Drilling machine with tower operable in various inclined positions. The tower has operator controlled mechanisms for selective drill pipe pickup or storage and subtraction or addition in whatever working condition the drill tower is erected for rotary-type drilling.
3,708,024

DRILLING MACHINE

BACKGROUND OF THE INVENTION

The present invention relates to improved drilling machines, for wells, bores, blast holes or the like, particularly adapted for mounting on trucks or vehicles or otherwise portable bases. Generally, the invention relates to a portable machine for rotary-type drilling with a tower operable in various inclined positions. Specifically, the invention provides a tower operable through a range of inclined positions, from vertical to substantially horizontal, and having cooperatively associated mechanisms for selective drill pipe pickup or storage and subtraction or addition.


There is no known specific prior art which relates to a portable machine for rotary-type drilling with a tower operable through a range of inclined positions, from vertical to substantially horizontal, and having cooperatively associated mechanisms for selective drill pipe pickup or storage and subtraction or addition.

SUMMARY OF THE INVENTION

A drilling machine should be versatile in operation. Different work projects mean different conditions. Well holes for water, gas and oil, test bores for soil, strata or mineralogical analysis; blast holes for quarrying, excavation or construction — each are drilled differently.

A drilling machine should also be durable. Different work projects are carried out in many locations under varying environmental conditions. There is always a demand for uninterrupted operations even under minimum maintenance programs.

Lastly, a drilling machine should require the minimum of operating personnel in constant attendance. Practical economics justify a "one-man" drilling machine that can go almost anywhere and do almost anything.

It is therefore an object of the invention to provide a portable drilling machine which is versatile, durable and economical to operate.

It is a further object of the invention to provide a portable drilling machine for rotary-type drilling with a tower operable in various inclined positions.

Still further, it is an object of the invention to provide a drilling machine tower operable through a range of inclined positions and having cooperatively associated mechanisms for selective drill pipe pickup or storage and subtraction or addition.

These and other objects of the invention, as well as the advantages thereof, will be apparent in view of the Description of A Preferred Embodiment as set forth below.

In general, a drilling machine according to the invention is carried on a portable chassis. The drilling machine has an elongated rectangular tower. The tower is lifted and carried by mechanical means and selectively raised and positioned by power means. The drilling machine further has: drill power means movable lengthwise of the tower and having a rotating spindle for connection to a drill pipe; a track means for guiding both lengthwise and crosswise movement of the drill power means; and a magazine for drill pipe pickup or storage on the tower.

The drilling machine according to the invention may further have: an upper clamp means above the magazine for chucking a section of drill pipe during drill pipe pickup or storage; a lower clamp means below the magazine for chucking a section of drill pipe during subtraction or addition; and an elevator means for aligning a section of drill pipe during subtraction or addition when the drill tower is in an inclined working condition.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of a drilling machine according to the invention with the drill tower in the collapsed transport condition;

FIG. 2 is a rear view with the drill tower in a vertically erect working condition;

FIG. 3 is a partial side view with the drill tower in a vertically inclined working condition;

FIG. 4 is a partial side view with the drill tower in a vertically erect working condition;

FIG. 5 is an enlarged fragmentary view of the drill tower;

FIG. 6 is a further enlarged fragmentary view of the base end of the drill tower and controls for operation of the drilling machine;

FIGS. 7, 8 and 9 are a series of fragmentary side views of the drill tower in working condition performing the operations of drilling (FIG. 7); drill pipe pickup or storage (FIG. 8); and drill pipe addition or subtraction (FIG. 9).

FIG. 10 is an enlarged fragmentary plan view taken substantially as indicated on line 10—10 of FIG. 8 showing chucking of a section of drill pipe during pickup or storage;

FIG. 11 is a further enlarged fragmentary plan view taken substantially as indicated, on line 11—11 of FIG. 8 showing chucking a section of drill pipe chain during subtraction or addition;

FIG. 12 is an enlarged fragmentary side view taken substantially as indicated on line 12—12 of FIG. 5 showing a mechanism for aligning a section of drill pipe during the operations of drill pipe addition or subtraction when the drill tower is in an inclined working condition;

FIG. 13 is an enlarged fragmentary view in section taken substantially as indicated on line 13—13 of FIG. 3 showing the sliding mount for erecting the drill tower in a vertically inclined working condition; and

FIG. 14 is a schematic view of a cable system for movement of the drill pipe power means longitudinally of the drill tower.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to FIG. 1, a drilling machine 10 according to the invention is carried by a portable chassis such as the bed of a motorized vehicle or truck 11. Operation of the drilling machine 10 requires various components also mounted on the truck 11 including an engine, a reduction gear power transfer unit, pressure fluid or hydraulic pumps, a mud pump, a water injector pump, air compressors, coolers, storage tanks, outriggers and controls for selective actuation thereof. These com-
ponents are conventional for rotary-type drilling machines and so are not described in further detail.

The drilling machine 10 operates with multiple sections of conventional drill pipe. Each drill pipe section has an upper end with interior threads and a lower end with corresponding exterior threads. Each end also has parallel flat portions for relative holding of a section of drill pipe, during the operations of pipe pickup or storage and addition, as described in detail below.

The drilling machine 10 has a tower 12 lifted and carried by mechanical means indicated generally by the numeral 14. The drill tower 12 selectively raised and positioned by power means indicated generally by the numeral 15.

Referring also to FIG. 2, the drill tower 12 is constructed with a series of latticed beams and columns and transverse and side plates to provide an elongated and rectangular frame. The frame provides mounting and support for the several components of drilling machine 10 according to the invention.

These cooperatively associated mechanisms or components include:

a drill means movable lengthwise or linearly of the tower and having a rotating spindle for threaded connection to a drill pipe, indicated generally by the numeral 16;

a track means for guiding both linear and crosswise or lateral movement of the drill power means 16 during selective drill pipe pickup or storage and subtraction or addition and drilling, indicated generally by the numeral 17;

a magazine or rack means for drill pipe storage movable in a closed loop laterally of the tower, indicated generally by the numeral 18 (see also FIG. 6); an upper clamp means above the magazine for selectively chucking a section of drill pipe during pickup or storage, indicated generally by the numeral 19 (see also FIGS. 5 and 10);

a lower clamp means below the magazine for selectively chucking a section of drill pipe during subtraction or addition, indicated generally by the numeral 20 (see also FIGS. 6 and 11); and

referring to FIGS. 5 and 12, an elevator means for aligning a section of drill pipe during the operations of drill pipe subtraction or addition when the drill tower 12 is in an inclined working condition, indicated generally by the numeral 21.

As best shown in FIGS. 3 and 4, the drill tower 12 is lifted and carried by the mechanical means 14 and selectively raised and positioned by the power means 15. The mechanical means 14 for carrying the tower 12 on the chassis 11 may comprise a pair of forwardly directed lever track elements 25 mounted on the upper end of stanchion members 26. Referring to FIG. 13, the rear end of each lever track element 25 has depending flanges 27 pivotally mounted on a trunnion shaft 28. The track portion of each element has a slot 29 to slidably hold and engage a shoe flange member 30 carried on the face of a longitudinal tower frame beam 31.

The power means 15 may comprise two sets of pressure fluid or hydraulically actuated cylinders. A first set of cylinders 32 are base mounted on the stanchion members 26, preferably at a location coincident with the axis of the stanchion trunnion shafts 28. The piston rod 37 of each cylinder 36 is connected to a clevis 38 carried on the face of a longitudinal tower frame beam 31.

The tower raising cylinders 32 are relatively powerful with a relatively short piston stroke. The tower positioning cylinders 36 may be less powerful but require a relatively long piston stroke. The length of the tower shoe flange members 30 is determined by the piston stroke of cylinders 36.

As best shown in FIGS. 2 and 5, the drill power means 16 includes a head assembly 40. The head assembly houses a motor component of a hydrostatic transmission for rotating a drill spindle 41 with exterior threads corresponding to the threads in the upper end of a section of drill pipe. The motor component is connected by suitable flexible conduits (not shown) to a source of pressure fluid or a hydraulic pump on the truck frame. The head assembly 40 is supported and guided for longitudinal movement within the frame of the drill tower 12 by the track means 17, as described in detail below.

The head assembly 40 is moved longitudinally of the drill tower 12 by a pressure fluid or hydraulically actuated cylinder 42. Referring to FIG. 14, the cylinder 42 is base mounted on a beam 43 of the tower frame. The piston rod 44 of the cylinder 42 is connected to a sheave block 45. The sheave block 45 actuates a dual system of cables 46 connected to the head assembly 40.

Referring further to FIG. 14, one side of a system of cables 46 is illustrated. The upper cable end is connected to a beam 47 of the tower frame. The lower cable end is connected to the beam 43. Between the ends, the cable 46 is connected as at 48 to the head assembly 40. From the upper beam 47, the cable 46 is trained down toward the sheave block 45 and around a sheave 49 mounted on a common axis with a sheave 50. The cable 46 returns from sheave 49 to a rear sheave 51 carried by the tower beam 47. From sheave 51 the cable is trained over a front sheave 52 carried by the tower beam 47 and down to a connection 48 with the head assembly 40. From the lower beam 43, the cable 46 is trained up toward the sheave block 45 and over the sheave 50. The cable 46 is trained down from sheave 50 and around a rear sheave 53 and a front sheave 54 carried by the tower frame base plate 55. The cable 46 returns up from sheave 54 to a connection 48 with the head assembly 40.

Referring to FIG. 2, between the dual set of upper sheaves 51, 52 for the cables 46 are an additional pair of sheaves 56 carrying a hoist cable 57 powered from a winch on the truck frame and used for auxiliary purposes during drilling. These elements are conventional.

Movement of the drill head assembly 40 is guided by the track means 17. As best shown in FIG. 7, 8 and 9, the head assembly 40 has end mounted track engaging rollers 59. The rollers 59 move within the tracks provided by a front channel 60, a transfer channel 61 and a rear channel 62. The front channel 60 guides the head assembly 40 during the operations of drilling (FIG. 7), and drill pipe addition or subtraction (FIG. 9). The rear channel 62 guides the head assembly 40 during the operations of drill pipe pickup or storage (FIG. 8).
Transfer or switching of the head assembly 40 between channels 60 and 62 via channel 61 is controlled by switch plates 63. Referring also to FIG. 1, the switch plates 63 are selectively positioned at the intersection of channels 60 and 61 by a linkage 64. The linkage 64 is actuated by pressure fluid or hydraulically actuated cylinders 65 base mounted on side plates 66 on the press frame.

Sections of drill pipe are stored in the magazine or rack means 18. The magazine 18 comprises a base mechanism for supporting and carrying the individual drill pipe sections and a top structure to position each drill pipe section in relation to the spindle 41 of the drill power means 16 and the clamp means 19. The base mechanism and the top structure extend crosswise or laterally of the drill tower 12 and are spaced apart as determined by the length (usually 20 feet) of the drill pipe sections.

As best shown in FIG. 6, the base mechanism of the magazine 18 has a series of articulated socket elements 68 with an inner diameter slightly larger than the outer diameter of a section of drill pipe. The medial or body portion of each socket member 68 has oppositely directed link plates 69 suitably spaced for joining the socket elements as a unitary structure. The upper end of each socket element 68 has an elongated funnel 70 to guide and support a section of drill pipe being carried therein. The lower end of each socket 68 has a coiled spring 71 acting as an axially centered element to resiliently support a section of drill pipe being carried therein. The articulated socket elements 68 are moved laterally of the drill tower in a closed loop as by pressure fluid actuated motors 72 (see FIG. 6) operatively connected to drive shafts 73 (see FIG. 10). The drive shafts 73 are operatively connected to the socket elements 68 in a suitable manner.

As best shown in FIG. 5, the top structure of a magazine 18 includes a transverse plate 75 carrying an outer side flange 76 and a continuous interior baffle 77. The side flange 76 and interior baffle 77 provide a channel to receive and guide the upper ends of drill pipe sections carried by the socket elements 68 of the base mechanism. Sections of drill pipe are moved into or out of the channel through the opening 78. To facilitate movement of sections of drill pipe relative to the magazine 18, when connected to the head assembly 40, a half shoe element 79 may be mounted above the pipe opening 78.

During either the operations of drill pipe pickup or storage, the head assembly 40 of the drill power means 16 will be positioned in channel 62 of the track means 17.

If the operation is drill pipe pickup from magazine 18, the operational sequence is: move a socket element 68 carrying a section of drill pipe into registry with the opening 78; rotate the drill pipe spindle 41; and, move the rotating spindle 41 into threaded engagement with the upper end of a section of drill pipe. During drill pipe pickup, the upper clamp means 19, as described in detail below, may be actuated if desired. Thereafter, the head assembly 40 is raised (FIG. 8) and transferred via channel 61 to the drilling channel 60.

If the operation is drill pipe storage into magazine 18, the operational sequence is: move an empty socket element 68 into registry with the opening 78, move the head assembly 40 into channel 62; lower the head assembly so that the drill spindle 41 is just above the transverse plate 75; and, then the upper clamp means 19 is actuated.

As best shown in FIGS. 5 and 10, the upper clamp means 19 is above the top structure of the magazine 18 and includes a clamp or wrench element 80 carried on the piston rod 81 of a pressure fluid or hydraulically actuated cylinder 82. The cylinder 82 is mounted on the transverse plate 75 so that extension of the piston rod 81 will move the clamp element 80 into holding engagement with a section of drill pipe.

The upper clamp means 19 is used to hold the upper end of a section of drill pipe while the drill pipe spindle 41 is rotated out of the threaded engagement with the drill pipe section. Thereafter, the piston rod 18 is retracted and the lower end of the drill pipe section will drop a short distance into engagement with the coiled spring 71 in the socket element 68. The clamping means 19 may also be used during drill pipe pickup although it has been found that the inertia of a drill pipe section in a socket 68 is such that a threaded connection with the spindle 41 can generally be effected without clamping.

At the beginning of a drilling operation, a section of drill pipe is picked up from the storage magazine 18 as described above. The head assembly 40 of the power means 16 moves into and down channel 60 of the track means 17. The lower end of the drill pipe is inserted through a bushing 84 in the tower frame base plate 55 and the drill or cutting head (not shown) is attached in a conventional manner. The drill pipe spindle 41 is then rotated while the head assembly 40 is lowered and the drilling operation begins (FIG. 7).

When the upper end of the first section of drill pipe is just above the base plate 55, rotation of the spindle 41 is stopped and the lower clamp means 20 is actuated.

As best shown in FIGS. 6 and 11, the lower clamp means 20 is below the base mechanism of the magazine 18 and includes a clamp or wrench element 86 carried on the piston rod 87 of a pressure fluid or hydraulically actuated cylinder 88. The cylinder 88 is mounted on the base plate 55 and behind a side plate 89 housing the operative connection of the drive shafts 73 to the socket elements 68. Extension of the piston rod 87 will move the clamp element 86 into holding engagement with a section of drill pipe.

The lower clamp means 20 is used to hold the upper end of a section of drill pipe within the bushing 84 for addition of a drill pipe section which has been picked up from the storage magazine 18 as described above. When the drilling operation is complete, sections of drill pipe are removed by use of the lower clamp means 20 and the clamp mechanism 85. If desired, the operator may additionally employ a conventional clamp mechanism, indicated generally by the numeral 85 in FIG. 6, to manually position and fasten the drill pipe for assistance in unthreading the upper pipe section.

When the drill tower 12 is operated in an inclined position, an elevator means 21 is actuated to align a section of drill pipe being carried by the head assembly 40. As best shown in FIGS. 5 and 12, the elevator means 21 includes a crotch element 90 pivotally mounted as at 91 on an axial column 92 of the tower frame. The crotch element 90 is connected to the
piston rod 93 of a pressure fluid or hydraulically actuated cylinder 94 base mounted on a frame flange 95. Extension of the piston rod 93 will move the crotch element 90 into engagement with a section of drill pipe so that the drill pipe will be aligned with the bushing 84 in the base plate 55.

While a preferred embodiment of a drilling machine 10 according to the invention has been described, it will be apparent to those skilled in the art that changes could be made therein without departing from the concepts of the invention. For example, the power means 15 for raising and positioning the drill tower 12 could use a motor directly connected to the trunnion shafts 28 for lifting movement of the lever track elements 26. Or, the drill tower could be moved relative to the lever track elements as by a motor rather than the cylinders 36. Motors could also be used in lieu of the various cylinders 42, 65, 82, 88 or 94. Therefore, the true spirit and scope of the invention should be determined solely by the appended claims.

I claim:
1. A drilling machine (10) having an elongated rectangular tower (12) with longitudinal frame beams (31), said tower being carried on a portable chassis (11) by forwardly directed lever track elements (25) mounted on the upper end of stanchion members (26) on said chassis, the rear end of each lever track element being pivotally mounted on a trunnion shaft (28) on a stanchion member, the track portion of each lever track element having a slot (29) to slidably hold and engage a shoe flange member (30) carried on the face of a longitudinal tower frame beam, said tower having a track means (17) for guiding both lengthwise and crosswise movement of a drill power means (16) with a rotating spindle (41) for connection to a section of drill pipe, said tower further having a magazine (18) for drill pipe pickup and storage.
2. A drilling machine according to claim 1 wherein said drill power means has a head assembly (40) with end mounted track engaging rollers (59) and said track means includes a front channel (60), a transfer channel (61), and a rear channel (62), said rollers moving within said channels, said front channel guiding said head assembly during the operations of drilling and drill pipe subtraction and addition, said rear channel guiding said head assembly during the operations of drill pipe pickup and storage.
3. A drilling machine according to claim 2 wherein said magazine comprises a base mechanism for supporting and carrying drill pipe sections and a top structure to position a drill pipe section in relation to said rotating spindle, said base mechanism and said top structure extending crosswise of the tower and being spaced apart as determined by the length of the drill pipe sections.
4. A drilling machine according to claim 3 further having an upper clamp means (19) above said top structure of the magazine to selectively hold a drill pipe section while said head assembly is in said rear channel of the track means.
5. A drilling machine according to claim 3 further having a lower clamp means (20) below said base mechanism of the magazine to selectively hold a drill pipe section while said head assembly is in said front channel of the track means.
6. A drilling machine according to claim 3 further having an elevator means (21) for aligning a section of drill pipe being carried by said head assembly during the operations of drill pipe subtraction or addition.
7. A drilling machine according to claim 3 wherein said base mechanism of the magazine has a series of articulated socket elements (68) with an inner diameter slightly greater than the outer diameter of a drill pipe section and movable laterally of the tower in a closed loop, the medial portion of each socket member having oppositely directed link plates (69) for joining the socket members as a unitary structure, the upper end of each socket element having an elongated funnel (70) and the lower end of each socket element having an axially centered element (71) to resiliently support a section of drill pipe.