

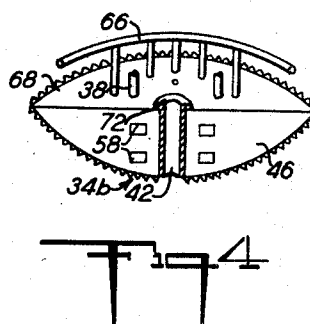
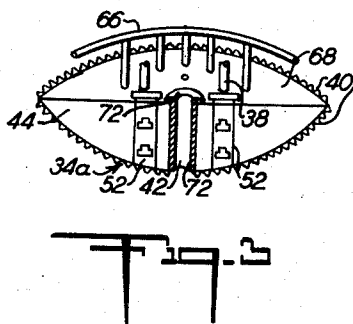
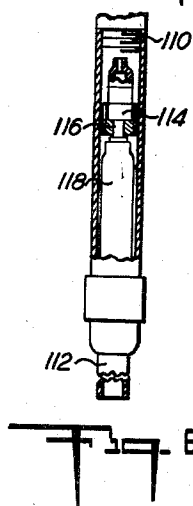
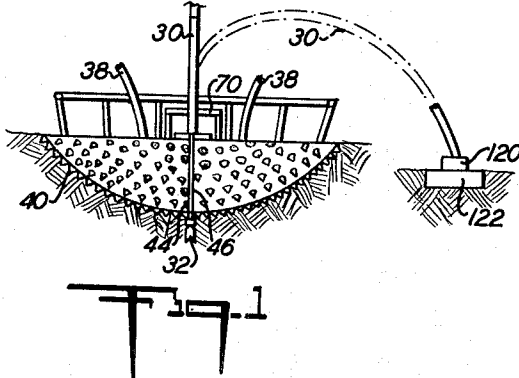
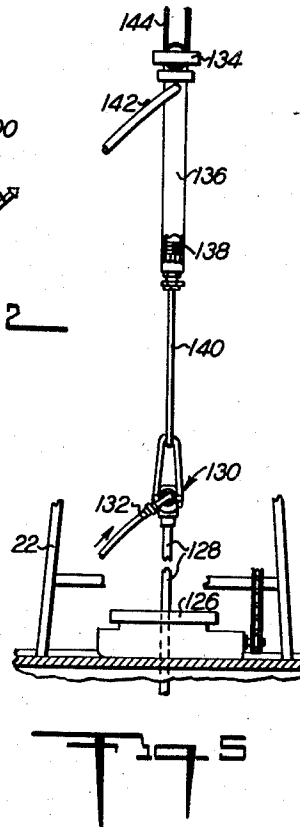
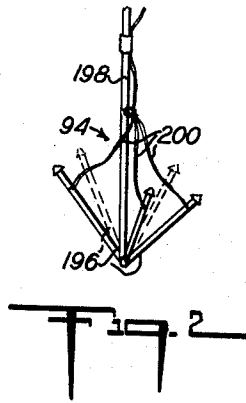
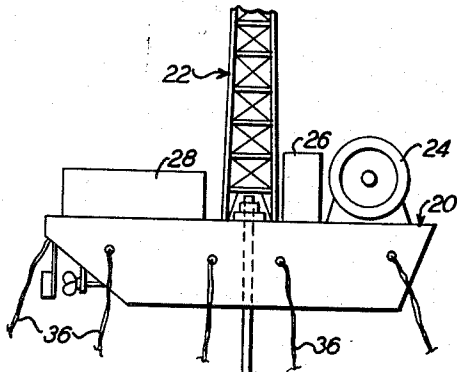
April 27, 1954

H. L. JOHNSON
DRILLING EQUIPMENT

2,676,787

Filed June 22, 1949

2 Sheets-Sheet 1



INVENTOR

HOWARD L. JOHNSON

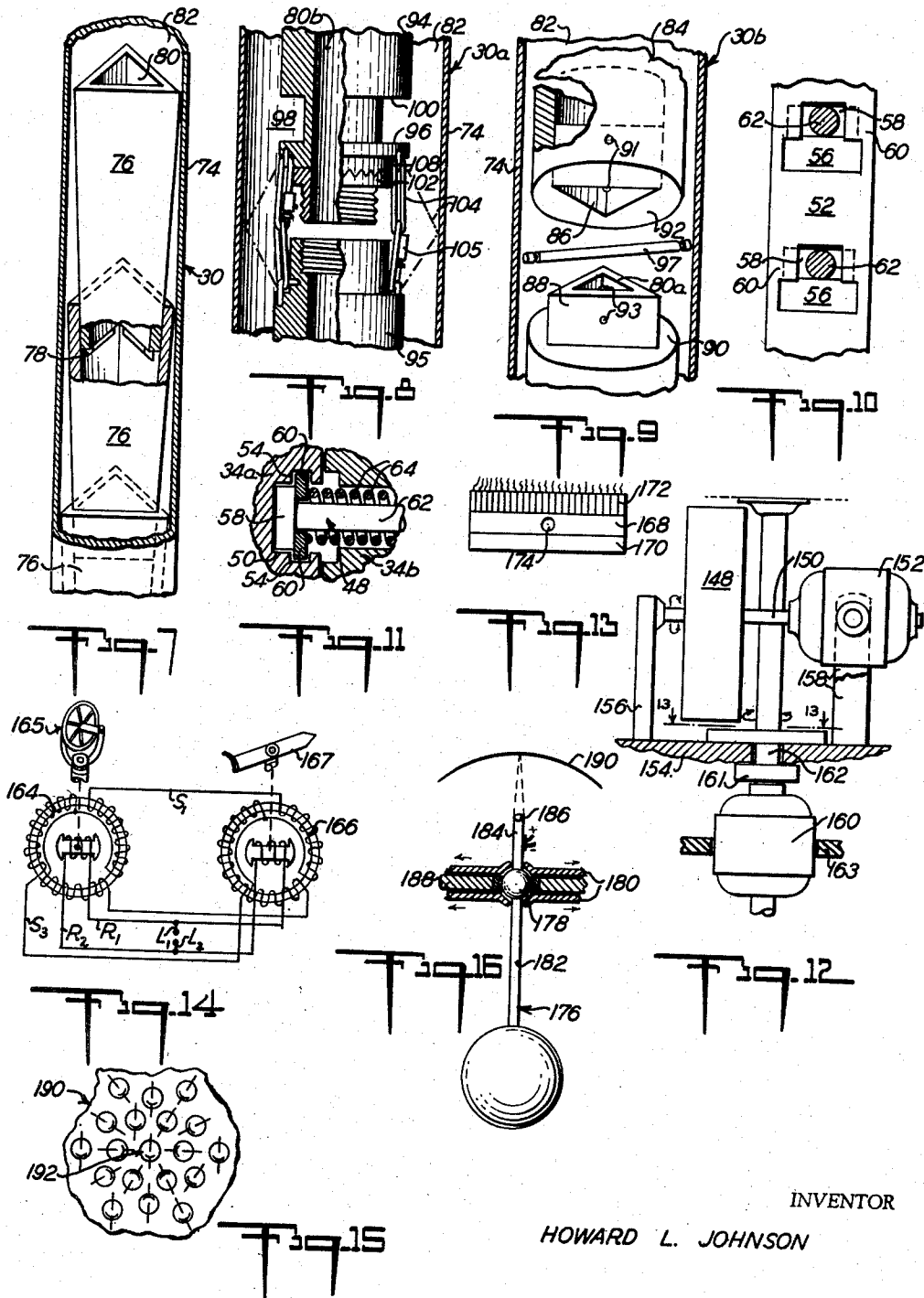
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

2,676,787

DRILLING EQUIPMENT

Howard L. Johnson, Washington, D. C.

Application June 22, 1949, Serial No. 100,578

12 Claims. (Cl. 255-1.8)

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This invention relates to drilling equipment for forming bores such as those of oil wells, thru the floor of a body of water such as the ocean.

It is well known that oil bearing strata underlie bodies of water just the same as they underlie the adjacent dry land. This is particularly true of the continental shelf area of western North America, the Gulf of Mexico, the Persian Gulf, etc.

Hitherto exploitation of such submerged oil deposits has been limited to slanting drill lines out from shore or else drilling from a rigidly anchored base vertically located over the oil field. Such operations have been by sinking a drilling barge or caisson on the floor of shallow water and then drilling from within the caisson, or from the surface of the water, or from above the water if the sunken structure extends up this far. Or a floating barge is anchored to the bottom by pilings so as to form what amounts to an artificial island. All of these methods are necessarily limited to use in calm and shallow water, and in addition involve great expense.

Now by the present invention there is provided means for vertically drilling thru that portion of the earth or ocean floor which is covered by any depth of water. Drilling is effected from a floating barge, temporarily anchored against substantial lateral displacement but vertically oscillatable with the swell in contrast to previous drilling barges. Whereas previous equipment required drilling from a rigid base because it employed a rigid drill stem, I use a segmented drill stem which is convertible at will between rigid and flexible forms; under pressure from the drilling head my stem is rigid and rotatable as a unit, when drilling is interrupted, the segments are separable so as to transform the drilling line into a completely flexible one, the rigid segments being longitudinally aligned at all times within a flexible conduit.

Since the drill stem is not laterally supported thru the depth of water, anchoring and guide means are provided for the drill stem and bit at the bottom of the water. These means comprise a sinkable barge, separable for refloating into two or more parts along a guide channel which receives the drill stem and bit therethru. The sunken barge is maneuverable on the ocean floor from the floating barge so as to direct the drill bit at any desired angle as it pierces the ocean bottom; the sunken barge is also provided with indicating means for conveying to the surface operator, information of the precise angular position of the guide channel.

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In this manner, drilling is no longer limited to the comparatively shallow depths in which a diver or sand hog could work (for limited periods) or to the extent to which piling could be used to support a rig for drilling from above the surface of the water. In addition, drilling is no longer limited to calm water, since my flexible drill line can be disconnected at the top, and the floating barge temporarily removed upon the imminence of a period of severe storms such as the monsoons. The freed end of the drill line is dropped to the bottom of the ocean in an arc to avoid the upper choppy zone of water, and later picked up and drilling continued after a storm. This of course would be impossible with a rigid drill line.

Aside from the marine equipment, certain features of my invention, in particular the segmented drill stem, can also be used to advantage in land based drilling.

Additional advantages will become apparent as the description proceeds.

In the drawings which form part of the present specification:

Fig. 1 is an elevational view of the floating drill rig, the sinkable barge shown in operative position on the ocean floor, and the anchoring member showing the drill line in broken lines in inoperative position;

Fig. 2 is a perspective view of a collapsible grappling hook adapted for separating the segments of Fig. 7 within the flexible conduit;

Figs. 3 and 4 are perspective views of the two halves of the sunken barge shown broken apart for refloating;

Fig. 5 is an elevational view, with portions broken away, of the operating structures connected to the upper end of the drill line on the floating barge;

Fig. 6 is an elevational view partly in vertical section of a turbo drill operatively connected to the lower end of the drill line;

Fig. 7 is a perspective view, partly in vertical section, of my flexible drill line;

Fig. 8 is a similar view of my flexible drill line showing a modified form of connectible segments therein;

Fig. 9 is a similar view of my flexible drill line showing yet another form of interlocking segments disposed within the outer conduit;

Fig. 10 is an elevational view of the locking mechanism of the barge segment of Fig. 3;

Fig. 11 is a horizontal sectional view taken through the interlocking means which holds together the two portions of the sunken barge of Fig. 1;

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Fig. 12 is an elevational view of mechanism within the sunken barge for indicating and altering the angular position of its central guide channel;

Fig. 13 is a top plan view showing a bank of photocells arranged to observe the position of a spirit level within the sunken barge as seen along the line 13—13 of Fig. 12;

Fig. 14 is a schematic showing of electrical circuits and mechanisms for correlating the rotational position of the sunken barge with a surface indicator;

Fig. 15 is a schematic lower face view of a concave bowl or supporting structure showing the manner of radial arrangement of photocells across the surface; and

Figure 16 is an elevational view, partly in vertical section of a freely swingable pendulum within the sunken barge, showing a brake therefor and carrying a light and lens at its upper end for indicating its swing or rest position to the photocells of Fig. 15 which latter structure is disposed generally horizontally thereabove.

There is here illustrated a floating drilling rig or ship 20 which is provided with such equipment as a derrick 22, engine 24, winch 26, pumps 28 for providing compressed air and circulating drilling fluid or mud thru the drill line 30 to the drill bit 32. Air pressure is used both for applying down-pressure to the drill stem and bit and for blowing water out of the sinkable barge 34 upon refloating. The drill rig together with the sinkable barge are moved to the location where a submarine well is desired, and the former is then secured by anchor lines 36 against lateral displacement over the place where seismic or other exploratory methods have indicated the presence of a geological structure likely to contain petroleum.

The sinkable barge 34 is formed of two outwardly similar parts 34a, 34b each having buoyancy chambers which can be pumped or blown out by lines 38, from surface equipment. The barge has a generally hemispherical bottom covered by spikes 40 for engaging the ocean floor, the two parts a and b being separable along a generally vertical line which bisects an upright guide channel 42 formed jointly by the adjacent end walls 44, 46. Accordingly the sunken barge can be broken apart along the guide channel 42 and refloated, leaving the drill line 30 (or the outer flexible conduit thereof) in place after the bit 32 has been driven to the desired depth, and withdrawn.

The drill bit 32 is connected to the drill line 30 and placed in the guide channel 42 before the barge is sunk, the two parts thereof 34a and 34b being held together by a series of horizontally oscillatable bolts 48 in part b which are extended into corresponding sockets 50 (Figure 11) in part a and held by a vertically slidable, metal plate 52 (Figure 10) disposed in a guide way 54 of part b, being cut-out at apertures 56 thru which the enlarged head 58 of each bolt may be inserted when the plate is in its "Up" position. The plate being then depressed to locking position (Figure 11), the portions 60 of the sliding plate are disposed along opposite sides of the neck 62 of the bolt and against the rear face of the protruded head 58 so as to prevent its withdrawal from the socket 50. Within the barge part 34b, the neck 48 of the bolt is connected to a coil spring 64 tensioned to withdraw it from the socket 50 in the adjacent barge part 34a.

The sliding plate 52 or at least the upper end

thereof being formed of rust resistant iron, it can be raised to release the bolts 48 and thus break apart the two parts of the barge, by means of a magnet or electromagnet (not shown) lowered from the surface vessel, or by an electromagnet built in the barge 34a and energised by a current from the floating barge 20. An elevated circular railing 66 is located about the flat top 68 of the complementary parts of the sinkable barge, above which top the severable guide channel 42 may extend in a peripherally enlarged guard portion 70. When employing a drill line 30 of less diameter than the guide channel 42, an axially split, detachable spacing collar 72 is located within the channel between the barge portions 34a and 34b, and the drill line 30.

The drill line 30 is composed of an outer flexible conduit 74 having disposed therein a series of longitudinally aligned, separable tubular segments 76, triangular (or other polygonal form) in cross section, with downwardly restricted, tapered walls so that the lower end of one segment will nest or fit snugly within the top of the segment immediately below. If desired, the base of the upper socket of a segment may be provided with an abutment ledge 78 discontinuous at the corners. It will be observed that the length of each segment is greater than the inner diameter of the conduit so that upon the segments 76 being separated from each other therein, they cannot become inverted but remain longitudinally aligned. When the segments are separated, the whole line 30 is thus flexible, but upon the outer conduit 74 being held upright, and down pressure applied to the inner string of separated segments 76, the latter will join together as above described to form a rigid drill stem which may be rotated as a unit, within the conduit, from the floating platform 20 so as to operate the drill bit 32 below the sunken barge. At the same time, drilling fluid or mud may be circulated to the bottom of the bore in the customary manner, pumped down thru the aperture 80 of the tubular drill stem and out thru or around the bit, thence back to the surface carrying the cuttings by moving thru the space 82 between the outside of the connected segments 76 and the inside of the outer conduit 74.

A modified form of segment construction is shown in Figure 9, wherein the longitudinally apertured body of the segment 84 may be cylindrical in shape, with its respective ends formed as a triangular socket 86 and a correspondingly shaped, engaging stud 88 projecting upward from an abutment ledge 90 and adapted to be received within the socket when the flat end 92 of the upper segment is pressed upon the abutment ledge of the lower segment. Again, in such position the segmented drill stem may be rotated as a rigid unit under down-pressure, with fluid circulated thru its length to the bit. If desired, a removable pin 97 may be inserted thru the aligned apertures 91, 93 to lock the segments against longitudinal separation.

Still another form of segmented drill stem, which is rotatable within the flexible conduit 74 is illustrated in Figure 8, in this case adjacent lengths 94, 95 of the tube being screw threadedly connected, similar to conventional practice. However, there is additionally provided on the male end of the segment 94, a loose fitting slidable collar 96 located in a peripherally restricted recess 98 and slidable between opposing terminal abutments 100 and 102 thereof. At several points,

the collar is connected by links 104 separable by disconnecting means 105, to the outer surface of the female end of the adjacent pipe segment, the links being of such length that a pair of coupled pipe segments can have their adjacent ends separated by the distance required to give the desired flexibility to the separated drill stem within the flexible conduit 74. The lower edge of the collar 96 is formed with generally axially and conically directed teeth 106 adapted to frictionally engage a corresponding series of teeth or sockets 108 around the upper edge of the segment shoulder 102. Accordingly, the upper segment 94 can be unscrewed from the lower segment while remaining within the conduit 74 and drawn up so as to mutually engage or lock the complementary teeth 106 and 108; further rotation of the upper segment 94 thereupon rotates the lower one 95 in unison so as to unscrew the latter from the similarly connected segment immediately below it. This process is effected from the drilling platform 20 for each joint which it is desired to unscrew. The segments may be recoupled within the conduit by merely reversing the direction of rotation. It will be observed that with this construction of drill stem with threaded segments, it does not require a continuous down-pressure from the drilling platform to keep the segments united, altho of course it may still be desirable to transmit pressure in such manner to the bit.

While rotation of the segmented drill stem within the conduit 74 for the purpose of imparting corresponding motion to a rotary drill bit of either the fish tail type 32 or a rock bit has just been emphasized, it should be apparent that the drill line 30 can also be employed without rotation, for drilling with a turbine type drill (Figure 6) by circulation of fluid thru the line opening (80) thereto.

In the turbo drill (Figure 6) the upper end of the shell 110 is threadedly or otherwise attached to the bottom of the non-rotating drill stem, and the bit (not shown) is secured at the other end to the rotating tube 112, thru each of which the drilling fluid passes to the bottom of the bore. Moving fluid forced down (by the surface pump) thru the rotor 114 of the hydraulic turbine, propels the drive shaft 116 which is coupled to sealed reduction gears 118 which in turn transmit the movement to the drive tube 112, the fluid traveling around the reduction gears which operate in oil.

When for any reason such as the imminence of a period of rough weather, it is desired to temporarily remove the drilling rig 20 before drilling is completed, after separation of the segments 76, 84 or 94 within that length of the conduit 30 which extends thru the water, the upper end of the conduit may be closed by a cap 120 which is attached to a weighted member 122 and dropped to the ocean bottom (Figure 1) some distance from the sunken barge 34. The upper end of the drill line 30 is thus removed from the region of the sea which is subject to violent agitation by surface winds or storms and is carried down to the bottom in the form of an arc 124 which may be readily engaged by a grappling hook from above and drawn to the surface when drilling is to be resumed. If desired, part or all of the drilling fluid within the line 30 may be removed before capping so that the air which replaces it will promote the continued elevation of the arc 124

beneath the water rather than leaving it fall laterally.

On the floating platform 20, rotation of the segmented drill stem (76, 84 or 94) may be effected by the conventional rotary table 126 thru the square central aperture of which extends a correspondingly shaped grief stem or "kelly" 128 suspended from a swivel 130 thru which the mud line 132 supplies drilling fluid into the kelly for transmission to the segmented drill stem. Within the derrick 22, from a lower or traveling pulley block 134 there is hung a tubular air chamber 136 within which a reciprocable piston 138 is slidably disposed, attached at its lower face to a piston stem 140 which in turn is connected to the swivel 130. Compressed air supplied to the upper part of the cylinder 136 thru the line 142 from the compressor 28 serves to exert a predetermined constant down thrust or pressure on the piston 138 and thence thru the kelly and drill stem so as to cushion the vertical oscillations of the boat caused by the ocean swell. Thus upon an up thrust of the floating platform around the grief stem, the air pressure upon the piston 138 will still hold the segments of the drill stem locked together. Upon a down thrust of the floating rig, consequent up movement of the kelly thru the rotary table 126 will be cushioned by the air in the chamber 136.

The pulley lines 144 are connected at their upper extremity to a conventional crown block (not shown) at the head of the derrick 22 and the line 146 therefrom to the winch 26 may be set to respond automatically (by known means) to changes from a predetermined tension so as to raise the block 134 and cylinder 136 upon upthrust of the piston 138, and lower them again upon slacking of tension on the line (caused by dropping of the boat into a trough of the swell).

It will be seen, that the direction at which the drill bit 32 and drill stem enter the earth will be a continuation of the direction of the guide channel 42. Accordingly it is desirable both to know at what angle this guide channel lies, as well as to be able to alter its direction by movement of the sunken barge 34. Thus, the barge may be dropped on a sloping seat bottom thru which it is desired to direct a vertical bore; or the barge may come to rest on a flat surface and it may be desired to start a slanted bore therefrom. In either event, it must first be determined at what angle the channel is slanted from the perpendicular and in what direction the deviation lies. For this purpose, the means of Figures 11-13 are provided.

Within one or both halves of the sunken barge, a fly-wheel 148 is mounted on a horizontal axle 150 for rotation in either direction by a quick-starting, reversible motor 152, the assembly being supported on a platform 154 by uprights 156, 158. The whole platform assembly in turn may be rotated by a reversible motor 160, acting thru reduction gears 161, on a vertical axle 162, the motor 160 being secured to the barge structure 163. Intelligence and control of the angular position of the sunken barge 34 is effected by means of a pair of synchronised motors 164, 166, respectively within the lowered barge and on the surface vessel 20, and electrically connected as shown. While the barge is descending, a gyroscope 165 connected to the rotor of motor 164, prevents rotation thereof while allowing movement of the stator with twisting of the barge

body in sinking. Accordingly, when a line current is imposed at L_1 , L_2 , the rotor in the surface motor 166 will assume the same position with respect to its stator that the rotor and stator of the lower motor 164 occupy. Movement of the upper rotor will turn the connected indicator 167 and thus show the directional heading of the barge on the bottom. Or in other words, assuming the two rotors were parallel when both were at the surface of the water, the indicator 167 will now show the amount and direction which the barge 34 has rotated on its vertical axis in sinking. Since the original directional heading of the flywheel 148 at the surface was known, its change of position — which is identical with the changed position of the barge — is also known.

Also mounted on the horizontal platform 154 is a spirit level 168 disposed between a light tube 170 and a bank of photocells 172. Position of the air bubble 174 along the level is shown by the particular photocell immediately adjacent thereto, due to transmission of a different amount of light from the lamp 170 thru the bubble than thru the surrounding liquid. Since the directional heading of the flywheel 148 is known, as just described, the same is known for the spirit level 168 since they are both mounted on the same platform 154 which remains stationary with respect to the barge as the latter descends. Accordingly, it is now known whether or not the barge has landed in a horizontal position or not, as well as the direction in which the flywheel and spirit level are aligned. If the barge is not level, the platform 154 can be rotated thru 360° by the motor 160, using the lower selsyn 164 as a pilot motor therefor, controlled from the surface motor 166, stopping to take readings of the spirit level 168 at intermediate points thru the 360°. In this manner it is learned in what direction the guide channel 42 slants and to what extent.

Accordingly, if it is determined, for example, that the sunken barge lists 3° SSW, and it is desired to right it, the platform 154 is turned until the flywheel 148 points in this direction and the flywheel is then given a number of quick spins so as to roll the barge by this amount on its spiked bottom, aided if desired by slightly lifting the barge from the surface by its cables 38. Or if the barge lands with its top horizontal and it is desired to tilt it in a certain direction by a specified amount, the same process is followed: the flywheel 148 is turned in this direction and rotated so as to tip the barge to this position, and the water in the several buoyancy chambers of the barge is then balanced so as to keep the barge steady at the new position. The platform 154 carrying the spirit level 168 and aligned photocells 172 can again be rotated to show on the surface indicator (not shown) connected to the photocells, the new inclination of the barge.

The selsyn-type system comprising the paired motors 164, 166 is based upon an instrument which is mechanically a miniature bipolar, rotating field, three phase alternator. The rotor is wound with a single-phase concentrated winding; the stator, with a three-circuit distributed Y-connected winding. Electrically, in normal operation, the device acts as a transformer and voltages and currents existing in the instrument are all single-phase. The rotor windings R_1 , R_2 are excited from an alternating voltage source. By transformer action, voltages are induced in

the three elements of the stator winding, the magnitude depending upon the angular position of the rotor. Assuming both rotors free to turn, they will take such a position that the voltages induced in the two stators are of balanced magnitude and displacement. Under this condition of stator-voltage balance between the two instruments there is no circulating current in the stator windings. Now if the rotor of one device is displaced by a certain angle and the rotor of the other remains in its original position, the stator-voltage balance is altered and a circulating current will flow in the windings. This circulating current reacting on the excitation flux provides a torque tending to turn the rotors of the machines to a position where the induced stator-voltages are again equal and opposite. Thus, with one rotor unrestrained, any motion given to the other rotor will be transmitted to and duplicated by the first rotor.

Another method of determining the position of the sunken barge is illustrated in Figures 12-13. Within the barge, a pendulum 176 is suspended by a ball and socket mounting 178 about which there are disposed brake means 180 operable from the surface vessel for engaging the pendulum stem 182 so as to prevent its swinging while the barge is having its position changed. Above the mounting socket, the stem carries an electric light 184 within itself and a converging lens 186 at its tip. Above the pendulum, with its lower annular edge disposed parallel to the mounting support 188 is a concave structural member 190 carrying on its under, arcuate face, photocells arranged on axial lines radiating from the center 192 thereof, which center is directly above the normal rest position of the pendulum when the support 188 is horizontal (i. e. the guide channel 42 is vertical). The dish surface of the support 190 describes an arc radiating from the center of the ball and socket mounting 178. The photocells are connected to a similarly arranged indicating device (not shown) on the surface vessel and a surface directional indicator 167 is connected to the photocell support 190 and gyroscope 165 by synchronised motors 164, 166 as just described.

Accordingly, when the barge comes to rest, the brakes 180 are withdrawn and the light 184 turned on. The swinging light being focused to a point by the lens 186, only those photocells along its path will transmit an impulse to the surface, so that by a straight line drawn thru the farthestmost cells, the direction and extent of swing will be seen immediately, from which its mid- or rest-point will be evident. From this, knowing the rotational heading of the barge, its inclination will be realized. In place of the photocells of Figure 12, an iconoscope could be substituted to convey the swing of the pendulum to a cathode ray oscilloscope at the surface, similar to television transmission between camera and station receiver. Or photographs of the pendulum could be made in the barge and transmitted to the surface.

When the segments of the drill stem are not positively connected together for lifting each other by raising the upper one, as in Figure 8, the drill bit is joined to the drilling table by a cable (not shown) extending thru the segment aperture 80, so that thus raising the bit within the bore or flexible conduit 74 will automatically pull up all the intervening segments of the drill stem. However, when it is desired only to lift the segments 76 starting at an interme-

diate point in the drill stem, this can be done by dropping a three-prong, upwardly slanted, collapsible grappling hook 194 (Figure 2) down the aperture 80 to the desired level and then raising it. The outswung arms 196 then engage the bottom corners of a segment 76 from beneath so as to slide or lift it out of the retaining socket of the immediately dependent segment socket. By thus temporarily separating the segments at any point, they can be removed merely from the flexible conduit 30, if desired; or in this manner side wall samples, for example, can be taken at any level in the bore without removing the drill bit. After the raised segments have been dropped back into place, the arms 196 are gathered about the shank 198 by the lines 200 from the surface, and the grappling hook is withdrawn from the drill stem.

While I have shown and described in some detail a presently preferred embodiment of my drilling equipment, it is to be understood that various modifications may be made in the construction and operation thereof within the spirit and scope of the subsequently claimed invention which it is my intention to claim broadly within the limitations imposed by the prior art.

Certain subject matter herein disclosed is claimed in my copending application Ser. No. 122,295.

I claim:

1. A separable, multiple-segment submarine vessel adapted to be sunk and to rest in a predetermined position on the bottom of a body of water; buoyancy chambers within the vessel adapted to float each segment thereof separately; a generally vertical guide channel formed along the line of separation of said segments and adapted to receive therein a longitudinally displaceable drill stem and a conduit surrounding said stem; means for detachably holding said segments together on said bottom; means carried by said vessel for measuring and transmitting its inclination and rotational position to receiving instruments at the surface of the water; and means carried by said vessel and operable from the surface of the water for adjusting the inclination of the sunken vessel to a desired position whereby said guide channel may be directed at a predetermined angle for drilling thru the bottom of the body of water by operation of said drill stem from the surface.

2. The vessel of claim 1 wherein the bottom thereof is substantially convex in all directions and carries projections for engagement with the bottom of said body of water.

3. The vessel of claim 1 wherein said measuring means comprise a spirit level having a longitudinal series of photocells in alignment therewith for determining the position of the entrapped gas bubble along said level; and means for jointly rotating the level and photocells a predetermined amount about an upstanding axis.

4. The vessel of claim 1 wherein said means for adjusting the inclination comprise a generally upright flywheel disposed within the vessel and rotatable in either direction on a transverse axle; and means for jointly rotating said flywheel and transverse axle about an upstanding axis.

5. In combination with a sinkable vessel, the improvement comprising: walls defining at least two segments of the vessel separable along an upright line, the walls along said line being complementarily recessed to define a generally vertical guide channel therebetween adapted to re-

ceive therein a longitudinally displaceable drill stem and a conduit surrounding said stem; buoyancy chambers within the vessel adapted to float each segment thereof separately; and means for detachably holding said segments together when sunk.

6. In combination with a sunken guide structure supported upon the earth beneath a body of water, and earth boring tools operated through the body of water and traversing said guide structure to form a bore in the submerged earth beneath the structure, the improvement comprising: a flexible conduit extending from the mouth of the bore through said guide structure to the surface of the water, laterally unsupported along most of its length and enclosing therein a drill stem adapted to operate a drill bit in the bore from a vessel floating on the surface of the water.

7. In combination with a surface vessel and earth boring tools operated therefrom in a submarine bore, the improvement comprising: a sinkable vessel having walls defining at least two buoyant segments separable along an upright line, the walls along said line being complementarily recessed to define a generally vertical guide channel therebetween, and a longitudinally displaceable drill stem and a conduit surrounding said stem disposed in said guide channel and extending to the surface vessel, whereby a drill bit may be operated in a submarine bore from the surface vessel by the drill stem within said conduit, and the sunken vessel may be separated along said guide channel and the segments refloated while leaving the conduit in the mouth of the bore.

8. In combination with a surface vessel and earth boring tools operated therefrom in a submarine bore, the improvement comprising: a sinkable vessel having walls defining at least two buoyant segments separable along an upright line, the walls along said line being complementarily recessed to define a generally vertical guide channel therebetween, a flexible conduit extending from the guide channel to the surface vessel and a drill stem disposed in said conduit and comprising a plurality of longitudinally aligned segments individually having a thrust-engagement socket formed at one end and having the other end correspondingly shaped so as to be insertable within the socket of the adjacent segment whereby a drill bit may be operated in a submarine bore from the surface vessel by the drill stem within said conduit, and the sunken vessel may be separated along said guide channel and the segments refloated while leaving the conduit in the mouth of the bore.

9. The method of earth boring beneath a body of water from the surface thereof, which method comprises: anchoring the lower end of a flexible conduit by insertion of same into the earth underlying said water; supporting said conduit at its upper end so the conduit extends substantially upright thru the water; forming a submarine bore by suspending a drill stem and attached drill bit down said conduit from said upper end and operating same from the surface; discontinuing drilling and withdrawing the portion of said drill stem which is within the water-surrounded section of the flexible conduit; capping the upper end of said conduit with a removable closure member; and dropping said capped end into the body of water at a point of lateral displacement from the lower anchored end thereof, from which position it may be subsequently raised to resume

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drilling, upon reinsertion of the withdrawn drill stem.

10. The method of earth boring beneath a body of water from the surface thereof, which method comprises: anchoring the lower end of a flexible conduit by insertion of same into the earth underlying said water; supporting said conduit at its upper end so the conduit extends substantially upright thru the water; forming a submarine bore by suspending a segmented drill stem and attached drill bit down said conduit from said other end and operating same from the surface; discontinuing drilling and separating the portion of said drill stem which is within the water-surrounded section of the flexible conduit; capping the upper end of said conduit with a removable closure member; and dropping said capped end into the body of water at a point of lateral displacement from the lower anchored end thereof, from which position it may be subsequently raised to resume drilling, upon reassembly of the drill stem within said conduit.

11. The method of earth boring beneath a body of water, which method comprises: sinking to the bottom of said water a vessel having a generally vertical guide channel formed therein and anchoring one end of a flexible conduit by insertion of same into the earth underlying said water, said conduit extending through said guide channel; supporting said conduit at its upper end so the conduit extends substantially upright through the water laterally unsupported along most of its length; forming a submarine bore by suspending a drill stem and attached drill bit down said conduit from said upper end and op-

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erating same; and then removing said sunken vessel while leaving the lower end of said conduit anchored in the bore.

12. The method of forming a well beneath a body of water, which method comprises: anchoring the lower end of a flexible conduit by insertion of same into the earth underlying said water; supporting said conduit at its upper end so the conduit extends substantially upright through the water; forming a submarine bore by operation of earth boring tools within said conduit from said upper end; discontinuing drilling and removing said tools; sealing said flexible conduit against entrance of water and allowing same to rest on the bottom of the water.

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