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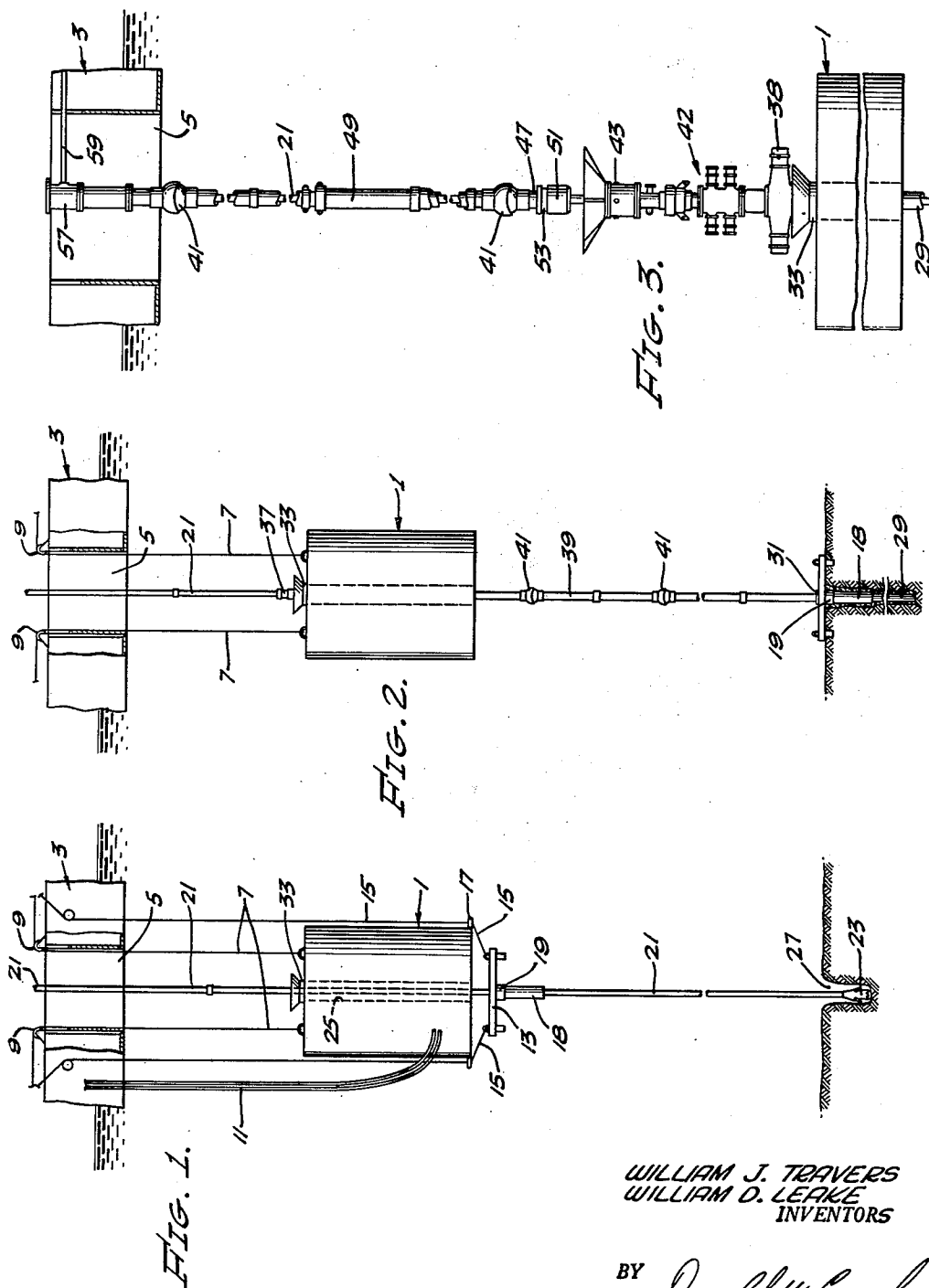
W. J. TRAVERS ETAL

3,196,958

OFFSHORE DRILLING METHOD AND APPARATUS

Filed April 4, 1960

3 Sheets-Sheet 1



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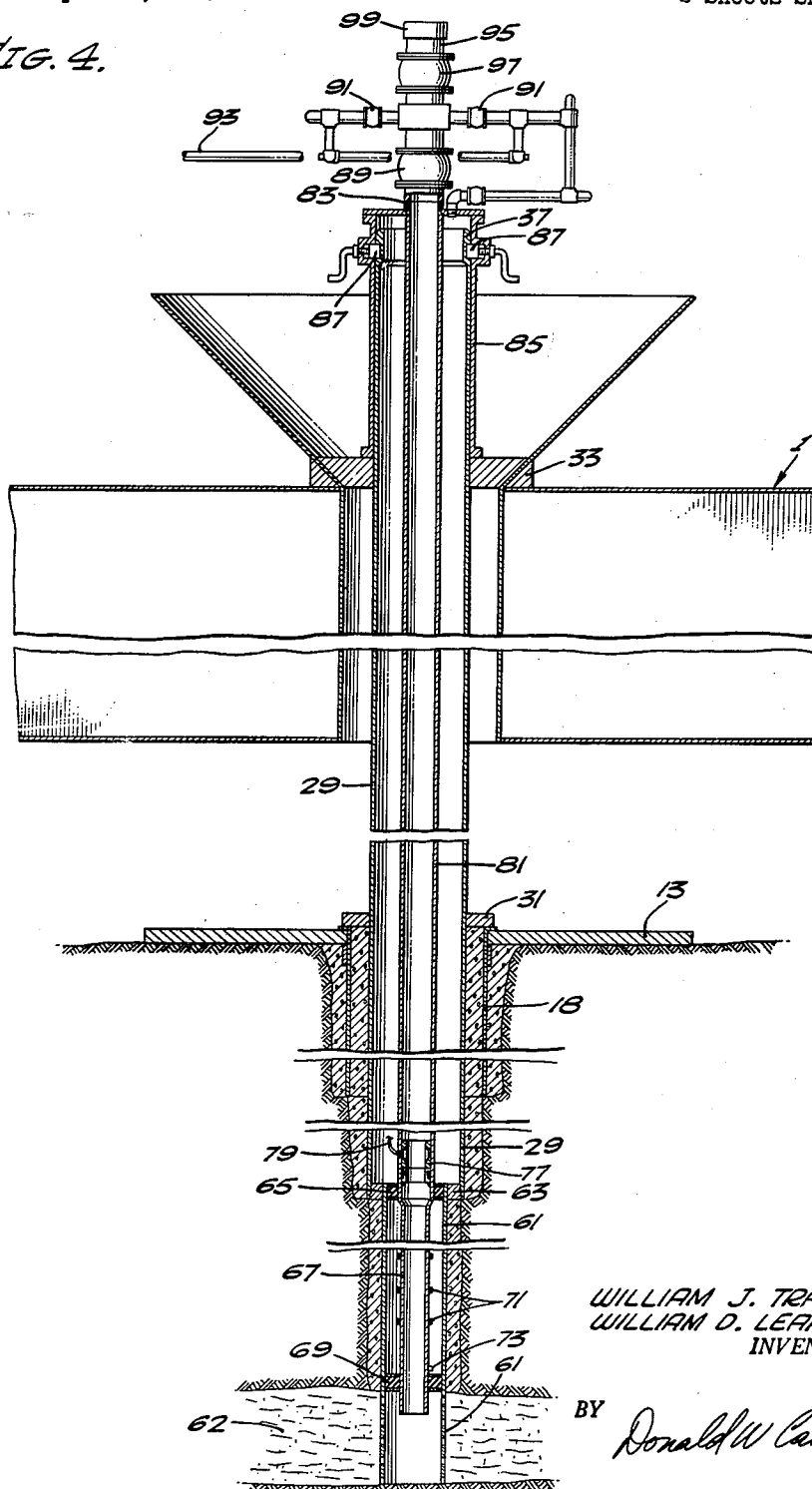
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3 Sheets-Sheet 2

FIG. 4.



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3,196,958

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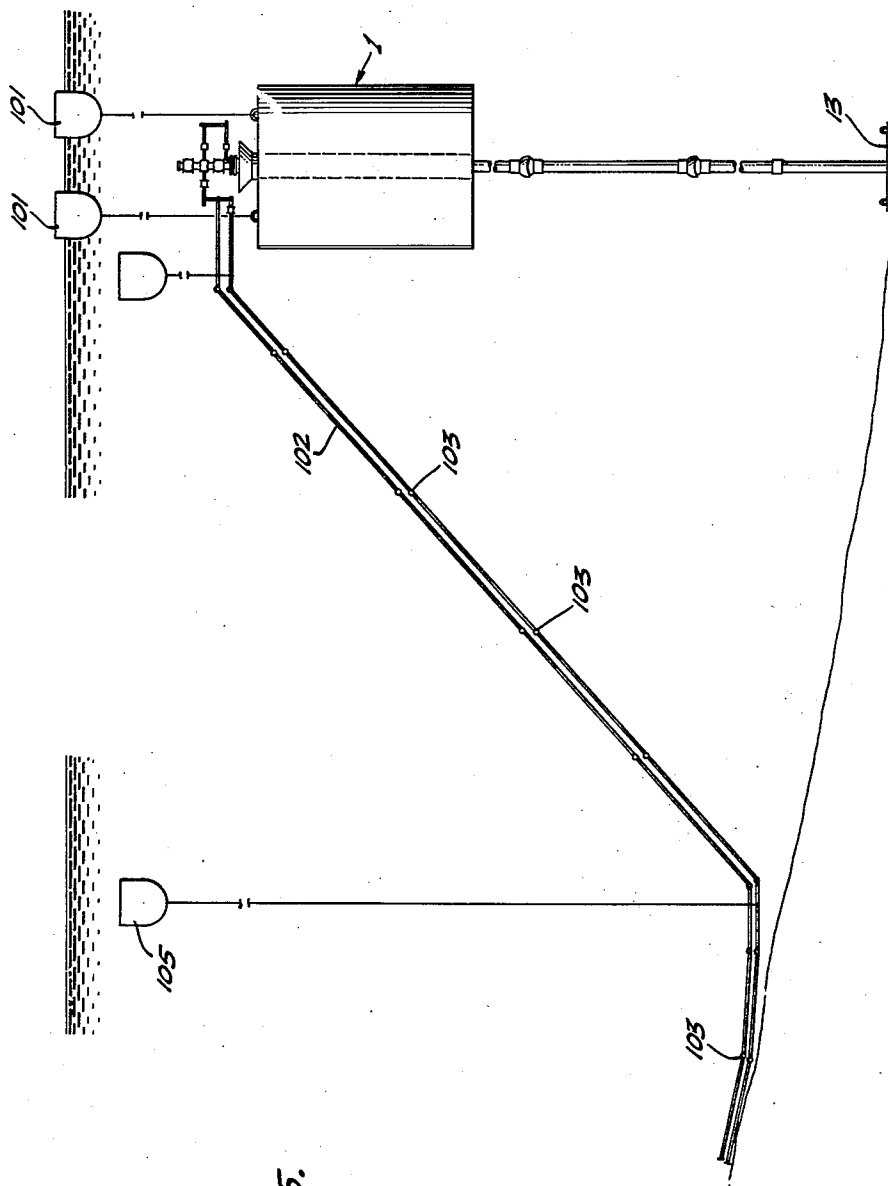


FIG. 5.

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1

2

3,196,958 OFFSHORE DRILLING METHOD AND APPARATUS

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4 Claims. (Cl. 175-7)

The present invention relates to a method and apparatus for drilling a well bore in a formation underlying a body of water and more particularly relates to a method and apparatus for drilling in deep water utilizing a float device submerged below the surface of the water for mounting well head drilling and production equipment.

Heavy waves and wind conditions normally encountered in the open ocean, pose difficulties in drilling with equipment based on a ship floating on the ocean. Movement of the drilling vessel relative to the ocean floor not only makes it difficult to re-enter the well bore with the necessary drilling equipment but also greatly hampers the drilling operation when the drill string or casing extension deviate from vertical.

Offshore drilling operations in water deeper than approximately 200 feet present difficulties with respect to making the necessary connections and repairs, and the replacement of various equipment by a diver as the drilling operation proceeds. Diving equipment does not enable the diver to remain submerged at such depths for long periods, hence work at greater depths is accomplished only with numerous short dives, which are expensive and time consuming.

It has heretofore been proposed to locate submarine well head equipment on a submerged float platform positioned beneath the surface of the water deep enough to avoid the disturbances due to wind and waves. These prior proposals, however, required an anchoring of the submerged float to prevent lateral movement of the float. This lateral movement is particularly undesirable in that during the drilling operation departure of the drill string from vertical will cause rapid wear on the casing and any bearing surfaces or packing equipment engaging the drill string. The use of anchors for guiding the float as proposed in the prior art is accomplished only with difficulty due to the serious limitations in presently known means for permanently anchoring equipment in deep water.

Accordingly, it is an object of the present invention to provide apparatus and a method for drilling into a formation underlying a body of water utilizing a submerged buoyant platform.

It is a further object of this invention to provide apparatus and a method for drilling in deep water whereby the equipment which normally wears out and requires servicing is positioned at an accessible depth beneath the surface of the ocean.

It is also an object of the present invention to provide apparatus and a method for drilling into the ocean floor in deep water utilizing a submerged buoyant platform which is unanchored laterally.

Other objects and a fuller understanding of our invention may be had by referring to the following specification and the appending claims taken in conjunction with the drawings, in which:

FIGURE 1 shows the float submerged below the drilling barge and the equipment arranged for drilling the initial hole for placement of the conductor pipe and base plate.

FIGURE 2 shows the surface casing and conductor pipe cemented in the hole and a surface casing extension or casing riser extending up through the float.

FIGURE 3 shows the blowout prevention equipment mounted on the float and a flexible casing riser which extends from the float to the drilling barge.

FIGURE 4 shows the well completion equipment in the well and at the well head after the drilling equipment has been removed and the barge disconnected from the float device.

FIGURE 5 shows the completed well with flow lines extended to separating and gauging facilities.

Briefly described, my invention utilizes an unanchored float submerged to a relatively shallow depth as a base for locating well control equipment for drilling from a floating barge and provides for a sufficient buoyant restoring moment in the float to resist any forces that tend to displace the float from a location directly above the well bore on the ocean floor sufficiently to interfere with insertion, retraction, or rotation of the drill string. The float is provided with an opening through which the drilling operation is conducted. When the drilling operation is finished and the well completed, the float serves as a base for the well head control equipment.

Referring now, to the drawings, a float 1 shown in FIGURE 1 is towed to the drilling location with a drilling barge 3 and a negative buoyancy imparted thereto to position the float as shown, beneath the well 5 of the drilling barge. Before submerging the float, wire lines 7 are connected to the float and mounted on pulleys 9 which, in turn, are mounted on the barge deck. The buoyancy control hoses 11 extend from the float to the ship. The float may be a chambered structure to facilitate controlling its buoyancy as by evacuation through hoses 11.

A well head base plate 13 is suspended from the barge below the float on cables 15 which are slidably connected to the float by means of hooks 17. The upper end of a conductor pipe 18 is affixed to the base plate 13 with a sleeve 19. A two-stage expanding bit 23 is lowered to the formation on a drill string 21 through a central opening 25 in the float and through the conductor pipe and base plate 13. The expanding bit is set at its large opening and a hole 27 drilled for the landing of the conductor pipe.

The conductor pipe and base plate are then lowered over the drill pipe 21 to the formation so that the conductor pipe extends into the initial hole 27, as shown in FIGURE 2. Using a smaller opening on the expanding bit 23 the hole 27 is deepened to exceed the desired surface casing length. Surface casing 29, of smaller diameter than the conductor pipe 18, is then lowered through the float and the conductor pipe over the drill string and landed when a ring 31 externally provided on the surface casing, engages the base plate 13. The casing extends from the ocean floor through the float 1 and is equipped with a massive collar 33 at its upper extremity to support the casing extension 39 and to restrain the float. An anchor mandrel 37 for the blowout prevention and well head equipment is affixed to the upper end of the surface casing 39. The casing extension or riser 39 is provided with swivel spherical couplings 41 to permit the casing to flex laterally to a limited extent. The massive collar 33 enables the float 1 with its reserve buoyancy to hold the surface casing riser 39 in tension and thus prevent substantial lateral movement of the float about the vertical.

The surface casing and conductor pipe are cemented in the hole 27 by pumping cement through the drill pipe 21 in the conventional manner. Up to this point, the float 1 has a negative buoyancy and is supported by cables 7. After the cement has hardened, the float is evacuated to impart a positive or reserve buoyancy to the float which tends to cause the float to move upward. This

upward force is resisted by the casing riser 39 through collar 33 which results in a tensioning of the casing 39.

With the drill string extending through the float, blowout prevention equipment 42 is lowered to the float on suitable cable lines (not shown). The lower end of the blowout prevention assembly 42 is landed on the surface casing mandrel 37 and the rams of the blowout preventer 38 closed to latch the blowout prevention equipment onto the surface casing and float assembly. The drill pipe over which the blowout prevention equipment is lowered, provides positive guidance onto the surface casing landing mandrel 37.

A flexible casing riser 47 having spherical swivel joints 41 and a slip joint 49 and equipped at its lower end with a casing riser hold down mandrel 51 is lowered over the drill pipe 21 down to the blowout prevention assembly with the hold down mandrel extending into the upper end of the blowout prevention assembly. Latching pins 43 are then actuated to engage groove 53 of the hold down mandrel to secure the casing riser to the top of the blowout prevention equipment. At the upper end of the casing riser a pitcher nipple 57 is provided and return hose 59 permits drilling fluid to return to the storage tank (not shown) for recirculation into the well through the drill string.

When the well is converted from a drilling to a producing well, a production liner 61 is hung inside the surface casing 29 and cemented from the top of the producing formation 62 to the bottom of the surface casing. The liner 61, which may be a combination blank and perforated liner, is hung from the liner hanger 63 which mechanically grips the lower end of surface casing 29 in the conventional manner. A conventional hydraulic tubing hanger and packer 65 may be used to land and hang tubing 67 inside the liner 61. An additional packer 69 may be positioned just above the perforated interval of liner 61, to center tubing 67 and seal between the tubing and liner. Tubing 67 may contain conventional fittings such as gas lift valves 71, closable circulating port 73, and a safety valve 77. A safety valve 77 may be held open with hydraulic pressure through a surface control unit 79 or equivalent mechanical means in such a manner that sharp pressure fluctuations or a sudden pressure reduction in the fluid flowing beyond this safety valve causes it to shut off all flow into the flow pipe 81. Thus the safety valve protects against the loss of oil in case of damage to the casing or tubing above the ocean floor, the float and well head equipment, or to the flow line.

Flow pipe or tubing extension 81 extends from the tubing hanger 63 to the tubing head 85 where it is threadably connected at its upper end 83. The tubing head 85 is lowered and landed on the massive collar 33 and is latched and sealed onto mandrel 37 with sealing rams 87 provided in the tubing head. These rams may be operated mechanically (as shown) by a diver or remotely by hydraulic means. The particular flow control arrangement in the well head is dependent upon the formation and the type of well being produced. The illustration shown in FIGURE 4 shows a master flow valve 89 with double exit flow line equipped with exit valves 91 which control the flow of well fluid into the flow line 93. An access head 95 is provided for re-entry into the tubing-casing annulus through a re-entry valve 97 and is equipped with a quick release re-entry cap 99.

Each of the aforementioned valves can be remotely controlled at the gauging and separating facilities by laying control lines with the flow lines. The well head control equipment is thus permanently located on the float and since it is beyond the area of extreme oxidation can be expected to last the life of the well.

FIGURE 5 shows the flow lines in place after the barge has left the immediate vicinity and the float device 1 is marked with marker buoys 101.

The float suspension lines 11 (FIGURE 1) are buoyed

off when the drilling barge leaves the well site and thus can be relocated whenever necessary. Flow lines 102 may be equipped with swivel couplings 103 to provide flexibility. Two flow lines may be used as shown in FIGURE 5, to permit the recirculation of hot oil to eliminate paraffin deposition and plugging in the flow line. The flow lines 102 descend gradually to the ocean floor in the direction of the land based separating and gauging facilities (not shown) and extend thereto on the ocean floor. The graduation may be facilitated by providing one or more auxiliary buoys 105.

Thus the present invention provides an unanchored submerged float which serves as a base for drilling and producing well control equipment which float is readily accessible to a diver for inspection or repairing. By providing flexible couplings in the casing riser between the ocean floor and the float and between the float and the drilling barge and in the flow lines, the float can move laterally to a certain degree without creating severe flexure stresses. By designing sufficient reserve buoyancy into the float and securing the casing riser 39 thereto it will inherently resist any force that tends to displace it from a point directly above the well location on the ocean floor. This designed buoyant restoring moment of the float can be made great enough so that the float's lateral movement will at no time cause sufficient curvature in the casing below or above the submerged float to interfere with the operation of the drill string or injure equipment used in the operation.

Although the invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of the method and the combination and arrangements of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

We claim as our invention:

1. Apparatus for use with a floating vessel for drilling a well in the formation underlying a body of water, comprising in combination: a bottom structure fixed on the formation, and underwater float of controllable buoyancy, a tubular member fixed to said structure and extending upward to said float, said tubular member having longitudinally spaced laterally flexible joints therein, tubular apparatus secured relative to the float and resting thereon and including a blowout prevention device, said tubular apparatus extending upward above said float and being fixed at its upper end to said floating vessel and having a telescopic joint therein, the buoyancy of the float serving to maintain said tubular member in sufficient tension to retain said float in substantial alignment with said vessel and said bottom structure and serving to support the weight of said tubular apparatus and means for operating drilling tools from the floating vessel through the interior of the tubular apparatus, underwater float and tubular member and said bottom structure.

2. The apparatus of claim 1 wherein said tubular apparatus includes a laterally flexible joint above and below said telescopic joint.

3. The apparatus of claim 1 including means for varying the buoyancy of said float.

4. A method for drilling a well bore from a floating vessel into a formation underlying a body of water, the steps comprising: imparting a negative buoyancy to an apertured float of controllable buoyancy to submerge said float to an accessible diving depth, operating a drill string extending through the interior of said float from said vessel to drill a hole in said formation, lowering a tubular member through the interior of said float and into said drilled hole, securing the lower extremity of said tubular member to said formation and the upper end of said tubular member to said float thereafter imparting a positive buoyancy to said float sufficient to tension said tubular member and maintain said float in

5

substantial alignment with said vessel and said formation and operating drilling tools from said vessel through said tubular member.

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