This invention relates to improvements in drilling rigs and more particularly to drilling rigs which may be operated with a minimum crew, usually two men or fewer.

The present rig has been so automated that it may be set up in a minimum of time and so constructed that two men can normally operate the rig efficiently, however, after the rig is set up and in operation, it is possible for a single operator to perform all of the functions necessary for carry.

The rig proper is built on a trussed frame construction on which a prime mover is mounted, which prime mover normally promotes propelling the rig over the terrain and for operating the mechanisms thereof, such as the pump, draw-works, etc., the lowering of the mast, and other operations ancillary to the moving, setting up the rig, performing the drilling operation, and the "tearing down" and moving to other locations.

The structure of the present rig, together with the associated components thereof, makes it possible for one or two men to successfully operate the equipment, which heretofore usually required three to five men. The present rig enables the work to be performed more efficiently and with less effort than that performed by conventional rigs with much larger crews.

Various mobile drilling rigs have been proposed heretofore, but these for the most part, would either be so small as to make them inadequate for drilling relatively deep holes, or if large enough to drill relatively deep holes, they required large crews and much manual work to be performed, which is automated with the present rig.

An object of this invention is to provide a mobile drilling rig, which, for the most part, has the operating elements built integral therewith.

Another object of the invention is to provide a mobile drilling rig which is automated to such an extent that a minimum crew can successfully operate the rig without undue physical effort.

Still another object of the invention is to provide a mobile drilling rig wherein the traveling block, swivel, and pipe rotating device are built to operate as a unit in guided relation with a mast.

Still a further object of the invention is to provide a mobile drilling rig that is capable of drilling wells from the surface of the earth down, even in hard formation.

Still a further object of the invention is to provide a drilling rig having a power pull down mechanism thereon which will move the pipe rotating device, swivel, and traveling block downward with a uniform pull.

And still a further object of the invention is to provide a drilling rig that is efficient in operation, easy to operate, low in the cost of operation, and simple in construction for the work performed.

With these objects in mind and others which will become manifest as the description proceeds, reference is to be had to the accompanying drawings in which like reference characters designate like parts in the several views thereof, in which:

FIG. 1 is a side elevational view of a mobile drilling rig with the mast being shown erected in dashed outline, and with the transport position of the mast being shown in full outline;

FIG. 2 is a top plan view of the drilling rig with the mast removed therefrom and showing the wheeled vehicle on which the mobile drilling rig is mounted;

FIG. 3 is an enlarged fragmentary sectional view of the lower portion of the mast with parts broken away and with parts being shown in section and with parts being shown in dashed outline with the traveling block, swivel, power sub, and pipe handling device being shown on a wheeled frame for operation within the mast;

FIG. 5 is a top plan view of the mast, on an enlarged scale, showing the crown block thereof and showing guy cables extending from the upper end of the mast;

FIG. 6 is an enlarged view of the wheeled frame mounting the traveling block, swivel, and power sub thereon with parts broken away and with parts shown in dashed outline, and shown apart from the mast;

FIG. 7 is a view taken at a right angle to FIG. 6 and on the same scale thereof, with parts broken away and parts shown in section;

FIG. 8 is a bottom plan view of the wheeled frame and power sub as shown in FIG. 6 and being on the same scale, with parts broken away and parts shown in section, and showing a fragmentary portion of the mast associated therewith; and

FIG. 9 is a side elevational view of a modified form of the drilling rig, as shown in FIG. 1, for drilling angular bore holes, with the transport position of the mast being shown in dashed outline and with the drilling position of the mast being shown in full outline.

With more detailed reference to the drawings, the numeral 1 designates generally a supporting frame, which, in the present instance, is a wheeled vehicle frame such as a trussed frame for mounting a rotary drilling rig thereon. A mast is pivotally mounted on pin 3 to the frame 1 near one end thereof so the mast 2 may be moved from the horizontal position, as shown in full outline in FIG. 1, to an upright position, shown in dashed outline therein. A prime mover 4, such as an engine, is mounted on frame 1 transversely thereof, which prime mover is connected through a chain drive mechanism 6 to drive a counter shaft 8, which counter shaft has sprockets 10 and 11 thereon, around which respective sprocket chains 14 and 16 are arranged and to drive sprockets 18 and 20 that are mounted on clutches on drum shaft 22 to enable the respective clutches 24 and 26 to be selectively engaged to drive a hoist drum 28, in a manner well understood in the art of rotary well drilling. The clutches 24 and 26 are preferably air clutches and have air connections 30 and 32 respectively, thereon to enable the rotation of the clutch in the conventional manner.

The hoist drum 28 has a cable 34 spooled thereon, which passes over crown block sheave pulleys 36 and down through traveling block 38 in a conventional manner.

The traveling block 38, a swivel 40 and a pipe rotating device, such as a hydraulically driven power sub 42, are mounted on and secured to an elongated, wheeled frame 44, which frame has pairs of opposed rollers 46 riding within the angle steel legs 48 of mast 2. It is preferable to have at least two pairs of opposed rollers 50 mounted on wheeled frame 44 and spaced near the ends thereof so as to roll in guided relation within the angle steel legs 48 of the mast 2, with the axis thereof at a right angle to the axis of rollers 46. Since there is less side strain than strain from front to back, it is preferable to have only four of these rollers 50, whereas it is preferable to have eight of the rollers 46.

Under normal drilling conditions, the weight of the traveling block 38, swivel 40, the power sub 42, and the frame 44 mounting these, together with the drill stem or drill collar and drill bit (not shown), is usually sufficient to drill from the surface down, in normal formations.
However, a tensioning element, such as a winch 52 is mounted on and secured to the lower end of mast 2, which winch is driven by a hydraulic motor 54 driving through a gear reduction unit 56, which hydraulic motor 54 is connected to the gear reduction unit 56 by a chain and sprocket reduction drive 58. The gear reduction unit is connected to a cluth 60 through a sprocket and chain reduction gear 62, so a predetermined torque may be exerted on the drum of winch 52. Hydraulic fluid under pressure is transferred by conventional hydraulic pump and by conduits, one of which conduits has a pressure relief valve which may be set to bypass hydraulic fluid at a predetermined pressure, back to the hydraulic fluid supply.

The setting of the pressure relief valve determines the output torque of the hydraulic motor 54, in this manner a predetermined and constant pull-down force may be exerted on the cable 66. A flexible tension member, such as a cable 66 is connected to an eye 70 and to drum of the winch 52 so as the cable is wound onto the drum of the winch 52, the frame 44 is drawn downward. An air pressure hose 64 is connected with a suitable source of air pressure and cluth 60 of the drum of winch 52 to be selectively dis-engaged or engaged.

A conventional mud hose 76 is provided, which leads from standpipe 78 to the swivel 40, as will best be seen in FIG. 3. The standpipe 78 has the lower end thereof connected to a mud pump, which sucks and sends to the side of mast 2. This arrangement enables the mud from a pump (not shown) to be directed up through standpipe 78 and into hose 76, down the through swivel 40 and power sub 42 into the drill pipe. As the drilling progresses, and it becomes necessary for additional lengths of drill stem to be utilized, these may be added by disconnecting the screw threaded joint 80 on the lower end of power sub 42, then by actuating power cylinders 82 and 84, the pipe handling device, designated generally by the numeral 86, is actuated to pick up a length of pipe from a substantially horizontal position, to move this into the mast 2 so as to be in substantially axial alignment with the screw threaded joint 80 and with the drill pipe (not shown) which is suspended in the well by slips or the like. Whereupon, the elongated frame 44, within mast 2, may be lowered until the joints on the lower end of the drill pipe being placed in the well engage the screw threads in the portion of the pipe suspended in the well, and by further lowering the power sub 42, the threaded joint 80 comes into complementary threaded engagement with the threaded portion of the upper end of the drill stem, whereupon, by directing fluid under pressure through the feedway 46 and into the drill stem, fluid is directed through pipes 90 and 92 to actuate the motor in one direction to screw the joints of pipe together, or in the opposite direction for unscrewing the joints. Guy cables 94 are connected to frame portions which extend outwardly on opposite sides of the upper end of the mast 2 (FIG. 5) and which cables are connected to suitable anchors (not shown). The cables 94 connected to the frame portions on the upper end of the mast 2 stabilize the mast against movement.

With a joint of drill stem screw threaded onto the lower end of power sub 42, the frame 44 may be lowered by hoist drum cable 34, which in turn, will lower the traveling block 38 and frame 44 to permit drilling to continue until the bore hole has been deepened by the length of the drill stem, whereupon, the operation is repeated. The pipe handling device 86 is more specifically brought out in my co-pending application, Pipe Handling Device, filed August 4, 1964, Ser. No. 387,459.

Space may be provided on the wheeled vehicle frame 1 intermediate the cab C and the prime mover 4 for a mud pump. However, it is preferably to have a self-propelled reciprocating pump, such as shown in my co-pending application Ser. No. 304,920, now Patent No. 3,254,735, issued June 7, 1966, thereby enabling the use of a larger and heavier draw works, with one or more engines on the wheeled vehicle frame 1 for driving the hoist drum 28 and for driving the fluid pumping mechanisms to furnish fluid under pressure to the fluid motors on power drive 42 for furnishing fluid pressure to the various fluid actuated mechanisms, such as the power cylinder for raising and lowering of the mast 2, for actuating the cylinders of the pipe handling device 86, clutches and the like.

The hoist drum cable 34 is adapted to pass over crown block pulleys 36, as will best be seen in FIGS. 1 and 5, to enable the raising and lowering of the traveling block 38, wheeled frame 44, and the mechanisms attached thereto to enable the raising and lowering of the drill stem connected to screw threaded coupling joint 80. The upper end of mast 2 has arms 2a secured thereto, on opposite sides thereof, which arms extend laterally outward therefrom. The arms 2a each have anchor members 2b secured thereto, near the outer end thereof, to which anchor members guy cables are connected at the respective upper ends thereof, and which guy cables extend downwardly to connect to respective anchors (not shown) so as to maintain the mast in upright, stabilized position. The controls for the rotary drilling equipment are conventional, as used on drilling equipment of the general character used heretofore.

It is preferable to use a self-propelled combination vehicle and rig drive, as disclosed in my Patent No. 3,033,528, except the present invention utilizes a non-telecoping mast to enable a wheeled frame 44 to be moved within the mast in guided relation, thereby making possible the elimination of a rotary table on the rig floor, which not only requires time to accurately set and remove, but also eliminates the hazards incident to a rotary table on a floor.

Operation

The present drilling rig is of a character as disclosed in my Patent No. 3,033,528 on a self-propelled combination vehicle and drilling rig drive which enables an operator to utilize a prime mover, such as an internal combustion engine, for propelling the wheeled vehicle frame over the terrain and by utilizing a hydraulic system, a telescoping jack 5, interconnected between the wheeled vehicle frame 1 and the mast 2, may be utilized to raise and lower the mast in a horizontal position as shown in full outline in FIG. 1 to the position shown in dashed outline in FIG. 1. With the mast erected in this manner, guy cables 94 may be connected to anchor points to hold the mast 2 in rigid upright position. The turned angles of the mast 2 form a track-way for guided movement of the drill frame 86 on the floor.

With the traveling block 38, swivel 40, pipe rotating device or power sub 42, and the pipe handling device 86 mounted on the wheeled frame 44, these are permitted to move downwardly by releasing cable 34 off of hoist drum 28. When the wheeled frame 44 in or approaches the lowestmost position in the mast, with the mast in upright position as shown in FIG. 1, the pipe handling device 86 will grip a length of drill stem immediately below the threaded upper end and, upon winding cable 34 onto hoist drum 28, the drill stem will be lifted from a substantially horizontal position to a vertical position and will be lowered onto a complementary screw threaded coupling on the length of drill stem suspended in the well, whereupon by further lowering the wheeled frame 44, the screw threaded end of joint 80 of the hollow shaft 81, which passes through the power sub, will engage the complementary threaded end of joint 80 on the upper end of the drill stem suspended by the pipe handling device 86. With the threaded coupling on each end of the length of drill stem in complementary engagement with the above mentioned threaded couplings, fluid power is applied to fluid motor 88 through one of conduits 90 or 92 and the hollow shaft 81 is rotated until the threaded connection on each end of the length of drill stem are tightly screwed together. With the threaded joints thus
connected, the hoist drum 28 is rotated by prime mover 4 to wind the hoist drum cable 34 thereonto, which will lift the traveling block 38 and wheeled frame 44 upward until the slips supporting the drill pipe in the well are released. When upon the traveling block and drill stem is lowered until the bit on the lower end of the lowermost drill stem is in contact relation with the bottom of the well.

If the formation is hard and the drill stem and/or drill collars are of insufficient weight to exert the necessary penetrating force, (not shown in Fig. 10) a predetermined pressure, is directed through a conduit to motor 54 which drives through a gear reduction unit 56, 58, 62 and clutch 60, which hydraulic fluid pressure is controlled to bypass in a conventional manner to give the desired amount of torque on the drum of the winch 52 and with a cable 66 attached to wheeled frame 44 by eye 70, the wheeled frame 44 is moved downward, which in turn moves the pipe rotating device or power sub 42 downward at a controlled pull while the drilling fluid is circulated through the swivel 40.

Simultaneously with the movement of the wheeled frame 44 downwardly fluid under pressure is directed into fluid actuated motor 88 through one of the conduits 90 or 92 with the fluid being exhausted out through the other of the conduits 90 or 92 to rotate hollow shaft 81 and the drill stem connected thereto while drilling, which is continued until the length of the drill stem has drilled a bore hole equal to a length thereof. Whereupon the drill stem within the well is gripped by slips (not shown) and the motor 88 on power sub 42 is reversed by introducing fluid under pressure into one of the conduits 90 or 92 and exhausting the fluid from the other conduit, whereupon the screw threaded joint 80 on the lower end of hollow shaft 81 is unscrewed from the drill stem suspended in the well and subsequent lengths of drill stem are picked up by pipe handling device 86 in the manner set out above and the cycle is repeated.

In coming out of the hole the procedure is reversed and each time a length of drill stem is elevated into the mast, and the length of drill stem therebelow is gripped by slips (not shown) to support the pipe in the well. Tongs, such as power tongs, engage the box and pin sections above and below the joint between the drill stems, and the lower joint is maintained against turning while the upper joint is initially broken by the power tongs, whereupon the power sub or pipe rotating device 42 may be rotated by fluid motor 88 to spin out the remaining engaged threads, whereupon the length of drill stem is swung outward and lowered to a horizontal position and racked for future use.

A toothed member 87 is secured on the lower end of shaft 87a which is connected in axially aligned, driving relation with the shaft of motor 88. A toothed lever 89 is pivotally mounted on the lower side of power sub housing 42 and is pivotally connected to a plunger 91 of fluid actuated cylinder 93, which plunger 91 is remotely controlled by applying pressure to and releasing pressure from conduit 95. Spring 89a normally holds the tooth of toothed lever 89 out of engagement with teeth on toothed member 87. By having this particular arrangement, shaft 87a may be maintained against rotation while a length of pipe is being unscrewed from the lower end of screw threaded joint 80 of hollow shaft 81 by a power tong.

**Alternate form of invention**

An alternate form of the invention is shown in FIG. 9. This form of invention is for drilling angulated holes, wherein substantially the same equipment is used for power lifting, except that in the present instance a vehicle frame, which is designated generally by the numeral 100, is so constructed as to have an upright support member 101, which enables the pivoting of the mast 102 by a pivot pin 103 to enable the moving of the mast from a horizontal position, as shown in dashed outline to an angulated position as shown in full outline in FIG. 9, or to a third or upright position, as shown in vertical, dashed outline in FIG. 9.

The present drilling rig, as shown in FIG. 9, may have the mast raised to the position shown in full outline in FIG. 9, with braces 104 secured thereunder to hold the mast in a fixed position. However, guy wires 106 may be directed to either side of the mast and guyed to an anchor (not shown) on each side of mast 102 to prevent lateral movement of the mast 102. A hinged table-like member 108 is pivoted on a pivot pin 112, so the drill stem 114 may be directed into a length of angulated surface pipe 116 in guided relation. The wheeled frame 44 mounts a traveling block 38, a swivel 40, and a power sub 42 for movement in mast 102 in the same manner as set forth in the above mentioned form of the invention. The cable 34 permits the traveling block 38 to move downward when the cable is unwound off of drum 28. However, a pull-down cable 118 is connected to the frame 44 and passes over pulleys 120 and onto a hydraulically powered winch drum 122, so as to draw the wheeled frame 44, which mounts the power sub, steadily downward so as to direct the drill stem 114 into the earth formation. With the arrangement shown in FIG. 9, the mast 102 may be adjusted to various angles by adjusting the length of braces 104 and by adjustment of a jack 109 which interconnects the base 110 and a table-like member 108. Conventional hydraulic pumps and conventional air compressors are utilized to furnish hydraulic fluid and air to the various fluid actuated mechanisms by controls well understood in the art of hydraulics and pneumatics.

While a power sub 42 has been shown as being mounted on wheeled frame 44 for rotating drill stem 114 for performing rotary drilling operations, it is to be understood that a conventional rotary table (not shown) may be mounted on hinged-like table member 108 so the axis thereof will be in register with the axis of the bore hole, which rotary table may be secured thereto and in the conventional manner and a conventional source of power utilized to rotate the rotary table in a manner well understood in the art of rotary well drilling.

When using a rotary table, this would necessitate the use of a Kelly joint which would be conventional and the upper joint of which Kelly jack would be secured to the lower end of the fluid swivel in the conventional manner.

While the use of a rotary table has been described with respect to the form of the invention as shown in FIG. 9, it is also to be understood that the rotary table may be used with the form of the invention shown in FIGS. 1–8.

In the mounting of the traveling block 38, swivel 40, power sub 42 and pipe handling device 86 on wheeled frame 44, it is to be understood that the mounting of rollers 46 and 50 is representative of one mode of journaling the wheeled carriage for longitudinal movement with respect to mast 2, and it is within the purview of this invention to mount rollers 46 on the opposite side of the mast 2 so one roller 46 will be within the confines of mast 2 and the other roller 46 will have the axis parallel thereto exteriorly of the angle 48 of mast 2. Likewise rollers 50 may be mounted wholly within the confines of angle 48 on the forward side of mast 2.

**Operation of alternate form of invention**

To operate the alternate form of invention, the prime mover 4 is utilized to drive through the gearing to move the vehicle over the terrain. When the vehicle is in location, the mast 102 is raised from the position as shown in dashed outline in FIG. 9 by a hydraulic cylinder 5, to the position shown in full outline therein, and braces 104 are secured to the under side of the mast 102 and to the frame 100 of the vehicle structure. Guy wires 106 are anchored laterally outward on each side of the mast 102 to stabilize the mast against lateral movement. An
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angulated table 108 which is pivotally mounted to base 110 by pivot pin 112 is positioned below the mast 102, and jacks 109 are tightened between the base 110 and the angulated table 108. With the angulated table 108 in this position, jack screws 111 in the lower end of legs of mast 102 are tightened to bear against the upper face of angulated table 108, whereupon a length of drill stem 114 is directed between guide rollers 115 and into surface pipe 116 at the particular angle at which the angulated surface pipe 116 is positioned.

The operation of the drilling of the bore hole is substantially the same as the aforementioned form of the invention, however, the power driven winch 122 is utilized to draw cable 118 downward which cable is attached to wheeled frame 44 and is used in the manner as set out above for drilling hard formations. In this arrangement, the winch 122 may be located beside the cab on the vehicle frame 100 and the cable 118 is passed around pulleys 120 so as to direct cable thereinto.

While this invention has been described with respect to two forms of the invention, it is to be understood that changes in the details of construction may be made without departing from the spirit of the invention and within the scope of the appended claims.

Having thus clearly shown and described my invention, what is claimed as new and is desired to be secured by Letters Patent is:

1. A drilling rig, including a prime mover, for drilling holes in the earth formation, which drilling rig is mounted on a supporting frame, which drilling rig comprises:
   (a) a hoisting drum for winding cable thereon, which hoisting drum is mounted on said supporting frame and is connected in power driven relation with the prime mover,
   (b) an elongated mast pivotally mounted on said supporting frame, which mast has the front only thereof open,
      (1) said elongated mast being rectangular in cross-section and having a leg on each corner thereof,
      (2) a crown block having sheaves thereon on the upper end of said mast,
   (c) an elongated frame mounted within said mast for longitudinal movement therein, which frame is in guided relation therein,
      (1) a traveling block having sheaves mounted thereon,
      (2) a swivel for passing fluid from a non-rotatable conduit into a rotatable conduit,
      (3) a power driven pipe rotating device,
      (4) a pipe handling device for picking up pipe which is arranged substantially horizontally and moving said pipe through an angle to an upright position,
   (5) said traveling block, said swivel, said pipe rotating device, and said pipe handling device being associated with said elongated frame for integral movement therewithin said elongated mast,
   (6) said elongated frame adapted to be raised within said elongated mast, by a cable, which cable is wound on said hoisting drum and passes over the sheaves of the crown block and around the sheaves of the traveling block, so as to enable the elongated frame to be raised by winding said cable onto the drum of the drilling rig, and to enable the elongated frame to be moved downward by gravity, within said elongated mast, upon unwinding said cable from said housing drum,
   (d) arms secured to said mast near the upper end thereof and extending laterally outward therefrom,
      (1) anchor means on each arm to anchor guy cables a spaced lateral distance from each side of said mast, and
      (2) guy cables secured to an anchor member on each arm and extending therefrom in diverse directions, with said guy cables each secured to an anchor to stabilize said mast in elevated position.

2. A drilling rig, including a prime mover, for drilling holes in the earth formation which is mounted on a supporting frame, as defined in claim 1, wherein:
   (a) said elongated frame within said elongated mast is a wheeled frame, and
   (b) the wheels of said wheeled frame being rollers, which rollers are journaled on said elongated frame for rolling engagement with the respective legs of said elongated mast.

3. A drilling rig, including a prime mover, for drilling holes in the earth formation which is mounted on a supporting frame, as defined in claim 2, wherein:
   (a) said legs of said elongated mast are angle members one of which angle members is positioned on each of the four sides and having the flanges thereof extending towards each other, and
   (b) said wheeled frame having the rollers thereof journaled at right angles so that the rollers will roll on the inner flanges of opposed angle members to maintain the wheeled frame against movement laterally in any direction.

4. A drilling rig, including a prime mover, for drilling holes in the earth formation, as defined in claim 1, wherein
   (a) said legs are parallel and form guides, and
   (b) said elongated frame is guided by the legs of said mast.

5. A drilling rig, including a prime mover, for drilling holes in the earth formation, which drilling rig is mounted on a supporting frame, and to said elongated mast in at least two places within the length thereof,
   (a) a Y-shaped support brace is connected to the supporting frame and to said elongated mast at
   (1) said Y-shaped support brace being adapted to support said mast at any angle between and including the vertical and the horizontal, and
   (b) adjustable guide means associated with the base of said mast for directing drill pipe into the earth formation, at any angle between and including the vertical and the horizontal.

6. A drilling rig, including a prime mover, for drilling in the earth formation, which drilling rig is mounted on a wheeled vehicle frame for movement over the terrain, which drilling rig comprises:
   (a) a hoisting drum for winding cable thereon, mounted on a wheeled frame and being connected in power driven relation with the prime mover,
   (b) an elongated mast pivotally mounted on said wheeled vehicle frame,
   (c) a frame mounted within said mast for longitudinal, guided movement therein,
   (d) a traveling block, a swivel and a power driven pipe rotating device mounted on and being movable with said frame,
      (1) which frame is adapted to be raised by the cable wound on the drum of the drilling rig, and to move downwardly by gravity within said elongated mast,
      (e) support means for supporting said mast at any angle between and including the vertical and the horizontal,
      (f) guide means for directing the drill pipe into the earth formation between and including any angle between the horizontal and the vertical,
   (1) said guide means being an adjustable, angulated, hinged, table-like member which may be adjusted perpendicularly to the axis of said elongated mast.

7. A drilling rig, including a prime mover, for drilling holes in the earth formation, as defined in claim 6;
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(a) a prime mover driven tensioning element is mounted on said wheeled frame,
(b) said mover tensioning element including a fluid driven motor and a winch connected in operative relation,
(c) a flexible tension member connected to said frame, in said elongated mast, and to said winch on said tensioning element, to move said frame downward within said elongated mast by controlled torque power of the prime mover.

8. A drilling rig, including a prime mover, for drilling into the earth formation, which drilling rig is mounted on a supporting frame, and which drilling rig comprises;
(a) a hoisting drum for winding cable thereon mounted on said supporting frame and which is connected in power driven relation with the prime mover,
(b) an elongated mast pivotally mounted on said supporting frame,
(c) a frame mounted within said elongated mast for longitudinal, guided movement therein,
(d) a traveling block and a swivel mounted on and being movable with said frame,
(1) said frame adapted to be raised by the cable winding onto the drum of the drilling rig,
(2) pull down means connected to said movable frame to move said frame downward within said elongated mast,
(e) a power driven pipe rotating device associated with said mast for drilling in the earth formation,
(f) support means for supporting said elongated mast at any angle between and including the vertical and the horizontal,
(g) guide means for directing the drill pipe into the earth formation between and including any angle between the horizontal and the vertical,

9. A drilling rig, including a prime mover, for drilling in earth formation, as defined in claim 8; wherein
(a) said pull down means includes a controlled torque motor mounted on said supporting frame,
(b) a cable winding drum mounted on said supporting frame and being connected in power driven relation with said controlled torque motor, and
(1) cable wound on said cable winding drum in operative relation and having an end thereof connected to said movable frame within said elongated mast for movement of said frame longitudinally downward within said mast.

10. A vehicle mounted drilling rig for drilling holes in earth formation, which drilling rig has a vehicle frame with ground engaging wheels mounted thereon to support the drilling rig for movement over the terrain, which drilling rig comprises:
(a) a prime mover mounted on the vehicle frame,
(b) a hoisting drum, for winding cable thereon, mounted on the vehicle frame,
(1) said hoisting drum being connected in power driven relation with said prime mover,
(c) an elongated mast pivotally mounted on the vehicle frame near an end thereof,
(1) said mast having four legs, each formed of an angle member, in spaced apart, braced relation, with one of said legs being at each corner of said mast, the angles of which legs are parallel,
(2) a crown block mounted on the upper end of said mast,
(3) a wheeled frame mounted within said angle members of said elongated mast for movement longitudinally thereof in rolling, guided relation with said angle members in said respective corners,
(d) a traveling block, a swivel, for conveying fluid from a non-rotating conduit to a rotating conduit, and a pipe rotating device rigidly mounted on said wheeled frame for movement as a unit,
(e) a cable associated with said traveling block on said wheeled frame and with said crown block and being connected to said drum in winding relation to upon rotation of said hoisting drum, said wheeled frame mounting said traveling block, said swivel and said pipe rotating device will be moved in guided relation within the angle members of said elongated mast, and
(f) mast raising means mounted on said vehicle frame and connected in operative relation with said mast,
(1) said mast adapted to be raised by said means from a horizontal position to a vertical position, and
(2) said mast adapted to be lowered by said means from a vertical position to a horizontal position, and
(3) said mast raising means being adapted to move said mast into any operative position between the horizontal and the vertical.

11. A drilling rig for drilling holes in the earth formation, which rig is mounted on a wheeled vehicle frame for movement over the terrain, and comprises:
(a) an elongated mast pivotally mounted on the wheeled vehicle frame near one end thereof,
(b) spaced apart support members extending between said mast and the wheeled vehicle frame,
(c) elongated brace members extending between said spaced apart support members and the mast of the drilling rig,
(d) a movable, wheeled frame mounted within said mast of the drilling rig for selective movement therein,
(e) a traveling block, a swivel, for conveying fluid from a non-rotating conduit to a rotating conduit, and a pipe rotating device rigidly mounted on said wheeled frame for movement as a unit within said mast of the drilling rig,
(f) the wheels of said movable wheeled frame being rollers mounted on each of said spaced apart members at right angles to each other to guide said wheeled frame within said mast.
(g) a prime mover mounted on the movable vehicle frame,
(h) a drum having a cable thereon, which drum is journaled on the wheeled frame and is connected in operative relation with said prime mover,
(i) said traveling block having the cable from said drum extending therearound and over the sheaves of the mast to operatively move said wheeled frame longitudinally on said mast, and
(j) a fluid driven winch associated with said vehicle frame, a cable secured to said winch, for winding thereon, and to the lower end of said movable wheeled frame for moving said wheeled frame, carrying said traveling block, said swivel and said pipe rotating device, to effectively control the pressure on the pipe of said pipe rotating device.

References Cited

UNITED STATES PATENTS

2,792,198 5/1957 Braun --------------- 173--43
3,126,063 3/1964 Pitt et al. --------------- 173--164
3,252,527 5/1966 Alexander et al. --------------- 173--44
3,266,582 8/1966 Homnick --------------- 175--85

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