This invention relates to the method of and apparatus for exploiting oil or other mineral deposits underlying submerged areas and more particularly to the method and apparatus for deep sea drilling of oil wells.

Where developed, oil structures underlying submerged areas have in general proven unusually prolific, and it has long been conceded that immense quantities of petroleum probably underlie the ocean beds in various parts of the world. Development of underwater oil resources has been carried on for many years, the wells being drilled by equipment mounted on barges, caisson type piles and piers supported upon piling. In some cases the piers are built out over the water as far as practicable and as many wells as practicable drilled directly from these piers. In some areas drilling barges have been used where the sediments under the water do not lend themselves to pile-supported construction, but all of the pier and barge operations have been limited to locations where there is less than fifty foot depths of water due to the limitations of presently available equipment. In some locations a huge caisson type piling has been used in relatively shallow water where the underwater sediments and underlying strata provide competent footing. Such footing must be ideal for the caisson type of piling. None of these prior methods and apparatus are suitable for exploiting oil and mineral deposits which require the drilling and producing operations to be performed in relatively deep water, for example in depths of two hundred feet or more.

The principal objects of the present invention are to provide a deep sea well drilling unit having an extendible support adapted to be imbedded in the ocean floor; to provide an underwater drilling unit consisting of a chamber supported by its own buoyancy at or near the surface of the water and having drilling equipment, materials and crew quarters therein for carrying on the drilling operation and a stem extending therefrom into the sediment and strata below the water for anchoring said chamber; to provide an underwater drilling unit consisting of a chamber containing buoyancy control apparatus and essential equipment for oil well drilling and producing operations to provide an underwater drilling unit adapted to contain all essential drilling equipment therein and retain sufficient buoyancy to be floated to desired location, arranged vertically in the water by shifting center of gravity of said unit and a stem projectable therefrom and into the strata below the water for anchoring said unit therein; to provide a drilling unit structure capable of taking advantage of the buoying effect of displaced water for supplementing the support of underwater footings; to provide for access to the drilling unit through waterproof hatches located in the portion extending above the water level; to provide for anchoring the drilling unit to the strata below the water by sinking a pile by jettying or the like into said strata and cementing said pile therein; to provide a drilling unit in which the anchoring pile extends into said unit with a watertight seal around said pile; to provide for projecting a plurality of strings of casing from inside the drilling unit into the strata below the water for drilling of wells therethrough; to provide for storage of drill stems and casing in the unit; to provide material handling equipment on said drilling unit for moving material from boats and the like into said unit; and to provide apparatus of this character that is heavily reinforced to withstand weather conditions encountered in the ocean capable of being anchored to the ocean floor and all drilling and producing operations being carried on from inside the unit and a sequence of method steps for locating, anchoring and operating said unit for exploiting oil and mineral deposits in underlying submerged areas.

In accomplishing these and other objects of the present invention, I have provided improved details of structure and methods of operation, the preferred form of which is illustrated in the accompanying drawings, wherein:

Fig. 1 is an elevational view of a drilling unit, embodying the features of the present invention, supported in the strata below the water and wells drilled from said unit to an oil deposit.

Fig. 2 is a diagrammatic view illustrating the drilling unit being moved to a desired location.

Fig. 3 is a diagrammatic view illustrating preliminary step of righting before setting of the drilling unit at a selected location.

Fig. 4 is a vertical sectional view through an underwater drilling unit embodying the features of the present invention.

Fig. 5 is a transverse sectional view through the drilling column on the line 5--5, Fig. 4.

Fig. 6 is a transverse sectional view through the drilling column on the line 6--6, Fig. 4.

Fig. 7 is a transverse sectional view through the drilling column on the line 7--7, Fig. 4.

Referring more in detail to the drawings:

1 designates a drilling unit adapted for marine oil operations, for example exploration, drilling and producing operations for exploiting underwater oil or mineral deposits. The drilling unit
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3. consists generally of a column 2, a stem 3 and an anchoring pile 4, said pile being adapted for sinking into the sediment and strata 5 below the surface of water 6, to anchor the drilling unit above or in the vicinity of a possible oil bearing stratum, for example over a sand dome or the like where oil has been found to likely occur.

The drilling unit is preferably substantially self-contained and is a see-going unit able to stand the most severe storms that might be encountered during its location and operation.

The column 2 and stem 3 are preferably prefabricated, cylindrical members of sufficient length to allow the upper end 7 of the column 2 to project above the water when the bottom of the stem is adjacent to or imbedded in the sediment on the ocean floor. The column 2 is designed to contain substantially all of the operating equipment and preferably consists of a cylindrical water-tight shell having a wall 8 of sufficient thickness and strength to withstand water pressure, action of the tide and the like, the upper end of said column being rounded as at 9 and having an opening 10 therein preferably closed by waterproof hatches 11 of suitable structure. The column is preferably of considerable size, being the largest portion of the entire drilling unit, and is of such length to provide desirable drilling and essential supplies, materials and quarters for the crew operating the unit. The diameter of the well hole to be drilled will determine the size of the drilling equipment required and will in turn dictate the overall size of the column. For example, a diameter of field 20 feet to forty feet is ample to accommodate the heaviest drilling equipment now being used. The column is also of such size in proportion to the weight that it is supported by its own buoyancy with ten to twenty feet of the column extending above mean sea level. A total length of one hundred eighty to two hundred feet should provide the space and buoyancy required in most installations. Substantially all of the operating equipment is carried in the column 2 and it is believed obvious that various arrangements and disposal of said equipment may be made therein.

In the form illustrated a wall 12 preferably cylindrical in shape is arranged in coaxial and spaced relation with the column wall 8 with its upper end suitably secured as by welding to the upper end 7 of the column as at 13. With this arrangement the cylindrical wall surrounds the hatch-covered opening 10 and extends downwardly in the column forming a guide for equipment moved into the column through the opening 10. The cylindrical wall 12 also provides a support for the inner edge of a floor 18 spaced downwardly a suitable distance from the upper end 7 of the column 2 to provide sufficient room for living and sleeping quarters 16 for the crew, the floor 15 being secured to the outer wall 8 of the column in such a manner as to add bracing support to the shell of the column as well as provide a floor for the quarters of the crew on which bunks 17 and other essentials for the comfort of the crew may be mounted.

Spaced below the floor 15 and the lower end of the wall 12 is a tubular member 18 preferably concentric with the axis of the column 2 to provide a space 19 between said member and the outer wall 8 of said column. Located in said space are a plurality of tubular shells 20 preferably of such size that each shell has contact with its adjacent shells as at 21, and also concentrically above the wall 8 at 22, and the member 18 as at 23. Each of the shells is preferably secured to the adjacent shells and to the wall 8 and member 18 as by welding or the like, forming a rigid structure that also lends support to the wall 8 to resist the pressure of the water surrounding same. One of the shells 20 preferably forms an engine compartment 24 and is provided with a plurality of engine generator sets 25 suitably supported in said compartment as by a plurality of vertical struts or other means to support it and provide an electric current for operation of all the power units in the drilling unit.

Another of the shells 20 preferably positioned diametrically of the shell enclosing the power plant is adapted to contain an elevator 26 or the like for moving personnel and equipment to the different levels in the column. The remainder of the shells 20 are preferably closed at the bottom by heads 27 to form tanks 28 for containing fuel, drilling mud, and other liquids necessary in operating and maintaining the drilling unit and in addition to provide sufficient space between the shells 20 and the wall 8 as a plurality of cylindrical tubes 30 or tanks which may also be used for storage and buoyancy control, some of said tubes preferable being equipped with ladders or the like 31 to form escape passageways for the crew in case of emergencies. Other tubes 32 may be arranged in the spaces between the cylindrical shells 20 and the member 18 to provide ventilating ducts and the like, some of said tubes being closed and used for storage of materials if desired.

The upper end of the shells 20 is preferably provided with a covering 33 the outer periphery of which is secured to the wall 8 at at 34, the inner edge of said covering 33 preferably being secured to the tubular member 18 at 35. This covering closes the upper ends of the tanks where desired and may have openings cut therethrough for escape passageways, ventilation, stairs and toilet shaft as desired. The spacing between the covering 33 and the floor 15 is of such height as to permit mounting of drawworks 36 and ventilating equipment therein, the drawworks being mounted on and supported by the covering member 33 and so arranged thereon that suitable pulleys 37 connected to the drawworks will guide cables 38 operated therethrough by means of the drawworks 36 or similar equipment therewith.

At the lower end of the column the wall 8 is turned inwardly as at 42, terminating in an inwardly directed flange forming the lower end wall 43 of said column 2, said end wall having a central opening 44 therein substantially the same diameter as the tubular member 18 to permit passage of tools and other equipment therethrough. The end wall 43 of the column is preferably spaced below the bottom of the tubular member 18 and shells 20 sufficiently to provide a drilling
chamber 45 adapted to contain rotary tables, mud pumps and other equipment normally used in conventional rotary drilling.

Mud pumps 46 are preferably mounted on the end wall 43 of said column whereby mud return lines 47 will not interfere with movement and operations on the drilling floor 45 which is mounted on the wall 5 of the column in upwardly spaced relation to the end wall 43 of said column, said spacing being sufficient to provide room for operating and maintaining the mud pumps.

Secured to the wall 8 and arranged between the floor 48 and the lower end of the shells 28 is a catwalk 45 which extends around the column to provide access to the traveling block 49 and enable the operators to carry on the drilling operations. Mounted on said catwalk or any other suitable location is a drilling station 50 preferably including control levers and the like for the drilling equipment, said drilling station being arranged whereby the driller may have visibility of the operating equipment and maintain a control thereof.

The drilling floor 45 preferably is provided with a central opening 51 to permit passage of equipment and materials therethrough. Arranged around the traveling block and secured thereto is a circular track 52 for mounting individually driven rotary tables 53 and 54, the operating motors 55 being attached to the support of said rotary tables. This arrangement of the tables on the track permits said rotary tables to be moved completely around the axis of the column whereby said rotary tables may be positioned as desired for drilling wells in any direction as later described.

Suitably secured to the end wall 43 of the column and extending downwardly therefrom is a cylindrical wall 56 forming a production chamber 57 for the unit. The chamber 57 is preferably concentric with the column and of reduced diameter, for example from twenty to twenty-five feet in diameter. The lower end of the chamber wall is turned inwardly as at 58 to provide a bottom wall 59 having an opening 60 therein concentric with the column, the width of the bottom wall 59 being sufficient to provide a plurality of openings 61 for the passage of well casing 62 as later described. Each of the openings 61 will constitute a well 63 provided with pressure equipment 64 such as are in common use in the drilling of wells in submerged areas, said pressure equipment providing a seal to prevent water from entering the production chamber.

Secured to the lower end of the production chamber around the opening 60 thereof is the stem 3. The stem preferably is hollow as at 65 and extends downwardly in close proximity to the sediment or strata below the water. Where the depth in which the exploration is to be made is known the stem may be fabricated into a single length. However, where the depth may vary the stem may be made up of a plurality of telescoping tubular members whereby the members may be extendible to a proper length for substantially extending through the depth of the water in the particular location, suitable sealing devices being provided for each section of the telescoping stem to prevent water from passing through and any drilling unit. The lower end of the stem preferably is provided with a gripping device 66 having suitable seals or packing 67 therein for engagement with the exterior surface of a pile 68 slidably mounted in the stem 3, the gripping device and packing providing a watertight seal between said pile and the stem.

The pile may be of any suitable material such as reinforced concrete and is preferably hollow as at 69. The end of the pile is tapered as at 70 and is provided with a plurality of jet openings 71 of suitable design whereby water pressure may be applied to said jets for jetting the pile into place substantially as in conventional pile sinking apparatus. After sinking the pile 68 to a suitable depth in the strata 5 below the water, concrete may be directed through the jet openings 71 for disposal around the pile as at 72 to cement the same in place, thereby anchoring said pile in the strata and providing substantial support to prevent movement of the drilling unit.

Extending outwardly through selected well heads 66 are surface casings 62. Casing is projected through the well head and into the sediment below the water. Each surface string is washed or jetted into the sediment and strata below the water with pump pressure or a jetting action as deeply as practicable and then said casing cemented in place. The casings are particularly for enclosing the drilling tools while wells are being driven, however, the casings also provide additional support and act as grout for the drilling unit to avoid spreading. Moderate flexing of the casing will not interfere with drilling or producing operations. The casing extends outwardly from the bottom of the production chamber at an angle to the axis of the drilling unit. This will require that all wells be drilled directionally but the amount of control will be minimized by starting off center. Also directional drilling is desirable in order to exploit as large an area as possible from one drilling unit. The casings 62 extend upwardly in the production chamber to substantially the lower end 43 of the column 2, however, the spacing between the upper end of the casings and the rotary tables 53 and 54 may be arranged as desired to facilitate control, maintenance and operation.

The rotary tables 53 and 54 are preferably arranged at an angle to the drilling floor, said angle being such that the axis of rotation of each table will be in alignment with the end of the respective well casing. As shown in Fig. 4, drill pipe 73 extends through the rotary table 54 and into the aligned casing whereby operation of the rotary table will rotate the tools to drill the hole for the well. Drilling mud is supplied to the drill as in conventional practice by means of mud pumps 68, the discharge of which is connected by means of a mud line 67 with the swivel head 74 on the upper end of the drill pipe as in conventional practice, said swivel head being connected to the traveling block by means of conventional balls 75.

It is to be noted that while the rotary table 54 is in operation for drilling a well, the drill pipe 76 is left in the other well casing, said drill pipe being rotated by means of the rotary table 53 and drilling mud supplied thereby by the mud line 77 to prevent the drill from freezing in the hole.

In order to facilitate drilling and storage of casing and drill pipe, the stem 3 and pile 4 are hollow, providing a large space for storage of equipment. Not only does this maintain the equipment in a convenient location for subsequent use without remachine of working area, but also provides the weight in the lower end of the drilling unit which adds to the stability of the device. If desired water may be placed in the stem and pile to assist in balancing the exterior pressure acting thereon, particularly when operating in areas covered by considerable depth of water.
While the drilling unit as shown and described will contain large quantities of supplies and essential equipment, it is necessary that additional supplies and equipment be delivered thereto. For example, in present marine practice drilling mud is mixed on the shore and delivered to the drilling site. Such practice is utilized with the present drilling unit and in order to facilitate the delivery of said and other material required in the drilling unit the upper end of the column is preferably provided with vertically extended tubular masts 78 and 79, said masts preferably extending through the upper wall 7 of the column to a point below the floor 15, the upper end of said mast being provided with suitable 80 to prevent entry of rain and the like while permitting movement of air through the tubular masts into the column for assisting in ventilating same. Carried adjacent the upper end of the tubular masts 78 and 79 is a truss structure 81 carrying a track 82 mounting a crane 83 which may be utilized for moving supplies and other material from boats, airplanes or the like used in servicing the drilling unit and disposing of said materials through the opening 85 and into the drilling unit.

In using an apparatus constructed as described, the column 2 will preferably be assembled in horizontal position on shore and an anchoring stem 3 of any required length attached thereto. All of the necessary equipment is installed in the column, concrete pile 4 inserted in the stem and the gripping device 66 adjusted to prevent any water from entering into the drilling unit. The drilling unit is then floated and towed by a suitable tug 84 or the like to the drilling site. At the selected drilling site the unit is righted by emptying the tanks 23 in the column to provide greater buoyancy adjacent the upper end thereof. The stem having less buoyancy will then settle in the water and by allowing additional water to enter said stem the unit can be arranged in a vertical or upright condition. The operations chamber being emptied of all liquid keeps the device afloat and upright, whereas the anchoring pile is released and jetted into the ocean floor with water pressure as in conventional pile sinking operations. The top 7 of the drilling unit may then be adjusted to the proper height above the surface by means of water ballast and the anchoring stem 3 reengaged with the pile 4. Concrete is then run in around the pile if required to secure anchor the unit to the ocean floor, the anchoring stem and pile being of sufficient rigidity to resist excessive movement until two or more strings of surface casing have been run from within the operations chamber and cemented to further support the device during adverse weather conditions.

Initial drilling operations will amount to running casing 67 from the operations chamber into the sea bed, said casing preferably being directed into the sediment 5 on the ocean floor at a point in line with the final objective for the well to be drilled through it. Each surface string of casing should be washed into the ocean floor with pump pressure as deeply as practicable before being cemented as at 85. A moderate amount of flexing caused by movement of the ocean water will not interfere with subsequent operations. After the desired casings have been cemented into the ocean floor, the unit is then ready for further operations. Fuel, drilling mud, water and any other required liquids are placed in the various tanks, suitable supplies for the crew arranged in the crew quarters 6 and a supply of casing and drill pipe is arranged in the hollow casing of the anchoring stem and pile. Drilling operations may then be commenced and conventional drilling practices will be followed as nearly as practicable until the wells penetrate the oil deposits 86.

In operation the drilling preferably proceeds in two steps alternately. Thus the drill pipe can be pulled from one hole and run into the second without standing it on the drilling floor. This keeps the drilling floor clear and prevents top-heaviness in the column and eliminates the need for a derrick. Use of two individuals driven rotary tables 53 and 54 mounted on a circular track 52 about the center of the drilling floor 48 permits the positioning of the rotary tables in a position suitable for drilling the holes in the direction of the well object. Independent mud circulating systems permit the drill pipe remaining in one hole to be rotated and circulated while drilling proceeds in the other, thereby preventing the freezing of the drill pipe in the hole. Should it be undesirable to drill more than one well at a time it is still possible to keep the drill floor clear by running the drill pipe into the stem as it is pulled. This also provides decreased top-heaviness and buoyancy of the column. The anchoring stem may also be kept full of water or mud to aid in balancing external pressures it being preferable that the differential pressure on any part of the column or stem not exceed one hundred pounds per square inch. It is to be noted that the mud pumps are located below the drilling floor whereby the mud circulating lines may extend downwardly into the production chamber and back up to the swivel head on the end of the drill stem, thereby preventing the tangling or interference of the mud return lines.

Should the test of the earth structure prove unsuccessful, all except the anchoring pile can be salvaged and moved to a new location. If production is found it will be left in place until the wells drilled therefrom are depleted. While drilling is still in progress, we're already completed may be produced from under the drilling floor, the oil stored in certain of the tanks in the column and delivered from there to tankers.

The structure illustrated is a simple form of the invention and it is possible to provide compartmented closing and sealing hatches, and other equipment in case there is any requirement for same. The engines are placed in a separate compartment and all oil leaks can be prevented by proper supervision thereby substantially eliminating hazard of fire. Elevators and passageways provide access to all parts of the unit and ventilation is maintained during bad weather through the tubular masts. During good weather the hatch 11 may be left open.

It is believed obvious that I have provided a simple, economical and efficient method and apparatus for exploiting submerged oil and mineral deposits.

What I claim and desire to secure by Letters Patent is:
1. The method of exploiting submerged oil deposits consisting of enclosing drilling and producing equipment in an impervious buoyant housing, floating said housing to a selected location, shifting the center of gravity of the housing to position same upright in the water with the portion extending above the water, projecting an extension from the housing into the submerged strata on a substantially vertical
9 line for anchoring said housing, cementing the extension in said strata projecting well casing from inside the housing into the strata at an angle to the vertical line of the housing, inserting drill devices into the casing, and rotating said drill devices from inside the housing for drilling through the submerged strata to oil deposits thereunder.

2. A drilling unit for exploiting submerged oil deposits including, an elongated waterproof chamber, well drilling equipment in said chamber, an axial extension means in the chamber projectable into the submerged strata supporting said chamber in an upright condition with the upper end extending out of the water, a packing in the lower end of the chamber and having sealing engagement with the extension for excluding water from the chamber, well casings extending from within the chamber into the strata in spaced relation to the extension means and at an angle to the axis thereof, and means for drilling wells through said casing into underlying oil deposits.

3. A drilling unit for exploiting submerged mineral deposits including, a buoyant column, well drilling equipment in said column, an axial extension in said column projectable into the submerged strata for anchoring the column, a packing means on the lower end of said column sealingly engaging said extension, a plurality of tanks adjacent the upper end of the column for controlling the buoyancy of the column to effect upward movement thereof relative to the anchoring means, means for projecting casing members from the column into the submerged strata at an angle relative to the axial line of the column, and means for drilling well through the surface casing into the strata to mineral deposits therein.

4. A drilling unit for exploiting submerged mineral deposits including, a buoyant column, well drilling equipment in said column, a pile in said column coaxial therewith and projectable into the submerged strata for anchoring the column, means for controlling the buoyancy of the column to effect upward movement thereof relative to the anchoring pile, means in the lower end of the column for engaging the anchoring pile to form a waterproof seal preventing leakage of water in the column, a plurality of tanks for projecting casing members from the column into the submerged strata at an angle relative to the axial line of the column, and means for drilling wells through the surface casing into the strata to mineral deposits therein.

5. A drilling unit for exploiting submerged mineral deposits including, an elongated buoyant column, well drilling equipment in said column, a coaxial tubular extension on the lower end of said column, a pile slidably mounted in said extension and projectable into the submerged strata for anchoring the column, a plurality of tanks adjacent the upper end of said column for controlling the buoyancy of the column to effect upward movement thereof relative to the anchoring pile, means in the extension engaging the anchoring pile to form a waterproof seal preventing leakage of water in the column, a plurality of tanks for projecting casing members from the column into the submerged strata in spaced relation to the extension means and at an angle relative to the axial line of the column, and means operated by the well drilling equipment for drilling wells through the surface casing into the strata to mineral deposits therein.

6. A drilling unit for exploiting submerged mineral deposits including, an elongated cylindrical chamber, a plurality of ballast tanks in said chamber for controlling the buoyancy thereof whereby said chamber will stand upright in the water with the upper end thereof projecting above the water level, drawworks and ventilating equipment in the chamber above the ballast tanks, rotary tables and mud pumps in the lower end of said column, a production compartment extending downwardly from said chamber and having a plurality of openings therein, casings extending through the openings in the production compartment wall and through the water into the strata, pressure equipment for sealing the openings around said casing, a coaxial tubular extension on the lower end of said chamber, a pile slidably mounted in said extension and projectable on a substantially vertical line into submerged strata for anchoring the chamber to the submerged strata, means in said extension engaging the pile for sealing said extension against entry of water, and means for drilling wells through said casing and submerged strata to underlying oil deposits.

7. A drilling unit for exploiting submerged oil deposits including, an elongated cylindrical chamber, a plurality of ballast tanks in said chamber for controlling the buoyancy thereof whereby said chamber will stand upright in the water with the upper end thereof projecting above the water level, material handling equipment on the upper end of the chamber, operating crew quarters at the upper end of said chamber, drawworks and ventilating equipment under the crew quarters, a drilling compartment at the lower end of said chamber, rotary tables and mud pumps in said drilling compartment, a production compartment extending downwardly from said drilling compartment and having a plurality of openings in the wall thereof, casings extending through the openings in the production compartment wall and through the water into the strata, pressure equipment for sealing the openings around said casing, a hollow stem extending downwardly from the production chamber, a hollow pile mounted in the stem and having projecting end means in the submerged strata for anchoring the chamber thereto, means in the stem engaging the pile to form a waterproof seal preventing leakage of water into said stem, and means for drilling wells through said casing and submerged strata to underlying oil deposits.

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