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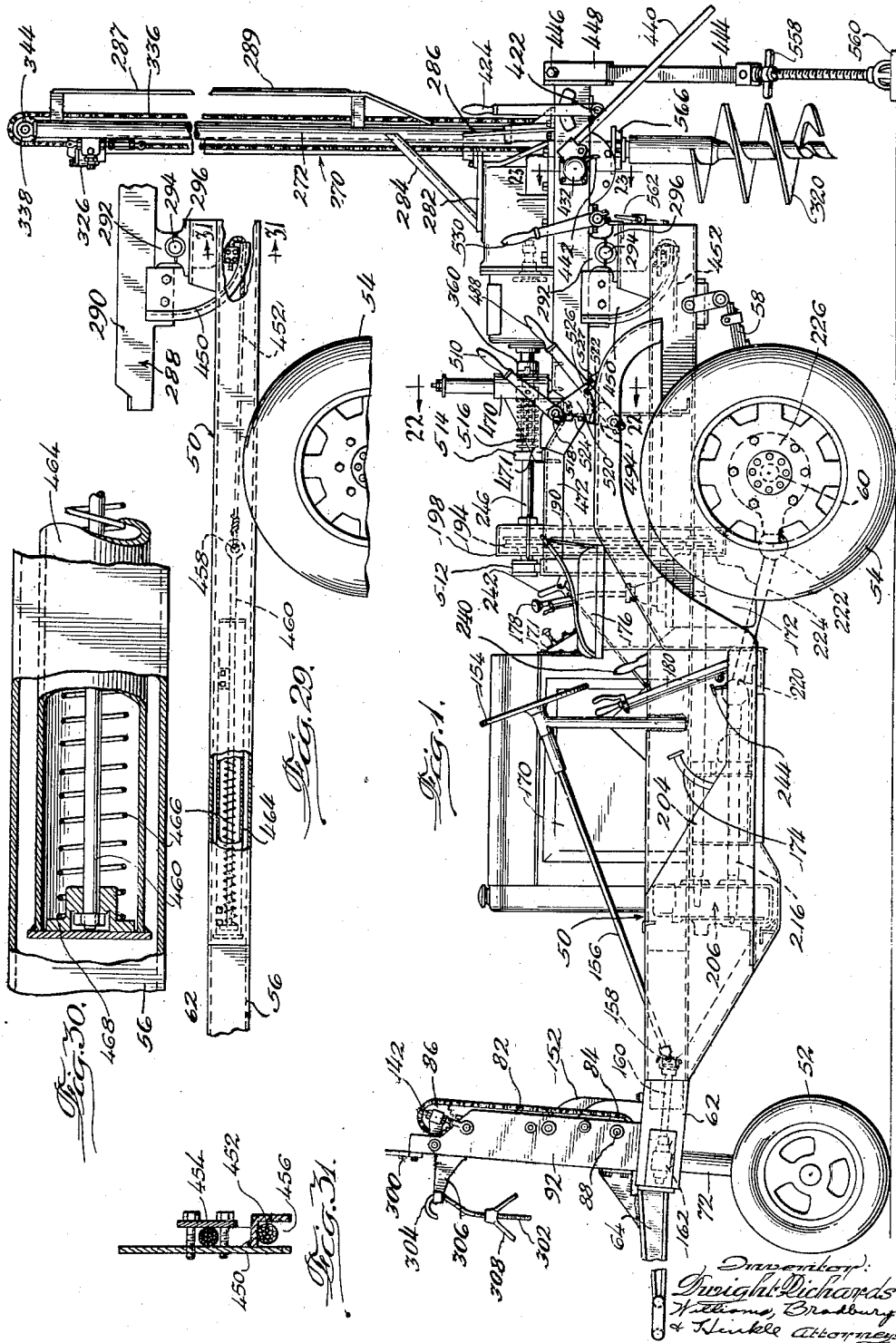
D. RICHARDS

2,418,601

EARTH DRILL

Filed Jan. 19, 1944

18 Sheets-Sheet 1



April 8, 1947.

D. RICHARDS

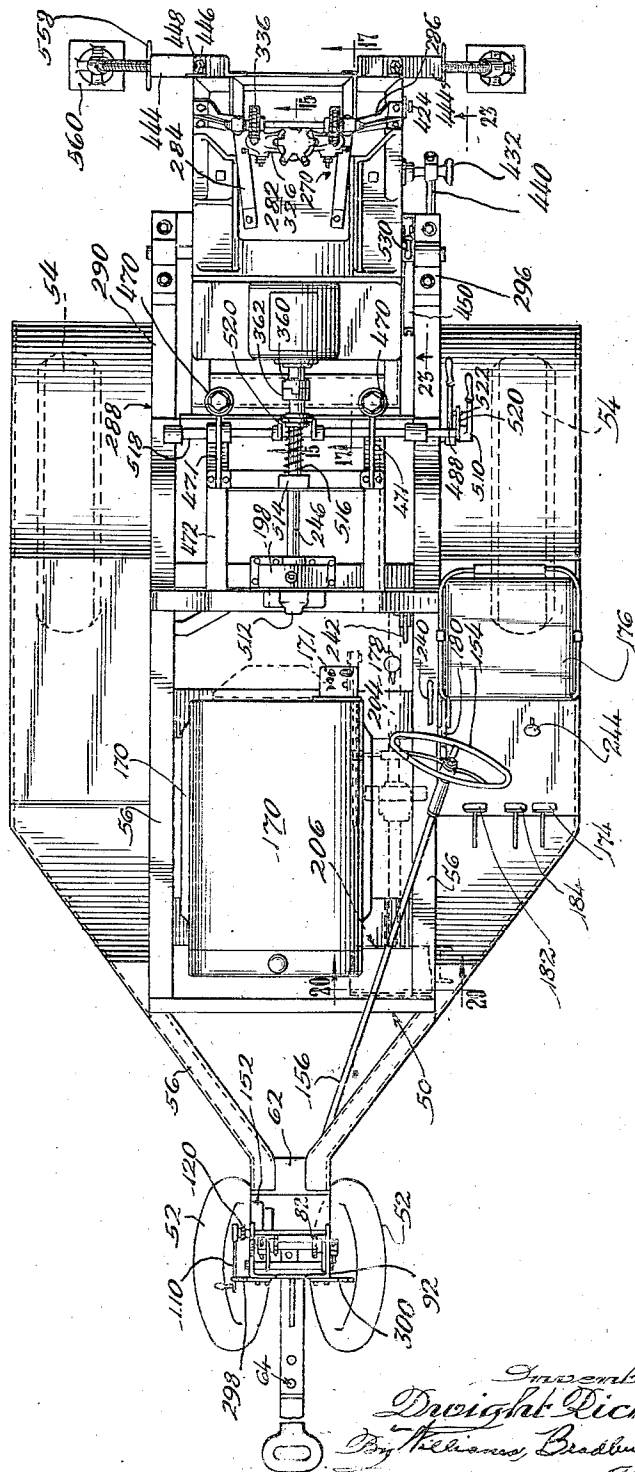
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EARTH DRILL

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18 Sheets-Sheet 2

Fig. 2.



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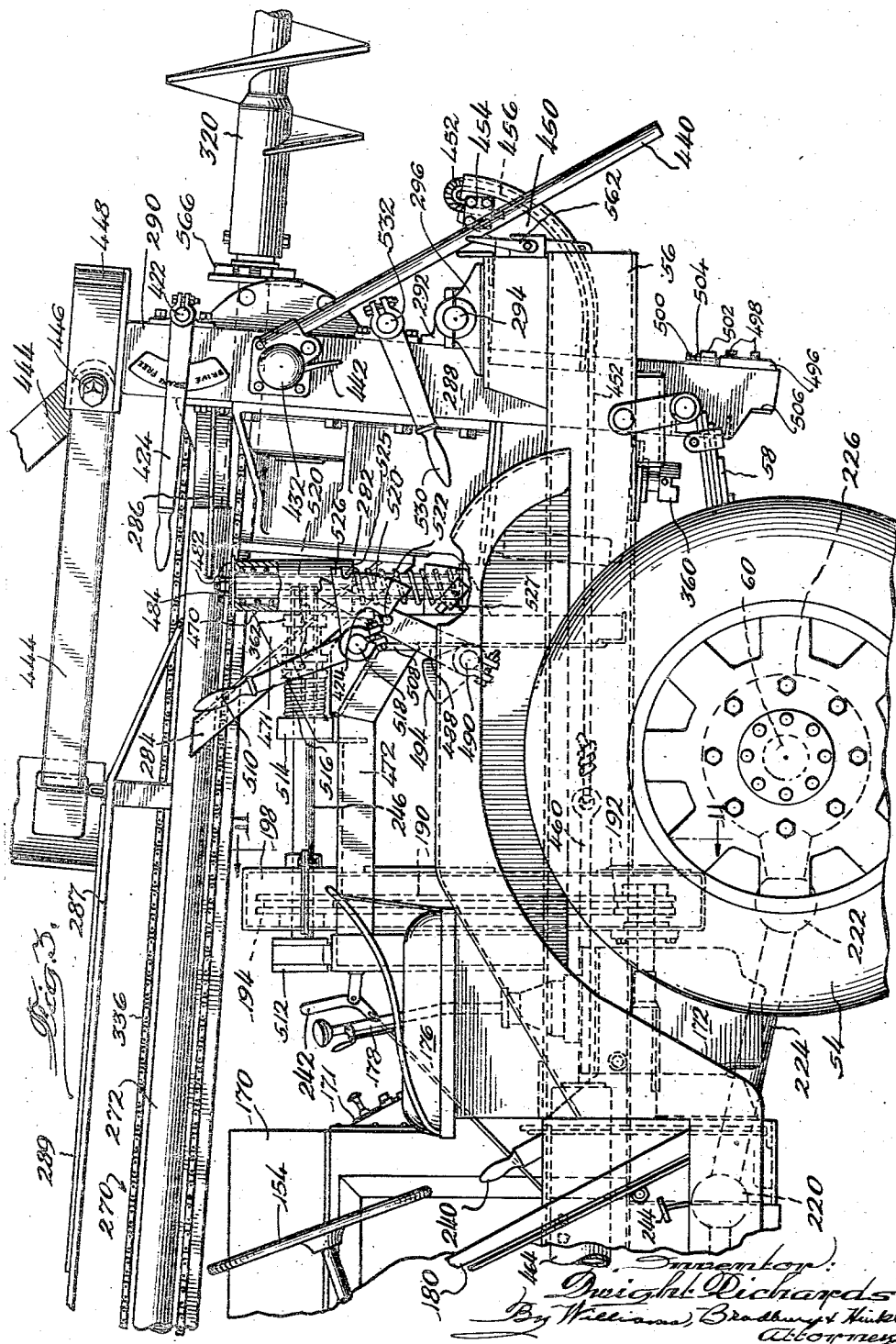
D. RICHARDS

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EARTH DRILL

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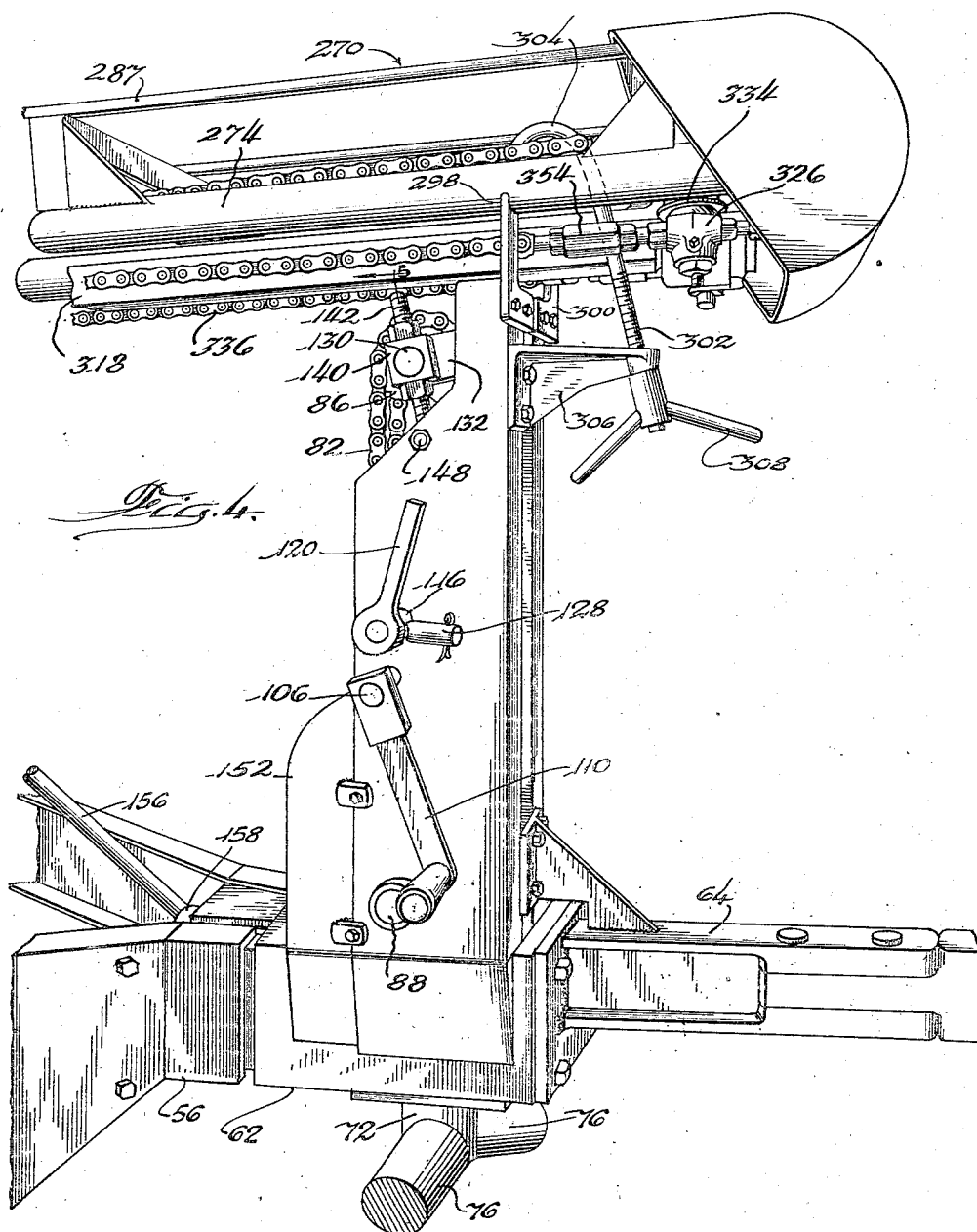
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EARTH DRILL

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18 Sheets-Sheet 4



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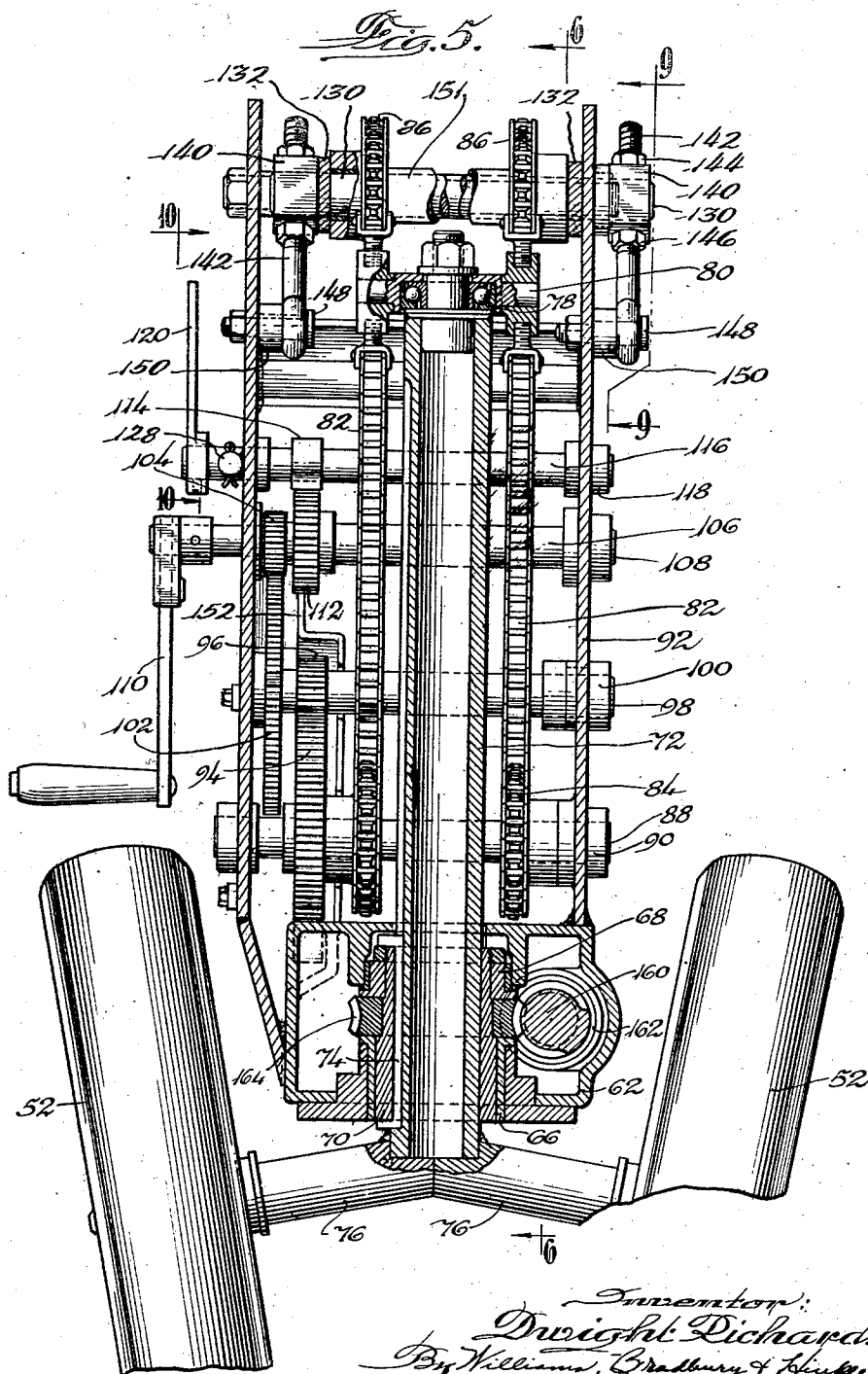
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EARTH DRILL

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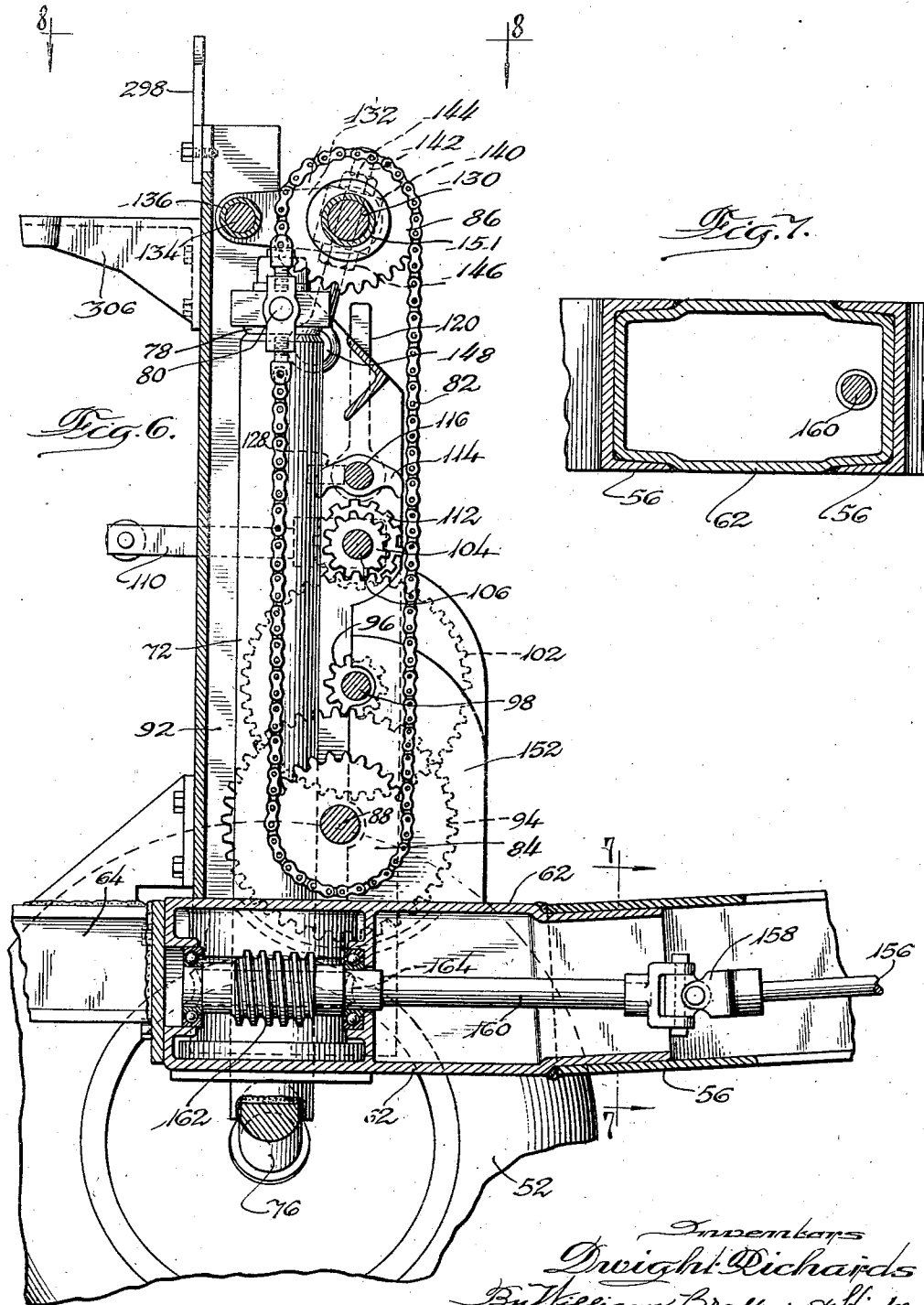
D. RICHARDS

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EARTH DRILL

Filed Jan. 19, 1944

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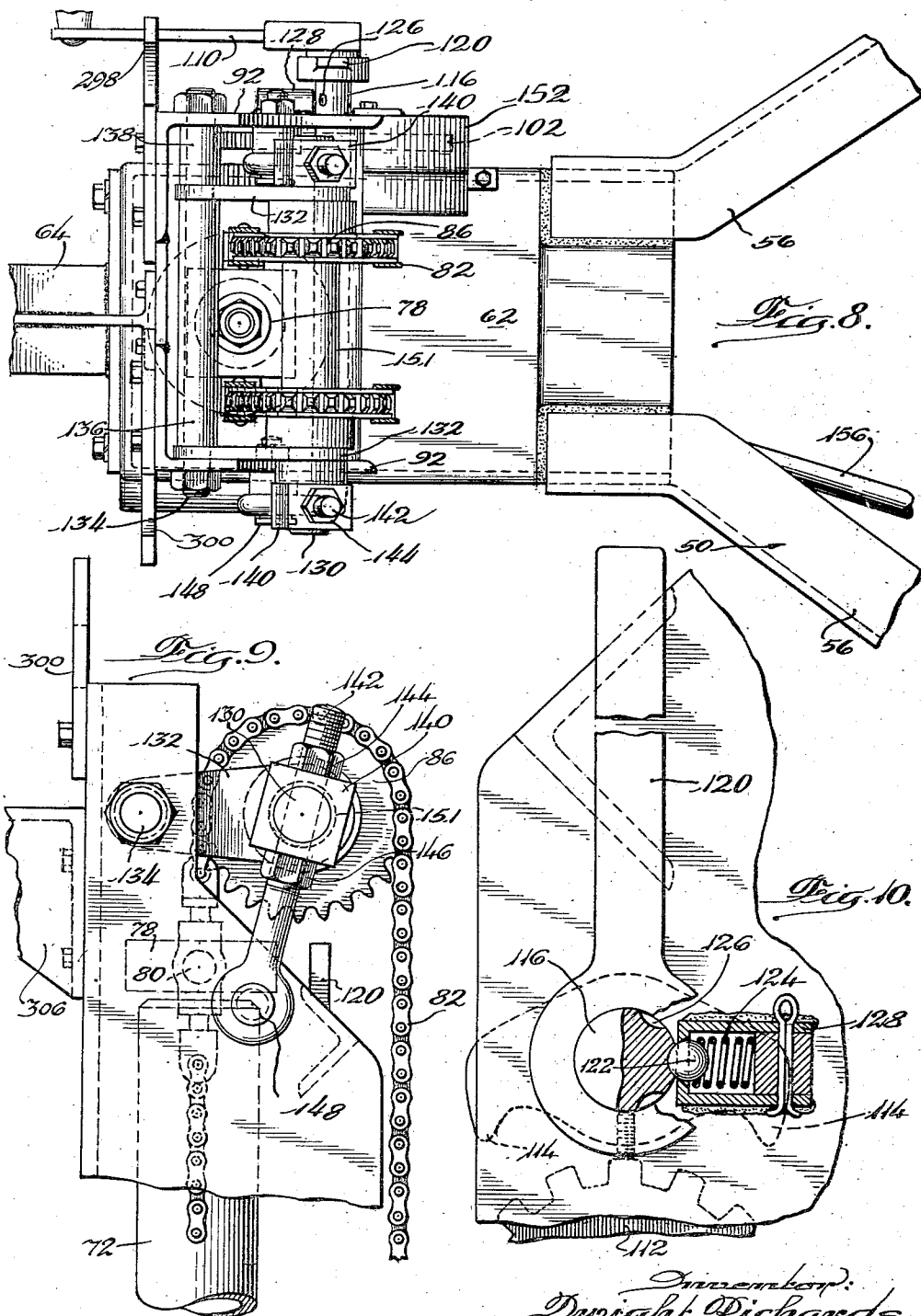
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EARTH DRILL

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18 Sheets-Sheet 7



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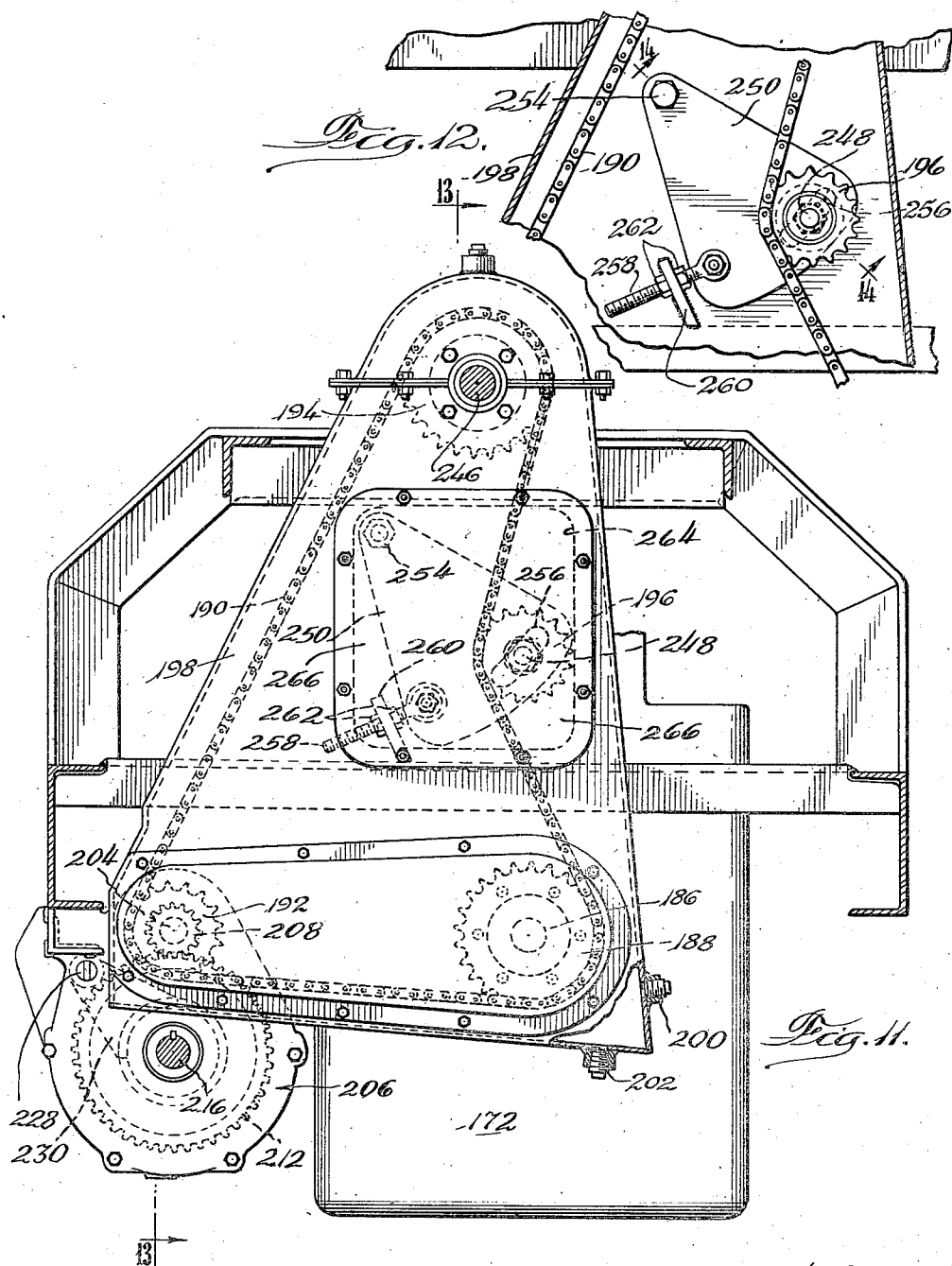
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EARTH DRILL

Filed Jan. 19, 1944

18 Sheets-Sheet 8



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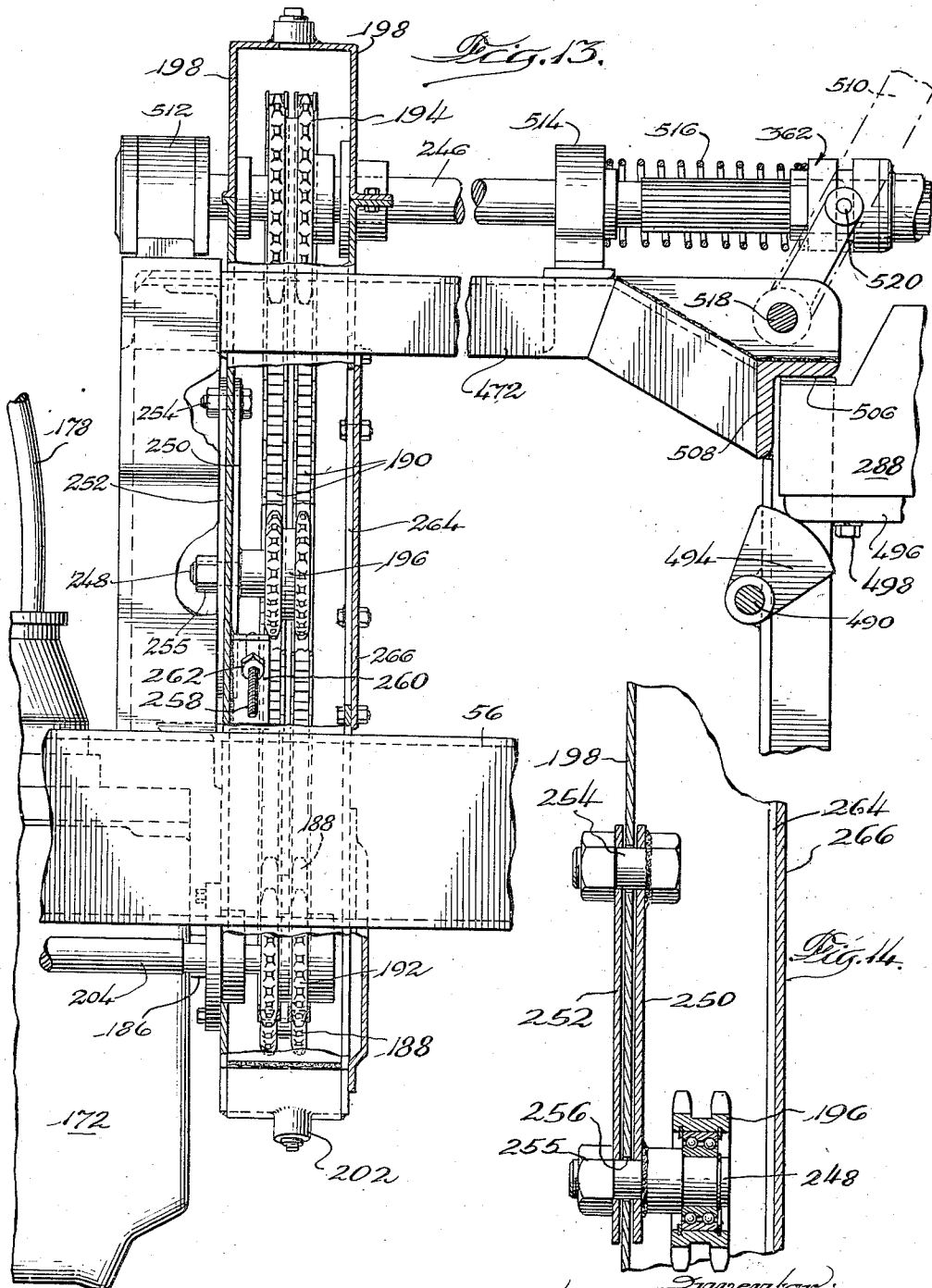
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18 Sheets-Sheet 9



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EARTH DRILL

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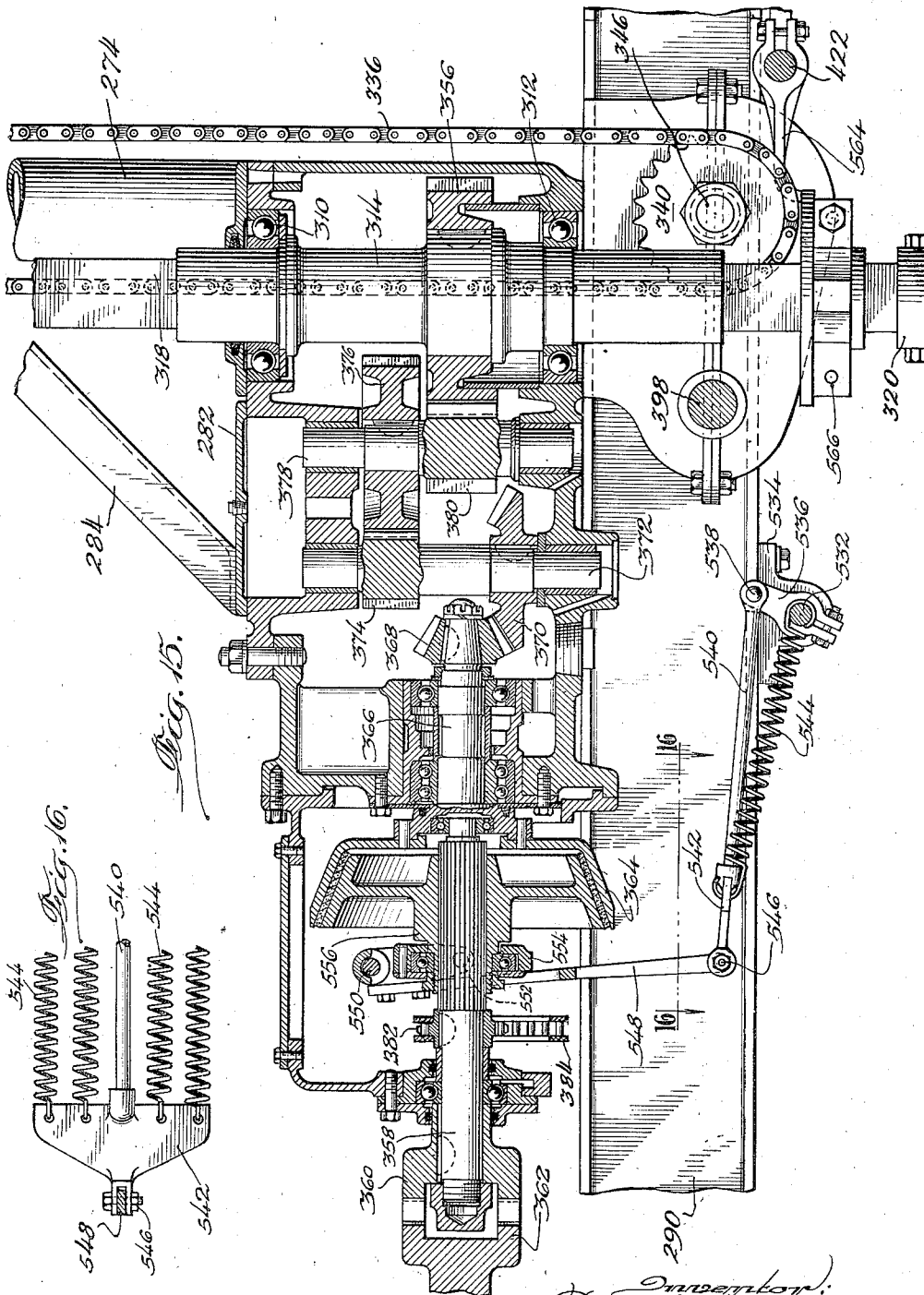


Fig. 15.

Fig. 16.

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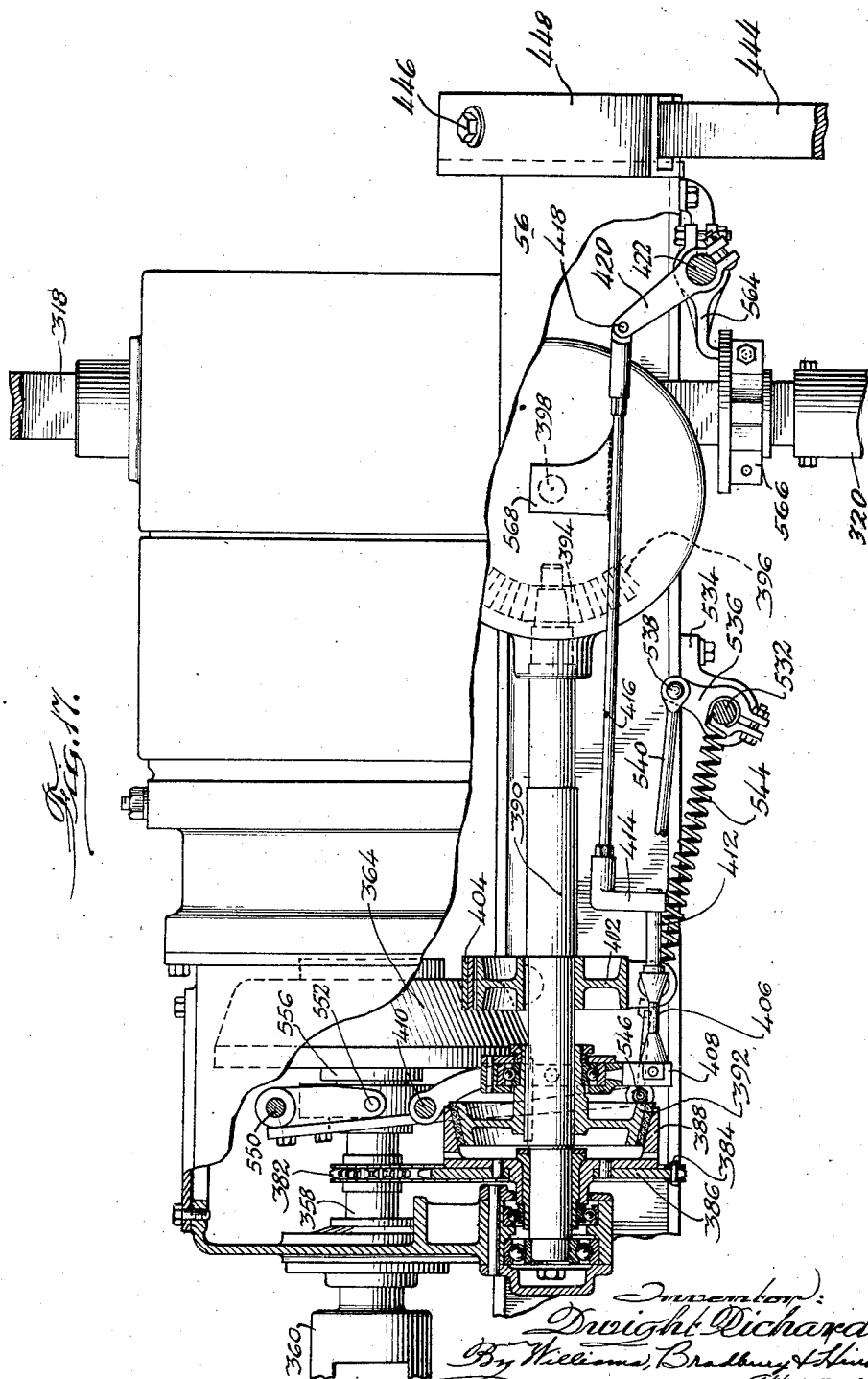
D. RICHARDS

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EARTH DRILL

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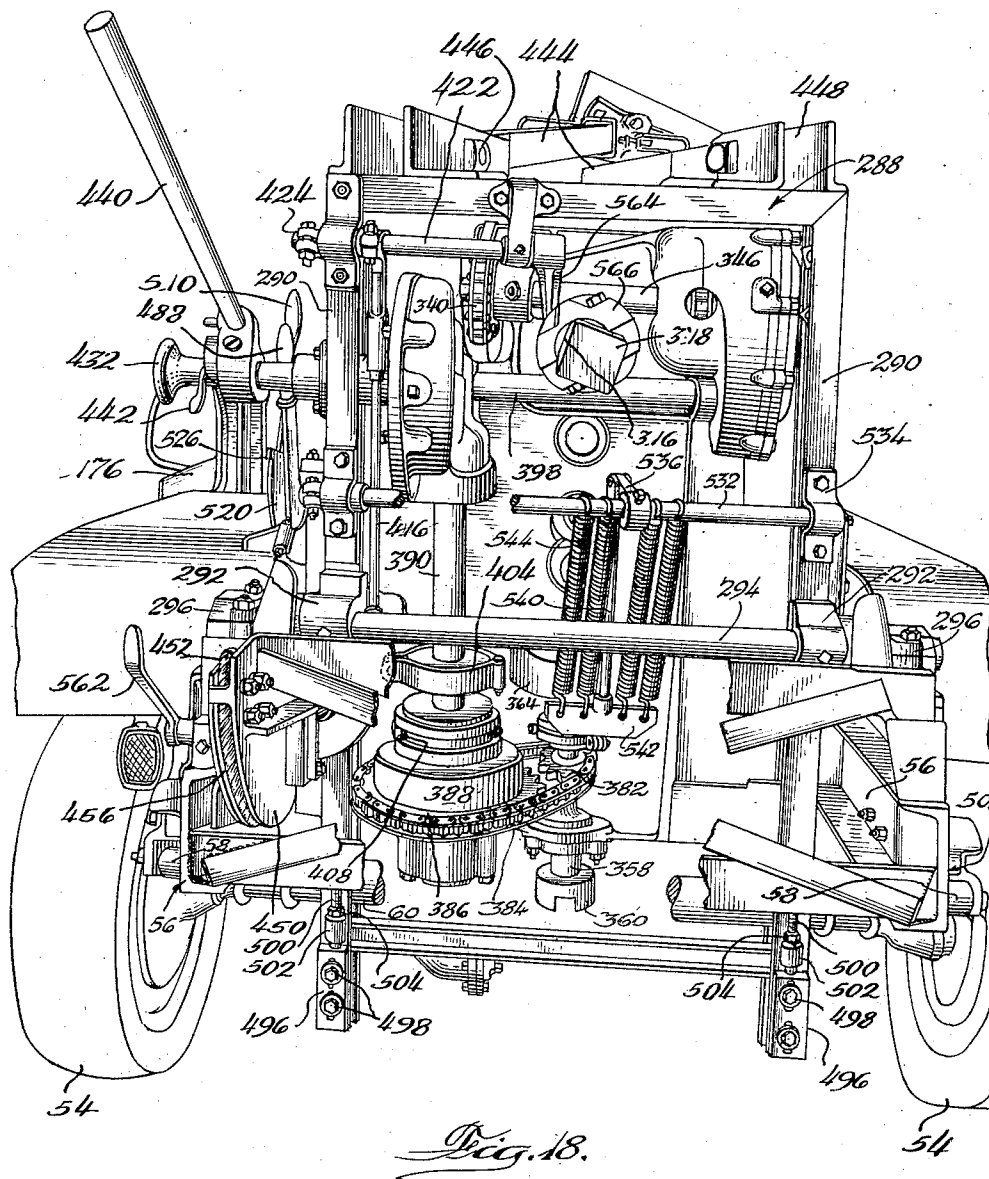
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EARTH DRILL

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EARTH DRILL

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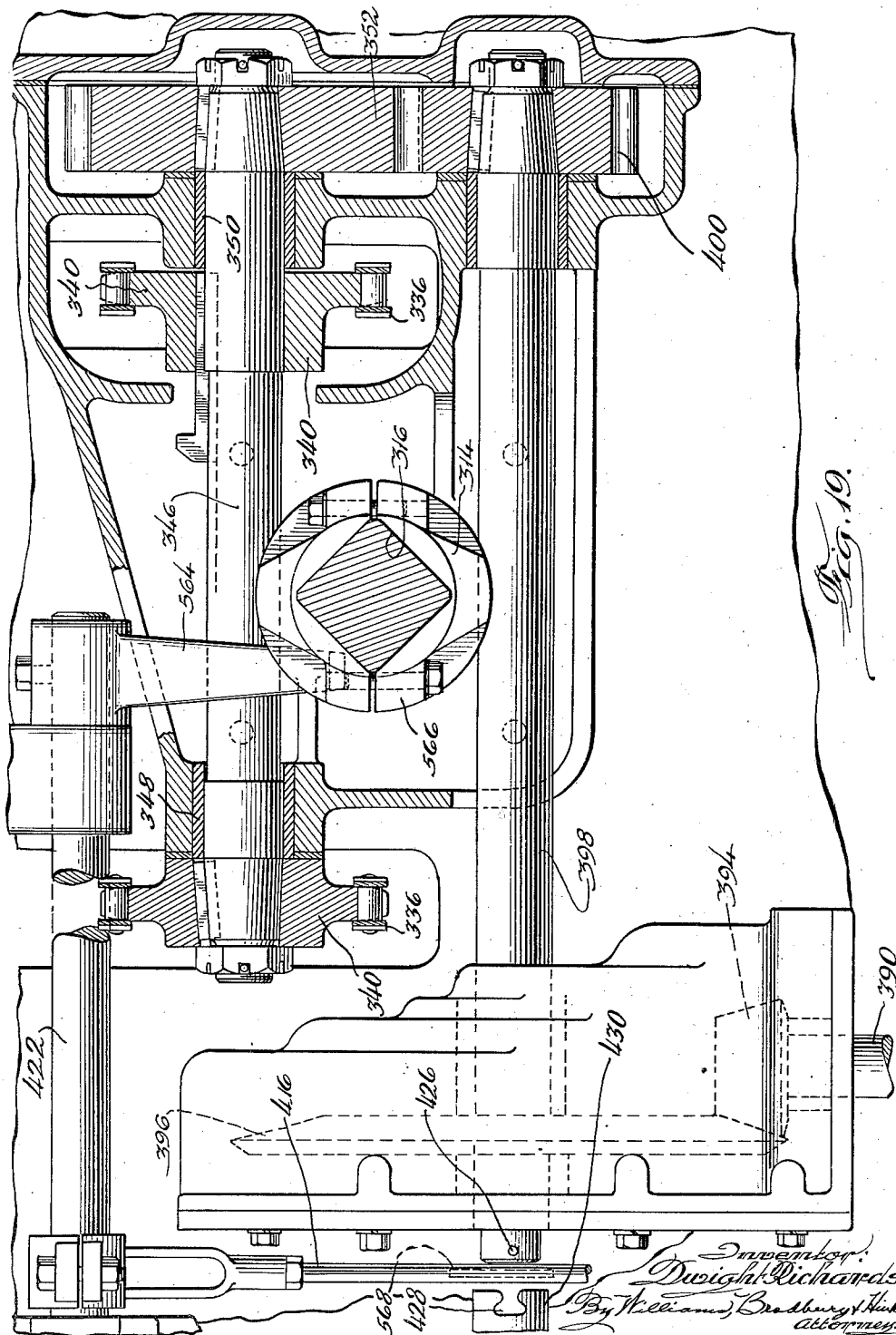


Fig. 19.

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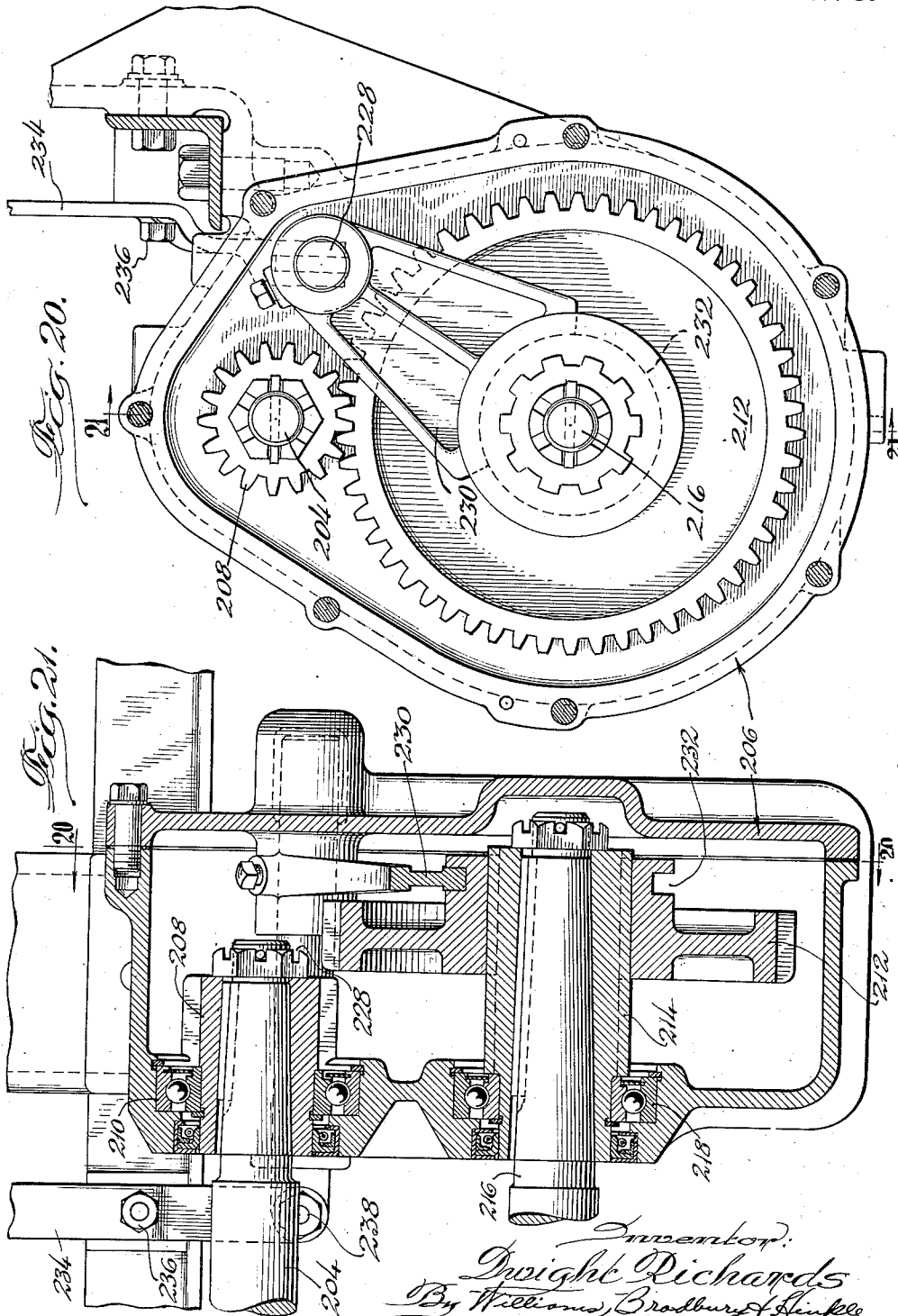
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EARTH DRILL

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18 Sheets-Sheet 14



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EARTH DRILL

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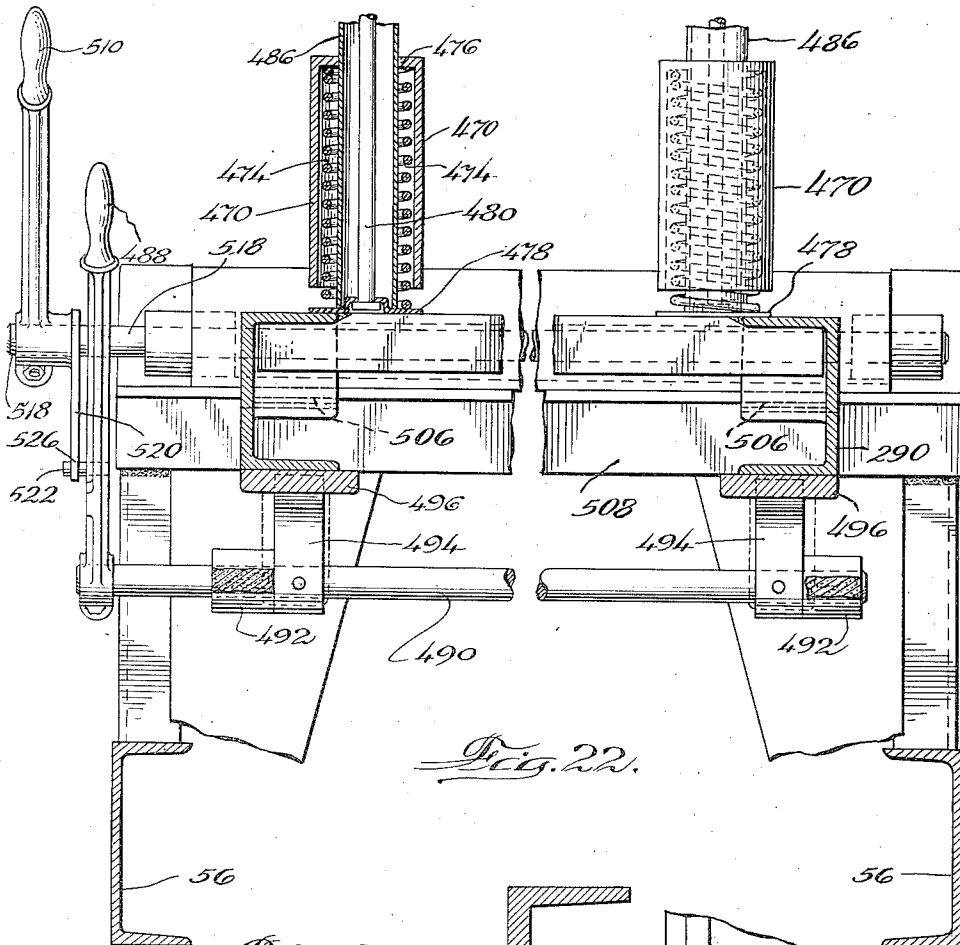


Fig. 22.

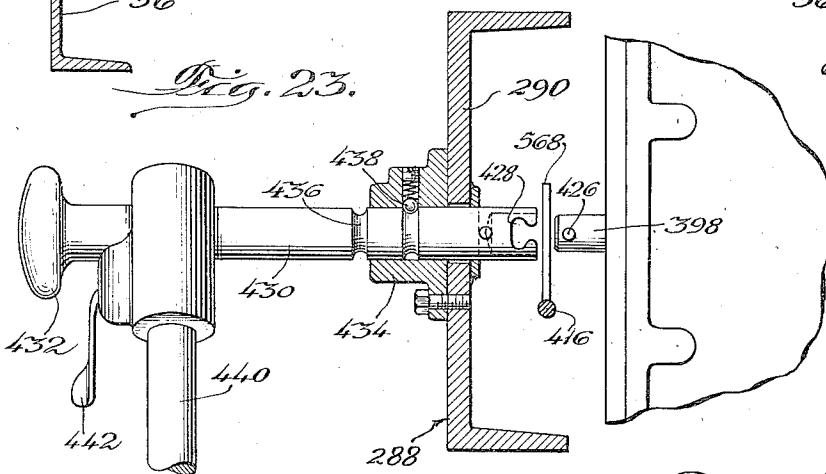


Fig. 23.

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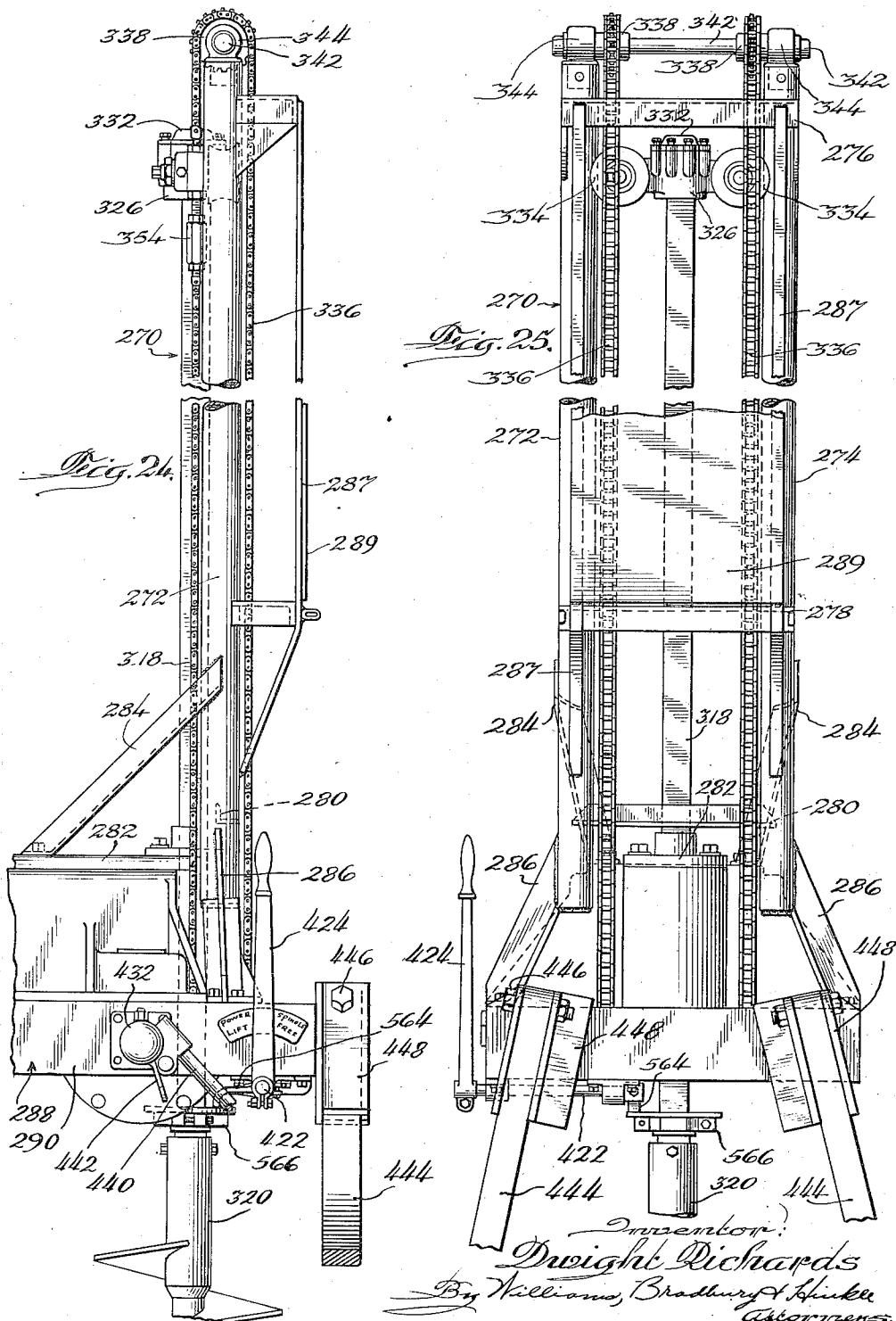
D. RICHARDS

2,418,601

EARTH DRILL

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18 Sheets-Sheet 16



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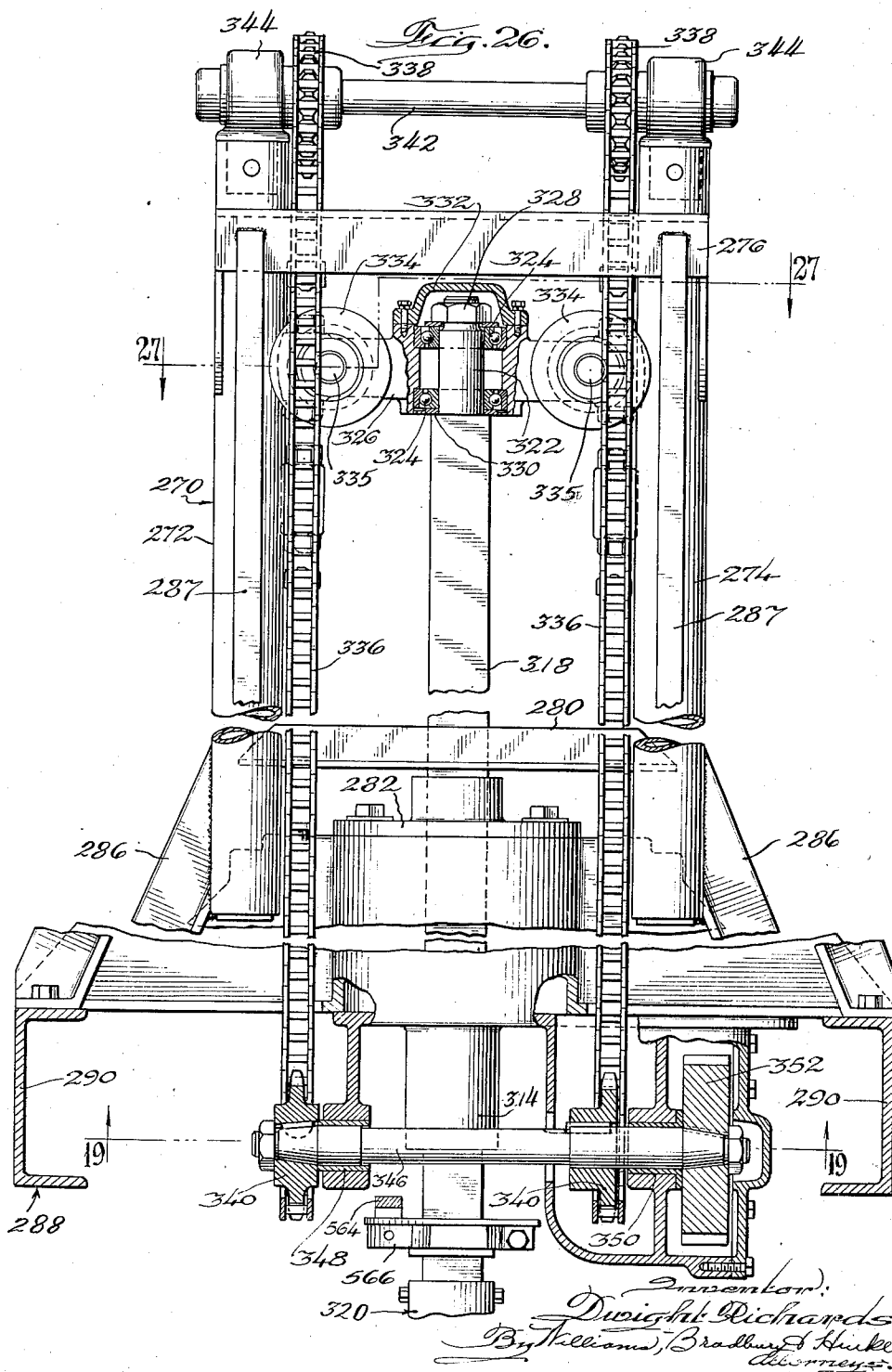
D. RICHARDS

2,418,601

EARTH DRILL

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April 8, 1947.

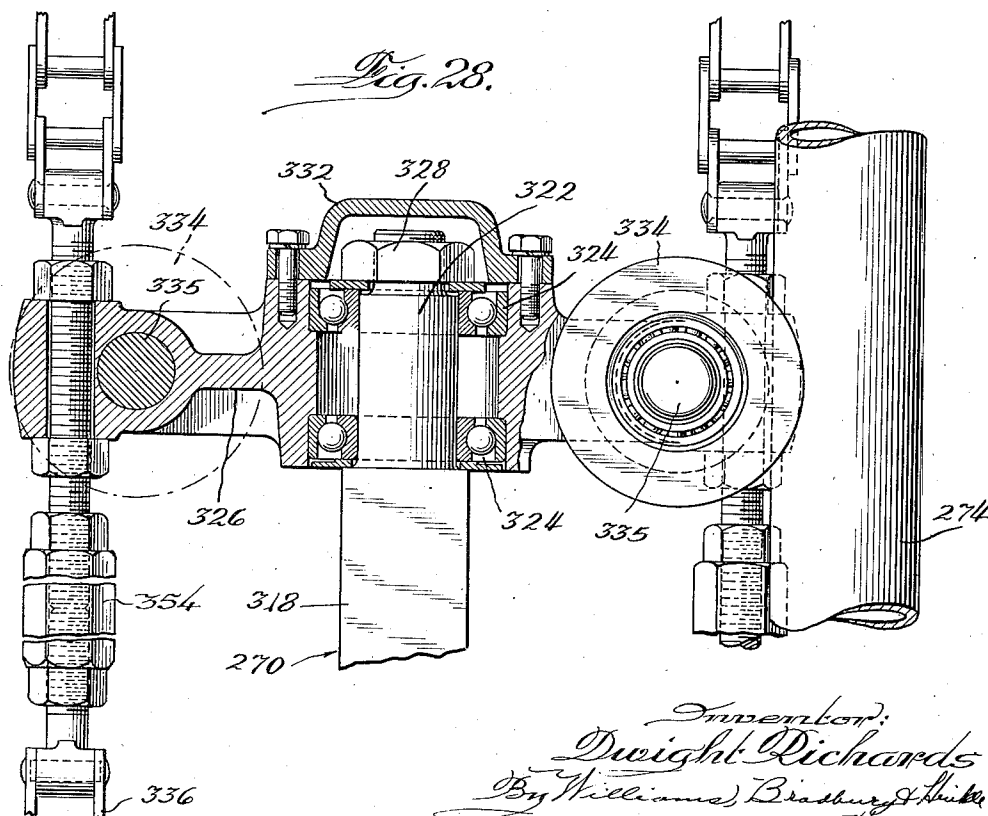
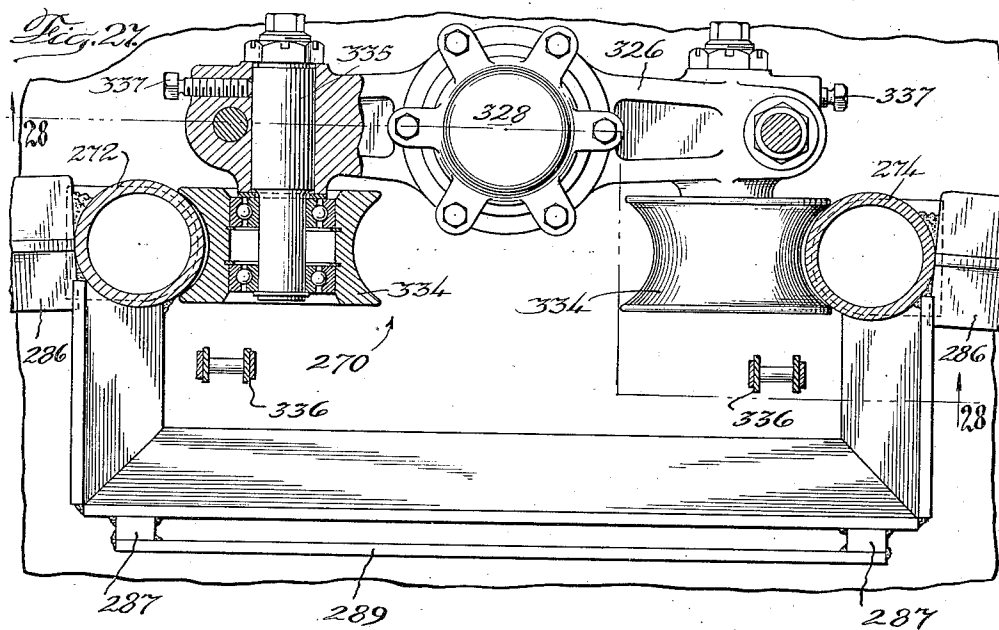
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18 Sheets-Sheet 18



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UNITED STATES PATENT OFFICE

2,418,601

EARTH DRILL

Dwight Richards, Harvey, Ill., assignor to The
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Application January 19, 1944, Serial No. 518,845

9 Claims. (Cl. 255—19)

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My invention relates to earth drills and more particularly to a portable earth drill adapted to dig holes for telephone and telegraph posts, building supports and other general purposes.

An object of my invention is to provide a new and improved earth drill constructed as a vehicle which can be either towed as a trailer or operated under its own power.

Another object of my invention is to provide a new and improved earth drill of the portable type which is more compact and easier and safer to operate than the earth drills of the prior art.

Another object of my invention is to provide an earth drill of the vehicular type having a new and improved mechanism for raising or lowering the front wheels of the vehicle.

Another object of my invention is to provide an earth drill of the vehicular type having a new and improved arrangement of driving means for operating the vehicle under its own power.

Another object of my invention is to provide an earth drill having a new and improved tower construction for supporting and guiding an auger.

Another object of my invention is to provide an earth drill having new and improved means for raising and lowering an auger and for driving the same.

Another object of my invention is to provide an earth drill having simplified and more accessible control means.

Other objects and advantages will become apparent as the description proceeds.

In the drawings:

Fig. 1 is a side elevation of an earth drill embodying a preferred form of my invention;

Fig. 2 is a top plan view of the earth drill shown in Fig. 1;

Fig. 3 is an enlarged side elevation of the earth drill of Fig. 1 showing the tower in lowered position;

Fig. 4 is an enlarged perspective view of the forward part of the earth drill also showing the tower in lowered position. In this figure the front wheels have been omitted.

Fig. 5 is a sectional view taken on the line 5—5 of Fig. 4 and showing the operating mechanism for raising and lowering the front wheels;

Fig. 6 is a vertical, sectional view taken on the line 6—6 of Fig. 5;

Fig. 7 is a transverse, sectional view showing a detail of construction and is taken on the line 7—7 of Fig. 6;

Fig. 8 is a horizontal, sectional view taken on the line 8—8 of Fig. 6;

Fig. 9 is a partial, irregular, vertical section taken on the line 9—9 of Fig. 5;

Fig. 10 is a partial, vertical section taken on the line 10—10 of Fig. 5;

Fig. 11 is a transverse, vertical section taken on the line 11—11 of Fig. 3, showing part of the driving mechanism for the auger;

Fig. 12 is an enlarged view showing the adjusting means for the driving chain of Fig. 11;

Fig. 13 is an irregular section taken on the line 13—13 of Fig. 11;

Fig. 14 is a partial section taken on the line 14—14 of Fig. 12;

Fig. 15 is a partial, longitudinal section taken on the line 15—15 of Fig. 2;

Fig. 16 is a view of a detail and is taken looking in the direction of the arrows 16—16 of Fig. 15;

Fig. 17 is a partial, longitudinal section taken on the line 17—17 of Fig. 2;

Fig. 18 is a rear, perspective view;

Fig. 19 is a sectional view taken on the line 19—19 of Fig. 26 and showing part of the mechanism for raising the auger;

Fig. 20 is a sectional view taken on the line 20—20 of Figs. 2 and 21, showing the driving mechanism for moving the vehicle under its own power;

Fig. 21 is a sectional view taken on the line 21—21 of Fig. 20 and also showing the driving mechanism;

Fig. 22 is an irregular, sectional view taken on the line 22—22 of Fig. 1 showing part of the control mechanism for the auger;

Fig. 23 is a partial, sectional view showing a detail of the manual feed for lowering the auger and is taken on the line 23—23 of Fig. 2;

Fig. 24 is a side view showing this tower in elevated position;

Fig. 25 is a rear view showing the tower in elevated position;

Fig. 26 is an enlarged view similar to Fig. 25, but showing parts cut away to illustrate various details of construction;

Fig. 27 is an irregular, sectional view taken on the line 27—27 of Fig. 26;

Fig. 28 is a sectional view taken on the line 28—28 of Fig. 27;

Fig. 29 is a view showing a balancing mechanism for the tower;

Fig. 30 is an enlarged view of the lefthand end of Fig. 29; and

Fig. 31 is a sectional view taken on the line 31—31 of Fig. 29 showing a constructional detail.

I have illustrated a preferred form of my invention as including, in general, a frame 50

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mounted on front and rear wheels 52 and 54, respectively. The frame 50 includes longitudinal channel members 56 which, at their rear ends, are mounted on springs 58 carried by the rear axle 60. The forward ends of the channel members 56 are telescoped about the rear end of a rectangular housing 62, as best shown in Figs. 6 and 7. This housing 62 is mounted on the front wheels 52 in a manner which I shall presently describe. A tongue 64 projects forwardly from the housing 62 and forms a convenient means for attaching my novel earth drill to a tractor vehicle, which also forms a support for the forward end of the earth drill when the latter is being towed as a trailer.

Referring particularly to Fig. 5, it will be seen that the housing 62 provides bearings 66 and 68 for a rotatable sleeve 70 in which a hollow post 72 is slidably mounted. A spline 74 prevents relative rotation between the sleeve 70 and post 72. The lower end of the post 72 is attached to the stub axles 76 on which the front wheels 52 are mounted. It will be noted that the stub axles 76 are inclined with respect to each other to give the wheels 52 inclination with respect to the vertical which facilitates steering of the earth drill when it is moved from place to place as a separate vehicle under its own power.

The upper end of the post 72 is rotatable in a bearing 78 provided by a crosshead 80 attached to both ends of each of a pair of chains 82. Each of these chains passes over a lower sprocket 84 and an upper sprocket 86 and by rotating the lower sprockets 84 the post 72 and wheels 52 may be raised or lowered as desired. In Fig. 5 these wheels are shown in a raised position, whereas in Fig. 1 they are shown in the lowered position.

The sprockets 84 are keyed or otherwise secured to a shaft 88 mounted in bearings 90 carried by uprights 92 which are attached at their lower ends to the housing 62. The shaft 88 has a relatively large gear 94 keyed thereto and this gear is adapted to be driven by a smaller gear 96 on a shaft 98 supported in bearings 100 carried by uprights 92. A relatively large gear 102 is keyed to the shaft 98 and meshes with a small gear 104 keyed to a shaft 106 mounted in bearings 108 carried by uprights 92. The shaft 106 and gear 104 are rotated by a hand crank 110 which drives the sprockets 84 through two sets of reduction gears to raise or lower the wheels 52.

A ratchet wheel 112 is keyed to the shaft 106 and is adapted to be engaged by either end of a double ended pawl 114 keyed to a shaft 116 mounted in bearings 118 carried by uprights 92. When it is desired to hold the wheels 52 in elevated position, one end of the pawl 114 is brought into engagement with the ratchet 112, whereas when it is desired to lock these wheels in lowered position, the other end of pawl 114 is brought into engagement with ratchet wheel 112. When it is desired to raise or lower the front wheels, the pawl 114 is moved to the neutral position shown in Fig. 10. The pawl 114 is shifted by a handle 120 attached to one end of the shaft 116 and the pawl is held in any of its three positions by a detent shown in Fig. 10 as comprising a ball 122 urged by a spring 124 into engagement with any of the three depressions 126 formed in the shaft 116. The ball 122 and spring 124 are carried in a housing 128 attached to one of the uprights 92.

I preferably provide means for adjusting the tension of the chains 82 and I shall now describe the means for taking up the slack in these chains.

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The sprockets 86 are rotatably mounted on a stationary shaft 130 passing through openings formed in the free ends of links 132 pivotally mounted on a pin 134 carried in the upper ends of uprights 92 and provided with spacing sleeves 136 and 138. The shaft 134 is journaled in blocks 140 adjustably mounted on the upper ends of threaded rods 142 and secured in adjusted position by lock nuts 144 and 146. The lower ends of the rods 142 are provided with eyes pivotally mounted on pins 148 attached to uprights 92 and carrying spacing sleeves 150. A spacing sleeve 151 is also preferably located between the sprockets 86.

The gears for raising and lowering the front wheels are preferably enclosed in a casting 152 which protects them against rain and dirt. By enclosing these gears, an operator is protected against injury by getting his clothing caught therein. When the front wheels are lowered the vehicle may be steered by a steering wheel 154 attached to a steering rod 156 having a universal connection 158 with a worm shaft 160. The worm shaft 160 carries a worm 162 which meshes with a worm wheel 164 affixed to the sleeve 70 so that rotating the steering wheel 154 rotates this sleeve, post 72 and the front wheels mounted on the axle 76 attached to the lower end of this post.

In general, my earth drill is towed as a trailer to the site where it is to be used and thereafter is usually disconnected from the tractor vehicle and moved from one position to another under its own power. Care, of course, must be taken to lower the front wheels 52 before the earth drill is detached from the tractor vehicle. I shall now describe the mechanism for operating the earth drill as an independent vehicle under its own power.

The frame 50 supports an internal combustion engine 170 which may be of any suitable type and is started and stopped by the usual controls mounted on an instrument panel 171. This engine drives a multi-speed transmission 172 through the usual clutch which is controlled by a conventional clutch pedal 174 located in convenient juxtaposition to a driver's seat 176. The transmission 172 is provided with the usual gear shift lever 178. The vehicle is preferably provided with a conventional mechanical emergency brake which is controlled by the emergency brake lever 180. I preferably provide each rear wheel with a separate and independent electric brake.

The electric brake on the right wheel is controlled by a brake pedal 182 and the electric brake on the left rear wheel is controlled by a separate pedal 184. When it is desired to make a particularly short turn, the rear wheel on the inside of the turn may be braked, whereas the outer rear wheel can rotate freely. The earth drill is provided with an electrical system and battery of any type commonly used on automotive vehicles and when the earth drill is operated as an independent vehicle, the electric brakes are connected to this battery. The electric brakes are preferably provided with a switch for disconnecting them from this battery and connecting them to a cable from a tractor vehicle, so that when the earth drill is used as a trailer attached to a tractor vehicle having electric brakes, the electric brakes of the earth drill can be connected into the circuit controlling the electric brakes of the tractor and both sets of brakes operated from the same manual control.

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The engine 170 and transmission 172 drive a shaft 185 (Fig. 11) having a double sprocket wheel 188 (Fig. 13) affixed thereto for rotation therewith. This double sprocket wheel 188 drives a pair of chains 190 which pass over three other double sprocket wheels 192, 194 and 196, all located in a generally triangular shaped housing 198 which protects the chains and sprocket wheels against dust and dirt and which is partially filled with lubricant introduced through a plugged opening 200. The housing 198 is also provided with a drain plug 202 whereby old lubricant can be removed to permit the introduction of a cleansing liquid and fresh lubricant.

The double sprocket wheel 192 is mounted on a shaft 204 which extends forwardly of the vehicle frame and terminates at its forward end in another housing 206 attached to the vehicle frame. A small gear 208 is keyed to the forward end of this shaft and rotates in a ball bearing 210 supported in the housing 206. The gear 208 is adapted to engage a larger and sliding gear 212 splined to a sleeve 214, keyed to another shaft 216 and rotatable in a bearing 218 also supported by the housing 206. The shaft 216 drives the rear axle 60 through universals 220 (Fig. 1) and 222, a drive shaft 224 and the usual differential 226.

The sliding gear 212 constitutes a clutch for selectively engaging or disengaging the engine 170 with the rear wheels of the vehicle for driving the latter as an independent automotive vehicle. The clutch housing 206 may be filled with lubricant in the usual manner and provides supports for a slidable rod 228 having a finger 230 engaging a groove 232 in the hub of the gear 212 to shift the latter into and out of engagement with cooperating gear 208.

The lever 234 is pivoted intermediate its ends to a part of the vehicle frame, as indicated at 236, and one end of this lever is pivoted at 238 to the shifting rod 228. The other end of the lever 234 is connected by any suitable linkage to a manual control 240, best shown in Fig. 1. The control lever 240 is conveniently located adjacent the driver's seat 176, as are also the manual throttle control 242 and the accelerator pedal 244 for regulating the supply of fuel to the engine 170.

Referring again to Fig. 11, it will be seen that the double sprocket wheel 194 is attached to the forward end of a shaft 246 which constitutes the main driving shaft for rotating the auger and lifting the same after it has completed a digging operation. The double sprocket wheel 196 constitutes an idler which may be adjusted to take up slack in the chains 190. This sprocket wheel is mounted on a threaded pin 248 extending through circular openings in a pair of triangular plates 250 and 252 pivotally attached to opposite sides of one wall of the housing 198 by nut and bolt 254. The pin 248 extends through an arcuate slot 256 which permits this pin and plates 250 and 252 to pivot about the bolt 254. A nut 255 holds the pin 248 in place. The inner plate 250 has one end of a threaded rod 258 pivotally attached thereto. This rod slides freely in an opening provided in a bracket 260 attached to the housing 198 and nuts 262 lock this rod in any adjusted position relative to the bracket 260.

The housing 198 is provided with an opening 264 which is normally closed by a removable plate 266. In order to adjust the slack of the chains 190, nut 255 is loosened and plate 266 is removed. Nuts 262 are then adjusted to switch pivoted

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plates 250 and 252, pin 248 and sprocket wheels 196 to the desired position. Thereupon nuts 262 and 255 are tightened and cover plate 266 is replaced. It will be noted that the pivoted plates 250 and 252 are large enough to cover the arcuate slot 256 for all adjustments of the sprocket wheel 196 so that no dirt or water can enter through this slot.

My earth drill is provided with a novel auger-supporting and guiding tower indicated generally by reference character 270. Referring particularly to Figs. 24, 25 and 26, it will be seen that this tower comprises, in general, a pair of spaced tubular side members 272 and 274 connected at their upper ends by a cross piece 276 and intermediate their ends by other cross pieces 278 and 280. The lower end of the side members 272 and 274 are suitably secured to a base 282 and its supporting subframes by diagonal braces 284 and inclined supports 286 which are welded at their upper ends to the side members. Each of the side members 272 and 274 is also provided with a reinforcing truss 287 and the two trusses are connected by a plate 289 which braces the tower laterally and supports the jack legs when in rest position.

The base 282 is mounted on a subframe 288 and this subframe includes a pair of spaced channel irons 290, as most clearly shown in Figs. 18 and 26. This subframe is attached by brackets 292 to a transverse shaft 294 pivotally mounted in bearings 296 carried on the rear end of the main vehicle frame 56. This arrangement permits the tower to be swung from the upright position shown in Figs. 1, 2, 24, 25 and 26 to the horizontal position shown in Figs. 3, 4 and 18. When the vehicle is being towed to the location at which holes are to be drilled, the tower is ordinarily in the down or horizontal position, but before the drilling operation can commence the tower must be raised to the vertical or operative position.

When the tower is in the horizontal position, the forward end of the tower rests upon the structure containing the mechanism for raising and lowering the front wheels and is cradled in and held against lateral displacement by the curved upper ends of vertical supports 298 provided by a pair of angle shaped brackets 300 attached to the upper part of that structure. The forward end of the tower is clamped down against the upper ends of supports 298 by a threaded hook 302 having an upper end 304 adapted to engage a part of the tower structure. The threaded portion of the hook passes freely through an opening in a third bracket 306 attached to the forward part of the structure and the hook is drawn downwardly by a wing nut 308 to secure the forward end of the tower firmly in place.

Referring to Fig. 15, it will be apparent that the base 282 of the tower encloses certain operating mechanism for rotating and raising and lowering the auger. This base provides a housing having ball bearings 310 and 312 carrying an auger driving sleeve 314 having a rectangular opening therethrough which is indicated by the reference character 316 in Fig. 19. This opening slidably receives the rectangular auger shaft 318 to the lower end of which is attached a helix or auger 320. The upper end of the auger shaft has a cylindrical portion 322 rotatable in a pair of ball bearings 324 carried by a crosshead 326. The extreme upper end of the auger shaft is threaded to receive a nut 328 and this nut and shoulder 330 cause the auger shaft to move up

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and down with the crosshead 326. A cap 332 is preferably attached to the crosshead and encloses the upper end of the auger shaft.

The crosshead 326 is provided with a pair of grooved rollers 334 which engage the side members 272 and 274 of the tower to guide movements of the crosshead lengthwise of the tower. The rollers are rotatably mounted on ball bearings carried by pins 335 passing through the crosshead and held against rotation by set screws 337. This crosshead is connected to both ends of each of a pair of chains 336 which pass over sprocket wheels 338 at the upper end of the tower and sprocket wheels 340 at the lower end thereof. The sprocket wheels 338 are attached to a shaft 342 mounted in bearings 344 attached to the upper ends of the tower side members. The sprocket wheels 340, as best shown in Fig. 26, are attached to a shaft 346 mounted in bearings 348 and 350 provided by the tower base. This shaft is provided with a gear 352 whereby the shaft and attached sprocket wheels 340 may be rotated to raise or lower the auger. An adjustable connection 354 is preferably provided between the crosshead 326 and one end of each chain 336, whereby slack in these chains can be taken up.

I shall now describe the mechanism for rotating the auger and in this description reference will be made particularly to Fig. 15. The auger rotating or driving sleeve 314 has a gear 356 keyed thereto. This gear 356 is adapted to be driven from a clutch shaft 358 mounted in the tower base and having a fixed clutch member 360 adapted, when the tower is in lowered position, to be engaged by the movable clutch member 362 splined, as clearly shown in Fig. 13, on the rear end of jack shaft 246 which is rigidly mounted on the main vehicle and constitutes the main driving shaft for rotating the auger and lifting the same.

Power from the clutch shaft 358 is transmitted to gear 356 through a cone clutch 364 having one member splined to the clutch shaft 358 and a second member attached to a stub shaft 366 terminating in a beveled pinion 368. This pinion meshes with a beveled gear 370 on a transverse shaft 372 having a small gear 374 meshing with a larger gear 376 on a second transverse shaft 378. This second shaft has a small gear 380 meshing with the gear 356. The transverse shafts 376 and 378 and the gears carried thereby provide a speed reduction interposed between the clutch shaft 358 and the auger rotating sleeve 314 and clutch 364 provides means for disconnecting this gear reduction and auger rotating sleeve from the clutch shaft 358.

The clutch shaft 358 also transmits the power for raising the auger after a drilling operation. As most clearly shown in Figs. 15, 17 and 18, the clutch shaft 358 is provided with a sprocket wheel 382 connected by a chain 384 to a larger sprocket wheel 386 attached to a clutch member 388 (Fig. 17) rotatably mounted on a parallel shaft 390. This shaft 390 is supported in suitable bearings provided by the tower base and has a second clutch member 392 splined thereto for movement thereon.

A beveled pinion 394 is affixed to the rear end of the shaft 390 and engages a beveled gear 396 on a transverse shaft 398 journaled in bearings supported by the tower base. A gear 400 (Fig. 19) is keyed to the shaft 398 and meshes with the gear 352 on the lower sprocket shaft 346 of the tower. The multispeed transmission attached to the rear of the engine has a definite position to

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which the gear shift lever is moved when it is desired to rotate or lift the auger by power and all drilling operations are conducted with the gear shift lever in this position. When the gear shift lever is in this position, the connections are such that the driving connections between the engine 170 and lower sprocket wheel shaft 346 rotate this shaft in a direction to raise the crosshead 326 and auger connected thereto.

The shaft 390 also has a brake drum 402 (Fig. 17) keyed thereto and this brake drum is adapted to be connected by a brake band 404 urged into engagement with the brake drum by a conventional spring not shown. Application of the brake band 404 to the drum 402 is controlled by the spool shaped cam 406 located intermediate the ends of the brake band and serving, when in either extreme position, to separate these ends and release the brake. In intermediate position, the small portion of this spool permits the brake band to engage the brake drum and hold the shaft 390 and associated crosshead and auger in fixed position. One end of the brake cam is attached to the operating lever 408 for the clutch member 392, the other end of this lever being pivotally attached to a fixed support, as indicated at 410. The other end of the brake cam is attached to a rod 412 affixed to an elbow 414 threadedly secured to one end of a link 416 whose other end is pivotally attached at 418 to arm 420 on a control shaft 422.

Power lift lever 424 is attached to the control shaft 422. This lever can be shifted to any one of three positions. In the position of the parts shown in Fig. 17, the lever 424 would be in the driving position wherein the clutch members 388 and 392 are engaged to transmit power to the lower sprocket shaft of the tower and wherein the brake band 404 is released from the brake drum 402 to permit rotation of the shaft 390. In an intermediate position, clutch members 388 and 392 are disengaged and brake band 404 engages brake drum 402 to hold the auger in elevated position. In a third position of the power lift lever 424 the auger is in free position with the clutch members 388 and 392 disengaged and brake band 404 disengaged from brake drum 402. In this position of the power lift lever the auger can descend under its own weight or can be manually lowered by mechanism which I shall now describe.

In Fig. 19, shaft 398 is illustrated as being provided with a transverse pin 426 whose ends project from opposite sides of the shaft. This pin is adapted to be engaged by the slots 428 formed in the recessed end of a rod 430 terminating in a knob 432 (Fig. 23) which may be manually gripped to shift the rod 430 lengthwise to produce engagement or disengagement of the slots 428 with the ends of the pin 426. The rod 430 is slidably mounted in one of the channel irons of the tower subframe and in a sleeve 434 bolted or otherwise attached to this channel iron. The rod 430 has a pair of grooves 436 either of which may be engaged by a spring pressed detent 438 to hold the rod in adjusted position.

After the rod 430 has been shifted to engage slots 428 with pin 426 on shaft 398, the rod and shaft may be rotated to lift the auger by means of a handle 440 pivoted on the rod 430. The rod 430 is preferably provided with a ratchet wheel, not shown, which is engaged by a pawl carried by handle 440. In normal operation, the handle 440 is only used to lower the auger by oscillating this handle in an arc with the rod 430 as a center.

In case of power failure, however, it may be desirable to use the handle 440 to raise the auger and for such purposes the pawl and ratchet connecting this handle and the rod 430 are preferably made of the double acting type. A lever 442 is provided to shift the pawl to cause it to engage either on the upswing or the downswing of the handle, as may be desired.

A pair of adjustable jack legs 444 are pivotally attached by bolts 446 to the upper ends of inclined U-shaped guides 448, secured in any suitable manner to the rear of the tower subframe 288. When the tower is in the horizontal or inoperative position, these jack legs are folded back over the tower, as indicated in Figs. 3 and 18. After the earth drill has been towed to approximately the location of the hole to be drilled, the tower is raised to operative position. After the hook which holds down the forward end of the tower has been released, the jack legs 444 are swung through an angle of 180° from that shown in Fig. 3, so that they form, in effect, a continuation of the tower. By exerting his weight on the extending ends of these legs, an operator can use these legs as a lever for swinging the tower from the horizontal to the vertical position. This operation is assisted by mechanism which partially balances the weight of the tower and which I shall now describe in detail.

Referring particularly to Figs. 29, 30 and 31, it will be seen that a curved guide 450 is attached to one of the channel irons of the tower subframe. One end of a cable 452 is attached to this guide by a plate 454 bolted thereon. The guide 450 provides a groove 456 for receiving more or less of the cable end, depending upon whether the tower is in raised or lowered position, as may be seen from a comparison of Figs. 3 and 29. The forward end of the cable 452 is connected to the eye 458 of rod 460 extending into a cylinder 464 attached to the channel member 56 of the main vehicle frame. The cylinder 464 includes a spring 466 having one end abutting an in-turned flange at the rear of the cylinder and a second end abutting a head 468 attached to the forward end of a rod 460. It will be apparent from the foregoing that when the tower is in the horizontal position, the spring 466 is compressed and the force exerted by the spring assists in raising the tower to upright position.

I have also provided spring bumpers for absorbing any shock which might otherwise be produced when the tower is swung from a horizontal to a vertical position. These spring bumpers are shown in Figs. 1, 3 and 22 and comprise the sleeves 470 attached by brackets 471 to an auxiliary frame 472 permanently attached to the main vehicle frame. Each sleeve 470 contains a spring 474 whose upper end abuts an in-turned flange 476 formed by the upper end of the sleeve 470. The lower end of each spring 474 bears upon a plate 478 engaged by the enlarged head of a rod 480 whose upper end passes through a second plate 482 and is threaded to receive nuts 484. The tubular spacer 486 is interposed between the plates 478 and 482 and is slidable in the sleeve 470 and spring 474. When the tower is in the horizontal position, these bumpers assume the position shown in Fig. 3, whereas, when the tower is raised, plates 478 are engaged by the forward end of the tower subframe and these bumpers assume the position shown in Figs. 1 and 22.

After the tower has been shifted to upright position, it is locked in this position by means of a locking lever 488 (Fig. 22) attached to one

end of a transverse shaft 490 supported in bearings 492 carried by the main vehicle frame. This shaft has spaced cams 494 which engage beneath tapered plates 496 slidably attached by screws 498 (Fig. 3) to the forward corners of the tower subframe and adjustable lengthwise of this subframe by means of screws 500 threaded into ears 502 and secured in adjusted position by lock nuts 504. The cams 494 force shoulders 506 of the subframe against an angle iron 508 affixed to the rear end of the auxiliary frame 472. It is important that the driving mechanism of the tower assembly be not connected with the motor of the vehicle until the tower assembly is firmly secured in place and it is likewise important that the driving mechanism of the tower assembly be disconnected from the motor before release of the cams 494 which lock this assembly in upright position. A feature of my invention lies in the interconnection of the manual locking lever 488 with the jaw clutch lever 510 which controls the driving connection between the motor and the driving mechanism of the tower assembly.

Referring to Figs. 13 and 15, it will be seen that the jack shaft 246, which is driven by the motor, is mounted in bearings 512 and 514 carried by the auxiliary frame 472. This jack shaft has a jaw clutch member 362 splined thereon and urged to the right by a spring 516 interposed between this clutch member and the bearing 514. The jaw clutch member 362 is adapted to engage the jaw clutch member 360 on the clutch shaft 358 of the tower assembly and engagement of these clutch members is controlled by the clutch lever attached to one end of a clutch operating shaft 518. This shaft has fingers 520 engaging in a groove in the clutch member 362 to shift the latter to and from engagement with clutch member 360.

The jaw clutch control lever 510 has movable therewith a plate 520 (Fig. 1) which cooperates with a pin 522 on the tower locking lever 488 to insure the proper sequence of operation of these levers. When the tower is in horizontal position, the locking lever 488 is in forward position and the pin 522 engages notch 524 in the forward edge of the plate 520. After the tower has been swung to vertical position and it is desired to lock the tower in this position, clutch lever 510 must be moved forward slightly to release pin 522 from notch 524 and thereafter locking lever 488 can be moved toward the rear to locking position. Thereafter clutch lever 510 is moved to the rear to permit engagement of the jaw clutch members 360 and 362 and to move locking plate 520 into position to prevent release of locking lever 488. In this position of the parts the pin 522 on the locking lever 488 engages a notch 525 in front of a lug 526 at the rear lower corner of the locking plate 520. When in this position, lever 488 is engaged by spring plunger 527 which holds pin 522 in notch 525. It will be apparent from the foregoing that in order to release the tower for swinging to horizontal position, it is first necessary to move lever 488 slightly to the rear and then shift jaw clutch lever 510 to clutch disengaging position so that accidental release of the tower with this clutch engaged is absolutely prevented.

When the tower is in horizontal position, the power lift lever 424 is normally in the brake position shown in Fig. 3. In this position the clutch member 392 is held out of engagement with the cooperating clutch member 388, so that no power can be transmitted from the engine to the hori-

zontal shaft 390 which controls the raising of the auger. The clutch 364 (Fig. 15) which controls the rotation of the auger is also normally in disengaged position. This clutch is operated by a spindle clutch lever 530 attached to a shaft 532 mounted in bearings 534 attached to the channel irons 290 of the tower subframe. This shaft has an arm 536 pivoted at 538 to a clutch operating link 540, whose other end is threaded into a crossmember 542.

A plurality of tension springs 544 connect this crossmember to the shaft 532 to hold the clutch 364 in either engaged or disengaged position. The crossmember 542 is pivotally connected at 546 to one end of a lever 548 pivoted on a fixed pin 550 and having fingers 552 engaging and shifting a clutch collar 554 carried by the hub of the movable clutch member 556. The normally disengaged position of this spindle controlling clutch 364 prevents the initial engagement of jaw clutch members 360 and 362 from producing rotation of the auger.

After the tower has been located in upright position and the jaw clutch members 360 and 362 engaged, the earth drill is moved forward or backward under its own power to bring the auger directly over the spot where the hole is to be drilled. It is essential that this tower be truly vertical if a hole is to be drilled and the mechanism heretofore described as being provided for the purpose of raising and lowering the front wheels of the vehicle performs an important function in this regard. After the spindle has been located directly over the spot where the hole is to be drilled, the pawl control lever 120 is moved to pawl releasing position and hand crank 110 is rotated to raise or lower the front end of the main vehicle frame to bring the tower and auger into a truly vertical position. Thereafter the pawl control lever 120 is moved to pawl engaging position.

After the frame of the earth drill has been properly leveled to bring the auger in vertical position, the left and right jack legs are individually adjusted as to length by rotating wing nuts 558 (Fig. 1) so that the feet 560 attached to the lower ends of these legs rest firmly upon the ground. The adjustment of these jack legs should not be changed after drilling has begun, as such a change in adjustment may result in damage to the auger and auger shaft or spindle.

In order to lower the auger to the ground, the power lift lever 424 is moved from its intermediate or spindle brake position to its rear or spindle free position. With the engine 170 operating, the gear shift lever 178 is pulled back into extreme rear or drilling position. Spindle clutch lever 530 is then shifted to its rear position to produce rotation of the auger. Hand feed knob 432 is pushed inward to engage slots 428 with pin 426 on the end of shaft 398. Handle 440 is then raised to the top of its swing and ratchet control lever 442 is pushed down to cause handle 440 to rotate knob 432 and rod 430 on its downward swing. The engine 170 is preferably throttled down to slow the rotation of the auger and this is accomplished by moving hand throttle 562 which is conveniently located at the rear of the main vehicle frame adjacent the controls for rotating and raising and lowering the auger. The handle 440 which forms the hand feed lever is lowered and the auger is gradually started into the earth.

After the auger has penetrated the earth to about six inches, the throttle lever 562 is moved

to speed up the rotation of the auger. Manual feeding of the auger by means of the hand feed lever 440 ordinarily must be continued until the loosened soil covers the auger to the top of the auger and thereafter the auger will ordinarily feed itself. As the auger descends, the tower crosshead and its associated rollers 334 travel downwardly along the tower side members 272 and 274 which insure a straight line motion of this crosshead and properly guide the upper end of the auger shaft. This shaft is guided by the bearing in the crosshead 332 and also by the sleeve 314, so that the auger descends in a straight line.

After the hole has been drilled to the desired depth, the spindle clutch lever 530 is moved to its forward position to discontinue rotation of the auger. Hand feed knob 432 is then pulled outwardly to disengage the notches 428 from the ends of pin 426 of shaft 398 and the power lift lever 424 is moved to its extreme forward position to engage the clutch members 388 and 392 and raise the auger from the hole it has just drilled. I preferably provide an automatic control for preventing this auger from being lifted beyond its normal upper limit. This control comprises an arm 564 (Figs. 15 and 19) and a split collar 566 which is clamped about the auger shaft and engages this arm when the auger reaches its upper limit of movement. The arm 564 is attached to one end of the shaft 422, carrying the power lift lever 424 and serves to move this shaft and lever to intermediate or brake position, thereby disengaging clutch members 388 and 392 of the power lift clutch.

An important feature of my controls lies in the provision of means for preventing simultaneous engagement of the manual feed for the auger and the power lift therefor. This safety feature comprises a plate 568 attached to the link 416 (Figs. 17 and 23) which controls the position of the spindle brake and power lift clutch. When the power lift clutch is engaged, this plate is interposed between the end of shaft 398 and the control knob shaft 430, as shown in Fig. 23, so that the manual feed can not be connected while the power lift clutch is engaged. If the manual feed is connected at the time an attempt is made to move power lift lever 424 to clutch engaging position, the plate 568 will contact hand feed shaft 430 and prevent movement of power lift lever 424 to clutch engaging position.

After the auger has been raised from the hole, it is usually desirable to engage the auger rotating clutch 364 and speed up the engine to throw any accumulated dirt off of the auger. As soon as this dirt has been discharged, it is common again to lower the auger into the hole. Ordinarily the auger drops by virtue of its own weight and the spindle brake 402 can be used to control the rate at which the auger drops to avoid a damaging impact when this auger reaches the bottom of the hole. The auger is then again lifted from the hole by power and the earth drill may then be moved to the next location where a hole is to be drilled.

In moving the earth drill short distances, it is usual to operate the earth drill under its own power and ordinarily it is not necessary to lower the tower. Where the movement is entirely in a forward direction, the jack legs 444 can usually be left down so that they simply drag over the ground as the vehicle moves forward. Where the earth drill must be moved a long distance, it is ordinarily preferable to lower the tower and

secure this tower in the horizontal position with the jack legs located as indicated in Fig. 3.

From the foregoing, it will be apparent that I have provided a new and highly efficient earth drill which may be easily operated with a minimum of manual effort and which includes safety features which protect the operator against injury and prevent accidental misuse of the mechanism. While I have illustrated and described only a single embodiment of my invention, it is to be understood that my invention is not limited to the particular details shown and described, but may assume numerous other forms and that my invention includes all modifications, variations and equivalents coming within the appended claims.

I claim:

1. An earth drill of the class described comprising a vehicle frame, a subframe pivotally mounted thereon, a motor carried by said vehicle frame, drilling means carried by said subframe, driving connections carried by said subframe, a clutch for connecting said driving means with said motor, means for clamping said subframe in operative position, a lever for operating said clutch, a second lever for operating said clamping means, mutually engageable parts movable with said levers respectively, the part which moves with the clamp lever being positioned to block movement of the clutch lever into clutching position until the clamp lever is shifted to clamping position, and the part which moves with the clutch lever being positioned to block movement of the clamp lever to its release position until said clutch has been disengaged by movement of the clutch lever.

2. An earth drill of the class described, comprising a vehicle frame with front and rear wheels, drilling means mounted on said frame adjacent the rear wheels, a post carried by said front wheels, a sleeve slidably receiving said post, means rotatably supporting said sleeve on said frame, steering control means for rotating said sleeve, post, and wheels, means for raising and lowering said post relative to said sleeve including a crosshead attached to said post, chains connected to said crosshead, sprocket wheels carried by said frame and engaged by said chains, and a handle for rotating said sprocket wheels to raise and lower said crosshead relative to said frame, a pawl for locking said wheels in raised or lowered position, a lever for shifting said pawl, and a detent for holding said pawl in different positions.

3. An earth drill comprising, in combination, a vehicle including a frame with front wheels and rear supporting wheels, manually operable steering gear positively controlling said front wheels drilling mechanism including a tower, a spindle and an auger journaled in the tower, means pivotally connecting the tower to the vehicle frame adjacent the rear wheels and permitting said tower to be disposed in upright drilling position or swung into horizontal position over the frame for travel, a tongue extending rigidly from the front end of the frame and formed for attachment to a tractor, and means adjustably connecting the front wheels with said frame and adjustable to lift said wheels clear of the ground with the tractor supporting the front end of the frame by said tongue for towing the vehicle as a two-wheel trailer to transport the drilling mechanism.

4. In the combination defined in claim 3,

means for locking said front wheels at such lifted position and also in frame supporting position.

5. In an earth drill as defined in claim 3, said means connecting the front wheels with the vehicle frame including axle means for the wheels, a post extending upwardly from said axle means and an upright frame structure rigid with the vehicle frame providing guide means for vertical movement of the post relative to said frame structure, cradle means carried by said upright frame structure to receive the forwardly projecting end portion of the tower when it is swung down to horizontal position, and fastening means to secure the tower in said cradle.

6. In an earth drill as defined in claim 3, means for locking the tower in rigid relation to the vehicle frame in upright position, a single means for positively feeding said frame up or down relatively to said front wheels with said wheels engaging the ground for tilting the frame and tower bodily about the axis of the rear wheels, and means adjustable selectively to lock the front wheels against upward or downward movement relative to the frame at a plurality of positions in their range of adjustment.

7. An earth drill comprising, in combination, a vehicle including a frame with front wheels and rear wheels, drilling mechanism including a tower, a spindle and an auger journaled in the tower, means pivotally connecting the tower to the vehicle frame adjacent the rear wheels and permitting said tower to be disposed in upright drilling position or swung into horizontal position over the frame for travel, means adjustably connecting the front wheels with said frame including axle means, a post extending upwardly and rigidly from said axle means and an upright frame structure rigid with the vehicle frame providing guide means for vertical movement of the post relative to said frame structure, means for locking the tower in rigid relation to the vehicle frame in upright position, means for feeding the frame up or down relatively to said post with the front wheels engaging the ground to tilt the frame and tower bodily about the axis of the rear wheels, said post being swivelly carried in said upright frame structure for turning about its axis, power means on the vehicle frame engageable with the rear wheels for driving the vehicle, and steering gearing engaging said post and operable throughout the range of vertical adjustment of the front wheels relative to the frame for steering the vehicle when it is driven by said power means.

8. An earth drill comprising, in combination, a vehicle including a frame with front wheels and rear wheels, drilling mechanism including a tower, a spindle and an auger journaled in the tower, means pivotally connecting the tower to the vehicle frame at the rear end thereof permitting said tower to be disposed in upright drilling position or swung into horizontal position over the frame for travel, and a pair of vertically adjustable jack legs extending downwardly from the rear side of said tower to brace it when it is disposed in upright position, said legs being pivotally attached to the rear face of the tower for folding upwardly against it so as to lie substantially horizontally on said tower and within its length when it is swung down on its pivotal mounting to horizontal position for travel.

9. In an earth drill as defined in claim 8, said legs extending divergently toward the ground when folded down in bracing position, and the

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pivotal connections of said legs being inclined oppositely to each other and so that said legs extend convergently from their pivots when folded against the tower.

DWIGHT RICHARDS. 5

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