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Vilain

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[54] **INSTALLATIONS FOR SUBMARINE WORK**

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[52] **U.S. Cl.** .....**61/46.5,** 9/8, 114/.5 F

[51] **Int. Cl.** **B63b 35/44,** B65d 87/08, E02d 17/00

[58] **Field of Search** 61/46.5, 46; 114/.5; 9/8; 137/154; 220/1

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[57] **ABSTRACT**

An offshore drilling platform has a column which can be articulated by a universal joint to a base anchored to the seabed. The column is subdivided into a plurality of superposed ballasting compartments. Means are provided for external control, from a compressed air source, of the flooding or emptying of at least one of the compartments. One compartment close to the articulated end of the column can be flooded during positioning the structure so that the water compresses the air before it. Means are provided to allow the air to escape thereafter or be further pressurized to drive out the water. Floats which can be partly filled with water can be arranged radially around the column and emptied during the setting up operation. Oil dashpot type shock-absorber means can be provided for damping impact against the base.

10 Claims, 9 Drawing Figures

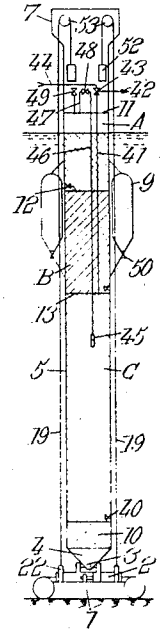


Fig. 1.

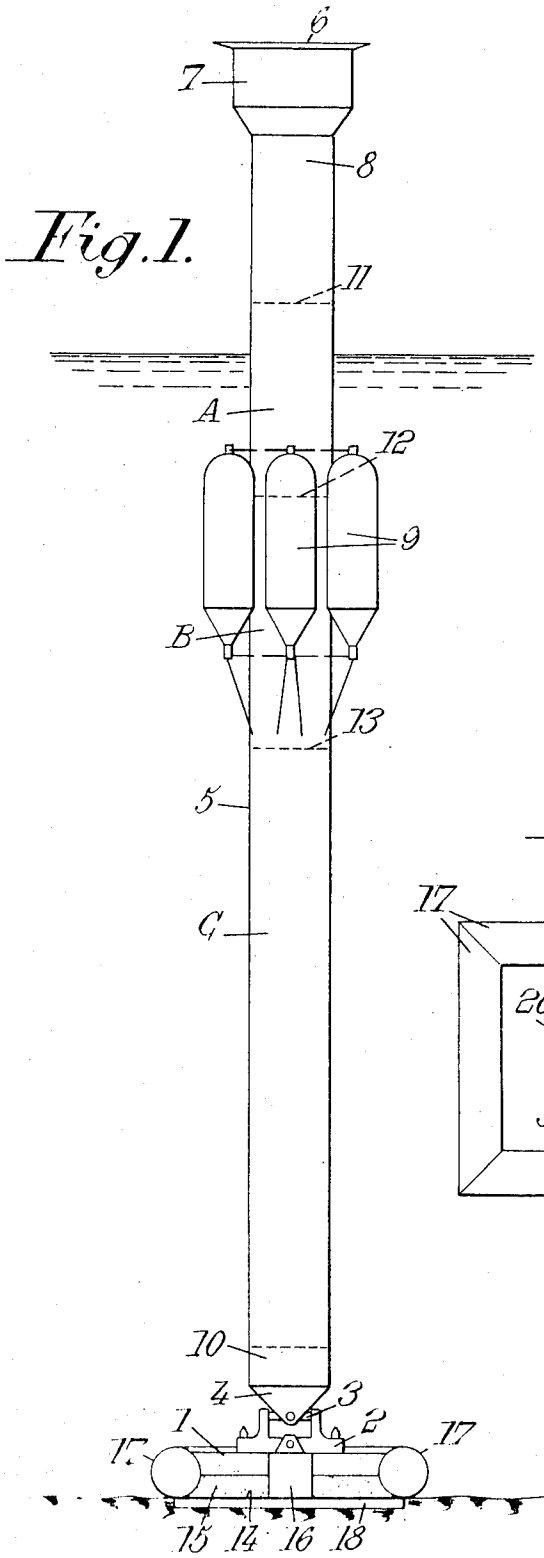
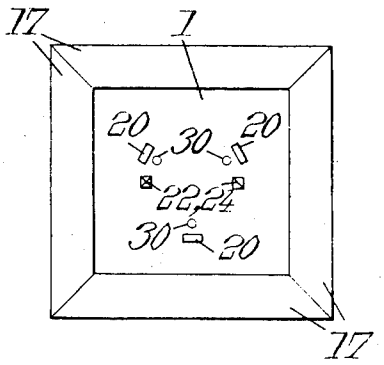
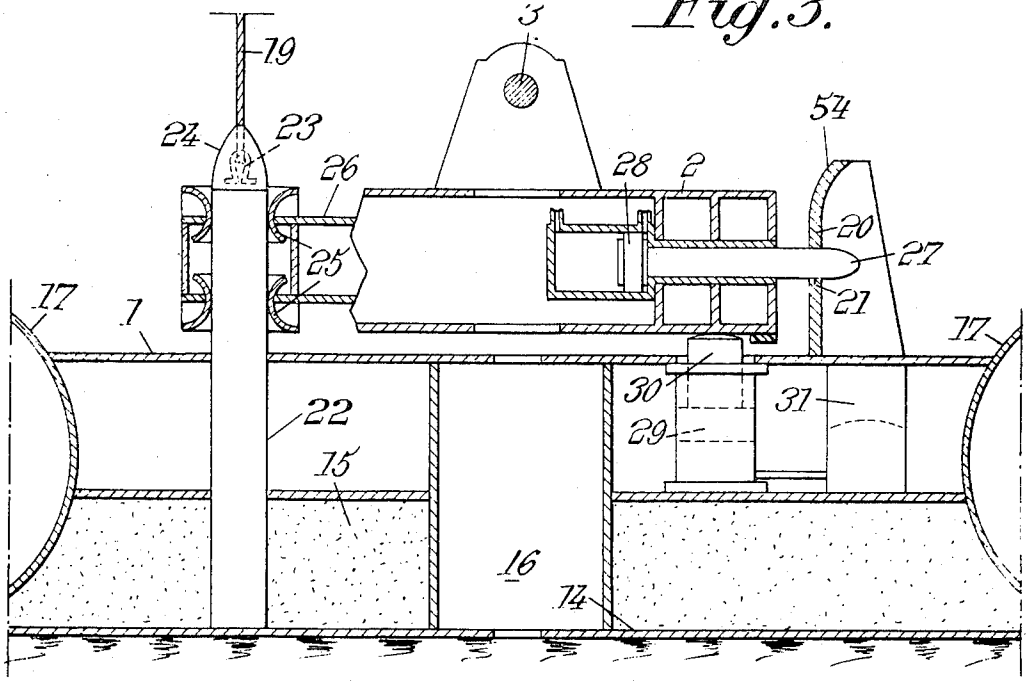


Fig. 2.



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Fig. 3.


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1
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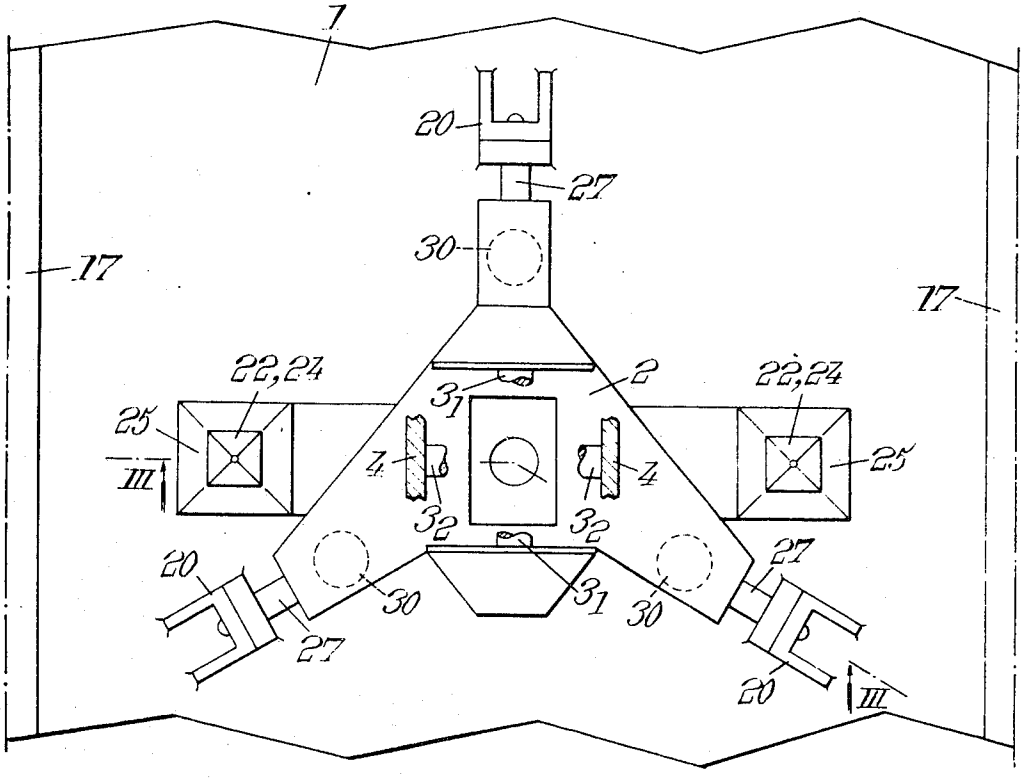

1
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27
30
17
17
22,24
22,24
2
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25
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III
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III

Fig. 4.

Fig 6.

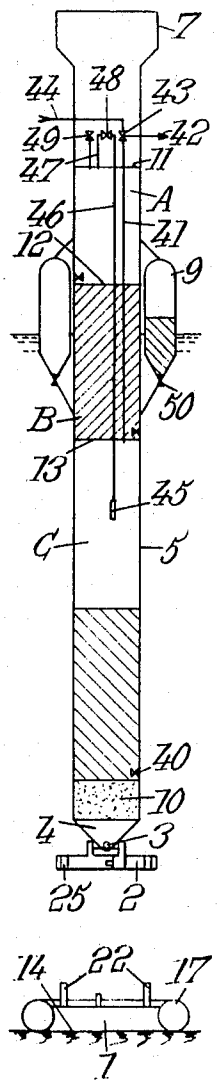


Fig. 7.

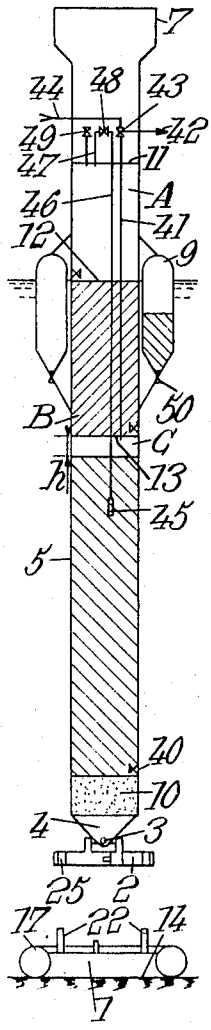


Fig. 8.

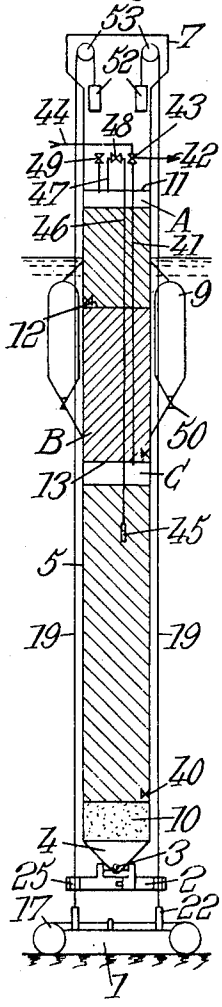


Fig. 9.

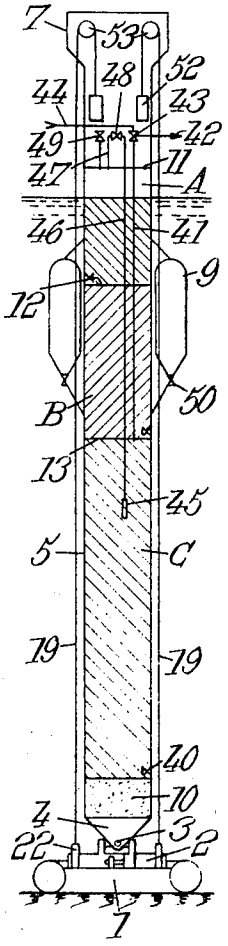
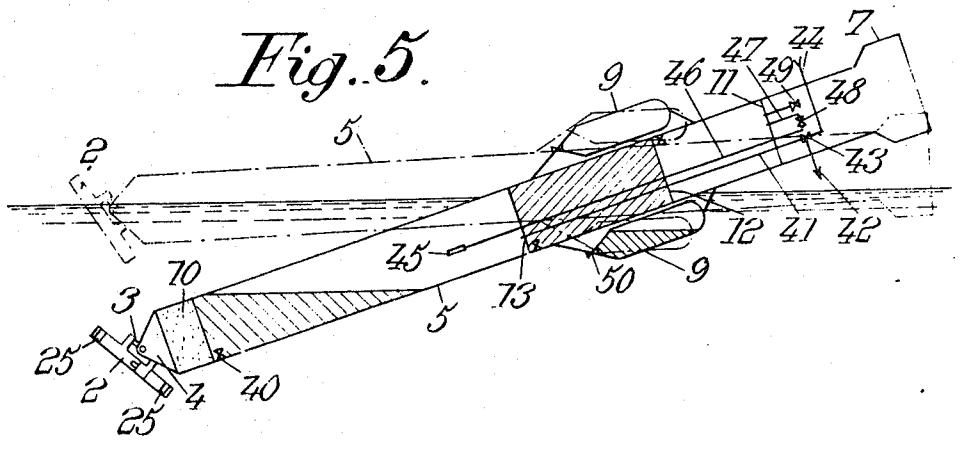


Fig. 5.



INSTALLATIONS FOR SUBMARINE WORK

The present invention relates to structures of the offshore platform type for submarine work, of the kind in which the platform proper is carried on a supporting column which is articulated, notably by means of a universal joint, to a base set down on the seabed.

Already known are means for floating and towing the platform and its column up to its location and for then fixing the column to the base, the column being first tilted over by water-ballast, then set in a vertical position and guided towards the base by means of guide-cables. It has further been advocated to ballast the column at its base and to provide it at the platform end with buoyancy floats for hydrostatic stabilization, whereby the base-ballast, together with the overall weight of the system, substantially balances the hydrostatic thrust exerted by the floats so as to relieve the universal joint or other securing means as much as possible.

The invention relates to a number of features for taking better advantage of the characteristics of these types of platform and for permitting easy transport of such platforms to the work site and for facilitating and increasing the reliability of the process of setting them up by providing reversible maneuvers.

One of these features, which relates specifically to the setting up of the column (and possibly the base), consists in providing the same with ballast compartments and with means permitting external control, by means of a compressed-air source, of the emptying of at least one of said compartments if need be, notably in order to enable the order of operations to be reversed should this prove necessary.

In one embodiment, a compartment is provided in the column, between the buoyancy float and its end to be fixed to the base. During the setting-up operation, water is allowed to flow into this compartment and to compress the air contained therein, this air being then allowed to exhaust or being on the contrary repressurized in order to drive out the water by the means referred to, if need be. An upper provisional flooding compartment may possibly be provided to complete the submerging operation.

In accordance with another feature, a plurality of buoyancy floats are arranged about the column, some of which are flooded during the towing up to the worksite and emptied for the setting-up operation, notably for the ultimate phase thereof.

Yet another feature relates to at least three latches arranged radially and symmetrically about the axis of the column, for the purpose of securing the coupling-block at the lower end of the column to the base.

The description which follows with reference to the accompanying non-limitative exemplary drawings will give a clear understanding of how the invention can be carried into practice.

In the drawings:

FIG. 1 shows in schematic side elevation one embodiment of a platform with an oscillating column in accordance with the invention, in its erect position;

FIG. 2 is a schematic separate plan view of the base of this column;

FIGS. 3 and 4 show on an enlarged scale, fragmentally and in greater detail, in section and in plan view respectively, said base and a portion of the column coupling-block, the whole in accordance with this invention;

FIG. 5 illustrates in schematic section the initiation of the column lowering operation, starting from the towing position; and

FIGS. 6 through 9 portray four different stages in the operation of lowering and securing the column to the base.

Reference is first had to FIG. 1 which shows a preferred embodiment of an offshore platform with an oscillating column intended to be set up in an offshore location, according to this invention, which comprises the following essential parts:

A base 1 intended to be set down on the seabed and to be weighted with concrete or in any other convenient way, and constructed, for example as described below;

an articulation system, notably of the universal joint type, for securing the column to said base and basically comprising a lower coupling-block 2 capable of being fixed to the base, the universal joint proper with its ring 3 and an upper block 4 forming part of the column; and

the column proper 5, consisting basically of a suitably compartmented cylindrical steel shell, i.e. comprising, at the top, the mooring plateform 6 with, below the latter, the living quarters and working premises 7 and the machine-rooms 8 and, further below still, buoyancy floats 9 which in the erected position of the column exert an upward thrust in order to stabilize the column and allow guiding cables to be dispensed with.

In accordance with a feature of this invention, a number of these floats are arranged around the column, and one or more of them are at least partly flooded during the towing phase in order to stabilize the system about its axis (FIGS. 5 to 9).

Adjacent the coupling-block 4, the lower end of the column includes a ballast compartment 10 tending to counterbalance the buoyancy force of the floats 9.

The interior of the column is furthermore divided into a plurality of ballast compartments A, B, C in conjunction with flooding and emptying means to be described hereinafter, the partition walls 11, 12, 13 of which compartments are shown on the drawings.

In what follows the base, and thereafter the column, with their associated positioning means and operations, will be examined in succession.

Referring first to the base 1, the same is constructed essentially with a metal framework comprising a baseplate 14 with partitions for possible ballast compartments 15 (concrete, etc.) and at least one flooding compartment, located for instance at the center at 16 or at any other convenient place, the whole arrangement being surrounded by floats 17.

The complete base may be square or rectangular shape (FIG. 2), its dimensions varying according to the height of the column. For a column approximately one hundred meters long, the sides of the square would be approximately 20 to 25 meters long and the loaded weight approximately 1,000 to 1,500 tons, these figures being given for purely indicative purposes only.

Underneath the base is provided a suitably reinforced plate forming an erosion arrester (FIG. 1) to prevent erosion of the seabed by the hydrostatic undermining effect of the sea.

On top of the base are provided means for securing the lower coupling-block 2 and means for securing guiding cables preferably provided to guide the column

at least during the ultimate phase of the operations, which cables are shown only in FIGS. 3, 8 and 9, at 19, in order not to clutter the drawings unnecessarily.

The means for making the lower coupling-block 2 of the column fast with the base 1 are provided at three points at least, arranged radially and symmetrically, i.e. at 120° about the axis of the system. They consist for example of connecting elements 20 (FIGS. 3 and 4) formed with holes 21 for receiving bolts 27 carried on the lower coupling-block 2.

The elements 20 comprise guides 54 for correctly locating the lower coupling-block 2 during assembly.

The base includes a further two guiding elements 22 for attaching the guide-cables 19, and these elements consequently include shackling means 23, the whole arrangement being covered with masks 24 for facilitating penetration into elements formed with openings 25 therein and carried by the lower coupling-block 2 (FIG. 3).

FIGS. 3 and 4 show that in order to enable it to cooperate with the elements 20 and 22 just described, the coupling-block includes a substantially triangular shaped base from which the three bolts 27 may protrude, while a cross-member 26 carries the elements formed with the openings 25 therein.

It is a further feature of this invention that provision is made for remote-control means of the bolts 27 once the coupling-block has been positioned and located by the elements 20, 54, which means are possibly of the hydraulic type and include jacks 28. Additional means associated with the base 1 are provided for damping any shocks which may occur when the lower coupling-block 2 contacts base 1, and such shock-damping means may be of the hydraulic type such as the shock-absorbers 29 and be actuated at 30 in conjunction with an oil reservoir 31 (FIG. 3).

Considering next the procedure to be adopted for submerging a base as hereinbefore specified and anchoring it to the seabed at the start of operations, this may be accomplished by providing the base with suitable flooding valves so that after it has been floated up to its final position it can be gradually weighted and caused to slowly submerge while it is suspended by a cable from an appropriate floating system.

The submerging process may be controlled by means powered by compressed air, an example being the means to be described below with respect to the column and which if necessary will allow the operation to be reversed by causing the water to be expelled by the inrush of compressed air into the float (notably in the event of an error requiring the operation to be repeated).

Flooding is first effected in the external floats 17 until the base is lowered on the seabed at a sufficiently slow speed, after which the setting onto the seabed is completed by flooding central compartment 16 or other appropriate compartments by remotely controlling appropriate valves.

Considering now the special means in accordance with this invention for submerging the column 5 and causing it to rest with its coupling-block 2 on the base 1, a possible embodiment thereof will now be described.

The column, comprising compartments A, B, C for example, is preferably towed into position, for instance with two or three of its floats 9 at least partly filled with water in order to stabilized the structure about its longitudinal axis, and for instance also with compartment B filled with water, which compartment is substantially level with the floats 9 (FIG. 5). The preferred procedure is then as follows:

In the first stage the water is caused to enter compartment C through at least one manually or remotely controlled valve 40 located on the same side as coupling-block 2, 3, 4, but without expulsion of the air contained therein, whereby compartment C is set under pressure and a final position of equilibrium is achieved (FIG. 6) with coupling-block 2, 3, 4 positioning itself at a certain distance from base 1.

In the second stage, the air contained at the top of compartment C is caused to exhaust at a suitable rate, for instance through a conduit 41 having port at 42 via a valve 43, and this is continued until a closer position is achieved (FIG. 7) in which a certain quantity of compressed air of height *h* is allowed to subsist in C.

In the third and final stage, the setting up of the column on its base is completed by causing the following to take place in any convenient order: at least partial flooding of upper compartment A, emptying of floats 9, and exhausting of the residual air remaining at the top of compartment C (FIGS. 8 and 9).

The process of compressing the air in compartment C as a result of the flooding is particularly advantageous, for the air pressure generated thus counters the hydrostatic pressure exerted on the column and consequently relieves the strain on the plates.

Further the reserve air *h*, upon being allowed to exhaust in the third stage of the submerging operation allows the coupling-block 2 to contact the base 1 without the hammering that would tend to occur under the effect of the swell during this ultimate phase. The shock of impact is in any event damped by the shock-absorber means referred to above.

In accordance with another important feature of this invention, means are provided, in combination with the means for exhausting the air from compartment C, for re-admitting air under pressure, for example at 44 through a possibly multi-way valve 43, towards the conduit 41, or through another valve or another conduit (see FIGS. 5 to 9). In this way, should difficulties be encountered during the submerging operation, a reversibility feature is resorted to, i.e. the possibility of reverting to the initial configuration by exhausting the compartment C.

Any convenient means may be devised by the specialist in the art for performing the above stages in the submerging operation, and such means may be directly or remotely actuated by any convenient hydraulic, pneumatic, electric or other control means.

The first stage is accomplished by opening the valve 40, the valve 43 remaining closed (FIGS. 5 to 9), whereby the upper part of compartment C is set under pressure.

The second stage is performed by opening discharge valve 43 and exhausting the air from compartment C until the residual supply of height *h* remains therein, said valve being then closed anew (FIG. 7).

The third stage requires for example a pump 45 for drawing in water and conveying it through a conduit 46, 47 into compartment A, by way of a valve 48. This

pump draws the water from compartment C when it is set in operation and when valve **48** is opened. Simultaneously the air is allowed to escape from compartment A through a valve **49** which is caused to open (FIG. **8**). The height of the water level reached in compartment A depends on the immersion depth to be obtained.

With regard to emptying of the floats **9**, this can be done in any convenient way, for instance by admitting air under pressure thereinto and temporarily opening liquid discharge valves **50**.

Lastly, with regard to obtaining the ultimate downward movement, accomplished by emptying the residual air in compartment C, this is initiated by actuating the exhaust valve **43** once more.

Once the final position has been reached, that is to say with coupling-block **2** resting on base **1**, the water level in upper compartment A may establish itself at the same level as the surface of the sea.

No reference has been made in the foregoing to the manner of handling the guide-cables **19** (shown in FIGS. **8** and **9** only). These cables may be employed as follows:

When the column is tilted over (FIG. **5**) and is in the configuration of FIGS. **6** and **7**, these cables are in position along its entire length. At the bottom of the column, adjacent the coupling-blocks, these cables are threaded through the rings **25** on lower coupling-block **2**, **26** and their ends are coiled up temporarily pending attachment to the shackles **23** on guiding elements **22**. When the configuration of FIG. **8** is reached, divers secure the cables to shackles **23** and the cables are then pulled taut. This provides excellent guiding means for coupling-block **2**, which can thus descend into its ultimate position (FIG. **9**) while receiving additional guidance from the ramps **54** of the three elements **20**.

Any convenient means may be provided for tightening the cables **19**, such as counterweights **52** supported at the top of the column and associated to pulleys or pulley-blocks **53** (FIGS. **8** and **9**).

The oil or drilling pipes, or other piping or devices to be run through the column **5** are not shown on the drawings, but it is to be understood that the passage of such pipes, notably through universal joint **3**, is accomplished in any convenient manner.

An offshore drilling platform or structure devised as hereinbefore disclosed offers numerous advantages over the prior art platforms of this kind, and the following in particular:

the positioning operations can be remotely controlled by the sole actuation of valves or the like;

the building up of dangerous hydrostatic pressures can be avoided during the column submerging operation, these pressures being balanced by the compression of the air;

it is possible to obtain a sufficiently rapid rate of descent during the ultimate positioning phase (through escape of the air under residual pressure) to avoid any hammering effects;

dangerous shocks are prevented by virtue of the shock-absorber means provided;

latching of the lower coupling-block on to the base can be remotely controlled from the platform by means of the jack which actuates the latching elements; and

appropriate utilization of the air under pressure permits of reversing the operations and hence of reverting to the starting configuration at any time if need be.

It goes without saying that many changes and substitutions of parts may be made to the specific embodiments described hereinabove without departing from the spirit and scope of the invention, and that, broadly speaking, the above-disclosed basic principles may be applied likewise to structures of a different kind and furthermore that variants may be adopted in regard to the nature, number and succession of the setting-up operations.

What is claimed is:

1. A structure of the offshore drilling platform type, having a column, coupling means at one end of said column to make it securable in articulated fashion to a base anchored to the seabed, the column being subdivided into a plurality of superimposed ballasting compartments, and air valve means arranged on said column to regulate air from a source of compressed air so as to control the flooding and emptying of at least one of said compartments and wherein proximate said coupling means at least one of said compartments comprises water valve means for flooding said at least one compartment with water during positioning of the structure so that said latter water compresses before itself the air contained therein thereby counteracting the external hydrostatic pressure on the compartment, and air valve means for allowing said air to escape thereafter.

2. A structure according to claim 1 including, in combination with a system of external floats for providing hydrostatic compensation, three superimposed compartments within the column, of which one is adapted to be always flooded and located substantially level with said system of floats, another is located in the lower portion of the column adjacent to said base and has first water valve means permitting it to be filled with water in the course of positioning of the structure, and the third is located in the upper portion of the column and includes second water valve means enabling it to be filled at the end of the column positioning operation.

3. A method of positioning the column of a structure as claimed in claim 1, said column having at least one lower compartment and at least one upper compartment, comprising the steps of first allowing water to flood the lower compartment and compress the air before it so as to counteract external hydrostatic pressure on said compartment and thereby avoid distortion of the wall as the column is sunk, of then allowing the air to escape until a given height of compressed air remains in that compartment, of thereafter at least partly filling the upper compartment with liquid, and of finally reversibly effecting the escape of the compressed air remaining in the lower compartment at a rapid rate to avoid hammering effects during the final phase of positioning.

4. A structure according to claim 1, comprising a buoyancy system formed by a plurality of floats arranged radially about the column, float valve means on one or more of said floats to enable it to be at least partly filled with water while the structure is towed to its ultimate location to provide stabilization about the axis of the column, and to be emptied during the phase of positioning the structure.

5. A structure according to claim **4**, comprising a pipe connected to said second water valve means and a pump connected to said pipe and adapted to fill the upper compartment with water drawn from the lower compartment.

6. A structure according to claim **1**, wherein said coupling means comprises a coupling block fixable to the base at three points at least, and a universal joint between the coupling-block and the column.

7. A structure according to claim **6**, wherein the coupling means includes remote-controlled radially disposed jack-actuated latching means for fixing the coupling block to the base.

8. An offshore platform comprising a structure according to claim **6**, and a said base including shock-absorbing means for damping impact shocks when the coupling-block contacts the base.

9. A platform according to claim **8**, wherein said shock-absorbing means are of the oil dashpot type.

10. A method according to claim **5**, wherein said air valve means is adapted to cooperate with said coupling means in such manner as to achieve reversibly rapid positioning of the column on the base.

* * * * *