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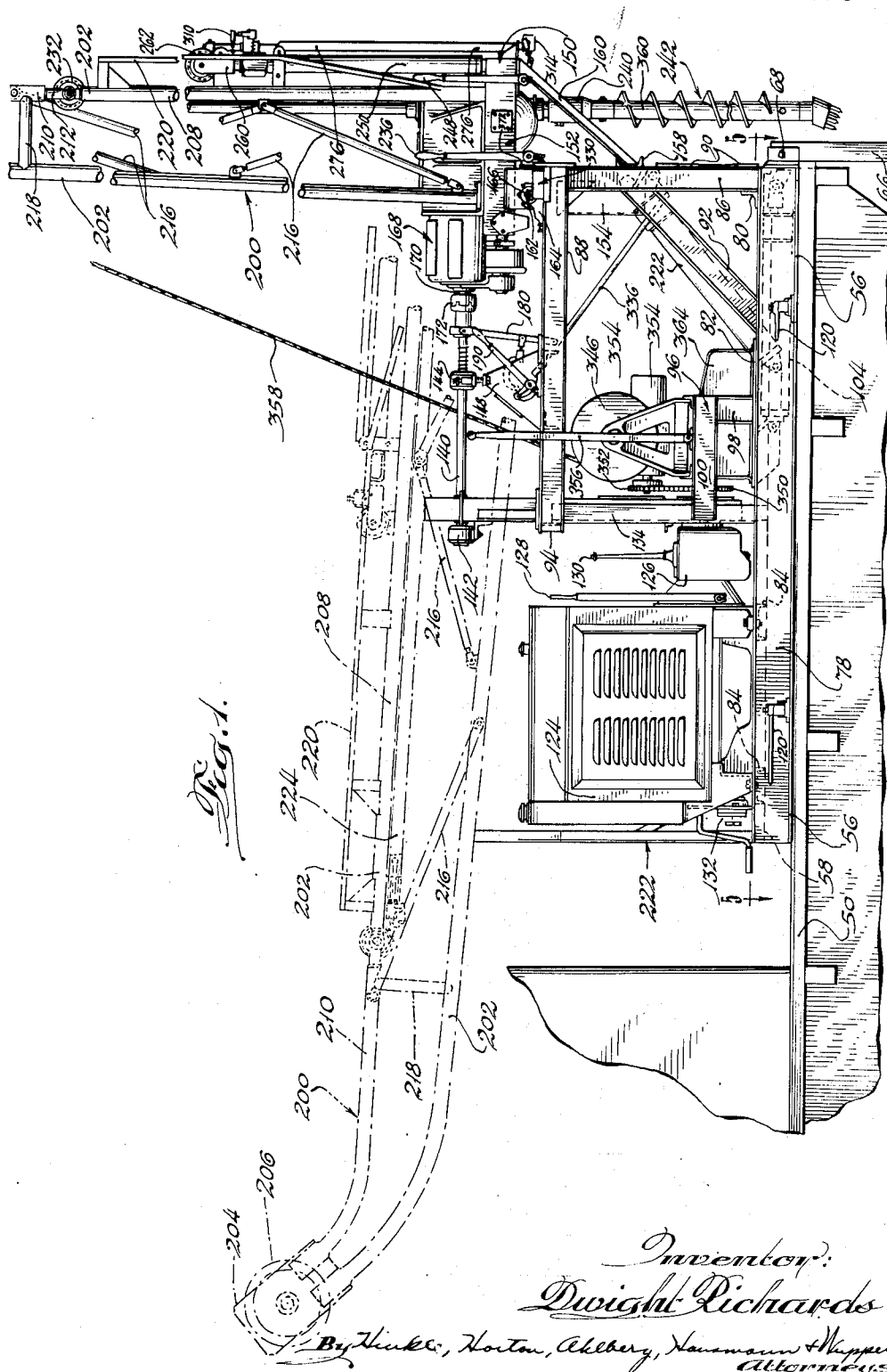
D. RICHARDS

2,657,906

EARTH DRILL

Filed Sept. 18, 1947

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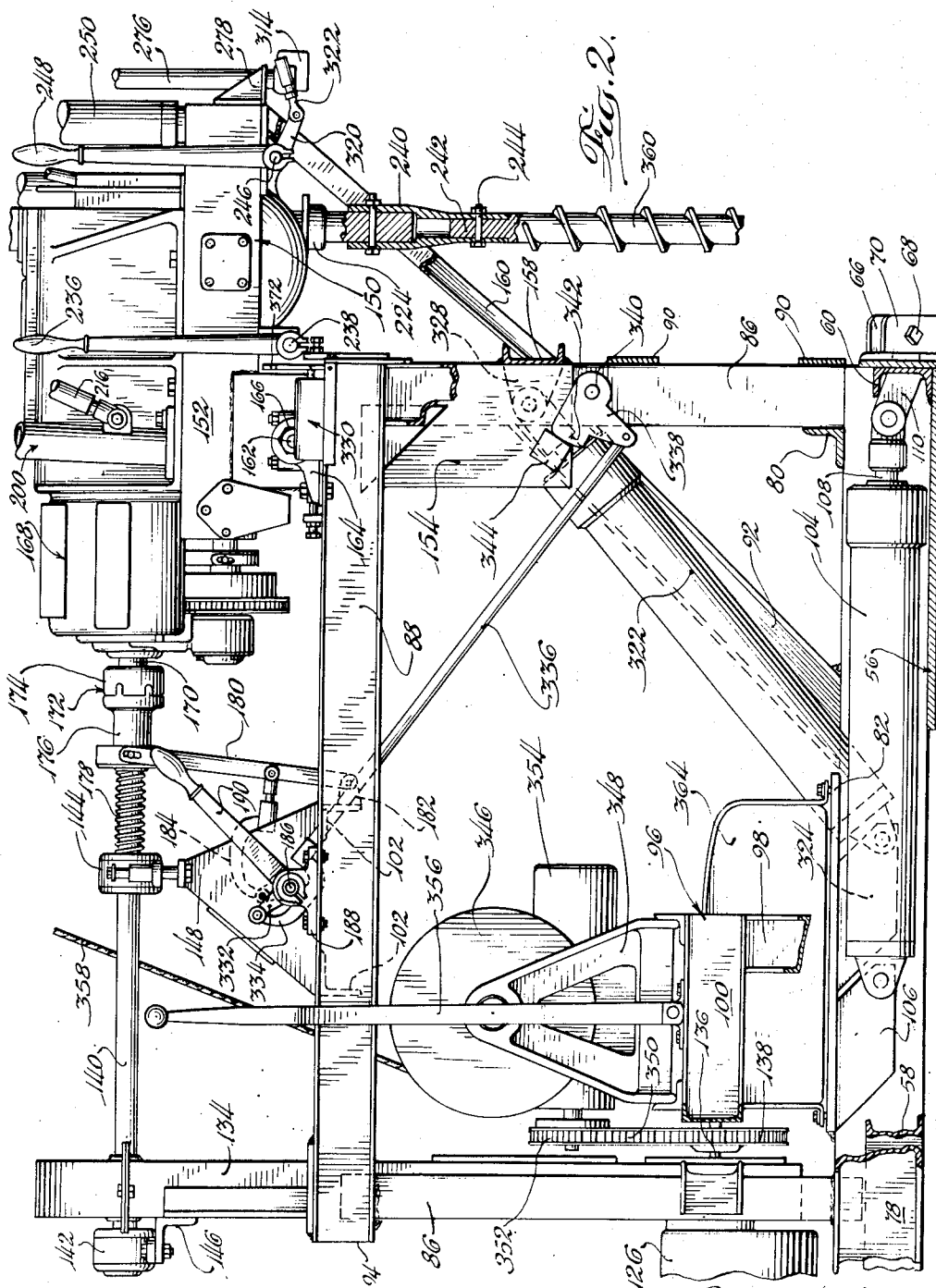
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9 Sheets-Sheet 2



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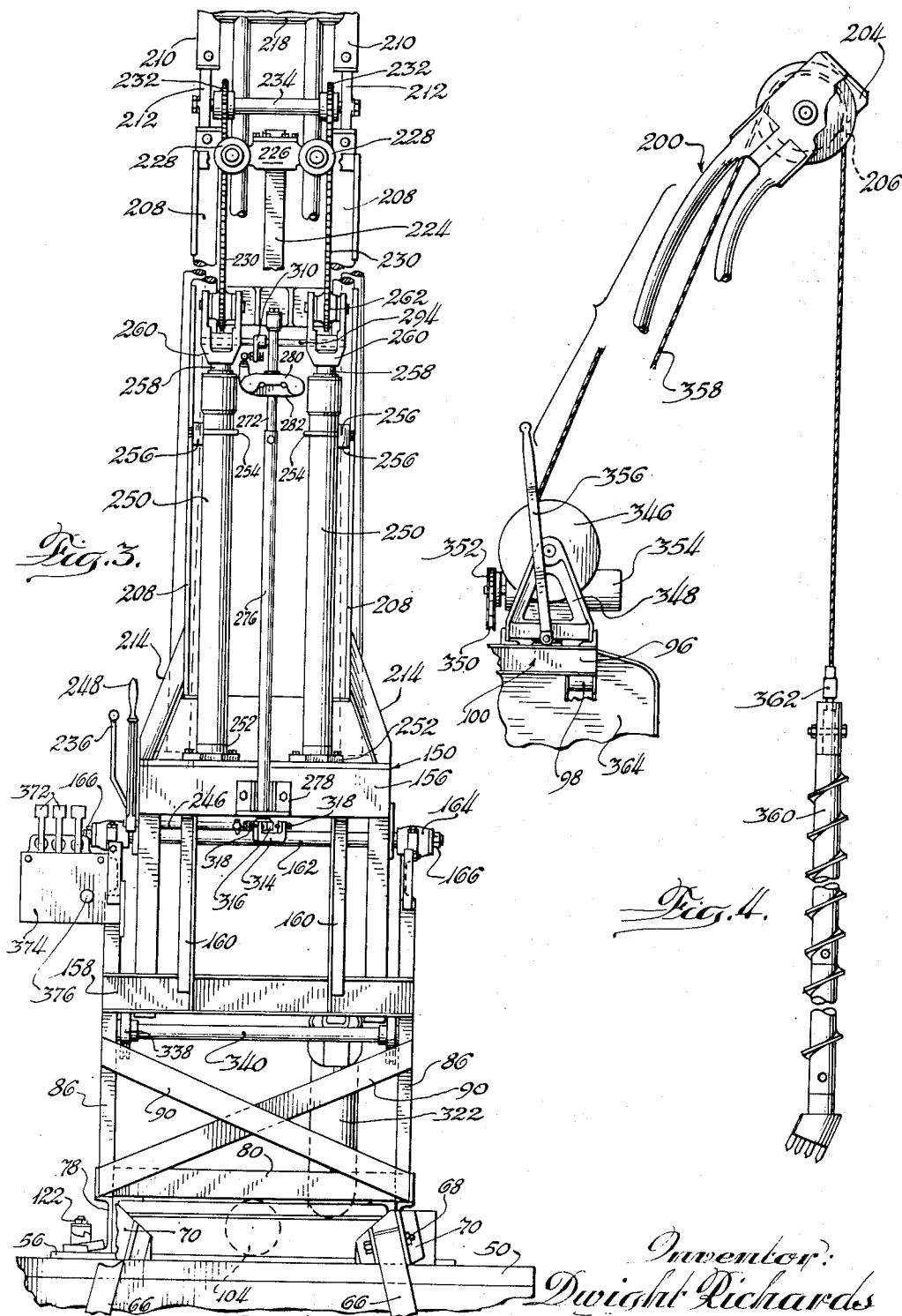
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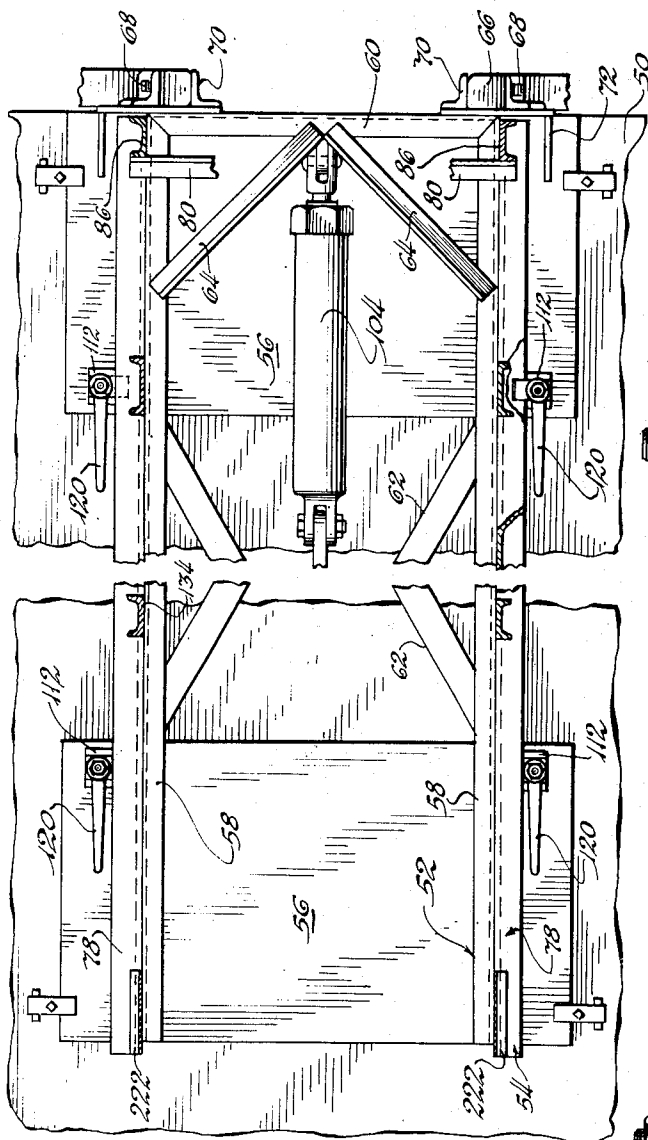


Fig. 5.

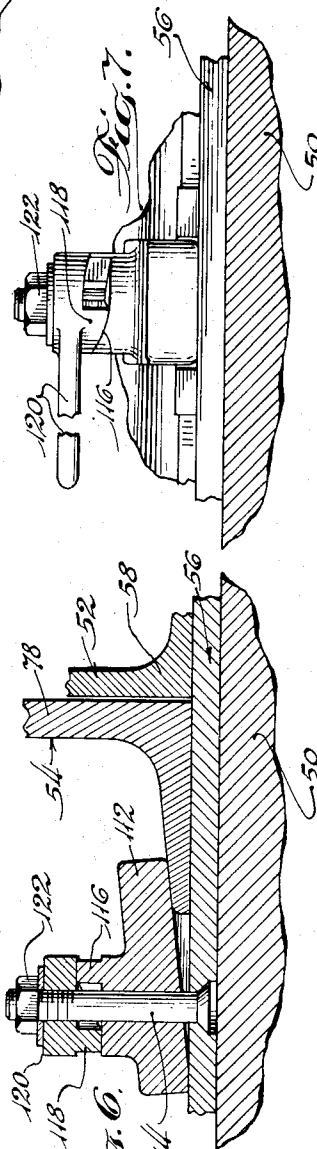


Fig. 6.

Fig. 7.

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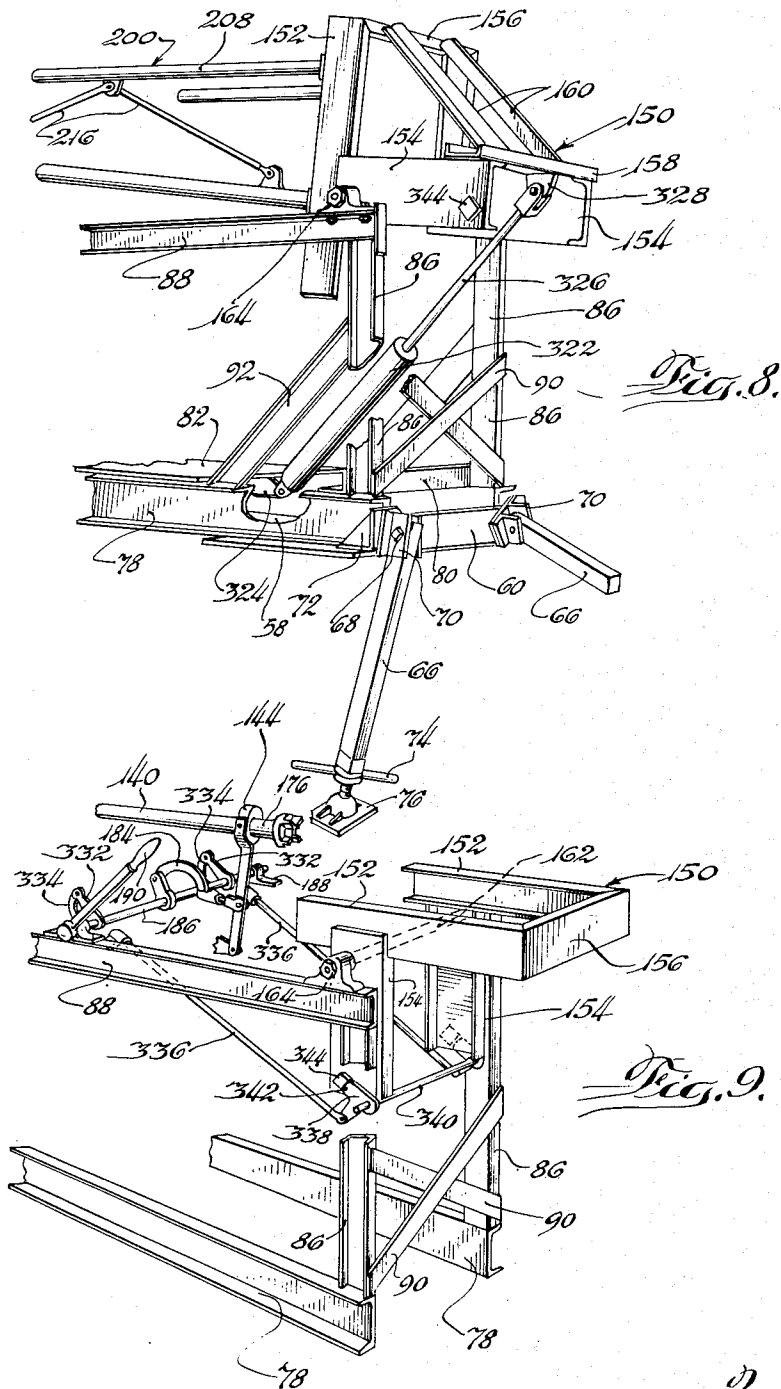
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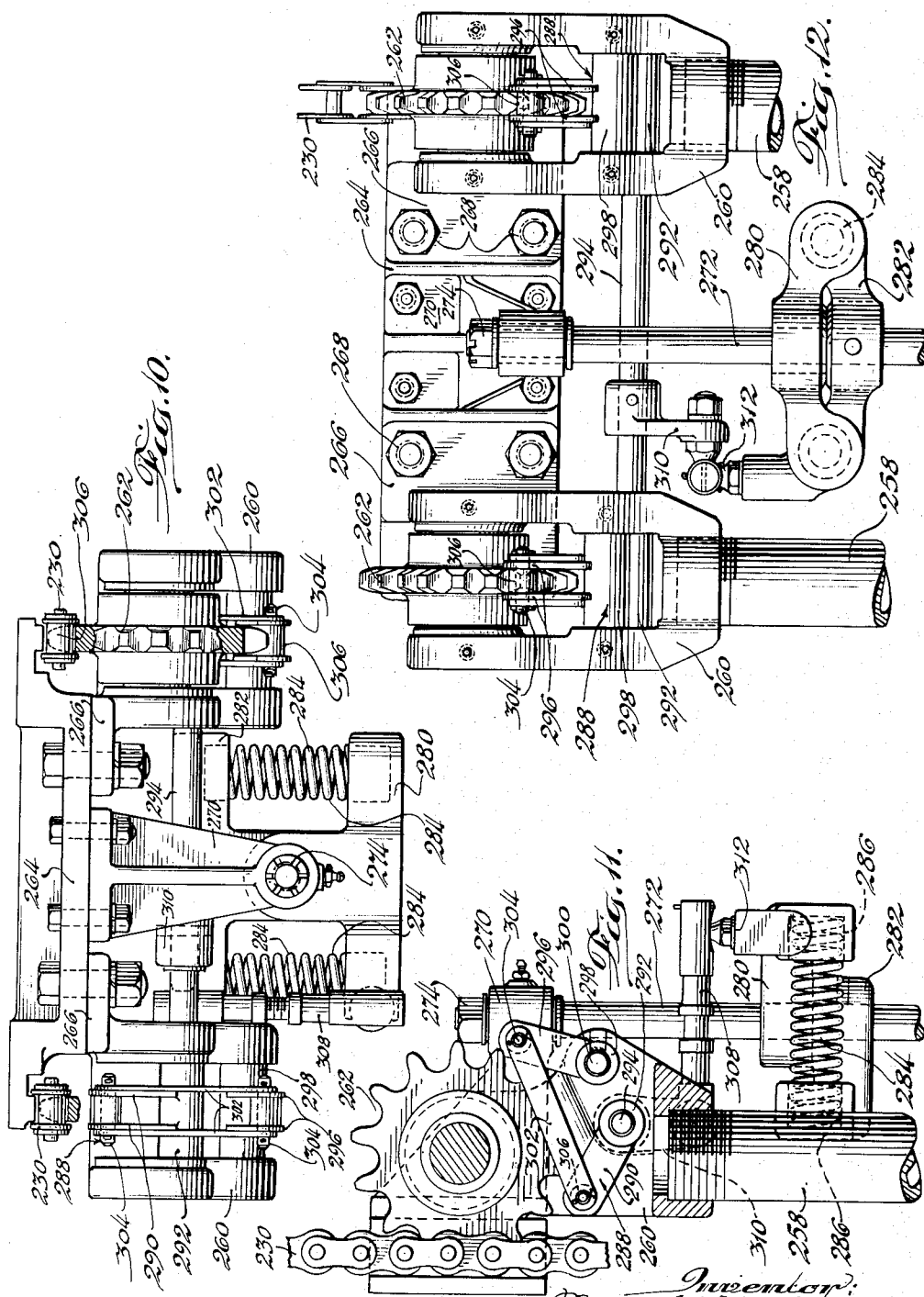
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9 Sheets-Sheet 6



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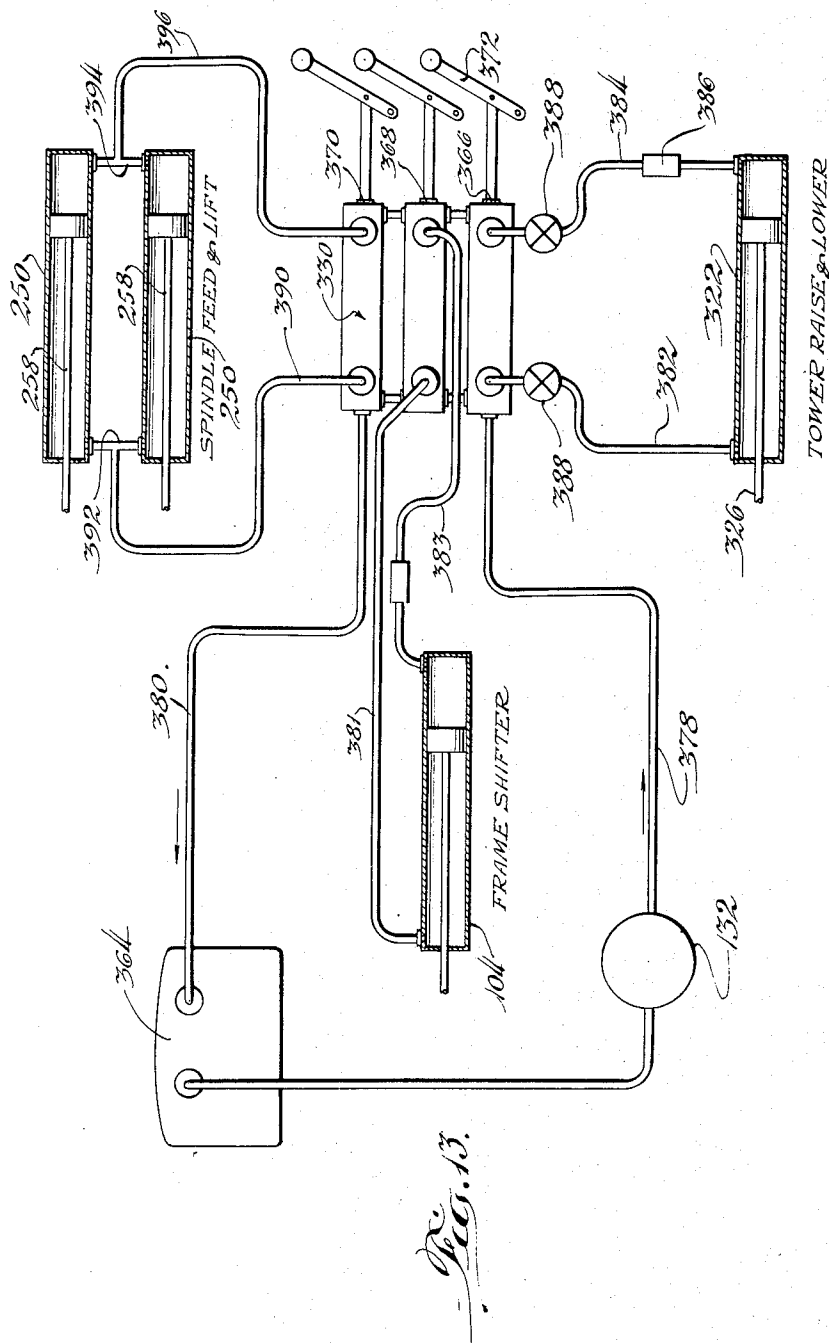
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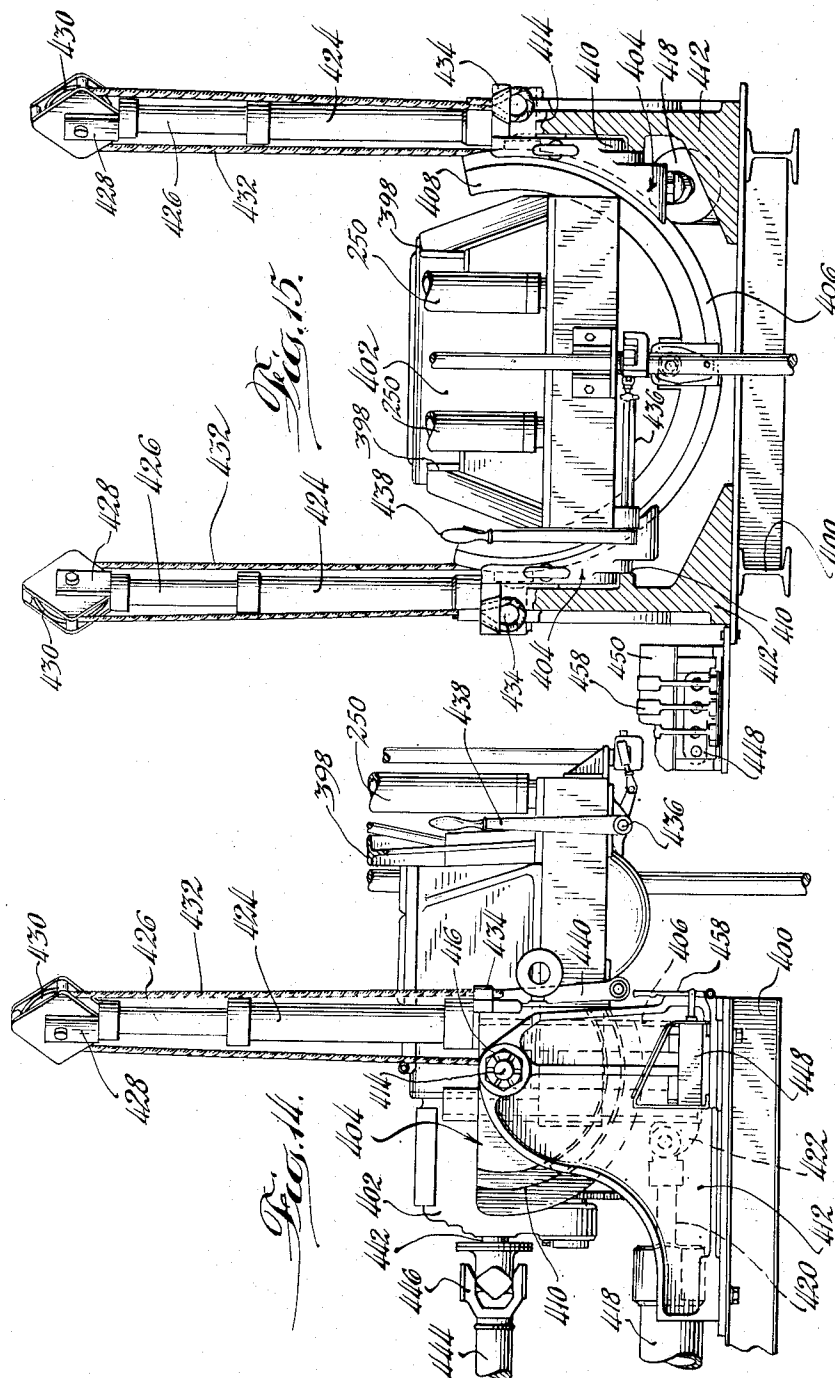
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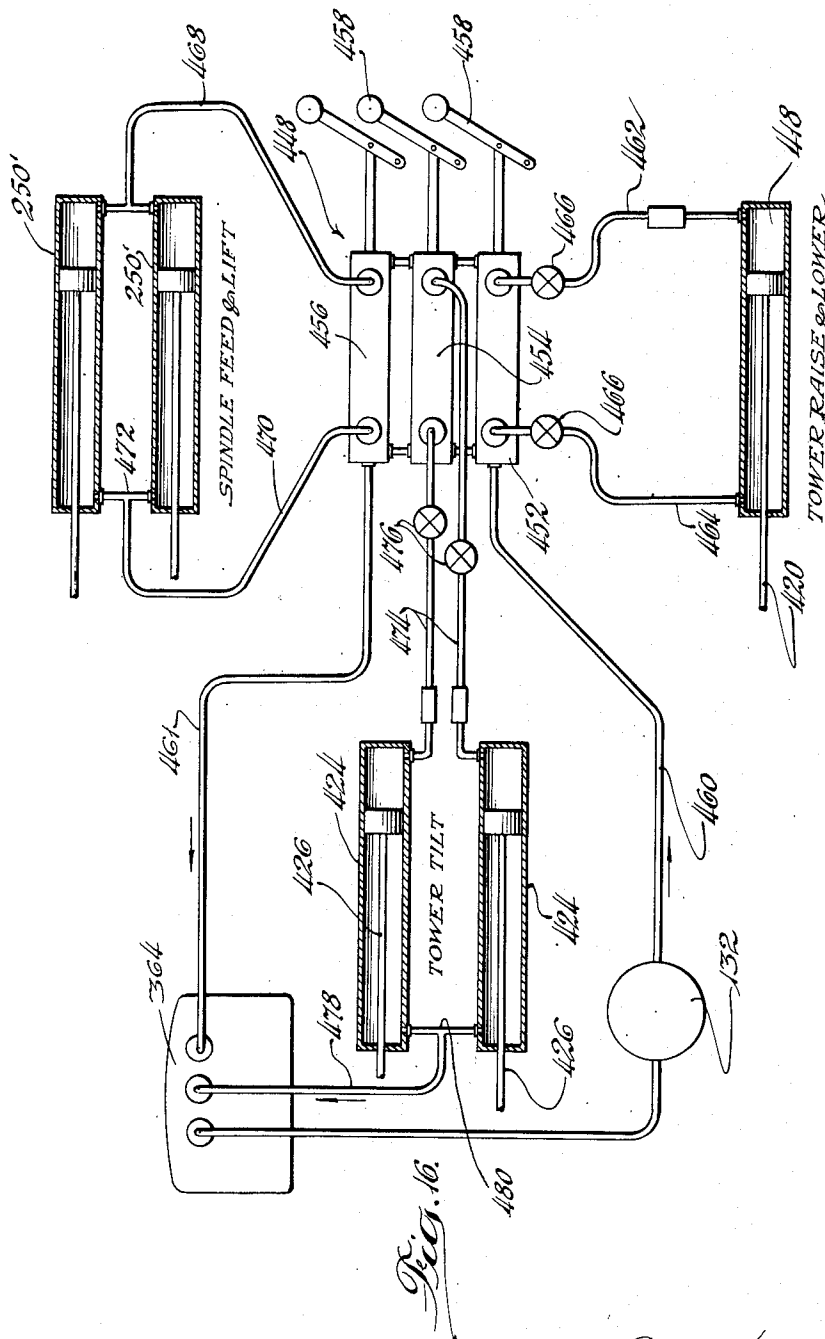
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UNITED STATES PATENT OFFICE

2,657,906

EARTH DRILL

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Application September 18, 1947, Serial No. 774,755

3 Claims. (Cl. 255—22)

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The present invention relates to earth drills for drilling relatively deep holes for electric line posts, building supports, or the like, or for sampling material, and more particularly to a drill of this type which has both mechanically and hydraulically operated means for moving the drill spindle axially to feed or retract an auger attached thereto.

The earth drill of the present invention is an improvement over the drill disclosed in my prior Patent No. 2,418,601, issued April 8, 1947, which discloses mechanically operated means for retracting the auger spindle, and manually operated means for feeding the spindle. In general the mechanically operated mechanism in the drill of the present invention is similar to that disclosed in my prior patent but combined therewith has hydraulically operated means for performing various functions, and interlocking means for the mechanically and hydraulically operated means for controlling their operation.

Accordingly, a primary object of the invention is the provision of a new and improved earth drill which has improved means for feeding and retracting the auger. A more specific object of the invention is the provision of a new and improved earth drill which has mechanically operated means for normally retracting the auger spindle, and hydraulically operated means for feeding the same, which augments the mechanical retracting means when the latter, upon actuation, fails to retract the spindle.

Another object of the invention is the provision of a new and improved earth drill which has mechanically operated means for axially moving the drill spindle in a retracting direction only, and hydraulically operated means for axially moving the drill spindle in either a feeding or a retracting direction, and interlocking control means automatically operable to prevent these spindle moving means from working in opposition to each other.

Still another object of the invention is the provision of a new and improved earth drill having spindle moving means automatically controlled, as above described, and a brake interlocked with the control means and operated thereby to engaged position for locking the spindle at a position whenever both of the spindle moving means are moved to inoperative position, and moved to disengaged position when either of the spindle moving means is moved to operative position.

A further object of the invention is to provide a derrick apparatus combined with an earth drill for raising a drill string of extreme length so

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that holes up to approximately one hundred feet in depth may be drilled.

A still further object of the invention is the provision of a generally improved earth drill adapted to be secured on a truck or trailer for transportation which is compact in construction and has simplified and readily accessible controls, making the drill more easy to operate.

Yet another object of the invention is the provision of an improved earth drill having a mechanism supporting frame movable with respect to a fixed base frame and releasable means for fixedly securing the movable frame with respect to the fixed frame.

A further object of the invention is the provision of an earth drill having a movable frame, as above set forth, supporting a tower movable between upright and horizontal positions for guiding a drill spindle for axial movement in which separate hydraulically operated means are provided for moving the movable frame, the tower and the drill spindle.

Another and further object of the invention is the provision of an earth drill adapted to drill holes at angles diverging from the vertical.

Another object of the invention is the provision of an earth drill having a tower for guiding a drilling spindle for axial movement which is supported for tilting movement in planes normal to each other and which includes hydraulically operated means for tilting the tower.

These and other objects, advantages, and capabilities of the invention will become apparent from the following specification wherein reference is had to the accompanying drawings, in which:

Fig. 1 is a fragmentary side elevational view partly broken away of the improved earth drill of the present invention, showing the tower in phantom in position for transportation;

Fig. 2 is a fragmentary view on an enlarged scale of a portion of the operating mechanism shown in Fig. 1;

Fig. 3 is a fragmentary front elevational view of the earth drill of the present invention;

Fig. 4 is a fragmentary diagrammatic view of the derrick apparatus which is combined with the earth drill of the present invention;

Fig. 5 is a fragmentary top plan view of a portion of the supporting frames for the earth drill of the present invention;

Fig. 6 is a cross-sectional view of a clamping means for locking the movable frame of the earth drill;

Fig. 7 is a side elevational view of the clamping means shown in Fig. 6;

Fig. 8 is a diagrammatic view of the tower cradle and means for rocking the same;

Fig. 9 is a diagrammatic view of the inter-locked tower locking means and main driving clutch;

Fig. 10 is a top plan view partly broken away of the driving connection between the hydraulically actuated spindle moving means and the drill spindle;

Fig. 11 is a side elevational view of the driving connection shown in Fig. 10;

Fig. 12 is a front elevational view of the driving connection;

Fig. 13 is a schematic view of a hydraulic control system for the earth drill;

Fig. 14 is a fragmentary side elevational view of a modified form of the invention;

Fig. 15 is a front elevational view of the modification shown in Fig. 14; and

Fig. 16 is a schematic view of the hydraulic control system for the modified form of earth drill.

The earth auger of the present invention is supported for transportation from place to place upon the bed of a flat bottomed truck or trailer, fragmentarily shown at 50 in Figs. 1 and 5, by means of a base frame 52 fixedly bolted to the bed and a main frame 54 longitudinally movable with respect to the fixed frame. The fixed frame 52 includes a pair of bed plates 56 secured to the bed of the truck or trailer and a pair of longitudinally extending channel iron side rails 58 interconnected at their forward end by a transverse channel iron 60 welded thereto along complementarily beveled ends of these parts, as indicated in Fig. 5, the channel iron members being disposed with their flanges extending inwardly so that the webs thereof present a smooth outer surface.

Diagonally extending plates 62 are provided intermediate the ends of side rails 58 for reinforcing the fixed frame along with a pair of angle iron reinforcing members 64 extending diagonally between the intermediate part of the transverse frame member 60 and the side rails. These reinforcing members may be welded at their opposite ends to the channels to form a sturdy and rigid frame.

Adjacent each end of the transverse frame member 60 an adjustable jack leg 66 is pivotally secured by means of bolts 68 carried in a U-shaped guide member 70 secured to the transverse channel 60 at an angle to the vertical as by welding, and to triangular gussets 72 which are also welded to the front bed plate 56. These jack legs 66 may be pivoted upon the bolts 68 between the downwardly extending operative position indicated in Figs. 1 and 8, and an upwardly extending inoperative position 180° removed therefrom when the earth auger is being transported. Suitable means may be provided for holding the legs in inoperative position. Each of the legs is provided with a wing nut 74 by means of which they may be individually adjusted so that the feet 76 attached to the lower ends of these legs rest firmly upon the ground when the earth drill is in use, and steady the same against lateral rocking.

The movable main frame 54, upon which the mechanism of the earth drill is supported, includes a bed having a pair of longitudinally extending channel iron side rails 78, shown in Figs. 1 and 5-9, spaced from each other slidably to

engage with the fixed frame side rails 58 by means of transverse reinforcing members including an angle iron 80, a cross-plate 82, and spaced channel iron members 84, all welded at opposite ends to the side rails 78. It will be noted in Figs. 2 and 8 that these side rails 78 of the main frame are of greater height than the corresponding parts of the fixed frame so that the transverse connecting members on each of the frames will not interfere with sliding movement between the two frames.

Secured to the forward half of this movable bed are four vertical channel iron members 86 welded at their lower ends to the side rails 78 and interconnected at their upper ends by longitudinally extending channel iron side rails 88. This upright structure is reinforced by diagonal plates 90 welded at opposite ends to the flanges of the two front vertical channels and by diagonal channels 92 welded at opposite ends to the back of the two front vertical channels, and to the top of the bottom side rails 78 in the main frame, as indicated in Fig. 8. The rear vertical channels of the main frame are reinforced by a transverse channel 94 connecting their upper ends, and by a step 96 which includes short vertical channel irons 98 secured on the cross-plate 82, and horizontal channel irons 100 secured on the top of the channels 98 and to the sides of the rear vertical channels. Additional reinforcement is afforded by a pair of transverse angle iron members 102 connecting the upper side rails 88.

The fixed frame 52 is rigidly secured to the bed of a truck or trailer with its forward end aligned with the rear end of the bed, as indicated in Figs. 1 and 5; and the movable main frame 54 is slidable rearwardly from a corresponding position by means of a double acting hydraulic power cylinder 104. This cylinder is of conventional construction and, therefore, will not be described in detail. At its rear end the cylinder is secured to a lug 106 welded to the bottom of the cross-plate 82 on the main frame, as shown in Figs. 2 and 5. A piston rod 108 projecting from the cylinder is pivotally secured at its outer end to a lug 110 welded to the transverse channel 60 of the fixed frame 52. When hydraulic pressure tending to force the piston rod outwardly is applied to the cylinder, it will be exerted equally on the fixed frame through the piston rod 108 and lug 110, and on the movable main frame through the lug 106. This force will cause the main frame to move rearwardly with respect to the fixed frame and to move the operating mechanism supported thereon rearwardly. Application of hydraulic pressure to the opposite end of the cylinder will cause the movable frame to be moved forwardly to the position shown in Fig. 2.

Means have been provided for releasably locking the main frame at a desired position with respect to the fixed frame, as shown in Figs. 1 and 5-7, including clamping plates 112 secured in position by means of bolts 114 extending upwardly from the bed plates 56. These clamping plates have an inclined portion for engaging the lower webs of the lower side rails 78 of the main frame and are provided with a double half-helical inclined formation 116 on the upper faces which cooperate with a like formation 118 on the bottom side of clamping levers 120, also engaged upon bolts 114 and locked in position by nuts 122 threaded upon the upper ends of these bolts. By means of the cooperating formations 116 and

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118 on the clamping plates 112 and levers 120, the plates 112 may be held in firm engagement with the webs of the lower side rails 78 when the levers are in the position shown in Figs. 5 and 7, but when the levers are moved to the position shown in Fig. 6 the clamping plates will be released sufficiently to allow the webs of these side rails to slide thereunder. Although I have shown four of these clamping levers, a greater number may be used if desired.

An internal combustion engine 124, shown in Fig. 1, of suitable size and conventional construction, which is operated by suitable controls of conventional construction, is supported at the rear end of the main frame 54 upon the cross-channels 84. This engine drives a multispeed transmission 126 through the usual clutch, which is controlled by a clutch lever 128, and the transmission is provided with the usual gear shift lever 130. By means of suitable gearing or other driving means, the engine operates a standard hydraulic pressure pump 132 located at the front of the engine.

The engine and transmission drive a main shaft having a double sprocket wheel which in turn drives a train of gears through a pair of sprocket chains. This system of gears is housed within the generally triangular shaped housing 134, shown in Figs. 1 and 2, and is similar to the corresponding parts of the earth auger described in my aforementioned Patent No. 2,418,601 to which reference may be had for a complete disclosure of this gear train.

However, since the earth drill described in that patent is self-propelled, whereas the present drill is not, the mechanism therein described for driving the rear wheels of the trailer upon which that drill is mounted is not included in the present construction, but this does not materially alter the construction and operation of the gear train because the gear therein described, which is operatively connected to the mechanism for driving the rear wheels, in the present construction, drives a winch shaft 136 shown in Fig. 2 upon which is fixedly secured a sprocket 138 for a purpose which will be described in greater detail hereinafter.

Referring to Figs. 1 and 2, a jack shaft 140 is shown which is driven by the gear train enclosed within the housing 134. This shaft constitutes the main driving shaft for rotating the auger and for driving the means for mechanically lifting it after it has completed a drilling operation. The jack shaft 140 is supported adjacent its opposite ends in nonfriction bearings 142 and 144 secured respectively upon an angle iron support 146 attached to the rear wall of the housing 134, and a pedestal 148 of welded plate construction supported upon the angle iron cross-pieces 102 on the main frame 54.

An operating head and tower supporting cradle 150, best seen in Fig. 8, is supported for rocking movement adjacent the forward end of the upper side rails 88 of the movable main frame 54. This cradle 150 includes side members consisting of channel irons 152 and 154 welded to each other at right angles, as indicated in Figs. 8 and 9, an upper cross-member 156 in the form of a channel iron joined to the ends of the channel 152 by welding the same along the joining edges thereof which are preferably complementarily beveled, and a lower cross-member 158 in the form of a channel iron having the back of its web welded to the front flanges of the channels 154 adjacent their lower ends. The ends of this

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lower cross-member project beyond the channels 154 to form stops for engaging the front vertical channels 86 on the movable main frame 54 to limit downward pivotal movement of the cradle. A pair of angle iron bracing members 160 are welded at opposite ends to the bottom flange of the top cross-member 156 and the web of the lower cross-member 158 to reinforce the cradle.

The cradle is rockably supported upon a trunnion shaft 162 extending through transversely aligned openings in the opposite channel members 154 somewhat below their place of connection with the channel members 152. The ends of this shaft are supported in bearings 164 adjustably secured to the top of the upper side rails 88 of the main frame, and the shaft is held in position by nuts 166 engaged upon each end of the shaft and preferably locked in position by cotter pins.

Fixedly secured upon the channels 152 of the cradle 150, as by bolts, is an operating head 168 which includes mechanism for rotating the auger and for mechanically raising the same upon completion of a drilling operation. This part of the earth drill of the present invention is similar in construction to the corresponding mechanism of the earth drill described in my aforementioned Patent No. 2,418,601 and, therefore, a detailed description of this mechanism is thought to be unnecessary.

As indicated in Fig. 2, the mechanism in the operating head is driven by a main drive shaft 170 which is operatively connected to the jack shaft 140 by means of a jaw clutch 172. This jaw clutch includes an element 174 fixed on the main drive shaft 170 and a retractable element 176 splined on the jack shaft 140 and urged into engagement with the fixed element by a tension spring 178 on the shaft 140 between the bearing 144 and the retractable element 176. The element 176 is retracted by means including a forked lever 180 pivotally secured to the movable element at its upper end and at its lower end to a bracket 182 secured on the depending flange of the front cross-member 102 of the main frame. Intermediate its ends the lever 180 is secured to a C-link 184 operatively connected to a clutch shaft 186 rotatable in bearings 188 attached to the upper side rails 88 of the main frame. A lever 190 is fixedly secured on the outer end of this shaft as seen in Fig. 2 for rotating the same in a counterclockwise direction to retract the movable clutch element 176, and in a clockwise direction to allow the clutch members to engage.

The earth drill of the present invention is provided with a novel derrick mast or tower 200, as indicated in Figs. 1, 3 and 4, which also forms a guide for the auger spindle when the latter is being fed or retracted. It will be seen that the tower comprises four rectangularly spaced tubular side members 202 which taper toward each other adjacent their upper ends. These ends are bent forwardly, as indicated, and welded to a sheave block 204 which has a sheave 206 rotatably secured therein. The front tower members preferably comprise a lower section 208 forming a guide for the auger spindle, and an upper section 210 joined to the lower section by a solid connection 212 to which the upper and lower sections are secured, as shown in Fig. 3.

At their lower ends the tubular side members 202 are suitably secured to the top side of the operating head 168 and are reinforced by inclined supports 214. The entire structure is also reinforced by tubular diagonal truss members 216

extending between and attached to the front and rear side members, as shown in Fig. 1, and by a suitable number of cross-members 218 shown in Figs. 1 and 3. The lower sections 208 of the front tower members are each additionally reinforced by a reinforcing truss 220 and these two trusses are connected by cross-members which brace the tower members laterally.

By reason of the pivotal mounting of the cradle 150, which supports the operating head 168 and tower 200, these parts may be swung from the upright position, shown in full lines in Fig. 1, to the horizontal position, shown in phantom, after the jaw clutch 172 has been moved to disengaged position. The tower is moved to horizontal position when the drill rig is to be transported, and in this position the intermediate portion of the tower rests upon an upright support 222 secured to the rear end of the movable main frame 54. It may be firmly secured or lashed against displacement by suitable means.

An elongated rectangular auger shaft or spindle 224 and mechanical operating means therefor is provided for the drill of the present invention similar to the corresponding parts of the earth drill disclosed in my prior Patent No. 2,418,601 wherein these parts are described in detail. As therein described, and as shown in Fig. 3 of the drawings of this application, the auger spindle 224 is rotatably secured at its upper end to a cross-head 226 for vertical movement with this head. The cross-head 226 is provided with oppositely disposed grooved guide rollers 228 which engage the oppositely disposed front tower members 208 to guide movement of the cross-head longitudinally of the tower.

This cross-head is connected adjacent each of its ends to both ends of each of a pair of sprocket chains 230 which pass over sprocket wheels 232 on a shaft 234 rotatably supported at opposite ends in the solid connections 212 between the upper and lower front tower sections. At their lower ends the chains 230 engage over drive sprockets in the operating head as described in the aforementioned patent and these sprockets may be driven in a direction for mechanically raising the cross-head and auger spindle.

Within the operating head 168 the auger spindle passes through a driving sleeve actuated from the main drive shaft 170 through a gear train and a clutch interposed therebetween which may be engaged and disengaged by operation of a spindle clutch lever 236, as described in the aforementioned patent. This lever is fixed on a clutch operating shaft 238 carried on the cradle 150 as shown in Figs. 1 and 2.

A chuck 240 adapted to receive the polygonal shank of an auger section 242 is pinned or bolted to the lower end of the spindle 224 where it projects below the operating head 168 and the shank of the auger may be secured in the chuck by a bolt 244 passing diametrically through these parts and secured by a nut threaded thereon. This auger, which may be in the form of a helix as shown, may be made in sections adapted to be detachably secured together so that holes of different depths may be drilled.

Also within the head 168 and driven from the main drive shaft 170, is a second gear train which is operatively connected to those sprockets in the head meshing with the sprocket chains 230 for driving the same in a direction mechanically to raise the cross-head and auger spindle. There is a clutch in this gear train for discontinuing operation of the same even though the main drive

shaft 170 is operating, and a brake interconnected with the clutch to operate in conjunction therewith for locking the auger spindle at a desired elevated position, as described in my prior patent previously mentioned. This clutch and brake are connected for operation from a power control shaft 246 rotatably secured on the cradle 150 and provided with a power lift lever 248 for rotating the shaft to move the clutch and brake to various predetermined positions that will be described in greater detail hereinafter.

A feature of the earth drill of the present invention is the hydraulically operated auger spindle feeding and retracting means which may be operated jointly with the mechanically operated means for augmenting the same in retracting the spindle, and which is also operable to feed the drill spindle. Briefly this hydraulically actuated means comprises a pair of double acting hydraulic cylinders 250 of conventional construction secured in upright position forward of the tower by means of feet 252 attached to the base ends of the cylinders and bolted to the upper cross-member 156 of the cradle, as shown in Figs. 2 and 3. The upper ends of the cylinders are secured in spaced relation to the tower by means of a pair of U-bolts 254 engaged in a pair of arms 256 projecting forwardly from the front members of the tower. These hydraulic cylinders are each provided with a piston to which a piston rod 258 that projects from the heads of the cylinders is attached. A yoke 260 is threaded on the outer ends of each of the piston rods, as shown in Figs. 3 and 12. These yokes each rotatably support a sprocket 262 between the arms thereof with the teeth on these sprockets meshing in the links on the front loops of the chains 230 and thus establishing a driving connection between the sprockets 262 and chains 230 by means of which the drill spindle 224 may be retracted or fed, as will be described.

In Figs. 10-12 ratcheting means for locking the sprockets 262 against rotation under certain conditions or permitting rotation thereof under other conditions is shown. The operating means for these ratchets is mounted on a spreader plate 264 attached to inwardly projecting lugs 266 on the inner arms of the yokes 260 by means of four bolts 268. A forwardly extending bracket 270 is also bolted to the spreader plate 264 intermediate the yokes 260 and this bracket supports the upper end of a control means which includes a rod 272 pivotable in the outer end of the bracket 270 and secured in position by means of a nut 274 locked to the rod with a cotter pin. A tubular shaft 276 (Figs. 1, 2 and 3) telescopically receives the rod 272 and is keyed thereto so that the shaft and rod pivot together. The lower end of this shaft 276 is secured for pivotal movement in suitable bearing means 278 on the front cross-member of the cradle.

The rod 272 carries a pair of generally T-shaped operating yokes 280 and 282 adjacent its upper end, oppositely disposed with respect to each other, and operatively interconnected by means of compression springs 284 seated at opposite ends in facing recesses 286 in the opposed arms of the yokes, as indicated in Fig. 11. The lower yoke 282 is keyed upon the rod 272, while the upper yoke 280 is unsecured. The spring connection between the two operating yokes allows a certain amount of lost motion between these parts, so that if one yoke is prevented from moving, the other may move to a limited degree.

However, if they are both unobstructed they will ordinarily move together.

Rotation of the sprockets 262 is controlled by ratchet means 288 mounted between the arms of each of the yokes 260. Each ratchet means includes a pair of spaced arms 290 projecting from a hub 292 keyed to a shaft 294 rotatably secured at opposite ends in a forwardly projecting part on the arms of yokes 260 below the sprockets, and a second pair of spaced arms 296 fixed to a second pair of hubs 298, rotatable upon shafts 300, fixed in the forwardly projecting part of the arms of the yokes. The two pairs of arms forming each ratchet are tied to each other by a pair of links 302 engaged over the outer ends of pins 304 which may be held in position by means of cotter pins or other suitable means, so that, upon movement of shaft 294, arms 290 will be moved and will in turn move arms 296. A roller 306 is mounted on each of the pins 304 between each of the pairs of arms 290 and 296, and these rollers are of proper size to engage between the teeth on the sprockets 262.

Shaft 294 is operatively connected to the upper operating yoke 280 on rod 272 by means of an adjustable connecting rod 308 engaged at one end with a crank arm 310 keyed to shaft 294 and swiveled at the other end upon a ball joint 312 projecting upwardly from the upper operating yoke 280 so that pivotal movement of this yoke rocks shaft 294 and with it the ratchet means 288.

Another feature of the earth drill of the present invention resides on the novel interlocking means which is provided for controlling operation of the mechanical and hydraulic spindle retracting and feeding means, whereby they may be actuated to operate jointly or severally to retract the auger spindle and whereby the spindle may be fed hydraulically, but the two actuating means are prevented from acting on the spindle in opposition to each other. The mechanism for accomplishing this will now be described.

Referring to Figs. 2 and 3, it will be seen that a U-shaped link 314 and an operating cam 316 are secured on the lower end of the tubular shaft 276, the cam being rotatable with respect to the shaft and having a finger projecting into the space between the arms on the link to provide an overrunning connection between the link, which is fixed on the shaft, and the finger. The amount of overrunning or lost motion between these parts can be adjusted by means of stop screws 318 threaded into the arms of the link and locked in position by lock nuts.

This operating cam 316 has a part projecting beyond the arms of the link and connected to a crank arm 320 fixed on the power control shaft 246 by means of an adjustable connecting rod 322 swiveled to the cam and pivotally secured to the crank arm 320. Thus, the control means for engaging or disengaging the hydraulically operated spindle feeding or retracting mechanism is operated from this same shaft as the clutch and brake in the gear train in the operating head for mechanically raising the auger spindle so that these two control means operate together in a manner which will be described.

The gear shift lever 130 on the transmission 126 has a definite position to which it must be moved when it is desired to rotate the auger for drilling a hole, and when it is in this position, the main drive shaft 170 is rotated in the proper direction to also drive the gear train by means of which the spindle feeding and retracting

chains 230 are moved in a direction to raise or retract the spindle, provided the power lift lever 248 is at the proper position. This lever is movable between three positions and in the brake locked position, shown in full lines in Fig. 2, the clutch in the gear train for mechanically raising the spindle is in inoperative position while the brake in this train is locked to prevent movement of the spindle either up or down and the ratchets 288 on the hydraulic interlocking control mechanism are in neutral position as shown in Figs. 3 and 11. Thus there is no force acting on the spindle tending to move it axially.

When the power lift lever 248 is moved forwardly (to the right as shown in Fig. 2) to its free position, the clutch and brake in the mechanical spindle retracting gear train in the operating head are both moved to disengaged position thereby releasing the spindle chains 230 and the auger spindle. At the same time, the shaft 276 by means of its connection to the power control shaft 246 above described, will be turned, thus causing the ratchet shaft 294 and the ratchets attached thereto to be moved in a clockwise direction, as seen in Fig. 11, so that the rollers 306 supported by arms 290 engage in the teeth on the sprockets 262. In this position of the ratchet means, the sprockets 262 are free to ratchet in a clockwise direction so that the front loops of the chains 230 meshing with the sprockets 262 are free to move in an upward direction past these sprockets leaving these chains completely unrestrained. Thus the auger spindle and auger are free to fall of their own weight until the auger strikes the ground. The resilient connection between the operating yokes 280 and 282 afforded by the compression springs 284 allows sufficient lost motion to permit this ratcheting of the sprockets. When the roller 306 engages the teeth on sprocket 262 the spring 284 shown in Fig. 11 is compressed to approximately its shut height. Thus any force exerted on the roller 306 by a counterclockwise rotation of the sprocket 262 will completely compress this spring holding the roller 306 in unyielding engagement with the sprocket teeth to prevent counterclockwise rotation of the sprocket, while any force exerted on the roller 306 by clockwise rotation of the sprocket 262 will elongate this spring, thereby holding the roller 306 in yielding engagement with the sprocket teeth to permit free clockwise rotation of the sprocket.

Since, in this position of the parts, the sprockets 262 are locked against counterclockwise rotation by the rollers on arms 290, a driving connection is established with chains 230 by means of which the front loops of these chains are driven upwardly and the auger spindle and auger thus fed. When hydraulic pressure is applied to the lower end of the cylinders 250, tending to raise the pistons and piston rods 258, the sprockets 262, being locked against counterclockwise rotation, will cause the front loop of the chains 230 to be moved upwardly with the piston rods, thus driving downwardly the back loops to which the cross-head and auger spindle are attached. In this manner the auger may be hydraulically fed while it is being rotated.

In the third or lifting position of the power lift lever 248, which is to the rear or left of the position shown in Fig. 2, the clutch in the driving train for the mechanical spindle raising mechanism in the operating head is engaged while the brake is released so that the sprocket chains 230 will be mechanically driven in a di-

rection to retract the spindle, provided the load is not greater than the clutch capacity. If the load is too great, and the clutch slips, the spindle raising mechanism may be moved by means of the hydraulic cylinders 250 because movement of the power lift lever 248 to the lifting position causes the shaft 276 to be moved in a counterclockwise direction through its connection with the power control shaft 246. This rocks the shaft 294 and the ratchet means 288 in a counterclockwise direction through the operating yokes 280 and 282, the connecting rod 308, and crank arm 310 and brings the rollers on the arms 296 into engagement with the teeth of the sprockets 262. In this position of the ratchet means rotation of the sprockets in a clockwise direction is prevented and a driving connection thus established between the piston rods 258 and chains 230 for moving the front loops of these chains downwardly to raise the auger spindle and augers, if the mechanical lifting means does not raise them, but the sprockets are free to ratchet in a counterclockwise direction.

Ordinarily the hydraulic lifting means will be applied by the operator at the time he moves the power control lever to lifting position, and if the load is not too heavy for the mechanical lifting mechanism, the drill spindle will be lifted by it because the mechanical lifting means operates at a faster rate of speed than the hydraulic lifting means. When this occurs the sprockets 262 which are moving downwardly with the slower moving piston rods 258 will merely ratchet in a counterclockwise direction. However, if the load of the auger attached to the drill spindle is greater than the lifting capacity of the mechanical lifting means, then due to the fact that the hydraulic controls normally will have been actuated to cause the piston rods 258 to move downwardly from the elevated position to which they have been raised during their feeding stroke, the forward loops of the chains 230 will be pulled downwardly by the hydraulic means, and the back loops moved upwardly so that the cross-head and spindle are raised. When the load is lessened to a degree where the power applied by the mechanical lifting means is sufficient to raise the spindle, it will take over automatically because of its greater speed, and the sprockets 262 will ratchet as the front loops of the chains are moved downwardly at a faster rate than the piston rods 258 travel.

In accordance with another feature of the present invention, the cradle 150, supporting the operating head 168 and tower 200, is rocked to move these parts between upright and horizontal positions by novel hydraulically actuated means, best seen in Figs. 2, 3 and 8. As there shown, a double acting hydraulic cylinder 322 of conventional construction has its base ends secured to a lug 324 attached to the bottom side of the cross-plate 82 on the main frame and the outer end of its piston rod 326 linked to a lug 306 secured on the back side of the bottom cross-channel 158 on the cradle so that the cylinder 322 is disposed in an inclined position. Preferably it is located to one side of the cylinder 104 which moves the main and fixed frames with respect to each other. The opposite ends of this cylinder 322 are connected by conduits to the source of hydraulic fluid under pressure through control means 330, as indicated diagrammatically in Fig. 13.

Assuming that the tower is in horizontal po-

sition, as shown in Fig. 8, the control means is operated to admit hydraulic fluid to the forward end of the cylinder while the rear end of the cylinder is relieved of pressure. This drives the piston in the cylinder rearwardly, thereby exerting a force on the lower cross-channel of the cradle, tending to cause the cradle to rock to the upright position shown in Fig. 2. When the piston in the cylinder reaches the approximate limit of its rearward stroke, the back of the cross-channel 158 will be drawn into engagement with the front of the uprights 86 on the main frame to prevent further rocking movement of the cradle.

The cradle is locked in this position by novel locking means, best shown in Figs. 2 and 9, connected to be operated upon operation of the jaw clutch lever 190 through the medium of a pair of crank arms 332 fixed upon the shaft 186, which are connected by means of C links 334 and tie rods 336 to an arm on each of a pair of locking cams 338 fixed upon a shaft 340 journaled in the front uprights 86 of the main frame. Operation of the lever 190 in a rearward direction for disengaging the jaw clutch 172 (to the left in Fig. 2) pivots the cams 338 from the position shown in Figs. 2 and 9 in which a boss 342 on the cams engages with one edge of a pair of locking blocks 344 fixed to the sides of the channel members 154 in the cradle adjacent their lower ends to a position in which the blocks 344 are free to move past the cams when the cradle 150 is pivoted in a rearward direction. In the position shown in Figs. 2 and 9, the tower 200 and working head 168 are locked in upright position due to the fact that the front cross-channel 158 of the cradle engages the uprights 86 on the main frame to prevent forward pivotal movement while the cams 338 engage upon the locking blocks 344 to prevent rearward pivotal movement. By operating both the jaw clutch 172 and the locking cams 338 from the same shaft and lever, a simplification in structure is achieved and assurance is had that the tower will be locked in upright position when the jaw clutch members are brought into engagement.

The earth drill of the present invention is particularly adapted for use in drilling relatively deep holes because of the novel means provided for raising a drill string when the latter consists of a plurality of auger sections too heavy to be lifted by the mechanical or hydraulic means previously described.

Referring to Figs. 2 and 4, it will be seen that a winch 346 is secured upon triangular supports 348 attached to the step 96 on the main frame 54. This winch is driven from the sprocket 128 on the shaft 126 which is operatively connected by means of a chain 350 to a sprocket 352 on a gear reduction unit of conventional construction secured in the housing 354. The application of a driving force to the winch is controlled by a lever 356 and the winch is provided with a cable 358 which passes over the sheave 286 in the top of the tower and is attached to the upper end of a drill string 360.

However, before this is done the drill string is disconnected from the chuck 240. Thereafter the main frame 54 is unlocked by turning the clamping levers 120 in the proper direction, and the hydraulic cylinder 104 then actuated until the main frame and parts secured thereto have been retracted sufficiently so that the forward end of the operating head is positioned to the rear of the upper end of the drill string and the

sheave 206 is brought into vertical alignment with the upper end of the drill string. The end of the cable 358 may be provided with a fitting 362 for detachably coupling the cable to the drill string and power is then applied to the winch to raise the drill string as shown in Fig. 4.

This novel elevating means for the drill string adapts the drill of the present invention for drilling relatively deep holes so that it may be used not only for drilling post holes, but also for drilling wells up to approximately 100 feet in depth and it may also be used for sampling material. In deep hole drilling auger sections each in the form of a helix as shown in Fig. 4, and adapted to be detachably secured together are used. After the first auger section has been secured in the chuck 240 of the auger feeding means and the drilling has progressed until the hole is approximately the depth of this first section, then the chuck is disconnected from the auger and the feeding mechanism raised. Thereupon a second section of auger is secured to the first and to the chuck of the feeding means. This is repeated until the hole reaches the proper depth.

In Fig. 13 is schematically shown the hydraulic system and the control means for supplying hydraulic fluid under pressure to the operating cylinders. This system includes the pump 132 operated from the engine, a fluid reservoir 364 secured on the cross-plate 82 on the main frame, as shown in Fig. 2, and three similarly constructed manually operated control valves 366, 368 and 370 which may be of conventional construction. These valves are operated by three control levers 372 secured on a control panel 374 at the forward end of the main frame so that these levers and the control levers 236 and 248 are all accessible to an operator stationed adjacent the front end of the machine. A hand throttle 376 and other control means for the engine may also be secured on the control panel.

As shown in Fig. 13, the fluid forced from the pump 132 flows through an inlet conduit 378 to the control member 330. The control valves 366, 368 and 370 communicate with each other and are of the type that include means for conducting a flow of fluid through the valves from the connection of the inlet conduit 378 on valve 366 through valves 368 and 370 to the connection of a return conduit 380 on the valve 370 if the levers 372 are in neutral position. However, if one of these levers is operated, a portion of the pressurized hydraulic fluid will flow to the cylinder connected to that valve.

As shown in Fig. 13, the tower raising and lowering cylinder 322 is controlled by the valve 366 and there is a hydraulic conduit 382 running from the valve 366 to the head of cylinder 322 and a second conduit 384 having a restrictor 386 therein running from the valve 366 to the base end of the cylinder 322. When the valve 366 is actuated to cause fluid to flow through conduit 384 to the base end of cylinder 322, the piston therein and the piston rod 326 connected to the cradle 150 are driven outwardly, thus rocking the cradle from the upright position shown in Fig. 9 to the horizontal position shown in Fig. 8. Fluid ahead of the piston flows through conduit 382 back to the valve 366 and through this valve into the hydraulic system. Shut-off valves 388 may be interposed in the conduits 382 and 384 so that the piston in a cylinder 322 can be locked at a desired position by closing these valves.

When it is desired to raise the tower, the valve

366 is operated to admit fluid under pressure to the conduit 382 leading to the head end of the cylinder 322 for initiating movement of the cradle to upright position. As the cradle approaches upright position, the weight of the tower and other parts supported on the cradle will automatically move the cradle to upright position. However this movement is damped or braked due to the fact that the restrictor 386 in the conduit 384 limits the flow of hydraulic fluid from the base end of the cylinder back to the control valve so that jarring of the mechanism is prevented.

Valve 368 controls operation of the frame shifting cylinder 104 and is connected thereto by conduits 381 and 383. This cylinder is operated in the same manner as the cylinder 322 when it is desired to shift the main frame 54 in order to raise the drill string as previously described. This frame shifting cylinder may also be used to center the auger spindle over the spot where a hole is to be drilled, although ordinarily such centering will be achieved by movement of the vehicle supporting the earth drill.

Valve 370 controls operation of the hydraulic retracting and feeding cylinders 250 for the auger spindle. This valve is connected to the head of the cylinders 250 by a conduit 390 and a T-connection 392 while the base end of the cylinders 250 is connected by a similar T-connection 394 and conduit 396 to the opposite side of the valve 370. As previously explained, when the spindle is to be raised, this valve 370 is actuated to admit fluid through conduit 390 and T-connection 392 to the head end of the cylinders 250 to retract the pistons and piston rods thereof at the same time that the mechanical lifting means is actuated. This mechanical means being faster in operation than the hydraulic, it will retract the spindle unless the load is too great for the mechanical clutch in which case the hydraulic lifting means automatically takes over until the load is lessened sufficiently so that the mechanical means can retract the spindle, whereupon it automatically takes over again.

This action follows from the fact that when the brake control lever 248 is moved to lift position, the ratchet means 288 are automatically moved to a position where the sprockets 262 are locked against clockwise rotation as previously explained, and thus will act on chains 230 to raise the auger spindle and auger as pressurized fluid flows into the head ends of cylinders 250 and forces piston rods 258 downwardly unless the load is light enough for the mechanical lifting means to raise, in which case, it being the faster, the spindle will be raised mechanically and the sprockets 262 will ratchet counterclockwise.

These cylinders 250 are also used to feed the auger as explained and this feeding is accomplished when the power control lever 248 is in its free position at which position the sprockets 262 are locked against counterclockwise rotation so that they cannot turn when force is applied upwardly on the piston rods 258 and yokes 260. Therefore, to feed the auger, the operator manipulates the control valve 370 so that fluid is admitted to the base ends of the cylinders 250, thus raising the piston rods 258 and the front loops of the chains 230 so that the back loops of these chains are lowered and thus feed the auger.

In Figs. 14 to 16 there is shown a modification of the earth drill described above which has a tower 398 secured for rocking movement in a fore and aft direction and laterally from side to side.

This drill is designed particularly for drilling holes at angles to the vertical.

In general the earth drill shown in these figures is similar to the earth drill previously described and comprises a supporting frame 400 which may be fixed by any suitable means to the bed of a truck or trailer for transportation. The operating head 402, similar to the operating head 188 previously described, is supported for pivotal movement in planes normal to each other upon means including a cradle 404. This cradle has a semi-annular shaped race formed therein for receiving a semi-annular shaped mounting member or ring 408 on the operating head whereby the head is supported on the cradle for lateral rocking movement.

The cradle is supported for rocking movement in a fore and aft direction upon complementary semi-annular shaped formations 410 formed on its outer ends, and on the inner sides of a pair of pedestals 412 fixed to the forward end of the frame 400 by means of bolts or the like. Trunnion shaft means 414, extending from the cradle 404 through the pedestals 412 and secured in position by nuts 416, hold the cradle in position on the pedestals.

As shown in Figs. 14 and 16, the cradle 404 and parts supported thereon are moved in a fore and aft direction by a two-way hydraulically operated raising and lowering cylinder 418 of conventional construction. The base of this cylinder is fixed to the supporting frame 400 and the cylinder has a piston and a piston rod 420 which is secured to a lug 422 projecting from the cradle 404.

Rocking movement of the operating head 402 in a lateral direction is effected by means of a pair of one way hydraulic cylinders 424 fixed at their base ends to the top of pedestals 412 in upright position. Each of these cylinders has the usual piston and a piston rod 426, to the upper end of which is secured a yoke 428 for pivotally supporting a sheave or pulley wheel 430. A cable 432, having its opposite ends fixed to the pedestals 412 by any suitable means, as indicated at 434, and its intermediate portion fixed to the mounting member 408 of the head, is trained over these pulley wheels 430 and is held taut by the cylinders. To tilt the head laterally the piston in one of the cylinders 424 is actuated to raise its piston rod 426, and the other cylinder 424 is de-actuated and relieved of pressure. This causes the piston in the actuated cylinder to be raised, thus exerting an upward pull on the cable 432 on the same side of the head as the actuated cylinder which causes the head to rock in the opposite direction. During this movement a downward force is exerted by the cable on the piston rod in the inactive cylinder 424, lowering that piston rod the same amount that the corresponding parts are raised in the actuated cylinder.

The drill spindle guiding tower 398 shown fragmentarily in the drawing is similar to the tower disclosed in my prior Patent No. 2,418,691 and is fixedly secured to the operating head 402 in the manner therein described. The operating head 402 and the mechanism therein and the auger spindle and mechanical and hydraulic feeding and retracting means therefor are similar to the corresponding parts of the embodiment of the invention previously described. Interlocking control means are provided between the spindle retracting and feeding means to effect feeding and retracting movement of the auger

spindle as previously described. A power control shaft 436 and power control lever 438 are provided for manually operating the interlocking control means along with a spindle clutch shaft and lever 440 for controlling rotation of the spindle.

The main drive shaft 442 of the operating head corresponding to the shaft 170 of the previous embodiment is connected to an engine drive shaft 444 operated by the motor of the drill by means of a universal joint 446 which may be detachably coupled to the shaft 442 on the operating head. By means of this joint and a sliding connection on the engine drive shaft 444, it is possible to drill holes at an angle to the vertical in a fore and aft direction up to approximately 15° on either side of the vertical. When the tower 398 is to be lowered for transportation, the universal joint 446 may be uncoupled to permit movement of the tower to a horizontal position.

The hydraulic system for this modification of the invention is similar to the system described for the previous embodiment of the invention with such modification as will be described in detail hereinafter. This system includes a control unit 448 secured on a control panel 450 adjacent the forward end of the machine. The control unit includes three control valves 452, 454 and 456 of duplicate construction similar to the valves in the unit 330 interconnected as are those valves, and operated by control levers 458. The system also includes a fluid reservoir 364, a pressure pump 132 operated by the motor of the drill and fluid supply, and return conduits 460 and 461, respectively.

Valve 452 is connected to the supply conduit 460 and to the tower raising and lowering cylinder 418 by means of conduits 462 and 464 connected to the base and head ends of the cylinder, respectively. Shut-off valves 466 are provided in these conduits for locking the tower at a desired position. Valve 456 is connected by conduits 468 and 470 and T-connections 472 to the head and base ends of a pair of spindle feeding and retracting cylinders 250, similar to the power cylinders 250 in the embodiment previously described, and these cylinders are interlocked with the mechanical feeding means and operated in the manner described for the corresponding cylinders of the previous embodiment.

Valve 454 controls the actuation of the lateral tilting cylinders 424. The base ends of these cylinders are connected to the valve 454 by means of conduits 474 which have shut-off valves 476 interposed therein for locking the operating head and tower at any desired angle to the vertical. The head ends of these cylinders are connected to the reservoir 364 by means of a conduit 478 and T-connection 480. When it is desired to tilt the operating head and tower, the valve 454 is actuated by means of its control lever 458 to admit fluid to the base end of one of the cylinders 424 and to relieve the other cylinder of pressure so that while one of the piston rods 426 is raised, the other is lowered, thus tilting the tower laterally through the cable 432. Hydraulic fluid forced from the cylinder in which the piston is rising flows from that cylinder through the T-connection 480, either to the reservoir 364 or to the head end of the opposite cylinder in which the piston is being lowered so that the piston in this latter cylinder floats freely. The valves 476 may be closed to lock the tower at the desired lateral angle.

Normally the tower is not tilted in either direction beyond 45° from the vertical, and stop means may be provided to limit tilting to this angle.

It will thus be apparent that I have devised a machine which has the advantages of the speed of operation inherent in a mechanically operated earth drill, but which nevertheless has combined therewith the advantages inherent in a hydraulically operated machine such as greater lifting power, and in addition the auger is hydraulically fed rather than being mechanically or manually fed as in the prior machine. A modification of this machine has the further advantage that it is adaptable for drilling holes at an angle to the vertical.

From the foregoing it will be apparent that I have provided a new and highly efficient earth drill which may be easily operated by a single operator with a minimum of manual effort, and which includes safety features protecting the drill against accidental misuse and the operator against injury. While the details of particular embodiments of the invention have been illustrated and described, it is to be understood that the invention is not limited to these precise details but may assume other forms, and, therefore, I desire to include within the terms of the present invention all the modifications, variations, and equivalents coming within the scope of the appended claims.

I claim:

1. An earth drill of the class described, comprising a supporting frame, an axially movable auger spindle supported on said frame for feeding or raising an auger attached thereto, a motor supplying power for operating said drill, gearing connected to said motor, a chain connected to said spindle, a control member for releasably connecting said gearing to said chain to drive the latter and raise said spindle, a fluid operated piston, a sprocket carried by said piston engaging said chain, ratchet means engageable with said sprocket and adapted in one position to hold said sprocket against rotation in one direction relative to said chain and adapted in another position to hold said sprocket against rotation in the other direction, linking members connected between said control member and ratchet means operable to hold said sprocket against rotation in said one direction when said control member connects said chain and gearing and operable to hold said sprocket against rotation in said other direction when said control member releases said chain and gearing, and a hydraulic circuit for moving said piston to raise said spindle when said ratchet means is in said one position and for moving said piston to feed said spindle when said ratchet means is in said other position.

2. An earth drill of the class described, comprising a supporting frame, an axially movable auger spindle supported on said frame for feeding or raising an auger attached thereto, a motor supplying power for operating said drill, gearing connected to said motor, a chain connected to said spindle, a control member for releasably connecting said gearing to said chain to drive the latter and raise said spindle and for holding said chain against movement, a fluid operated piston, a sprocket carried by said piston engaging said chain, a ratchet associated with said sprocket and adapted in a first position to hold said sprocket against rotation relative to said chain in one direction, in a second position to hold said sprocket against rotation in the other direction, and in a third position to permit rotation of said sprocket in either direction, and connecting members disposed between said ratchet and control member to move said ratchet into said first, second and third positions when said control member connects said gearing to said chain, releases said gearing and chain, and holds said chain against movement, respectively.

3. An earth drill of the class described, comprising a supporting frame, an axially movable auger spindle supported on said frame for feeding or raising the auger attached thereto, a motor supplying power for operating said drill, gearing connected to said motor, a chain connected to said spindle, a control member for releasably connecting said gearing to said chain to drive the latter and raise said spindle, a fluid operated piston, a yoke carried by said piston, a sprocket mounted on said yoke and engaging said chain, a ratchet mounted on said yoke adjacent said sprocket, a rotatable shaft connected to said ratchet, connecting links disposed between said shaft and control member, said ratchet being moved against said sprocket to hold the same against rotation in one direction when said control member connects said gearing and chain, and a hydraulic circuit to move said piston, chain and sprocket and raise said spindle.

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