arrived at its upper position, at the end of the columns 11, it is locked by appropriate means (not shown) wedges or stop-blocks preventing all subsequent descent. The platform is then completely emerged from the water, its rise above the water level having been compensated by a corresponding immersion of the columns.

It should be noted that the raising of the platform in its placing into the working position does not necessitate any filling of ballast, contrary to what is provided in the known analogous devices. Thus it is possible substantially to reduce the dimensions of the shell.

In fact the water ballast 17 situated immediately above the compartments containing the liquid charge have a very small volume and are essentially intended for the following operations. They permit especially of compensating on the one hand the loss of weight of the assembly due to the consumption of the solid materials (cement, earth, tubes, head tubing, etc.) in the course of drilling and on the other hand the downward thrust in the course of the extraction of the tubing. It should however be noted that as asymmetric arrangement of this water ballast 17 should be provided if the drilling tower 20 is placed, as represented in the drawings, at one of the ends of the platform. More generally, this water ballast 17 permits compensating for any normal or accidental variation in the apparent weight of the assembly and in particular that which will be caused by the utilization of the swell compensators which will be discussed hereinafter.

The controls of the pumps and of the water gates associated with this water ballast will of course be disposed on the platform 12.

The device further comprises mobile counter weights 22 permitting of displacing the centre of gravity of the assembly at will. The size and the depth placing of these counter weights will be established in each particular case as a function of the relative transverse narrowness of the assembly, of its total capacity and of certain working terms and conditions. Preferably, and as represented in the drawings, the metallic counterweights 22 will be constituted by solid plates affixed at the lower end of the metallic shafts 13 already mentioned, which will then be mounted for sliding in the submersible shell 10 and controlled in relation to the said shell by any appropriate means, such for example as the jacks 14 themselves.

In the navigation position, the counterweights 22 will be placed flat against and beneath the submersible shell 10. On arrival at the utilization site and before the raising of the platform 12 is effected, the jacks 14 will be actuated to sink the counterweights 22 to the desired depth. In order that the shafts 13 carrying the counterweights 22 may not be permitted to escape accidentally, stop-blocks 13' will be fixed on these columns at a suitable level. They will come to bear upon the top of the submersible shell 10, preventing the columns 13 from sinking further. If in this position the operation of the jacks 14 is continued, these will then cause the depression of the

shell 10 and of the columns 11 and the corresponding raising of the platform 12, as already mentioned.

When the platform is completely clear of the water, it will continue to rise without additional depression of the shell 10.

In addition to the means already described, which already permit a large number of adjustments, in accordance with the invention swell-compensating devices are provided which comprise on the one hand regulable immersion elements permitting essentially of varying the flotation area and on the other hand regulable counterweights. The floating devices of the kind which have just been described are in fact calculated so as to be situated in equilibrium for a swell of specific period. If the period of the swell varies, the balance which depends mainly upon the flotation area is no longer satisfactory and more or less significant vertical oscillations can occur. These variations of the period of the swell can be due, in general cases, either to the phenomenon of wave trains, or to a seasonal variation, or finally to variations of the atmospheric conditions. The same is obviously the case if a device designed for specific conditions is utilized in other regions characterised by the swell of different period.

The device thus comprises swell compensators constituted by a plurality of hollow cylinders 21 sliding in the platform 12 and actuated by means of winches or jacks (not shown). In the normal position these cylinders emerge above the platform 12, their lower face being situated at the level of the lower face of the platform. When there are variations of the period of the swell, the necessary number of compensating cylinders 21 is sunk in order to modify the flotation area. In general it is sufficient to have an immersion equal to half the amplitude of the maximum swell (position represented in dotted lines in FIGURE 3). Moreover, taking account of the fact that generally four cylinders are necessary in order to satisfy symmetry, a total of $4n$ is necessary in order than n stages of compensation may be utilized. From the practical point of view two or three compensation stages are sufficient, since a finer adjustment than three stages is illusory as a result of the various subsidiary variations which cause slow but aperiodic vertical oscillations of the order of 0.10 metre at the centre of the apparatus. The swell compensators 21 permit of reducing the total of the vertical oscillations at the centre of the craft below 0.15 or 0.10 metre under normal conditions. It should however be noted that in the case where the tower 20 is placed at the end or on the side, the compensators 21 will advantageously be used in asymmetric fashion in order to compensate the depression on any extraction of the pipes. Finally these compensators 21 permit of correcting the deviations of flotation in comparison with theoretical calculations, at the time of utilization.

The effect obtained by the adjustable-depth compensators 21 which have just been described is completed by the action of counterweights preferably disposed at the corners of the platform 12. These counterweights permit a more precise adjustment of the vertical oscillations and further contribute to reduction of roll. These counterweights are suspended on winches 23 situated on the platform and can be lowered to the bottom of the ocean where they rest partially.

Different styles of adjustment of these counterweights are envisaged. For example each counterweight can be constituted by a bundle of chains the "utilization length" of which is equal to the maximum amplitude of the vertical oscillation of the apices of the platform.

In the mean position the "half utilization length" of the bundle rests on the bottom, the other half length being vertical and causing a tension in the suspension cable equal to half of the weight of the bundle. On lowering of one of the apices of the platform, a greater part of the corresponding bundle of chains rests on the bottom and the tension in the suspension cable reduces.

The result is the appearance of a force and a moment contrary to the direction of the oscillation. The opposite phenomenon takes place on raising of one of the apices of the platform.

However a form of embodiment has been represented which appears more advantageous. In fact in practice the amplitude of the vertical oscillation to be damped does not exceed 60 cm. to 1 metre. Under these circumstances the chain device lacks "sensitivity" unless excessive lengths are available which burden the assembly. The damping device will thus be discontinuous and composed of a plurality of metallic plates 24 connected with one another by connecting rods 25 so that in the "open" position the total height of the assembly is equal to the amplitude of the oscillation and in the collapsed position it is as little as possible in view of the thickness of the plates. The assembly will be suspended on cables 26 operated with the aid of the winches 23.

In the neutral position, half of the plates will rest on the bottom. In the "low" position, the whole of the plates will rest on the bottom, all the connecting rods being folded and in the "high" position the whole of the plates will be raised, all connecting rods being extended.

However, it is quite apparent that the connecting rods could be replaced by telescopic elements possibly comprising elastic devices.

It would also be possible to utilize solid counterweights, 24, the adjustment then being effected by the tension of the suspension cables 26 (FIGURE 4).

Such adjustable counterweights of one or the other of the above-described types will be very effective for avoiding roll and pitching caused by the wind or by the subsidiary effect of the harmonics of the swell or by secondary interference swell. In fact it can be estimated that under bad sea conditions and wind conditions, the pitch will be of the order of 1% and the roll of the order of 3%, if the form of the platform is quite elongated.

On the other hand these adjustable counterweights also permit improving stability in the course of extraction of the tubing. More generally it can be said that an assembly of the compensator devices, adjustable-depth cylinders and adjustable counterweights provides the platform with a vertical stability never yet achieved for such appliances.

The device according to the invention will of course be equipped with anchoring elements such as those which are utilized on appliances of the same kind. However for work in very deep waters, where the use of anchors would become practically impossible, the device can comprise submerged motors 27 with propellers mounted on cylindrical columns 28 sliding through the platform 12 and bearing upon the submersible shell 10. The columns 28 or the motors 27 themselves will be orientable in such manner as to permit of directing the thrusts of the propellers in the suitable directions. The various control elements will, of course, be arranged on the platform 12.

Finally the floating device can comprise propulsion motors rendering it completely autonomous. Electric motors will preferably be disposed in the shell and will be supplied from generator sets mounted on the platform, it being possible moreover for these sets to be the same as those utilized for drilling.

As noted hereinabove, shell 10 is always submerged, has an approximately constant weight, and maintains the center of gravity of the device very low, thus necessitating a buoyancy for the shell of close to zero. On the other hand, since the platform 12 effects flotation of the device during transport, it must have a positive buoyancy. Lastly, columns 11 must have a high buoyancy, since it is manifest that they must overcome the lack of buoyancy

in the shell 10 and also support platform 12 when it is out of the water; this is why the columns should have a relatively large cross-sectional area.

The invention is not of course limited to the forms of embodiment which have just been described and represented, but on the contrary covers all variants thereof.

I claim:

1. A permanently floating device for deep-water drilling comprising:

an ordinarily submersed, sealed shell having a buoyancy close to zero;

a plurality of vertical columns attached at their lower ends to said shell, said columns having a high buoyancy;

a platform having a plurality of vertical openings for passage of said columns, said platform having a positive buoyancy, the buoyancy of said columns being sufficient to support said platform; and

means for controlling the relative motion of said platform and said columns, whereby said platform may be simultaneously raised on each of said columns out of the water.

2. The device as claimed in claim 1, wherein the cross-sectional area of said columns is at least six percent of the flotation area of said platform.

3. The device as claimed in claim 1, wherein the cross-sectional area of said columns is about 8 to 10% of the flotation area or said platform.

4. The device as claimed in claim 1, and additionally comprising a plurality of counterweights, said counterweights being movable to variable depths with respect to said platform.

5. The device as claimed in claim 4, wherein said counterweights comprise flat, horizontal plates attached to shaft means, said shaft means being supported by and vertically movable from said platform.

6. The device as claimed in claim 1, and additionally comprising a plurality of vertical cylinder means supported by and vertically movable from said platform, said cylinder means being adapted for partial submersion, thereby reducing instability due to swell effects.

7. The device as claimed in claim 4, wherein each of said counterweights comprises a plurality of vertically stacked flexibly connected elements connected to said platform by flexible means, the lowermost of said elements being adapted to rest on the bottom when said platform is stable.

8. The device as claimed in claim 7, wherein said flexible means are attached to said platform at the corners thereof.

9. The device as claimed in claim 7, wherein said flexible means comprise cables.

10. The device as claimed in claim 1, wherein said sealed shell has a plurality of internal compartments, and additionally comprising means for moving material from said compartments to said platform through said columns, and means for filling said compartments with water.

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