

[54] **HORIZONTAL DRILL RIG FOR DEEP DRILLING TO REMOTE AREAS AND METHOD**

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[51] Int. Cl. **E21b 7/04**

[58] Field of Search **175/52, 61, 62, 73, 75, 175/85**

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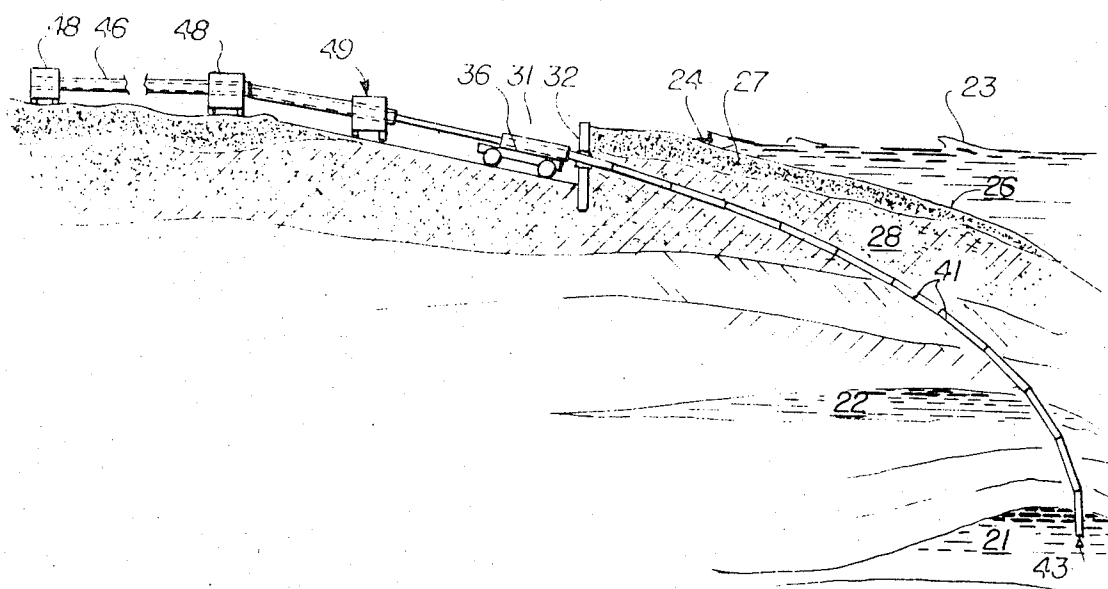
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Primary Examiner—David H. Brown
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[57] **ABSTRACT**

A ground storage rack preferably installed in a pit has substantially horizontal pipes each initially containing an elongated drill rod. Sequentially each rod is thrust from its storage pipe horizontally into the ground at one end of the pit and as it proceeds outwardly of the pit its direction is controlled so that it bends downwardly until the drill motor on its outer end is drilling approximately vertically. The rear remote end of each storage pipe is capped so that drilling mud pumped into the pipe from a mud pit travels to the remote end of the pipe, thence into the open end of the drill rod enclosed therein and through the rod (and also preceding rods) to the drill motor and bit. Mud is carried back through the annulus of the drill hole to the mud pit. The rig has particular adaptation to offshore oil drilling since offshore platforms will not be used and the danger of contamination from leakage of oil by the normal surface casing beneath such platforms into the ocean floor is eliminated since the surface casing is now on shore.

6 Claims, 9 Drawing Figures



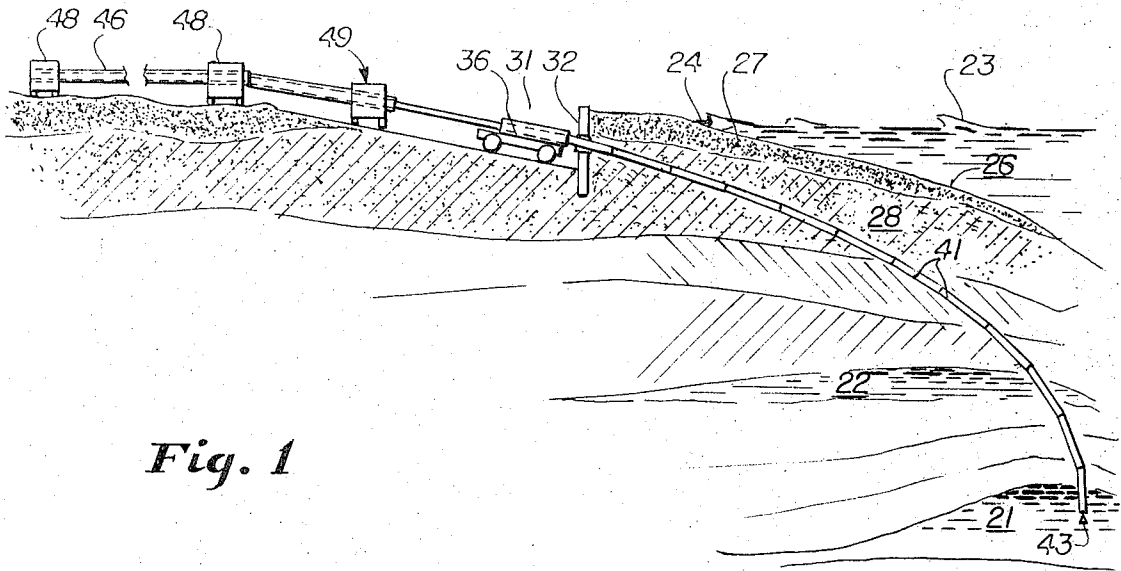


Fig. 1

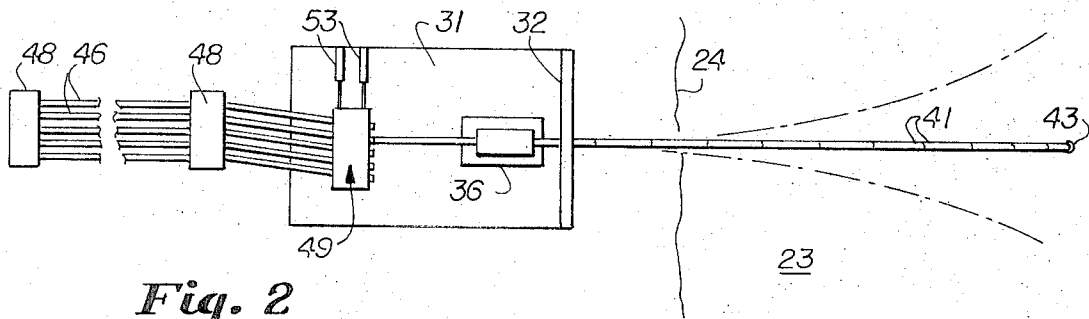


Fig. 2

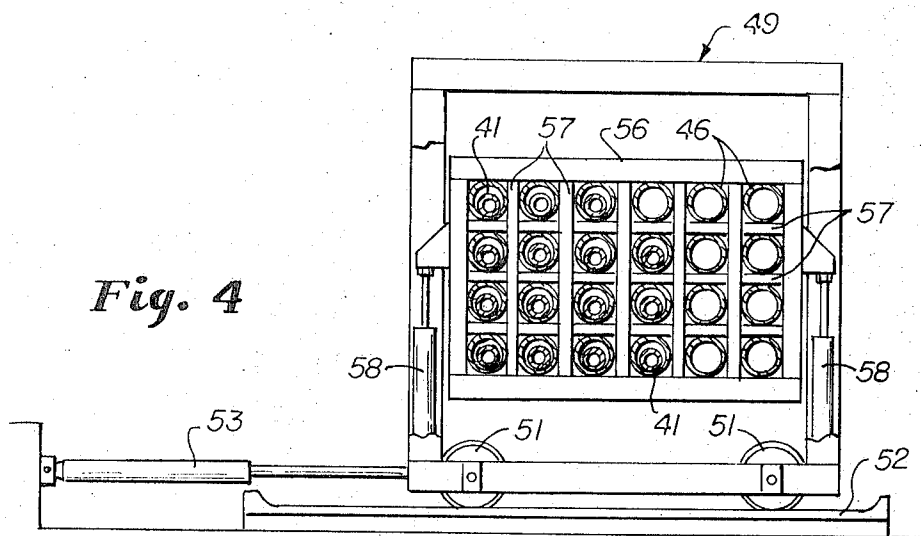


Fig. 4

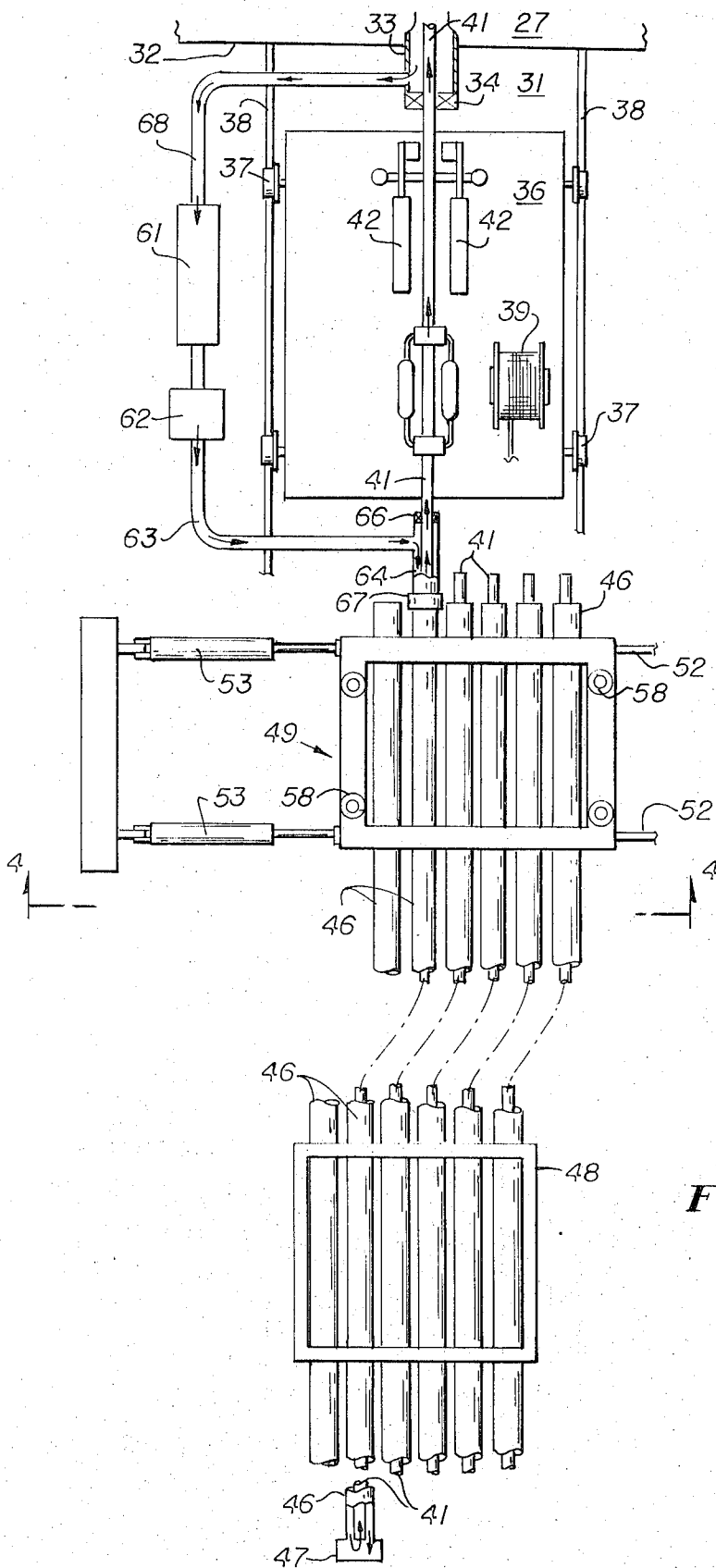


Fig. 3

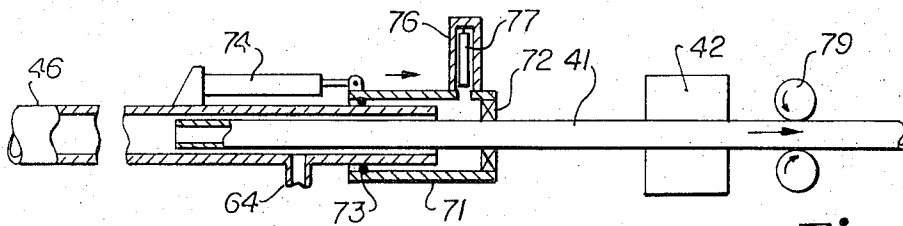


Fig. 5

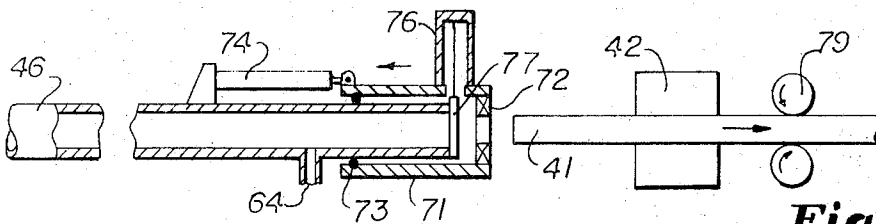


Fig. 5a

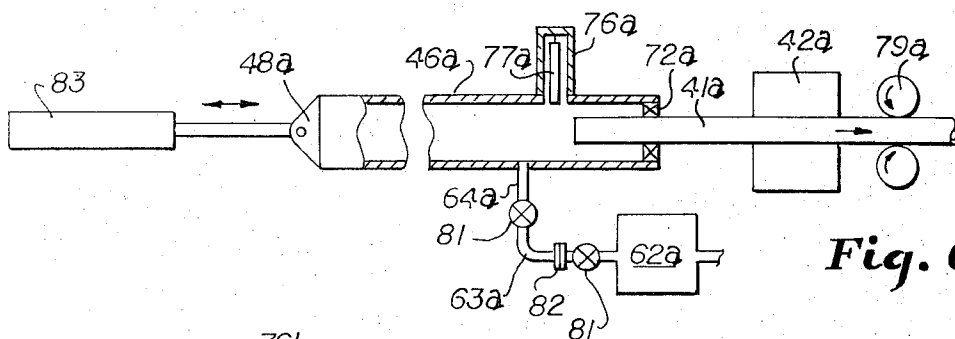


Fig. 6

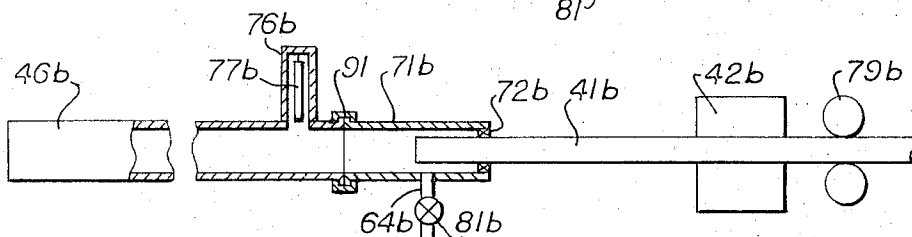


Fig. 7

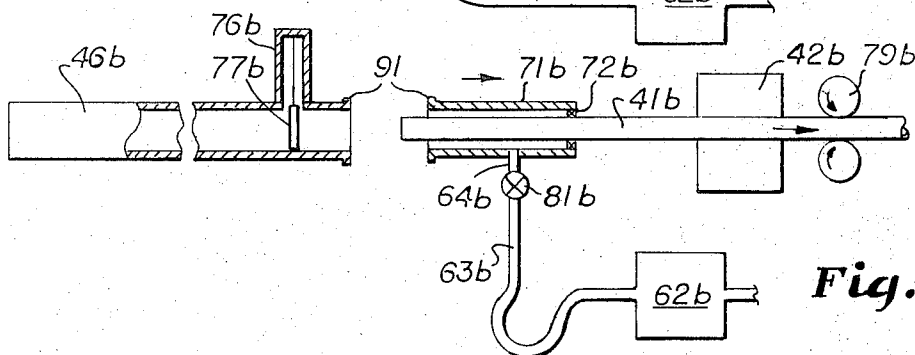


Fig. 7a

HORIZONTAL DRILL RIG FOR DEEP DRILLING TO REMOTE AREAS AND METHOD

This invention relates to a new and improved horizontal drill rig for deep drilling to remote areas and method of drilling. More particularly, the invention relates to a means and method for drilling holes for oil wells, etc., at a considerable distance from land without the use of the customary drilling platforms used for such purpose.

Several restraints exist for drilling petroleum resources on the continental shelves under oceans and seas. Among these are: (1) the very expensive platforms for vertical or directional drilling using the normal drilling modes. (2) The high cost and safety hazards of transporting and maintaining men at the platforms. (3) Weather and tide problems. (4) The problem of disturbing the ecological balance under the shoreline by oil spills around the surface hole casing onto the ocean floor. With respect to the oil spills which have occurred in platform drilling, the cause is frequently that the drill rod, or casing, penetrates one or more oil bearing formations which may be fairly close to the surface under the ocean. Through many years in geological history the pressure differential between the various formations or between any one of them and the ocean floor surface has been well established by nature. Disruption of this pressure balance by vertically penetrating the formation can, and has, caused very serious oil flows to the subsea surface and resulted in water and beach pollution.

It is, therefore, a principal purpose of the present invention to provide a means and method to drill offshore petroleum and other mineral deposits without disturbing the near-surface deposits and thereby not providing them a channel to the sea which will pollute the ocean and beaches.

One of the major limiting factors in drilling deep vertical holes for oil wells is the ability of the drill pipe to support its own weight in long strings vertically. Still another limiting factor is the time required to withdraw extremely long lines of drill rods when each 90 feet has to be connected and handled in the standard derricks.

A principal feature and advantage of the invention is that the foregoing major restraints to deep oil well drilling are overcome. Although in accordance with the present invention a greater length of drill rod is required to be in the hole than in standard vertical drilling, nevertheless a large percentage of this drill rod is lying on the bottom of the hole in nearly horizontal attitude and thus is not supporting itself. When necessary, the drill rod is withdrawn and stored in several large storage pipes lying on the ground in back of the drill and each of these may be of 1,000 ft. or so in length and provides in effect a derrick which is 1,000 ft. high (or long), whereas conventional derricks cannot reach much more than 90 ft. in height. Loss of time in handling relatively short segments of drill rods is reduced by practice of the invention.

Other objects of the present invention will become apparent upon reading the following specification and referring to the accompanying drawings in which similar characters of reference represent corresponding parts in each of the several views.

In the drawings:

FIG. 1 is a schematic vertical sectional view showing the invention used in off-shore deep drilling.

FIG. 2 is a schematic top plan of FIG. 1.

FIG. 3 is an enlarged top plan view partly broken away in section to conserve space showing the on-shore portions of the invention.

FIG. 4 is a transverse sectional view taken substantially along the line 4—4 of FIG. 3.

FIG. 5 is a schematic view partly in section showing one means for maintaining the storage pipe filled with drilling compound after the drill rod has been removed.

FIG. 5A is a view similar to FIG. 5 showing the drill rod removed from the storage pipe.

FIG. 6 is a view similar to FIG. 5 of a modification.

FIG. F is a view similar to FIG. 5 of still another modification.

FIG. 7A is a view similar to FIG. 7 showing the drill rod removed.

Directing attention to FIGS. 1 and 2, the present invention is used to drill into an oil bearing or other mineral formation 21 which is quite deep and, as an illustration of an important feature of the present invention, there is shown an upper formation 22 which is so located that, were it not for the use of the present invention, drilling into the formation 21 would cause oil from the formation 22 to leak to the surface of the ocean 23 through the penetrated underwater land surface 27. In other words, a vertical drilling through the overlying formation 22 would show water surface leaks. The present invention employs a rig which is installed in a preferred form of the invention on the land side of the ocean shoreline 24. The continental shelf 26 is illustrated schematically and it will be seen that drilling can occur either under or beyond the continental shelf. There is a soft formation 27 near the surface and a harder formation 28 there-beneath.

The practice of this invention is preferably performed with the drilling mechanism installed in a pit 31 having a downwardly sloping floor so that the drill rod penetrates the hard formation 28 or at least is not long within the soft formation 27. Thus, the front wall 32 of pit 31 may be vertical and may be faced with concrete to prevent flooding of the pit. A section of casing 33 (see FIG. 3) is installed through the front wall 32 and for a sufficient distance through formation 27 to penetrate formation 28 in accordance with well accepted practices in vertical drilling. Stuffing box 34, or blow-out preventer, is installed at the outer end of casing 33. Located within the pit 31 is the drilling rig which is subject to some variation. In a preferred form illustrated in the accompanying drawings and herein described the drilling rig has a drilling carriage 36 having wheels 37 which run on tracks 38 perpendicular to face 32. Various means may be used to drive the carriage 36. In the form here shown in a winch 39 is used and a cable from the winch is attached to the upper end of pit 31. Gravity moves the carriage 36 downwardly to perform the drilling operation. It will be understood that a more positive drive or a different drive may be employed.

Drilling is performed by hollow drill rod 41 and it is one of the features of the present invention that the rod 41 is in very long sections as compared with the usual 90 ft. sections of conventional drilling rod. Thus it is contemplated that the sections of rod 41 will be approximately 1,000 feet in length. The rod extends through stuffing box 34 and through casing 33 and out through the formation 28. The rod may be used in a rotating mode driven from the surface or it may be used

in a non-rotating mode with an in-hole rotary motor as will be explained. When rotated, it will be ripped and rotated by a hydraulically operated hollow spindle drills 42. The chuck on these drills grips, rotates and advances the rod usually by action of hydraulic cylinders. This is a well known art for horizontal, angle and vertical drilling, particularly in mining diamond bit exploration drilling so will not be described in detail here. Reference is made to Pat. No. 2,768,830 illustrating one typical chuck. Torque requirements are modest, particularly with lubricants added to the drilling mud. The rod may be non-rotating particularly in hole directional work where frequently a drill motor 43 is preferably installed at the working end of the rod and such motor may be driven by various means. A preferred means is to drive the motor 43 in a turbine action by means of the pumping of drilling fluid down the interior of the hollow rod 41. By observation of FIGS. 1 and 2, it may be seen that the rod extends outwardly from wall 32 sloping downwardly and gradually bends until the rod is digging in a vertical position and reaches the formation 21. As best shown in FIG. 2 in the dot-and-dash lines, the drill rod 41 not only bends downwardly but also may curve in a horizontal component in either direction as desired. There are various well-known techniques for controlling the direction of a drill motor. Various whipstocks or bent subs may be used. These and other well-known techniques in the drilling art are known and not herein illustrated or described in detail.

As has been explained, the drill carriage 36 contains grippers 42 which close inward and grip the rod 41 and force it down the hole as the drill bit clears the way. The drill rod 41 may be withdrawn or reinserted when changing bits or adding direction tools much more rapidly by the use of rod extractor 79. Two opposing wheels which have grooves to fit the pipe are powered and drive the 1,000 foot sections of drill rod 41 into and out of their storage pipe 46 at the rate of about 100 feet per minute or faster. In feeding the carriage 36 is moved by hoist 39 to the upper or left-hand end of the pit 31, the grippers 42 then grip the rod 41 and then hydraulic cylinders or a hoist, assisted by gravity move the carriage 36 to the right, thrusting rod 41 into the hole following the clearing of the front end of the hole by the drill motor 43 or bit.

The foregoing means of advancing (and retrieving) the drill rod 41 makes it desirable to store long lengths of drill rod 41 substantially horizontally. For such purposes, there are provided a plurality of storage pipes 46 each having an inside diameter somewhat greater than the outside diameter of rod 41. The length of storage pipe 46 is slightly longer than the length of each section of drill rod 41. Cap 47 is applied to the back end of each storage pipe 46 to close it off. Each storage pipe 46 initially contains a drill rod 41 therein. The rods 41 are withdrawn from the pipes 46 one by one, each rod being coupled to the preceding pipe by any well known technique as drilling continues. To facilitate handling the drill rods in the pipes 46, a plurality of stationary fixed racks 48 are positioned rearwardly of the pit 31 at suitable intervals. Depending upon the number of pipes 46 which are to be handled, compartments formed by horizontal and vertical dividers 57 are provided to space the pipes 46 apart. Closest to the pit 31 is movable rack 49, shown in detail in FIGS. 3 and 4.

Movable rack 49 is mounted on wheels 51 which run on transverse tracks 52 on the bottom of the pit. The rack 49 may be caused to move from left to right as viewed in FIG. 4 by various means such as the hydraulic cylinder 53 shown. Vertically reciprocating within the frame of movable rack 49 is a vertical pipe holder 56 having dividers 57 similar to those of stationary racks 48. Vertical holder 56 may be caused to move upward and downward by means of vertical actuating cylinders 58 or other means. By means of cylinders 53, 58 or other equivalent means, each of the pipes 46 may be brought into alignment with carriage 36 and particularly grippers 42.

The technique of pumping "mud" into drilling holes is well understood. Preferably such a technique is used in connection with the present invention. Thus a mud pit 61 is provided. Mud consisting of a slurry of bentonite or other suitable additives and water is pumped out of the pit 61 by pump 62 and through conduit 63 to tee 64 which is connected to stuffing box 66 attached to the forward end of one of the pipes 46 from which the drill rod 41 is being withdrawn. The mud flows in the annulus between rod 41 and pipe 46 to the back end of pipe and, by reason of the fact that the back end of pipe 46 is capped by cap 47 (see bottom end of FIG. 3), the mud flows forwardly through the inside of drill rod 41 and down to the drill motor 43. Tee 64 is connected to the forward end of the particular pipe 46 in a version shown in FIG. 3 by a connector 67 which can be removed after the pipe 41 has been fully withdrawn and connected to the next pipe 46 which is moved into position by the rack 49. The mud traveling down the drill rod 41 in non-rotating mode drives the turbine type motor 43 (although such motor may be driven by other means or the drill rod when properly directed may be rotated by the surface drill) and then washes the cutting from the bottom of the hole up the annulus around the drill rod 41 and out through the casing 33, from where it is carried back to the pit 61 by an intake pipe 68. The cuttings are separated out from the mud in the pit 61 and the mud is circulated.

It is desirable from time to time to withdraw the drill rod 41 from the hole in order to change drills or to install special tools used to changed direction, etc., as is well understood in the drilling art. Hence, although as shown in FIG. 3, there is no means for preserving the drilling mud inside the pipe 46 after rod 41 has been withdrawn, nevertheless it is desirable to do so. One means of retaining mud within the pipe 46 is shown in FIG. 5. An extension 71 which fits around the outside of the forward end of pipe 46 and extends there-beyond has a seal 73 such as an O-ring which forms a tight engagement with the exterior of pipe 46. The forward end of extension 71 has a stuffing box 72 which engages the outside of rod 41. A hydraulic cylinder 74 or other means is used to reciprocate the extension 71 relative to pipe 46. Adjacent the forward end of extension 71 is a gate valve 76 having gate 77. In normal usage, while the rod 41 is being withdrawn from pipe 46 the extension 71 is in right-hand position as shown in FIG. 5 and gate 77 is open. As the rod 41 is completely withdrawn, gate 77 is closed and the extension 71 is pulled rearwardly by cylinder 74 so that gate 77 closes off the forward end of pipe 46. Thus the drilling mud remains inside pipe 46 for future use when a section of rod 41 is to be reinstalled in the pipe.

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FIG. 6 illustrates still another means for storing drilling mud in the storage pipe 46a after the drill rod 41a has been removed. In this modification, valves 81 are installed in two positions in the conduit 63a leading from pump 62a to the tee 64a and a connector 82 is positioned between the two valves 81. The rod of hydraulic cylinder 83 is connected to cap 48a and may be used to push the entire pipe 46a forwardly while the rod 41a is being withdrawn. During this operation, the gate 77a is raised. After the rod has reached the position shown in Fig. 6, gate 77a is closed, capturing the mud within the pipe 46a and thereupon the pressure in the cylinder 83 is reversed causing the pipe 46a to move to the left while the rod 41a remains stationary and exposing the left-hand end of the rod 41a for coupling to the next rod.

FIG. 7 shows still another modification of the structure of FIGS. 5 and 6. In this modification, the pipe 46b remains stationary. Extension F1b is connected to the right-hand end of pipe 46b by quick disconnect coupling 91. The gate valve 76b is to the left of such disconnect 91. When the rod 41b has been moved to the position shown in FIG. 7, the gate 77b is closed, capturing the mud within the pipe 46b and thereupon the valve 81b is closed. The extension 71b may be removed and the next section of drill rod 41b connected.

Many of the elements of FIGS. 6 and 7 resemble in structure or function those of elements of the preceding modifications and the same reference numerals followed by subscripts a b respectively are used to designate corresponding parts.

What is claimed is:

1. A method of drilling for deep formations comprising providing a drilling location at the surface which is horizontally remote from the bottom of the hole to be dug, storing at said location a plurality of long drill rods

each substantially horizontal, thrusting a first drill rod into the earth slanted only slightly downward from the horizontal, drilling at the remote end of said drill rod a hole which slopes downwardly and then curves to a substantially vertical direction as drilling progresses, and sequentially joining additional drill rods at said drilling location and thrusting each additional drill rod into the hole as drilling progresses.

2. A method according to claim 1 which further comprises providing at each drilling location a plurality of pipes in which one section of drill rod is stored and withdrawing each section of drill rod from its pipe as it is joined to the preceding drill rod.

3. A method according to claim 2 in which each said pipe is sequentially moved into alignment with the upper end of the hole being drilled prior to withdrawing the drill rod from such pipe.

4. A method according to claim 2 in which said drill rod is hollow and which further comprises pumping liquid into said pipe and from said pipe into the end of the drill rod in said pipe at the on-shore end of said pipe remote from the drilling end of said drill rod and through said drill rod in said pipe and all preceding drill rods.

5. A method according to claim 4 which further comprises a drill motor on the remote end of the string of said drill rods, said motor of the type actuated by liquid pressure in said drill rod, and which further comprises driving said motor by liquid pumped into said pipe, returning said liquid to said drilling location and recirculating said liquid.

6. A method according to claim 4 which further comprises closing off said pipe to escape of liquid after the drill rod has been withdrawn from said pipe so that said pipe remains substantially full of liquid.

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