May 7, 1940. W. T. CALDWELL 2,200,075

HYDRAULIC POWER DRILLING RIG

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Fig. 1.

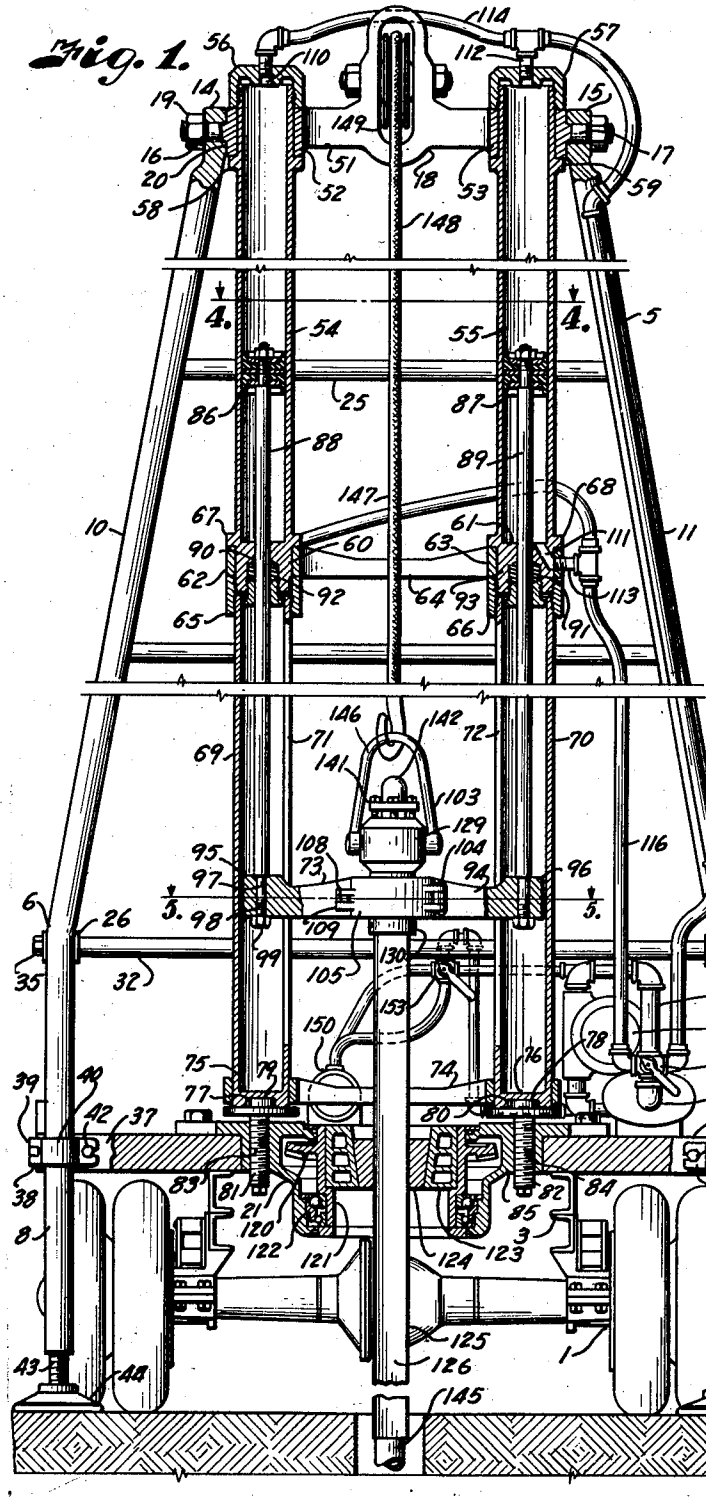

Fig. 2.

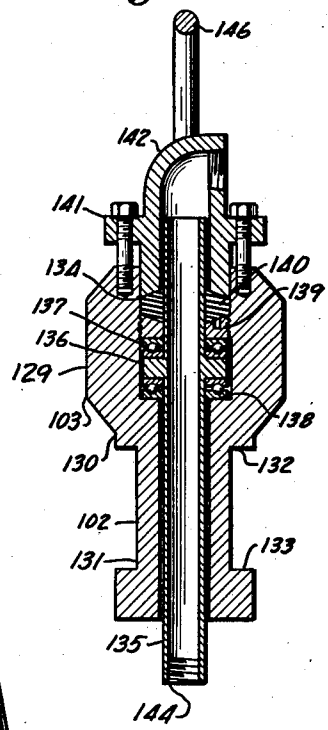

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Fig. 3.

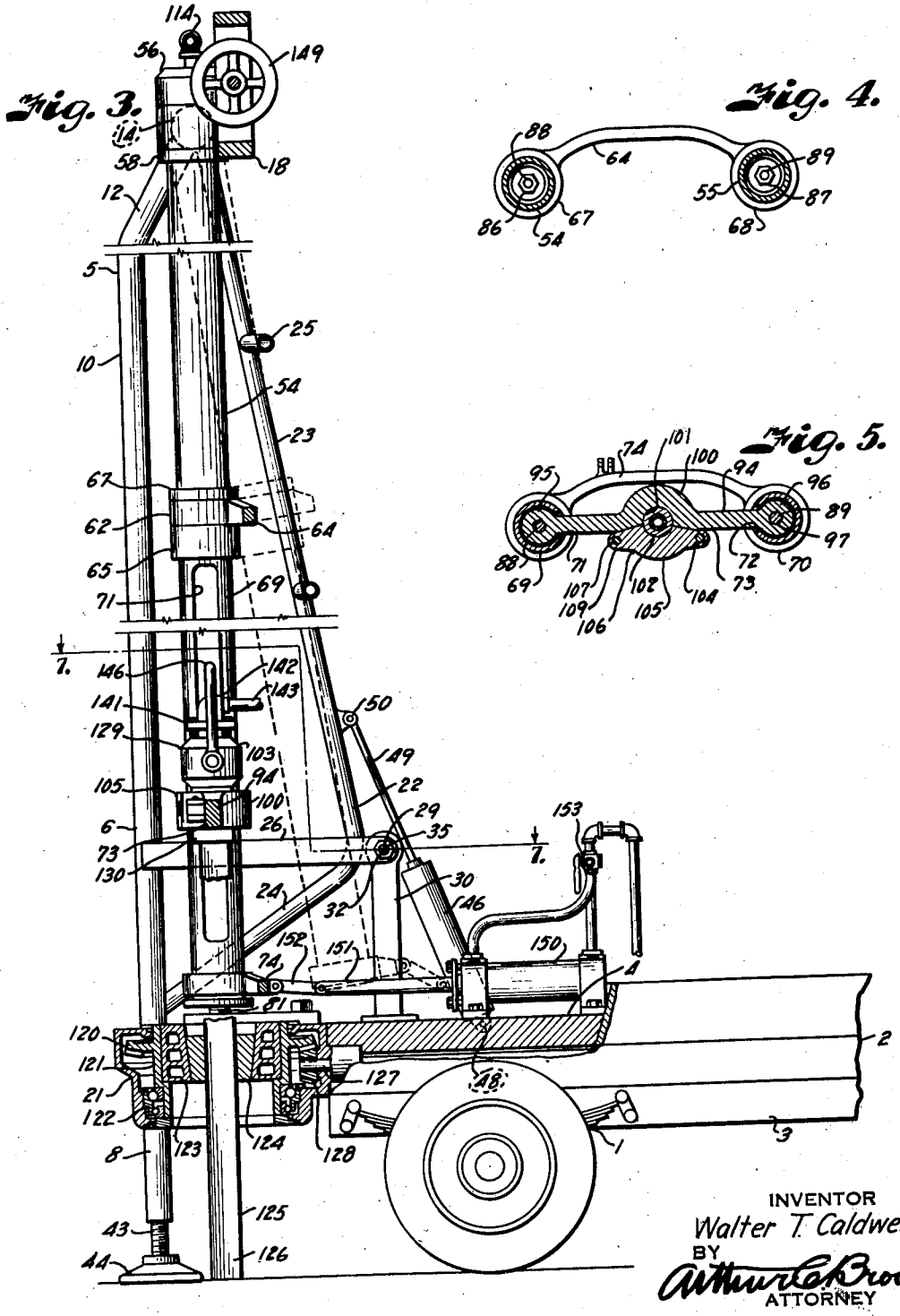

Fig. 4.

Fig. 5.

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Fig. 6.

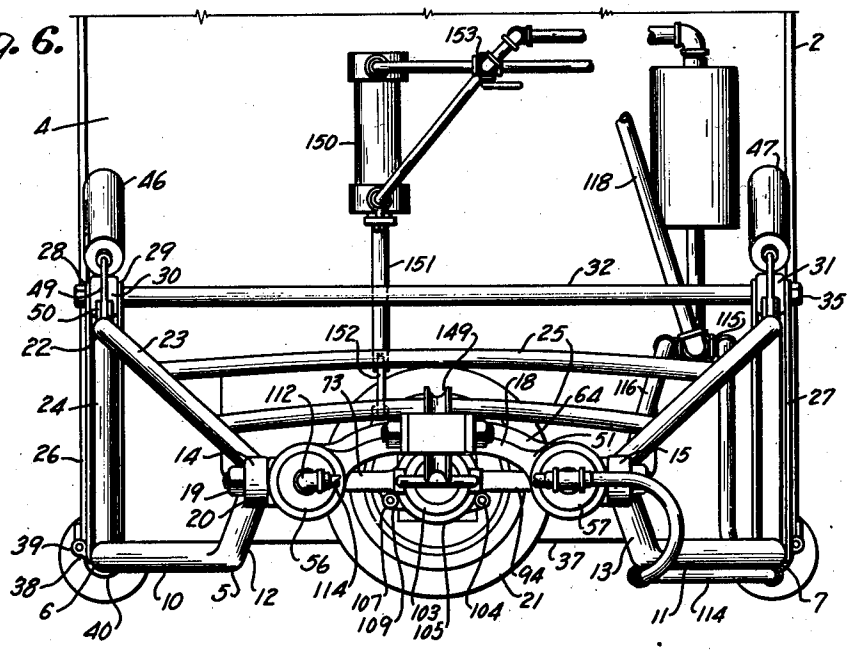
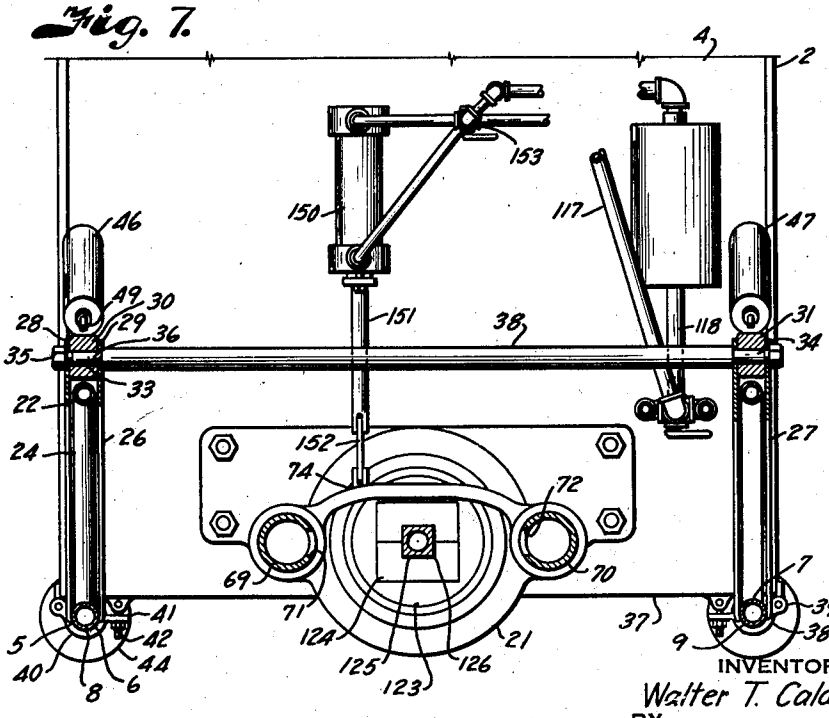


Fig. 7.



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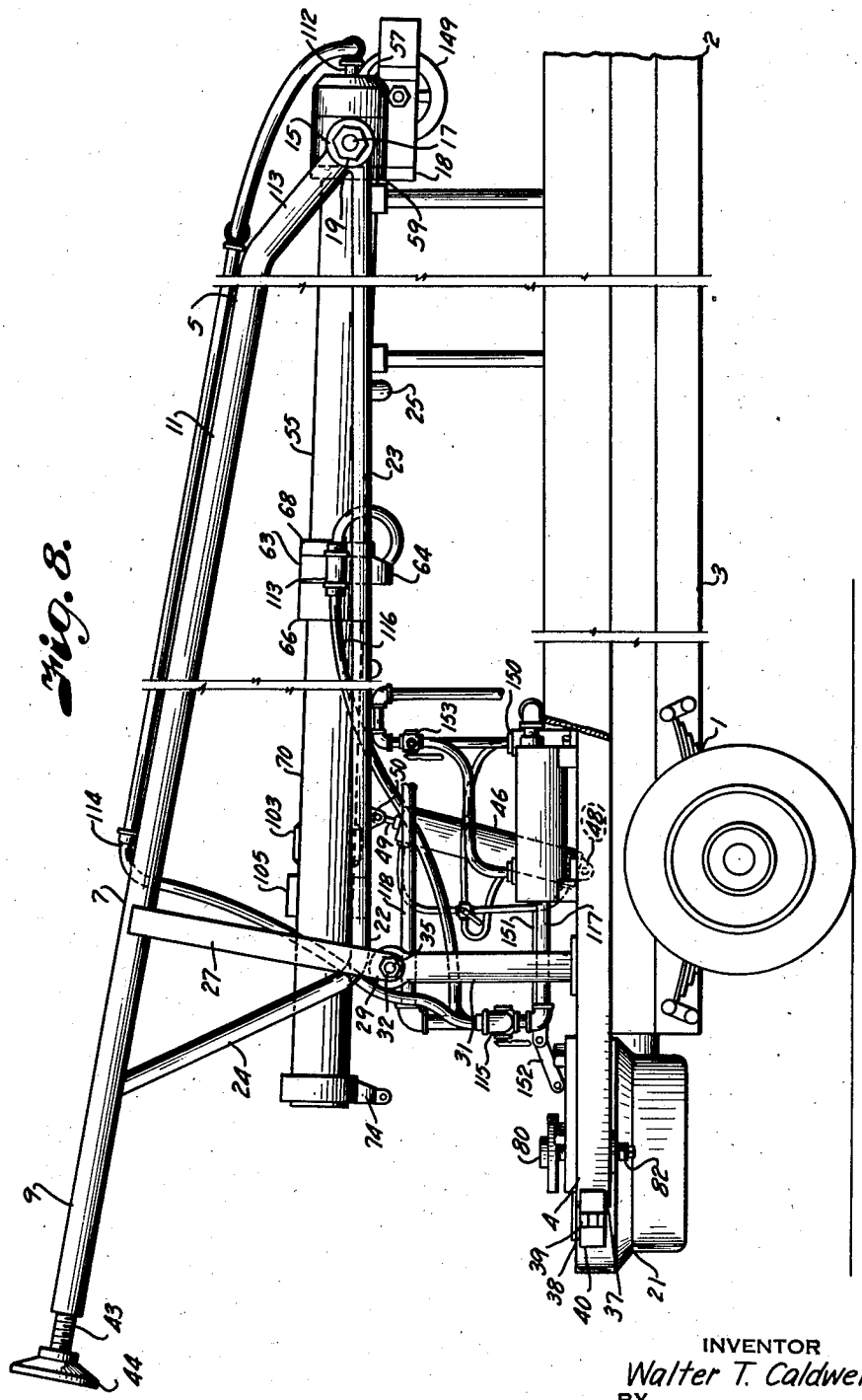

Fig. 8.

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UNITED STATES PATENT OFFICE

2,200,075

HYDRAULIC POWER DRILLING RIG

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Application April 6, 1938, Serial No. 200,389

12 Claims. (Cl. 255—22)

This invention relates to drilling rigs and particularly to a rotary drilling unit which includes a hydraulic power device for controlling pressures applied on the drill bit.

Rotary drills have been extensively used in oil fields but certain difficulties are encountered, among which is the liability of the drill pipe freezing in the hole due to the packing of mud or sludge used in the drilling operations, and another disadvantage is that it is difficult to control the amount of pressure applied to the drill bit. When drilling through certain formations it is desirable to apply pressure in excess of the pressure applied by the weight of the drill pipe and at other times it is desirable to relieve this weight for efficient operation. Also when the hole reaches substantial depths the weight of the drill pipe is such as to interfere with rotation of the bit with the result that the drill pipe is often twisted apart. To overcome these disadvantages various hydraulic powers have been used to selectively sustain or apply control pressure on the drill bit, however, the movement of the hydraulic powers are relatively short and it is customary to provide a drive rod through which the drill pipe extends, the drill pipe being connectingly engaged with the drive rod by means of chuck mechanisms carried on the rod. It is therefore necessary to stop the drilling operations and to rechuck the drill pipe numerous times to feed the bit the length of each stand of drill pipe that is connected into the string as the drilling proceeds. This retards the drilling and results in greater cost in operation.

It is, therefore, the principal object of the present invention to provide a drilling unit of the rotary type with a hydraulic power device of longer length and which is incorporated in and made a part of the tower or mast employed in the drilling rig so as to reduce the drilling time and to avoid the necessity of a drive rod and chuck for connecting the drill pipe with the hydraulic mechanism.

It is also an important object of the present invention to provide a drilling apparatus of this character which is particularly adapted for portable drilling outfits, such as used in core drilling, seismic surveying of subterranean formations, and the like.

It is a further objection of the invention to provide a hydraulic power device and mast structure whereby the hydraulic mechanism may be readily moved out of position to permit running in and removal of the drill pipe.

In accomplishing these and other objects of the invention, as hereinafter pointed out, I have provided improved details of structure, the preferred forms of which are illustrated in the accompanying drawings, wherein:

Fig. 1 is an end view of a portable drilling unit equipped with a mast and hydraulic power device embodying the features of the present invention, parts of the unit being shown in section to better illustrate the construction.

Fig. 2 is a vertical section of the swivel head through which hydraulic power is applied in controlling the pressure on the drill bit.

Fig. 3 is a side elevational view of the drilling unit, parts of which are also shown in section.

Fig. 4 is a cross-section through the mast on the line 4—4 of Fig. 1.

Fig. 5 is a similar horizontal section on the line 5—5 of Fig. 1.

Fig. 6 is a plan view of the drilling unit.

Fig. 7 is a horizontal section on the line 7—7 of Fig. 3.

Fig. 8 is a side elevational view of the drilling unit showing the mast moved to position for transportation.

Referring more in detail to the drawings:

In carrying out the invention I have shown it as applied to a portable drilling unit which includes a wheeled support such as the chassis 1 of a motor vehicle 2. Supported on the frame 3 of the chassis is a platform 4 forming a base for supporting a mast or drilling tower 5. The mast 5 includes a pair of spaced standards or legs 6 and 7 having substantially parallel lower end portions 8 and 9 and converging upper portions 10 and 11 terminating in forwardly extending ends 12 and 13 carrying eyes 14 and 15 for journaling trunnions 16 and 17 of a cross head 18, later described, the trunnions 16 and 17 being threaded and provided with nuts 19 which cooperate with shoulders 20 on the head for spacingly retaining the upper ends of the standards so that when they are in perpendicular position, as shown in Fig. 3, the axis of the trunnions are in plane with the axis of a turntable 21 that is carried on the platform 4, as later described.

Connected with the standards are truss-like legs 22 having upper portions 23 diverging from the upper end of the standards and terminating above the platform 4 in angularly extending portions 24 that are connected with the parallel portions of the standards. The truss members 22 are interconnected at spaced points by girth or tie bars 25 to form a derrick-like structure. Connected with the standards 6 and 7 and with the truss bars 22 are pairs of arms 26 and 27 terminat-

ing in ears 28 and 29 that respectively engage the opposite sides of mounting brackets 30 and 31 carried upon the platform 4. The ears 68 and 69 are pivotally connected with the brackets by a tie rod 32 having reduced threaded ends 33 and 34 extending therethrough as best shown in Fig. 7, the projecting portions of the threaded ends 33 and 34 being provided with nuts 35 which cooperate with the stop shoulder 36 on the tie rod to retain the parts in assembly. The brackets 30 are located on the platform so that when the mast is in erect position, as shown in Fig. 3, the parallel lower ends 8 and 9 of the standards are in position to substantially engage the rear face 37 of the platform. When in this position the standards are secured by straps 38 that are hinged to the platform, as indicated, at 39, and which have seat portions 40 engaging over the standards and terminating in slotted ends 41 whereby the seat portions are clamped against the standards by swing bolts 42 so that the mast is rigidly retained in erect position.

The foot portions of the standards are internally threaded to mount jack screws 43 having base plates 44 that are moved into engagement with mud sills or the like so that the mast and drilling equipment carried thereby is partly supported upon the ground independently of the chassis.

In order to raise and lower the mast, I provide double acting hydraulic cylinders 46 and 47 having ends pivoted to the platform as indicated at 48, Fig. 3, and operating rods 49 connected with brackets 50 projecting from the truss-like members of the mast, as shown in Fig. 3. The hydraulic cylinders 46 and 47 are supplied with a pressure fluid to act on the respective sides of pistons carried by the rods 49 so as to move the derrick from carrying position as shown in Fig. 8, to the operative position as shown in Fig. 3 and back to carrying position.

The cross head 18, previously mentioned, includes a substantially yoke-shaped bar 51, having ring-like ends 52 and 53 carrying the trunnions 16 and 17 previously described for suspendingly supporting a hydraulic mechanism as now to be described.

The hydraulic mechanism includes a pair of tubular cylinders 54 and 55 having their ends projecting through the ring-like ends of the cross head and are rigidly retained therein by cylinder heads 56 and 57. The heads 56 and 57 are in the form of internally threaded caps mounted on the projecting ends of the cylinders and engaging the cross head to draw shouldered portions 58 and 59 of the cylinders into rigid engagement with the opposite side of the cross head, as clearly shown in Fig. 1. The lower ends of the cylinders depend from the cross head when the mast is in erect position and terminate substantially half-way the height of the mast in ends 60 and 61 that are sleeved within the ring-shaped ends 62 and 63 of a yoke-shaped cross bar 64, as best shown in Fig. 4. The ends of the cylinders project through the ring-shaped ends of the bar 64 and are externally threaded to mount couplings 65 and 66 that are threaded into engagement with the cross bar to retain the cross bar in engagement with shoulders 67 and 68 on the cylinder.

Dependingly connected with the couplings 65 and 66 are tubular guides 69 and 70 having longitudinal facing slots 71 and 72 for passing the terminal ends of a guide yoke 73, later described. The lower ends of the tubular guides terminate slightly above the platform when the mast is in erect position and are connected by a tie member 74 similar to the cross bar 64. The ends of the tubular guides are closed, as at 75 and 76, and are provided with centering sockets 77 and 78 for engaging bosses 79 and 80 on adjusting screws 81 and 82. The adjusting screws 81 and 82 are threaded in openings 83 and 84 of the framework 85 of the turntable, previously mentioned, so that when the mast is in erected position and the hydraulic cylinders are located in alignment with the turntable, the adjusting screws 81 and 82 may be manipulated to engage the bosses thereon in the sockets of the tubular guides whereby the tubular guides and cylinders are retained in perpendicular position as shown in Figs. 1 and 3.

Slidably mounted within the cylinders are pistons 86 and 87 connected with rods 88 and 89 that are slidable through stuffing boxes 90 and 91 carried in heads 92 and 93 closing the lower ends of the cylinders, the rods 88 and 89 being of sufficient length to allow for full movement of the pistons within the cylinders and to connect with the guide yoke 73. The guide yoke 73 is best illustrated in Fig. 5 and includes a bar 94 having cylindrical ends 95 and 96 provided with bores 97 to engage reduced ends 98 on the piston rods, the guide yoke being rigidly retained on the reduced ends of the rods by nuts 99 that are threaded thereon to clamp the ends of the bar against shoulders formed on the rods. The cylindrical ends of the bar are of sufficient diameter to provide a sliding fit within the tubular guides, as shown in Fig. 5.

Formed in the intermediate portion of the bar is a semicylindrical offset 100, having a semicylindrical seat 101 for accommodating a cylindrical neck 102 on a swivel head 103, later described. Pivotally supported on the bar by a hinged pin 104 is a gate 105 which is provided with an arcuate seat 106 cooperating with the seat in the bar to encircle the neck of the swivel head. The gate 105 is retained in closed position by means of a pin 107 extending through an ear 108 and through aligning ears 109 on the gate. The connecting bar and gate thus form a connection for the swivel head whereby the power of the hydraulic cylinders is applied to the drill pipe, as later described.

In order to actuate the pistons 86 and 87 hydraulically in either direction, the heads at the respective ends of the cylinders are provided with ports 110 and 111 in which are threaded fittings 112 and 113 as best shown in Fig. 1, the upper fittings 112 being connected by a flexible hose 114 with a control valve 115 while the lower fittings 113 are connected by a similar hose 116 with another outlet of the control valve. The control valve also includes connections 117 and 118 with the intake and discharge connections of a hydraulic pump 119 whereby pressure fluid may be selectively discharged on one or the other sides of the pistons and drawn from the opposite sides depending upon the setting of the control valve. For example, when the pressure fluid is admitted through the upper connections, pressure of the hydraulic fluid is applied to the pistons so as to move the pistons downwardly within the cylinders to apply pressure on the drill bit through the guide yoke 73, and when the valve is moved to admit pressure through the lower ports the pistons are moved upwardly to relieve pressure acting on the drill bit, as later described.

The turntable 21, previously mentioned, may

be of ordinary construction and includes a beveled gear 120, having a ring-like hub 121 that is journaled in suitable bearings 122 in the supporting frame of the turntable. Formed in the ring-like hub is a shouldered socket for mounting a slip carrier 123 having slips 124 for engaging the drive faces 125 of a Kelly rod 126 or the drive slips may be removed and other slips inserted for supporting the drill pipe incidental to running in or removal thereof as in customary practice. The gear 123 is rotated from a suitable prime mover (not shown), located on the truck, the prime mover being connected through a power shaft 127 having a beveled pinion 128 meshing with the teeth of the ring gear. The swivel head 103 includes a body 129 having a reduced portion 130 provided with an annular groove 131 forming the neck 102 and annular shoulders 132 and 133 for engaging the respective upper and lower sides of the guide yoke 73.

Rotatably mounted within a stuffing box 134 of the swivel head is a tubular nipple 135 having a flanged collar 136 supported within the swivel head by antifriction bearings 137 respectively engaging a shoulder 138 and a packing nut 139 that is threadedly supported in the bore of the head. Also received within the socket and engaging the nut 139 is a packing 140 that is compressed about the nipple by a packing gland 141. The packing gland 141 is of substantially standard construction and has a connection 142 for connecting a flexible hose 143 with a sludge pump (not shown) wherethrough a sludge or drilling fluid is delivered through the nipple by way of the drill pipe for discharge through the drill bit into the bore-hole. The lower end of the nipple is internally threaded, as at 144 to connect the pin of the Kelly rod 125. The Kelly rod 125 has its lower end provided with a suitable coupling for connecting the upper section of the drill pipe, as indicated at 145 in Fig. 1. The swivel head is provided with the usual bail 146 for connection with a tackle mechanism, as indicated at 147, including a cable 148 operating over a pulley 149 that is carried by the cross head 18, the opposite end of the cable being wound upon a suitable winding drum (not shown) that is carried on the truck.

When it becomes necessary to add sections of drill pipe or to withdraw or run in the drilling string, it is desirable to move the hydraulic cylinders away from the turntable. This is effected by disengaging the adjusting screws 81 and 82 with the lower ends of the guides, whereupon the cylinders and tubular guides are free to be swung retractively as shown in dotted lines, Fig. 3. To facilitate movement of the cylinders and retain them in retracted position, the platform carries a double acting hydraulic cylinder 150, having a piston rod 151 that is connected with the lower cross bar 74 by means of a link 152, as best shown in Fig. 3. Pressure fluid is selectively admitted to the respective ends of the cylinder by way of a control valve 153 which is suitably connected with a source of fluid pressure.

In using a drilling rig constructed and assembled as described, it is moved to location with the mast in position as shown in Fig. 8. Upon arrival at the drilling location the mast is moved to an erect position by means of the hydraulic cylinders 46 and 47, as shown in Fig. 3. The straps 48 are swung about the standards of the mast and secured by the swing bolts. The jack screws 43 are then adjusted so that the foot portions 44 thereof firmly engage a mud sill or the like to partially support the load independently of the truck chassis. The screws 81 and 82 are threaded so that the bosses 79 and 80 engage in the centering sockets 77 and 78 of the tubular guides 69 and 70. The Kelly rod is connected with a drill bit. The guide yoke 73 is moved to its uppermost position by adjusting the valve 115 so that the pressure fluid is delivered to the lower ends of the cylinders 54 and 55. In this position of the valve the liquid above the pistons is displaced through the upper ports. The Kelly rod is connected with the drill bit and lowered through the turntable to a position where the neck 102 on the swivel head engages within the seat of the guide yoke 73. The gate of the guide yoke is then closed about the neck and the pin inserted to retain the swivel head in connection with the yoke. Driving slips are then inserted in position within the turntable and the rotating mechanism started to effect rotation of the drill bit. If desired hydraulic pressure may be imparted to the drill bit by adjusting the control valve 115 so that the pressure is admitted to the upper ends of the hydraulic cylinders to apply downward pressure on the Kelly rod through the yoke-shaped guide 73.

As the drilling proceeds, the yoke-shaped guide reaches the bottom of the tubular guides whereupon the drilling string is raised by the tackle mechanism and a stand of drill rods is connected in the string. During this operation the screws 81 and 82 are backed off to release the lower ends of the cylinders, whereupon the hydraulic cylinder 150 is actuated to retract the hydraulic power unit away from the well hole to effect the respective connections in the drilling string. The drilling string is lowered into the bore hole so that the swivel head is in position to engage with the guide bar 73. The hydraulic cylinder 150 is again actuated to return the hydraulic cylinders of the power unit to operative position, after which the screws 81 and 82 are again adjusted to the position as shown in Fig. 2. The yoke is then adjusted relatively to the neck of the swivel head so that it seats within the yoke and the gate is closed to retain the head. In this position the yoke is at the upper end of its stroke and the lower end of the Kelly rod is engaged with the slips in the turntable. The rotating mechanism is again started to rotate the Kelly rod during which rotation the swivel head rotates within the yoke 73. Pressure may be again applied to effect downward feed of the bit by admitting pressure fluid to the upper ends of the hydraulic cylinders. The drilling operation may thus proceed for the full length of the Kelly rod before it is necessary to insert another stand of drill pipe in the drilling string. As the drilling progresses and it is necessary to partially support the weight of the drill pipe, this may be effected by applying the fluid pressure under the pistons of the hydraulic cylinders. When the drill bit is operating in loose formations it may be desirable to admit the pressure fluid to the lower ends of the cylinders so as to regulate downward movement of the Kelly rod. When running the casing the hydraulic unit may be swung retractively out of the way of the borehole so that the casing may be run into the hole, as in standard practice.

From the foregoing it is obvious that I have provided a drilling rig equipped with a hydraulic power device wherein the entire effective length of a Kelly rod may be utilized without making it necessary to change the connection between the hydraulic unit and the swivel head.

Attention is also directed to the fact that when the hydraulic cylinders and tubular guides are in position they form a part of the derrick structure and assist in supporting much of the load that is ordinarily taken by the legs of a derrick.

What I claim and desire to secure by Letters Patent is:

1. A rotary drilling unit including a platform, a turntable carried by the platform, a mast on the platform, a hydraulic power device, means suspending the hydraulic power device from the mast whereby the lower portion thereof is adapted to move in an arc to and from drilling position, hydraulic means on the platform for moving the hydraulic device to and from operative relation with the turntable, and means connecting the hydraulic means with the hydraulic device, said connecting means including means for compensating for said arcuate movement of the hydraulic device.

2. In a device of the character described, a platform, a mast carried by the platform, a turntable carried by the platform, a pair of hydraulic cylinders pivotally suspended from the mast, a pulley carried by the mast intermediate said cylinders, a tackle operating over the pulley to support a drilling string rotated by said turntable, pistons in the cylinders, guides connected with and depending from the lower ends of the cylinders, a cross head slidably connecting the guides, piston rods connecting the pistons with the cross head, means connecting the cross head with the drilling string, means for moving the cylinders to carry the guides away from operative relation with the turntable, and means on the platform centeringly engaging the lower ends of the guides whereby the cylinders and guides cooperate with the mast in supporting the load of the drilling string when the guides are in operative relation with the turntable.

3. In a drilling apparatus, a rotary table, a Kelly rod rotated thereby, positive feeding mechanism for the Kelly rod including power devices disposed at opposite sides of the rotary table and between which the Kelly rod extends, said feeding devices including hydraulic cylinders, guides depending from the lower ends of the cylinders, means pivotally anchoring the upper ends of the cylinders whereby the guides are swingingly movable away from the sides of the rotary table, and jack screws selectively anchoring the lower ends of the guides for fixed support relatively to the rotary table.

4. In a drilling apparatus, a supporting platform, spaced standards on the supporting platform, a cross head connecting the standards, a rotary table, a Kelly rod rotated thereby, positive feeding mechanism for the Kelly rod including power devices carried by the cross head and disposed at opposite sides of the rotary table, said feeding devices including hydraulic cylinders, means pivotally supporting said cylinders from the cross head, guides depending from the lower ends of the cylinders, a Kelly rod engaging member slidable in the guides, pistons in the cylinders, rods connecting the pistons with the Kelly rod engaging member, and means for anchoring the lower ends of the guides to the supporting platform.

5. In a drilling apparatus, spaced standards, a cross head trunnioned on the standards, a pair of cylinders connected with the cross head, a pulley connected with the cross head intermediate the cylinders, Kelly rod rotating means positioned below the cross head, tubular guides connected with the cylinders, means for selectively anchoring the lower ends of the guides, pistons in said cylinders, piston rods connected with the pistons and operable within the tubular guides, a Kelly rod engaging member connecting the piston rods and having portions slidably engaging said guides, means on said Kelly rod engaging member for connecting the Kelly rod, and means for effecting trunnioning movement of the cross head to carry said Kelly rod engaging member away from a position in alignment with the pulley and the rotating means.

6. In a drilling apparatus, a platform, spaced standards pivotally supported on the platform for movement from erect to substantially horizontal positions, a cross head, means trunnioningly supporting the cross head at the upper ends of the standards, a rotary table carried on the platform, a Kelly rod rotated thereby, a powder augmenting mechanism carried by the cross head and having removable connection with the Kelly rod, and means on the platform for moving said power augmenting mechanism incidental to said trunnion mounting of the cross head.

7. In a drilling apparatus, a platform, spaced standards pivotally supported on the platform for movement from erect to substantially horizontal positions, a cross head, means trunnioningly supporting the cross head at the upper ends of the standards, a rotary table carried on the platform, a Kelly rod rotated thereby, a power augmenting mechanism carried by the cross head and having removable connection with the Kelly rod, means on the platform for moving said power augmenting mechanism incidental to said trunnion mounting of the cross head, and means on the platform for raising and lowering the standards to carry the power augmenting mechanism to an inclined position on the platform.

8. In a drilling apparatus, a platform, spaced standards pivotally supported on the platform for movement from erect to substantially horizontal positions, a cross head, means trunnioningly supporting the cross head at the upper ends of the standards, a rotary table carried on the platform, a Kelly rod rotated thereby, a power augmenting mechanism carried by the cross head and having removable connection with the Kelly rod, means on the platform for moving said power augmenting mechanism incidental to said trunnion mounting of the cross head, means on the platform for raising and lowering the standards to carry the power augmenting mechanism to an inclined position on the platform, and means for latchingly retaining the standards in erect position on the platform.

9. In a drilling apparatus, a platform, spaced standards pivotally supported on the platform for movement from erect to substantially horizontal positions, a cross head, means trunnioningly supporting the cross head at the upper ends of the standards, a rotary table carried on the platform, a Kelly rod rotated thereby, a power augmenting mechanism carried by the cross head and having removable connection with the Kelly rod, means on the platform for moving said power augmenting mechanism incidental to said trunnion mounting of the cross head, means on the platform for raising and lowering the standards to carry the power augmenting mechanism to an inclined position on the platform, and means for latchingly retaining the standards in erect position on the platform.

10. A drilling apparatus including a support-

ing platform, a mast carried by the platform, a rotary mechanism carried by the platform for rotating the Kelly rod of a drilling string, feeding mechanism for engaging the Kelly rod including hydraulic power cylinders disposed at opposite sides of the rotary mechanism, means pivotally connecting the upper ends of the cylinders with said mast, guides connected with the lower ends of the cylinders and having lower ends terminating near the supporting platform, and jack screws connecting said lower ends of the guides with the platform whereby the cylinders are retained from swinging movement in the mast and the cylinders including the guides cooperate with the mast in supporting the load of the drilling string.

11. In a rotary drilling unit, a platform, a mast on the platform including a pair of laterally spaced cylinders and legs having connection with the cylinders and platform to cooperate with the cylinders in suspendingly supporting a drilling string, pistons in the cylinders, means connecting the pistons with the drilling string for raising and lowering the drilling string responsive to movement of the pistons in the cylinders, and anchor means engaging the lower ends of the cylinders to anchor the cylinders on the platform.

12. In a rotary drilling unit, a platform, a mast on the platform including a pair of laterally spaced cylinders and legs having connection with the cylinders and platform to cooperate with the cylinders in suspendingly supporting a drilling string, pistons in the cylinders, means connecting the pistons with the drilling string for raising and lowering the drilling string responsive to movement of the pistons in the cylinders, anchor means engaging the lower ends of the cylinders to anchor the cylinders on the platform, supports on the platform, and means hingedly connecting said legs with the supports whereby said legs and cylinders are adapted to be moved to a transport position on the platform.

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