Nov. 12, 1946. H. S. BROWN 2,410,959

EARTH DRILL

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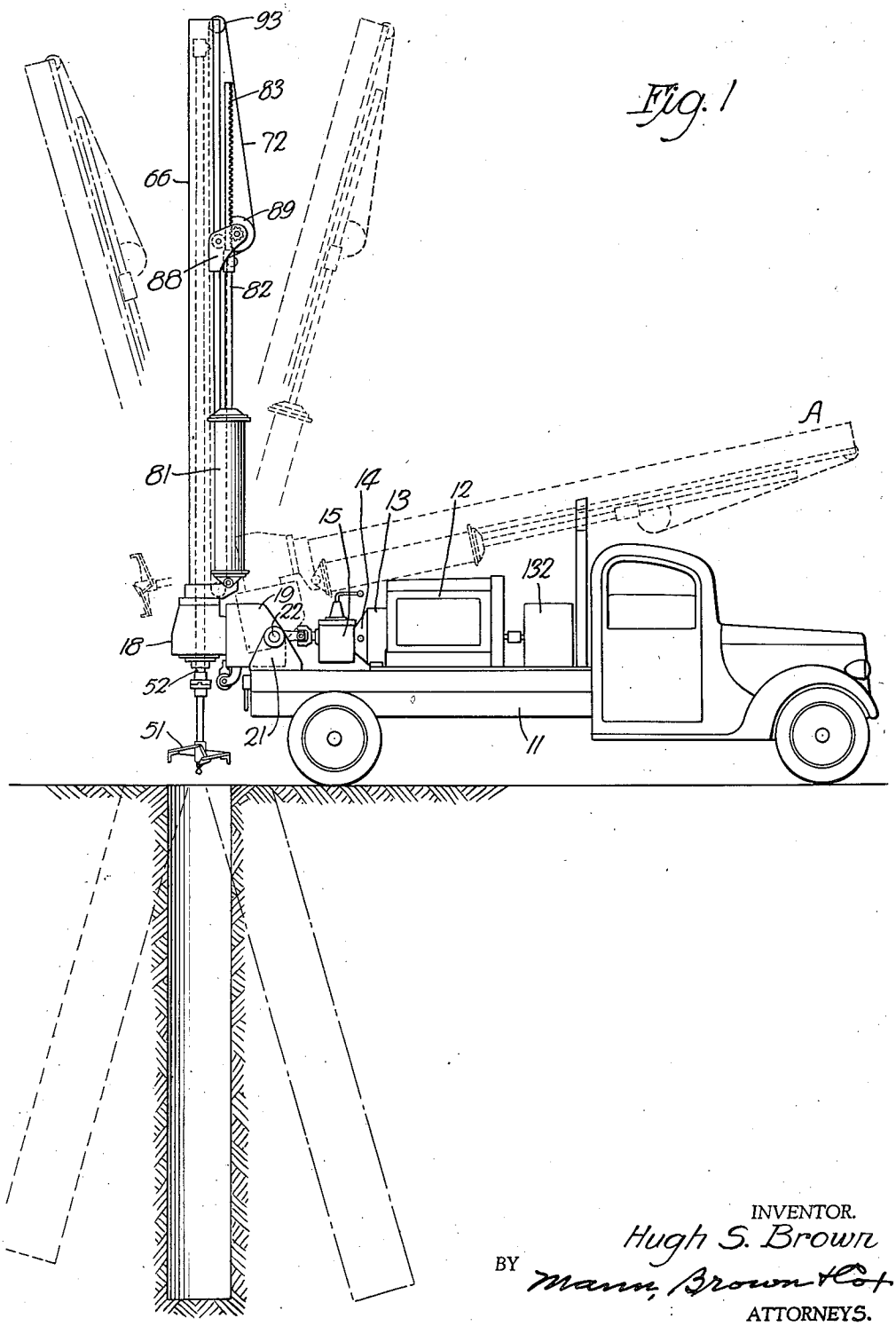


Fig. 1

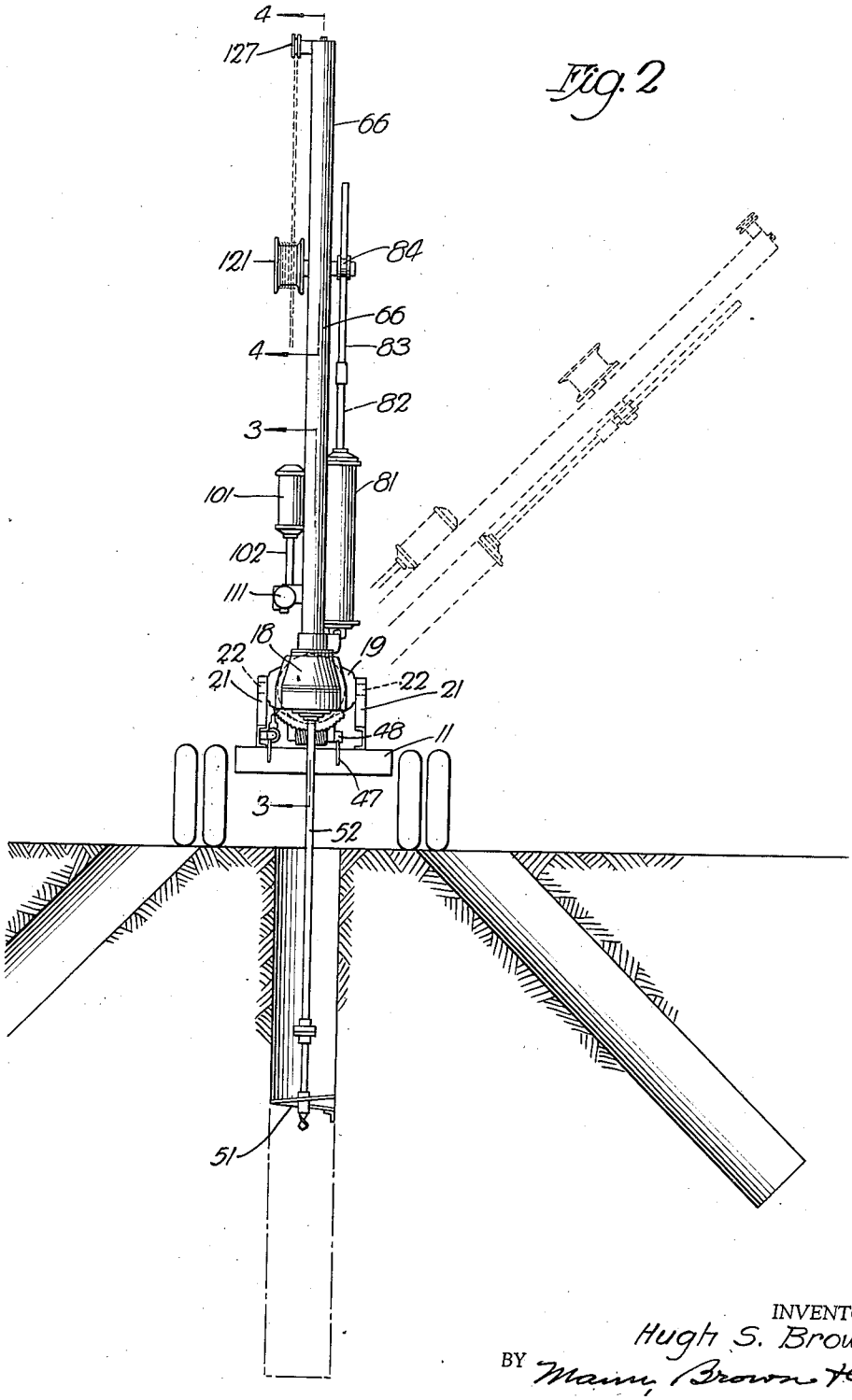
INVENTOR.
Hugh S. Brown
BY Mann, Brown & Cox
ATTORNEYS.

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Fig. 2



INVENTOR.
Hugh S. Brown
BY Mann, Brown & Co.
ATTORNEYS.

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Fig. 3

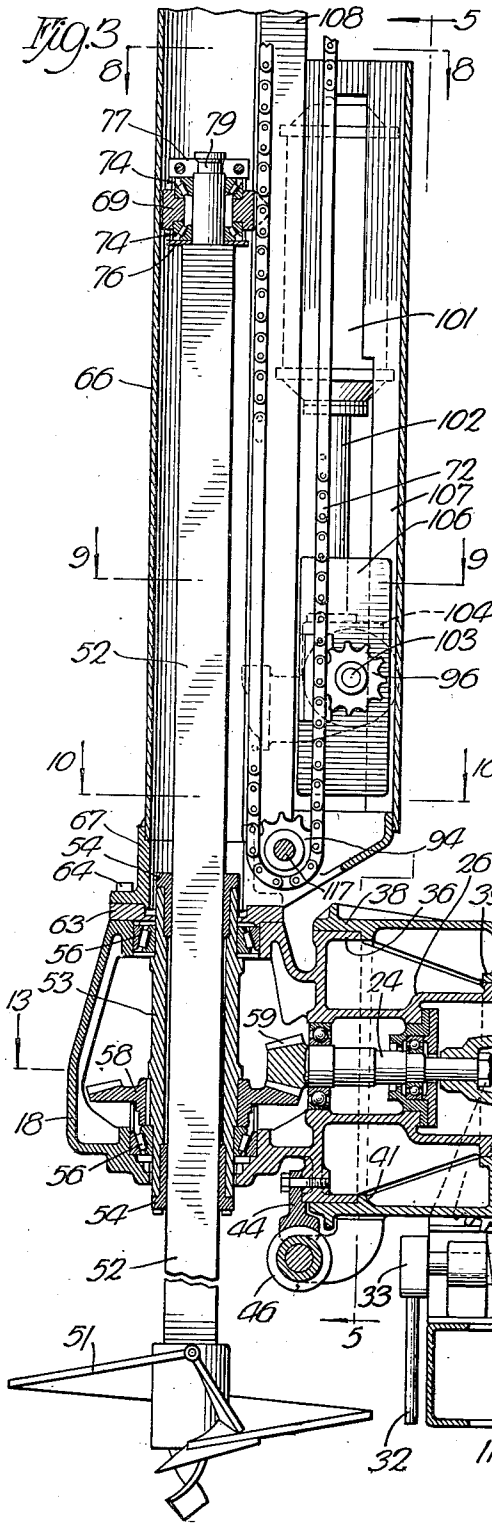
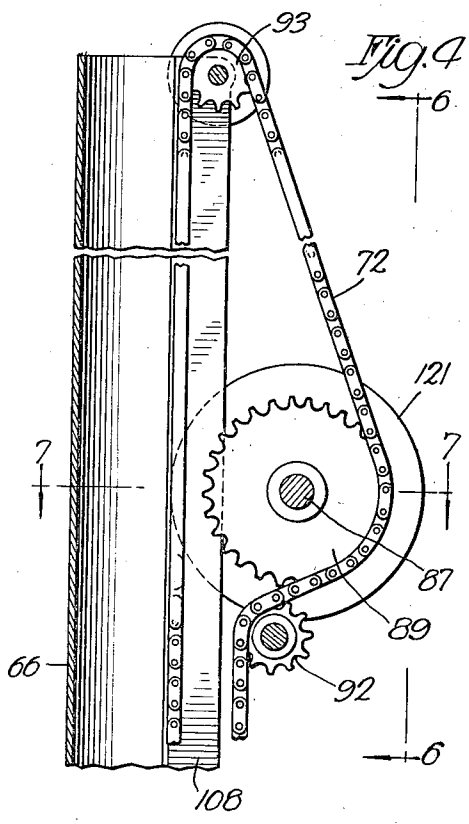
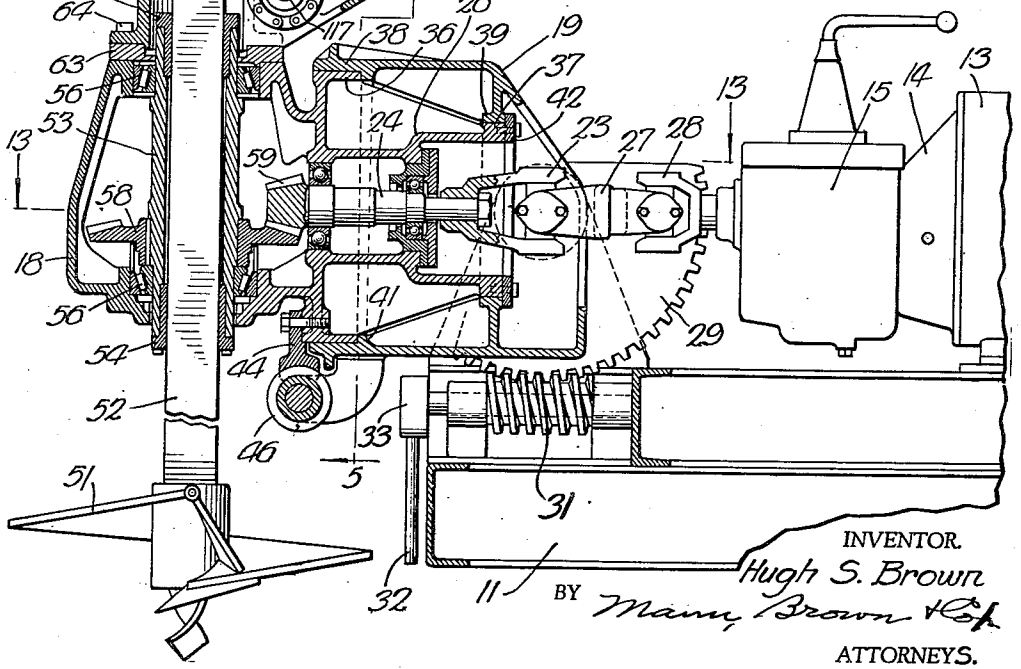


Fig. 4





INVENTOR.
Hugh S. Brown
BY Mann, Brown & Co.
ATTORNEYS.

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Fig. 5

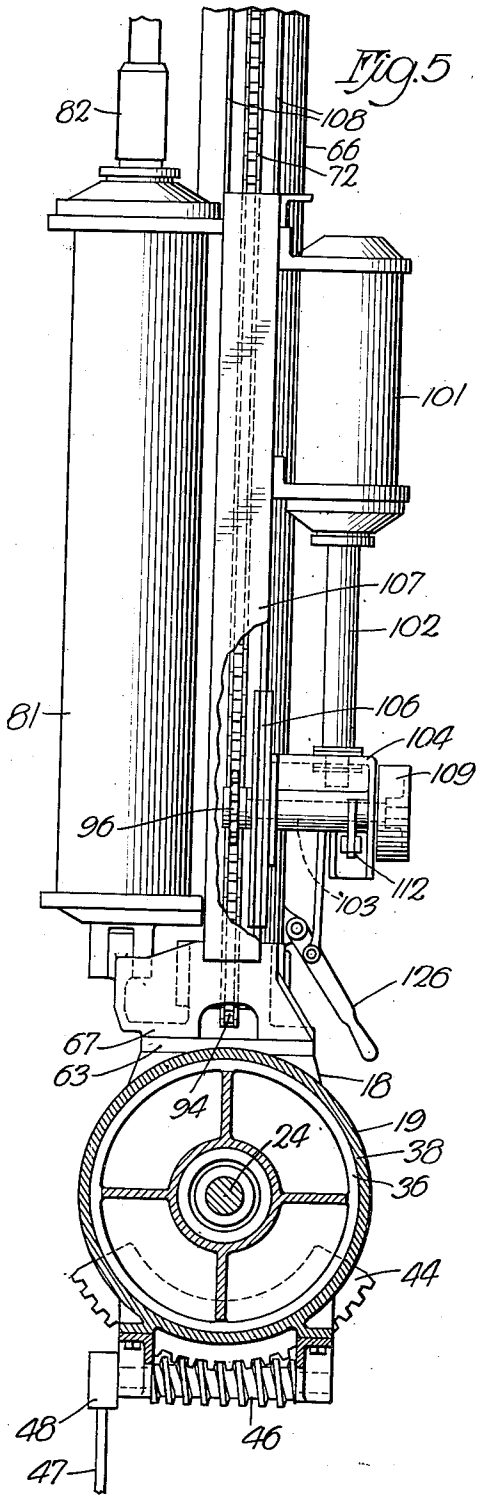
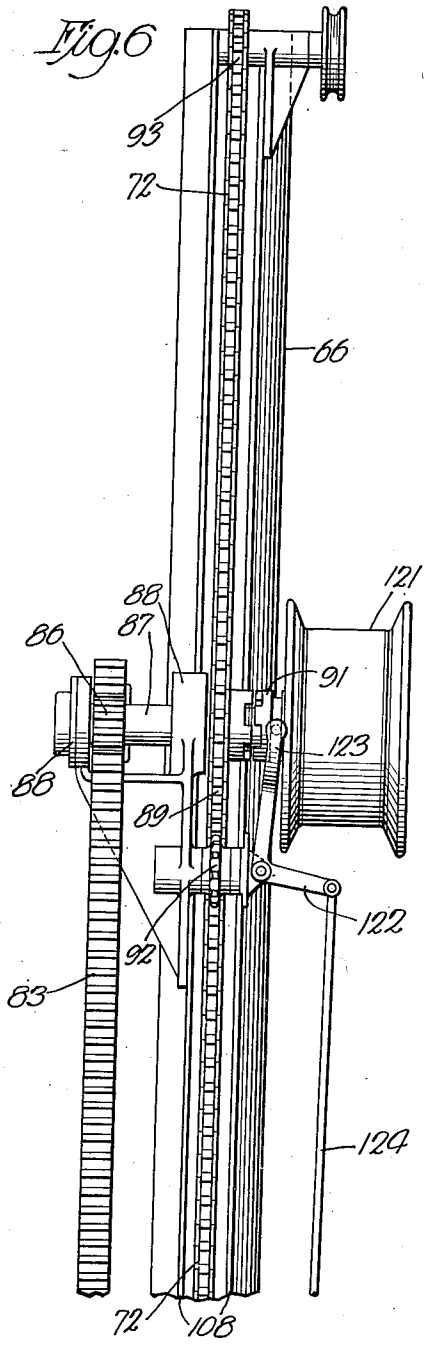


Fig. 6



INVENTOR.
Hugh S. Brown
BY Mann, Brown & Co
ATTORNEYS.

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Fig. 8

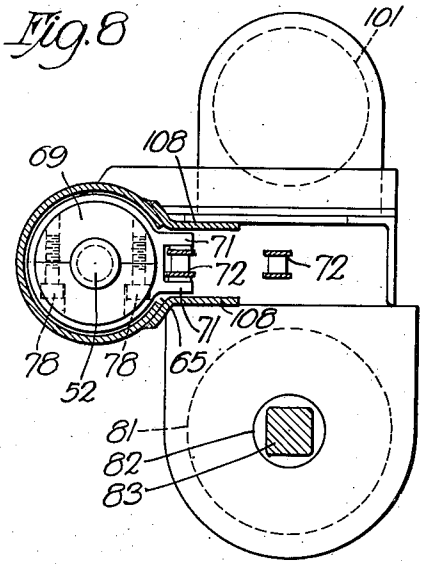


Fig. 7

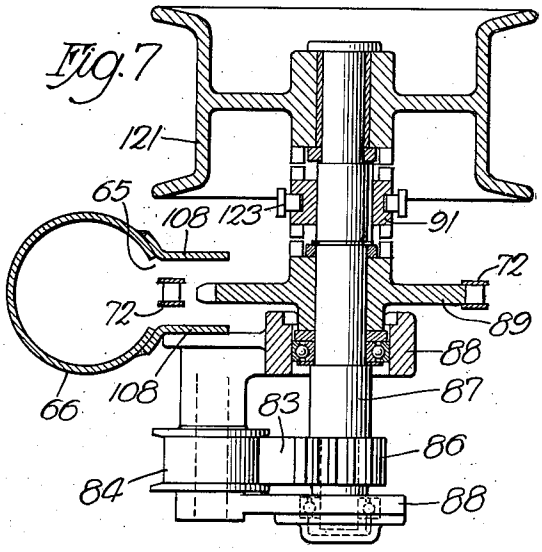


Fig. 9

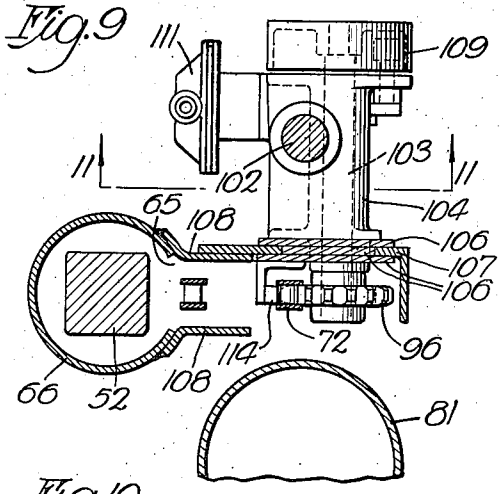


Fig. 10

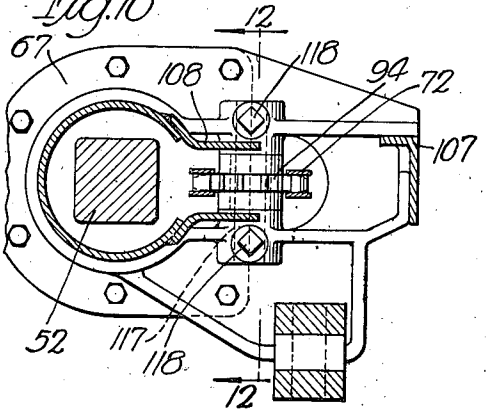


Fig. 11

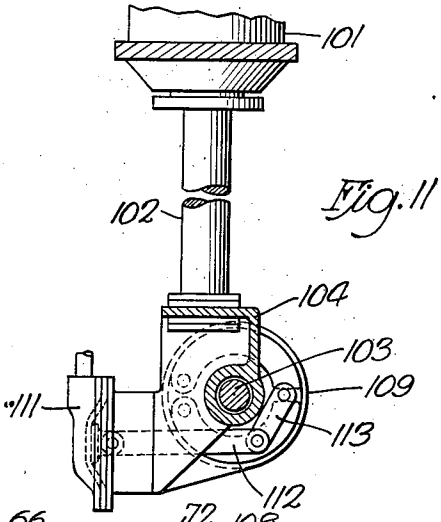
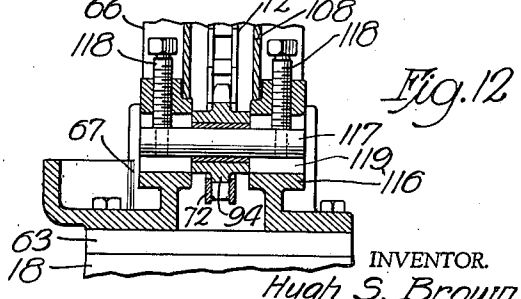


Fig. 12



INVENTOR.
Hugh S. Brown
BY Mann, Brown & Cof
ATTORNEYS.

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Fig. 13

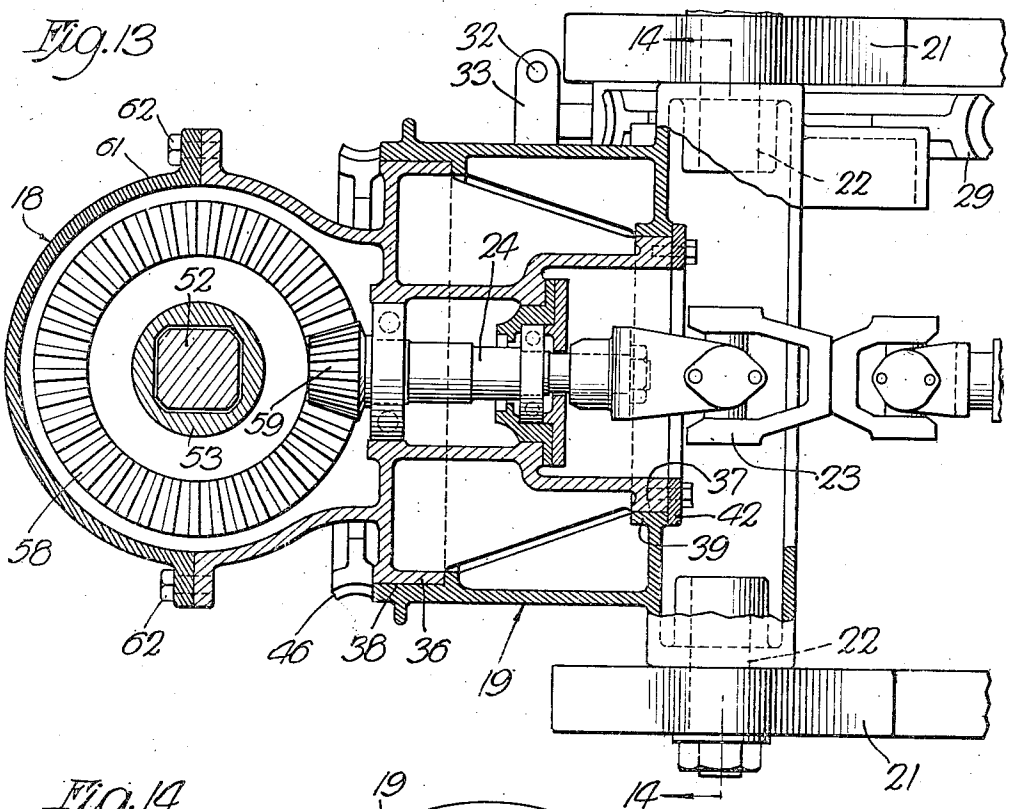
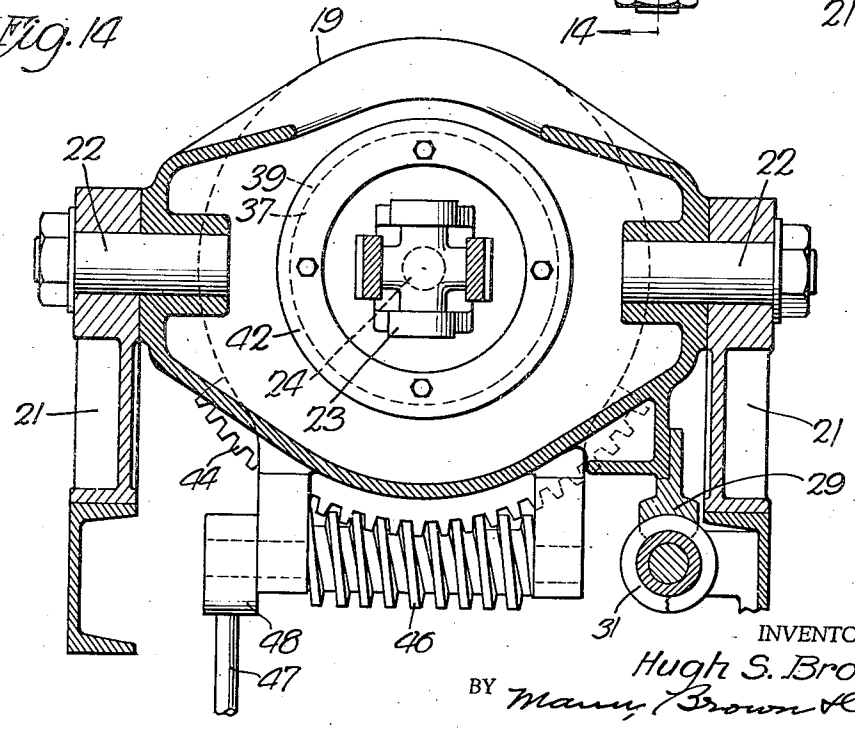


Fig. 14



INVENTOR.
Hugh S. Brown
BY Manny, Brown & Cof
ATTORNEYS.

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Fig. 15

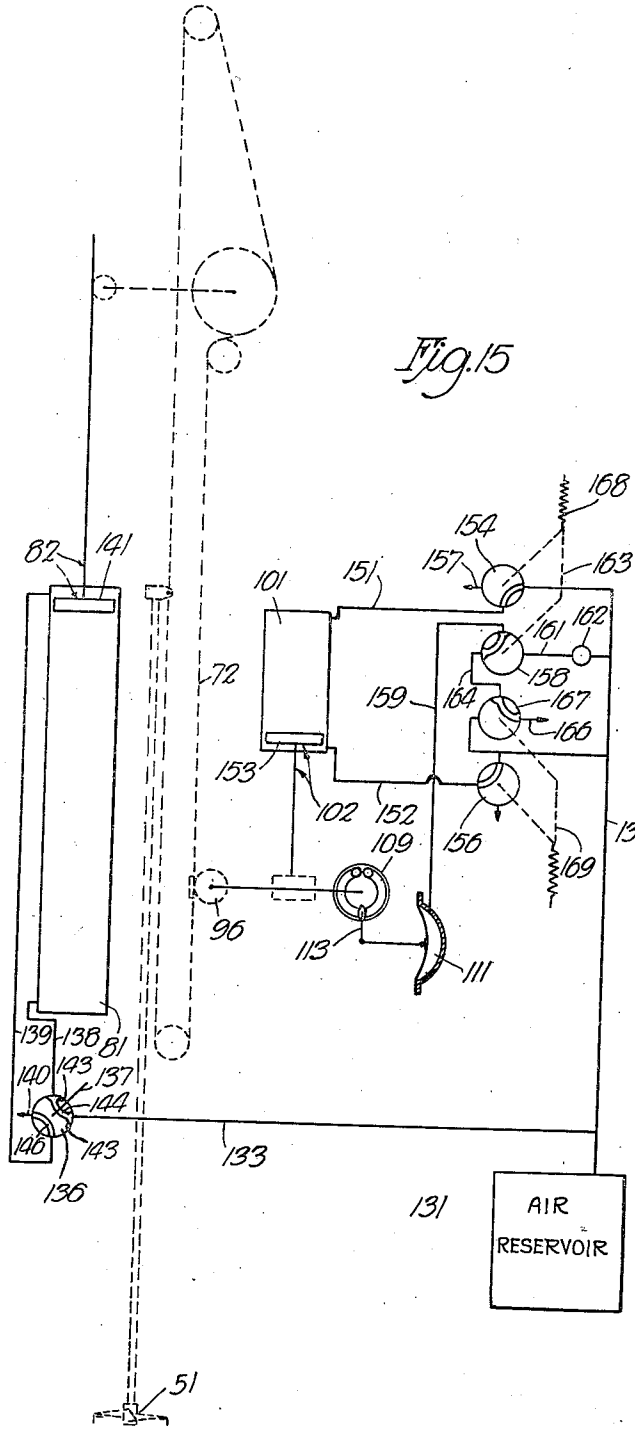
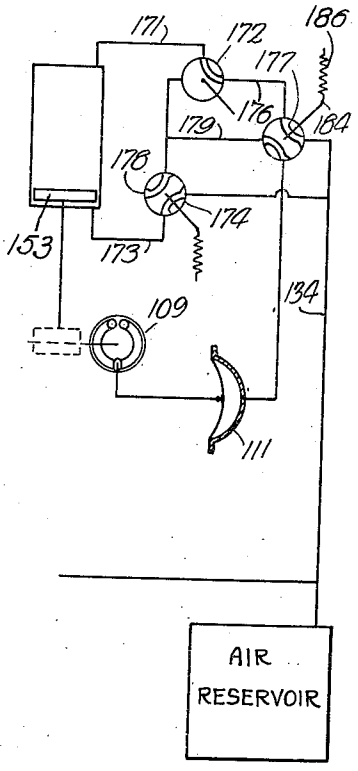


Fig. 16



INVENTOR.
Hugh S. Brown
BY Mann, Brown & Cox
ATTORNEYS.

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2,410,959

UNITED STATES PATENT OFFICE

2,410,959

EARTH DRILL

Hugh S. Brown, Wauwatosa, Wis.

Continuation of application Serial No. 410,623, September 12, 1941. This application December 13, 1943, Serial No. 514,080

10 Claims. (Cl. 255—22)

1

The present inventor has devoted a great deal of energy and thought to the improvement of earth drills. He has filed numerous applications, including Patent No. 2,255,241, relating to a construction permitting portability and permitting drilling at a 45° angle; and Patent No. 2,329,388, relating to an improved auger designed to have all the advantages of past augers while permitting reverse turning in the hole in case a single operation of the drill is continued until so much loosened dirt is above the drill that it cannot be pulled out.

The present invention, while utilizing some aspects of the previous inventions, provides still further improvements. The ability to drill at a 45° angle is retained, as is the ability to tilt the drill rig to a nearly horizontal position for portability. Considerably greater over-all speed, flexibility and ease of operation are provided by inclusion of a plurality of novel features. Pneumatic means is provided for raising the auger from the hole with the loosened dirt thereon. The same pneumatic cylinder may, if desired, be used for lifting a pole to be dropped into the hole. Additional pneumatic means operating with more force and at slower speed may be used when required for driving the auger down during drilling, or for boosting the auger upwardly if the normal high-speed raising means does not have adequate force. The pneumatic feed unit is so arranged that, although it is normally inoperative, it may be brought into operative relationship simply by manual movement of the control valve and without any slamming together of parts which would be destructive to the life of the equipment.

The housing and rigging is considerably simplified, the upper end of the spindle being guided by a simple slotted tube, the drill casing pivoting about a horizontal axis which is also the axis of the drive shaft, and the entire casing pivoting about a perpendicular horizontal axis which is also the axis of the universal joint in the drive shaft, which permits driving the drill in spite of angular movement of the housing.

Additional advantages and objects of the present invention will be apparent from the following description and from the drawings, in which:

Fig. 1 is a side elevation of the apparatus of this invention mounted on a truck;

Fig. 2 is an end view as seen from the left in Fig. 1;

Fig. 3 is a fragmentary vertical, sectional view, taken approximately on the line 3—3 of Fig. 2;

Fig. 4 is a fragmentary vertical, sectional view of the structure seen in Fig. 2, taken approximately on the line 4—4 thereof;

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Fig. 5 is a fragmentary sectional view taken approximately on the line 5—5 of Fig. 3;

Fig. 6 is a fragmentary view corresponding to Fig. 5, but taken on the line 6—6 of Fig. 4;

Fig. 7 is a horizontal sectional view taken approximately on the line 7—7 of Fig. 4;

Figs. 8, 9 and 10 are corresponding views taken approximately on the line 8—8, 9—9 and 10—10 of Fig. 3;

Fig. 11 is a fragmentary sectional view taken approximately on the line 11—11 of Fig. 9;

Fig. 12 is a fragmentary sectional view taken approximately on the line 12—12 of Fig. 10;

Fig. 13 is a fragmentary sectional view taken approximately on the line 13—13 of Fig. 3;

Fig. 14 is a fragmentary sectional view taken approximately on the line 14—14 of Fig. 13;

Fig. 15 is a diagrammatic representation of the pneumatic hoisting and feeding system; and

Fig. 16 is a diagrammatic representation of a modified form of feed control.

Although the invention has been shown in detail in accordance with R. S. 4888, it will be understood that additional forms of the invention, and additional ways of using some aspects of the invention, will be discovered by those skilled in the art, and the claims are to be interpreted as broadly as permitted by the prior art.

Since one of the important features of the invention is ready portability, it is fitting that the entire apparatus be carried by a truck 11, as illustrated in Fig. 1. Of course, means can be provided for utilizing the truck motor as a source of power, but it has been found more satisfactory to use a separate motor 12. According to the present invention the motor 12 is preferably connected to the drilling apparatus through a fluid drive unit 13, a manually controlled friction clutch unit 14, and a transmission 15 which need merely be slidable between the forward and reverse drives. The provision of the fluid drive unit 13 is considered an important feature of the invention, since it, together with the fluid feed and hoisting features of the invention, make the apparatus almost fool-proof. It is impossible to stall or overload the motor 12 by improper manipulation of the drill unit controls.

Mounting of the drill head

The drill head 18 is mounted for pivoting about a horizontal axis in an intermediate housing 19, which in turn is mounted on pedestals 21 for pivoting about a horizontal axis at right angles to the first axis. The pivoting of the drill head 18 about the first-named axis permits drilling at the diverse angles shown in Fig. 2, a sweep of at least 90° being preferred. The pivoting of the housing 19 about the second-named axis permits drilling at least through a range of 30°, as illus-

trated in Fig. 1, and furthermore permits folding the entire drill rig to the nearly horizontal position shown in dotted lines at A in Fig. 1 for transporting the drill unit from one location to another.

The casing 19 may be suspended from the pedestals 21 by means of stub shafts 22, which may be secured to either the casing 19 or the pedestal 21, and journaled in the other. The pivotal axis of the stub shafts 22 preferably coincides with the pivotal axis of the universal joint 23, the position of which is determined by shaft 24 carried by extension 26 of the drill head 18. By having the pivotal axis of the shaft 22, which is also the pivotal axis of the housing 19, coincide with the pivotal axis of the universal joints 23, there will be substantially no change in the position of the drive shaft 27 as the housing 19 pivots. With this arrangement it is possible to pivot the drill rig to its collapsed position, indicated at A in Fig. 1, without uncoupling the universal joint 23, or any part of the driving mechanism.

The drive shaft 27 is preferably of the conventional telescoping type, and is preferably provided with a second telescoping unit 28 merely for the purpose of avoiding any trouble with original misalinement of parts or from slight discrepancies between the positions of the axis of shafts 22 and the position of the axis of the universal joints 23. A worm gear segment 29 is rigidly secured to housing 19, and is driven by a worm 31 mounted on the truck frame, which in turn is driven by a manual lever 32 which preferably operates through a ratchet 33. Counterbalancing means may be provided for the drill rig, if necessary, but the structure herein contemplated is believed to be light enough so that for ordinary heights counterweighting will not be necessary.

Spaced bearings

It will be observed from Fig. 3 that the drill head 18 projects from the housing 19, and that the entire weight of the drill rig exerts a torque about any fulcrum point for the drill head within the housing 19. According to the present invention this torque is rendered harmless by providing substantially spaced bearings 36 and 37 of external cylindrical contour on the drill head extension 26, and corresponding bearings 38 and 39 of internal cylindrical contour on the housing 19, disposed to smoothly engage the bearings 36 and 38. The bearing 37 is smaller in diameter than the bearing 36, and therefore may easily be telescoped into the housing 19 until the bearing 36 seats against the bearing flange 41. The drill head extension 26 is then held in this position by a retaining ring 42, which may be secured to the extension 26 by bolts and which has a bearing engagement with the end of bearing 39.

It will be observed that the weight of the drill rig is borne entirely by the substantial cylindrical bearings 36 and 38, and the reaction is borne entirely by the cylindrical bearings 37 and 39, which are also fairly substantial although not as large in areas as the bearings 36 and 38. The bearings are spaced apart far enough longitudinally of the shaft 24 so that the torque of the drill rig about the bearings 36 and 38 may be taken up entirely by the bearings 37 and 39 without having to rely on any end bearings. This assures smooth action of the drill head 18 in the housing 19. The drill head 18 is actuated about its pivotal axis by a worm segment 44, which is rigidly secured to the drill head 18 or its extension 26, and is in turn actuated by a worm 46 which is operated by a handle 47, Fig. 2, preferably acting through a ratchet mechanism 48.

Spindle drive

The drilling auger 51 is carried by a square spindle 52, which is vertically slidable in sleeve 53. The sleeve 53 may be a square sleeve closely fitting the spindle 52, or it may more desirably be slightly oversize with respect to the spindle 52 and provided with replaceable bushings 54 which snugly fit the spindle 52. Dirt and sand getting on the spindle 52 cause a great deal of wear, and it is highly desirable to be able to replace the bushings 54 readily. It will be observed from Fig. 3 that they are both removable without dismantling of the drill head 18. They are preferably made of bronze. For ease of operation of the spindle and for reducing wear on the spindle, they may be secured in place by bolts screwing into the sleeve 53. The use of the bronze bushing permits forming the sleeve 53 from steel by casting. Of course, the sleeve can be square, or it can be cylindrical, relying on the securing bolts for the bushings 54 to make the bushings fast to the sleeve for transmitting the driving force to the spindle.

The sleeve 53 is preferably mounted in the head 18 by means of roller bearing units 56. These units may be of conventional form and should, of course, provide for end thrust as well as rotation.

The sleeve 53 has connected thereto a bevel gear 58 which meshes with a bevel pinion 59 fast on shaft 24. The spindle 52 is thus driven by the motor 12 through hydraulic drive unit 13, friction clutch unit 14, transmission 15, drive shaft 27 with its universal joint, drive shaft 24, pinion 59, gear 58, sleeve 53, and bushings 54.

The assembly of spindle 52, bushings 54, sleeve 53, gear 58, and bearings 56 may be easily inserted in the drill head 18 either by removing the end shell 61 of the drill head, which may be removed by removing bolts 62, Fig. 13, or by lowering the assembly into the drill head, the assembly being then held in place therein by retaining plate 63 and bolt 64, seen in Fig. 3.

Spindle guide

With a long drill spindle 52 it is important to guide the upper end of the shaft so that as the spindle rotates the free end will not gyrate. This is particularly important for drilling at an inclination as illustrated in Fig. 2, where the weight of the long spindle would cause high initial flexing. According to the present invention this guiding of the upper end of the spindle is accomplished by an extremely simple, inexpensive and light weight structure, namely, a slotted tube. This slotted tube may be welded to a slotted collar 67, which in turn is secured to the drill head 18 by the bolts 64. The slot 65 in the tube 66 is best seen in any of Figs. 8 to 10 in connection with special reference to yoke 69. The yoke 69 is provided for raising and lowering the spindle 52, and is therefore provided with ears 71 extending through the slot 65 for engagement with a chain 72, to which it is secured by one of the elongated pins serving to connect two links of the chain, slightly longer than the other such pins. The ears 71 must extend through the slots 65 as the spindle is raised and lowered, and hence the slot 65 must be at least as long as the stroke of the spindle. The yoke 69 is preferably positioned longitudinally of the spindle 52 by means of roller bearing units 74, seen best in Fig. 3.

In assembly, the one-piece yoke 69, together with the bearing unit 74 and a thrust plate 76, if desired, may be telescoped over the upper reduced end of the spindle 52 and secured in place by a split retaining plate 77, the two halves of which may be secured together by bolts 78. The split retaining plate 77 is clamped by the bolt 78 in an annular groove 79, preferably beveled on the top side to force the plate against the bottom. It is thus seen that the spindle rotates freely, and with a minimum of friction within the yoke 69, even though considerable upward or downward force is applied to the yoke for raising or lowering the spindle 52 and auger 51.

Raising mechanism

The auger and spindle will drop into the partially dug hole by gravity, and in soft soil may feed themselves by gravity even during the drilling operation. It is necessary, however, to provide power mechanism for raising the spindle, the auger, and the dirt which has been dug and has passed through the auger and rests on the top thereof. An ideal source of power for this operation is a pneumatic cylinder. This permits great ease of control, involves no clutches to wear out, and makes possible a very smooth operation, even at fairly high speeds. However, since the drill of this invention might be designed to drill holes of, say, 30 feet depth, a pneumatic cylinder 30 feet long for raising the spindle the 30 feet necessary to lift the auger from the bottom of the hole would be undesirable. According to the present invention a simple arrangement is provided whereby the cylinder can be only a fraction of the length of the lift required.

In the illustrated form, the hoisting cylinder 81 is carried rigidly by the slotted tube 66 and base casting 67, and is provided with a piston 82 (the number being applied to the piston rod when the piston is concealed), having about one-third the spindle stroke for which the apparatus is designed. Carried by the piston rod 82, and actuated thereby in opposite directions, is a rack bar 83, which, as seen best in Fig. 7, runs between an idler guide pulley 84 and a pinion 86 which meshes with the teeth of the rack. The pinion 86 is fast on shaft 87, which is journaled, preferably by ball bearings, in brackets 88 rigidly secured to an intermediate portion of the slotted tube 66 or flange 108 thereon. The outer portion of the bracket 88 may be secured to the inner portion, with a connecting part between the two portions comprising a shaft for the pulley 84. Suitable retaining or end thrust means should be provided for the shaft 87, although there will not ordinarily be any severe end thrust applied to the shaft.

Sprocket 89 is carried by the shaft 87 and runs freely thereon except when locked thereto by a sliding clutch 91, which will normally be left in engagement at all times. As seen best in Fig. 4, the chain 72 extends partially around sprocket 89, being guided therearound by an idler sprocket 92 and extending from sprocket 89 over and around top idler sprocket 93. From the top sprocket 93 the chain 72 extends alongside of the slot 65 in tube 66 to and around bottom idler sprocket 94, being secured to the yoke 69 between the top and bottom sprockets in the manner previously described. From the sprocket 94 the chain extends in contact with a feed sprocket 96, which is normally free to rotate, and

back to the point of the chain first described at sprocket 92, thus forming an endless chain.

From the foregoing it is seen that as the piston 82 and rack bar 83 are raised, they rotate the pinion 86 and sprocket 89, which in turn drives the chain 72 so as to raise the yoke 69 and with it the spindle and auger. It will be observed from Fig. 7 that the pitch radius of pinion 86 is only about a third of that of sprocket 89, and hence the chain 72 will be driven about three times the length of movement of the rack bar 83 and three times the stroke of the piston 82 and cylinder 81. The exact dimensions of the parts will, of course, be such that the spindle can be raised from its lowermost position to its uppermost position with the length of stroke of piston 82 that is available.

Not only does this arrangement permit the use of a cylinder 81, which is only one-third the length of the spindle stroke, but it also produces a faster movement of the spindle, the spindle being raised at approximately three times the speed of the piston 82.

Power feed

The force of gravity is not always enough to feed the auger with sufficient force to cause it to bite into the earth as rapidly as desirable. When additional feeding force is necessary it is possible to apply some feeding force with two-direction cylinder 81. In digging into harder shale, however, this still is not enough. Furthermore, the controls could be such that cylinder 81 would exert no feeding force, the feeding ordinarily depending entirely upon gravity, thus saving compressed air.

According to the present invention a feed cylinder is provided which is also rigidly mounted on slotted tubes 66, as seen best in Fig. 5. The digging portion of the downward stroke of the spindle is quite short, since it is desirable to raise the dirt after a few inches have been dug. Accordingly, the feed cylinder 101 may also be short, and it may nevertheless be connected to the chain to drive the chain in direct drive or in 1 to 1 ratio. Of course, the piston 102, or the piston rod to which the number is also applied, of the cylinder 101 could be provided with some sort of ratchetting dog engaging the chain. It is preferred, however, that the means engaging the chain be kept constantly in engagement therewith so as to avoid the wear from pounding parts together. In the illustrated form of invention this is accomplished by the use of sprocket 96, which is constantly in mesh with chain 72. The sprocket 96 is fast on a shaft 103, which is journaled in the feed head. The feed head 104 is raised and lowered by piston 102, and is guided by plates 106 which coact with a guideway formed in flanged bracket 107 secured to slotted tubes 66, or more accurately, to flange 108 welded thereto and to base casting 67.

Shaft 103 carries fast on its ends remote from the sprocket 96 a brake drum 109. This brake drum is normally free to rotate, and hence the sprocket 96 is normally free to rotate, and the actuation of the chain 72, by hoisting cylinder 81 or by gravity acting on the spindle 62, is unaffected by the sprocket 96. However, when it is desired to apply an extra feeding force to the chain, air is supplied to a diaphragm type of actuator 111 which actuates a rod 112, seen best in Fig. 11, to operate brake cam lever 113 and apply the brake to drum 109. The brake may be any conventional expansion type of brake, and,

of course, an external brake could be used. This prevents further rotation of shaft 103 with the result that as feed head 104 is raised by piston 102 the now rigid sprocket 96 holds the chain rigidly connected to the feed head 104, so that as the feed head moves the chain is driven. To prevent the chain from possibly slipping off the sprocket a slide block 114 is positioned near the far side of the chain, being carried by a bracket from the nearby rigid structure. Air can be admitted to the actuator 111 simultaneously with or slightly before its admission to the intermediate cylinder 101.

At the end of the feeding stroke air is released from the actuator 111, with the result that the brake is released by any suitable spring, not shown, and the sprocket 96 is free to rotate. This permits immediate raising of the auger and spindle by operation of hoisting cylinder 81. At the same time the feed cylinder 101 may be operated through its return stroke so as to return the feed head to its starting position.

Chain tightener

It is, of course, desirable that there be substantially no slack in the chain 72, since it is sometimes actuated in one direction and sometimes in the other. A very simple but satisfactory chain tightening arrangement is shown in Figs. 10 and 12. The bottom sprocket 94 slides between slotted plates 116, fitting smoothly therewith at all points so as to be free to rotate. The plates 116 may be secured to the flanges 108 on tube 66, or may comprise a part of casting 67 to which the tube 66 is secured. The vertical position of sprocket 94 is determined by shaft 117, which in turn may be urged downwardly by screws 118 until the proper tension is applied to the chain 72. It is only necessary that the slot 119 in which shaft 117 operates be long enough to provide a stroke for the shaft 117, slightly longer than half the length of a link in chain 72, since any greater variations may be accommodated by the removal of a link. The shaft 117 may be restrained against endwise movement by reduced extension of the screws 118 extending into corresponding apertures in the shaft 117.

Winch

One of the most common reasons for drilling a hole is the ground is to place a pole therein. For this purpose it is convenient to have some means for raising the pole and lowering it into the hole. According to the present invention this means is furnished at negligible additional expense by providing a winch drum on shaft 87 carried by the bracket 88. The winch drum is normally free to rotate on shaft 87 but is locked with respect to said shaft, when desired, by manual operation of the clutch 91. Any suitable means may be provided for operating the clutch 91 from the ground, such as the bell crank lever 122, the upper end of which forms a forked yoke 123 engaging an annular groove in the clutch member 91, link 124 and Fig. 5 operating handle 126, which may be locked to hold the clutch in either engaged position or in neutral position. A cable will ordinarily be wound on drum 121 and hooked to a lower part of the equipment so as to be accessible. When it is desirable to raise a pole, the cable will be drawn out and fastened around the pole, after which the clutch 91 will be shifted to the winch-operating position. Thereafter air will be admitted to hoisting cylinder 81, which will raise rack bar 83, turn sprocket 86, shaft 87, and winch drum 121. Since the same operation of clutch 91, which engages the winch to the shaft, disengages the sprocket 89 from the shaft, the sprocket 89 will not be driven.

Any suitable means may be provided for holding sprocket 89 (or drum 121) stationary when clutch 91 is disengaged therefrom. After the pole has been raised the cylinder 81 may be controlled to lower the pole into the hole.

The cable preferably passes around a sheave 127 at the top of tube 66, so as to get the benefit of the maximum height available.

The means for holding the sprocket 89 stationary may comprise a dog carried by the rigid structure and engageable with chain 72 at any convenient point.

Although the shaft 87 has been illustrated as supported by two spaced parts of bracket 88, but projecting therefrom, this should be recognized as somewhat diagrammatic. In any event a bracket could be secured to the tube 66 or flange 108 for supporting the shaft 87 at the end thereof opposite the end on which pinion 86 is mounted.

Control of drill

The rotational driving of the spindle can ordinarily be controlled entirely by the throttle. When desired, however, as if necessary to shift gears, the friction clutch 14 may be disengaged. Of course, it will not ordinarily be necessary to shift gears. The chief occasion for reversing the rotation of the auger is in the event that the auger is drilled too deeply into the ground on one bite, so that the loose dirt above the auger jams and prevents hoisting the auger. In this connection it may be noted that the auger is preferably that shown in my United States Patent No. 2,329,388, issued September 14, 1943.

One form of control over the various cylinders is illustrated in Fig. 15. The air reservoir, indicated diagrammatically at 131, may be supplied with compressed air by compressor 132, indicated diagrammatically in Fig. 1, and preferably driven by motor 12. From the air reservoir 131 supply conduit 133 and 134 carry compressed air to the two separate cylinder systems.

Control of primary cylinder

The primary or hoisting cylinder 81 is controlled by a two-positioned four-way valve 136, operated by handle 137. Normally this valve is in the position shown, and air is fed to the cylinder 81 near its bottom by conduit 138.

The valve 136 also connects conduit 139 leading from near the top of the cylinder to a vent 140. In this manner the piston 141 is held at the top of the cylinder. For lowering the piston the handle 137 is pulled down about 90°. The first effect of this is to feed compressed air from the conduit 133 to conduit 139 and the upper end of cylinder 81. This effect is obtained before other effects by the positioning of the relative positions of the fixed ports of valve 136 and the passages in its control member. Diagrammatically this is illustrated by enlargements 143 at the ends of the passage 144. It will be noted that the slot 146 does not have such enlargements. Supplying air to the conduit 139 will not ordinarily have any effect, because the differential sizes of the upper and lower faces of the piston head 141 will result in a force sufficient to hold the piston up.

As the handle 137 is turned slightly further, however, the passage 146 will begin to connect

the conduit 138 with the vent 140, thus releasing air from the cylinder 81 below the piston head 141. Speed of lowering the piston head 141 will be determined by the exact positioning of valve 137 and the consequent speed of release of air from below the piston. It may be limited by pipe size or a separate adjustable valve to a predetermined maximum speed. The lowering of the piston in this manner will cause a lowering of the auger 51 into the hole, and, if desired, will apply a feeding force to the auger as the motor is speeded up to turn the auger for drilling. The feeding force may be increased by drawing more air from below piston head 141, as by an injector.

To raise the auger 51 it is, of course, necessary to raise the piston head 141. This is accomplished by shifting handle 137 to the position shown in Fig. 15, or approximately to this position. The first effect is to connect conduit 133 with conduit 138 for supplying air below the piston head 141. When there is no load on the drill this may be enough to raise the drill, but ordinarily there will be no such movement until the valve 136 is turned far enough to connect conduit 139 with vent 140. Again, the movement of the piston head 141 will be controlled by the rate of escape of air from the space above the piston head 141, this in turn being controllable by the exact manipulation of the handle 137 or by a separate valve with a set adjustment.

It is desirable that both the cylinder 81 and the cylinder 101 be of the cushion type, the air conduits being arranged to open into the cylinder slightly spaced from the end thereof so as to be closed by the piston head, leaving cushioning pockets at the intermediate ends of the cylinders.

Auxiliary cylinder control

The piston 102 of the auxiliary cylinder 101 is normally in the position shown, air being supplied to both ends of the cylinder through the conduits 151 and 152. Both gravity and the fact that the upper face of the piston head 153 is larger than the lower face cooperate to keep the piston in this position. Air is supplied to conduit 151 through valve 154 connecting with conduit 134, and from the same conduit to conduit 152 by valve 156. In order to raise the piston 102 it is merely necessary to shift valve 154 about 90°, so that the conduit 151 is connected with vent 157 instead of with supply conduit 134. Of course, the resultant raising force applied to piston 102 can be controlled by the amount of air that is exhausted from above the piston by the valve 154.

As previously mentioned, the raising of the piston 102 will have no effect unless sprocket 96 is restrained from rotation by actuating brake cam lever 113. This is actuated by supplying the air to diaphragm type actuator 111. The air is supplied to this actuator by valve 158, which connects actuator conduit 159 with conduit 161, normally connected through open valve 162 with supply conduit 134. The valves 154 and 158 are preferably jointly operated, as indicated by the joint handle 163. The valve 158 may be arranged to connect actuator 111 with the supply slightly before conduit 151 is connected with vent 157, so that the brake drum 109 will be clamped by the brake therein before the piston 102 starts to move. Thus it is seen that lowering the handle 163 will first supply the air to actuator 111 and will then permit the air to be bled as gradually as may be desired from cylinder 101 above the

piston head 153 to feed the auger as it drills, or to boost the feeding force applied by cylinder 81. It is highly desirable to feed the auger 51 by venting air from one side of the piston while the other is under pressure, because this gives a smoother action and more delicate control than supplying air to one side while the other is left open to the atmosphere. It will be observed that cylinder 81 also is operated by a controlled venting except when it proves inadequate and control is passed over to cylinder 101.

Upon raising the handle 163 air will be exhausted from actuator 111 by connecting conduit 159 with conduit 164, which is normally connected with vent 166 by valve 167. Either simultaneously or thereafter air will be supplied by valve 154 from conduit 134 to conduit 151 to the space above the piston head 153, thus returning the piston to the position shown, the actuator 111 being collapsed so that the brake drum 109 is no longer held and the sprocket 96 may rotate freely as the piston 102 is dropped.

Although the cylinder 81 will be adequate for raising the auger under most circumstances, there will be some circumstances when it is loaded more heavily than usual, or when rocks or the like seem to wedge it in place so that the cylinder 81 is unable to move it. Under these circumstances it may be desirable to apply a boosting force with the cylinder 101. According to the present invention this can be accomplished.

In Fig. 15 the valve 162 is provided to enable the operator to raise the piston 153, while the sprocket 96 is still free to rotate. Thus, by closing valve 162 and shifting handle 163 to its lower position, air will be released from above piston head 153 without supplying air to actuator 111, this supply being shut off by valve 162. After the piston 102 has been raised, a handle 169 is raised, shifting valves 156 and 167. The valve 167 is preferably arranged to be effective, first, to connect conduit 164 to supply conduit 134, and at this same time handle 163 is released, thus supplying air to the actuator 113 to lock sprocket 96, and then supplying air above the piston head 153. Then the valve 156 becomes effective upon the further movement of handle 169 to release air from below piston head 153 so that the air above the piston head applies a boosting force to the chain 72 in a direction to aid in raising the auger 51. It will not ordinarily be necessary to boost the auger a second time, for once it is started the piston 81 will usually be sufficient. If a second boost is necessary, however, it is merely necessary to release handle 169 and pull handle 163 down again to start the process over. When no more boosting is necessary the valve 162 is opened and the parts are thus restored to the normal position so that pulling handle 163 down will again operate to supply feeding pressure to the auger.

Alternative booster control

Fig. 16 shows an alternative method of controlling auxiliary cylinder 101, it being understood that cylinder 81 is controlled in the same manner as in Fig. 15. According to the construction of Fig. 16, air is normally supplied to both the top and bottom of cylinder 101 by conduits 171 connected to valve 172, and conduit 173 connected to valve 174. Valve 172 is normally in the position shown in Fig. 16, and connects conduit 171 with conduit 176, which is connected through valve 177 with supply conduit 134. Valve 177 also normally connects actuator 111 to vent 178, the connection being through conduit 179 and

valve 177, conduit 181, to conduit 183 and through valve 174 to the vent.

With this construction the single valve 177 controls the operation of both actuator 111 and cylinder 101 by drawing the handle 184 downwardly. The first effect is to disconnect conduit 134 from conduit 176 and connect it to conduit 179 for supplying air to actuator 111. With a slight additional movement of handle 184 conduit 176 is connected to conduit 181 which is still connected to vent 173, so that air from above the piston head 153 is exhausted through the vent 178, allowing the air pressure below piston head 153 to raise the piston and apply a controlled feeding force to the auger, the sprocket 96 now being locked by the actuation of brake lever 113 through the diaphragm of actuator 111.

Releasing the handle 184 allows spring 186 to raise handle 184. This first connects actuator 111 with vent 178, and then connects the upper end of cylinder 101 with supply conduit 134, thus returning the parts to their normal position.

In order to convert the system for boosting cylinder 81 in raising the auger, it is merely necessary to shift handle 187 of valve 72 upwardly about 90°. This connects conduit 171 with conduit 183 which is connected through valve 174 with vent 178. The air above piston 153 thus being exhausted and conduit 173 still being connected with conduit 134, the piston 153 is raised. During this traverse of piston 153 sprocket 96 is free to rotate, since actuator 111 is still connected through the valve 184 and valve 174 with the vent 178. To apply the boosting force for raising the auger it is now merely necessary to raise handle 188 of valve 174. This will first connect supply conduit 134 with conduit 183, thus supplying air simultaneously to actuator 111 and the upper end of cylinder 101. Although there will be a differential pressure on piston 153, tending to move it downwardly at once, it probably will not have sufficient force to move the piston 153 materially before the actuator 111 operates to lock sprocket 96. As a matter of fact, the actuator 111 will probably operate before the full pressure is built up in cylinder 101 above the piston 153. If necessary to this end, the conduits to the actuator 111 may be designed to carry the air more quickly than the conduit to cylinder 101.

Upon slightly further upward movement of handle 188, conduit 173 will be connected to vent 178, thus exhausting air from below piston 153, which has previously been raised, as described. The speed at which the air is exhausted will determine the boosting force applied through piston head 153 through the locked sprocket 96, to the chain 72, to aid cylinder 81 in raising the auger. Upon release of handle 188 the valve 174 will first connect actuator 111 with the vent 178 to release the sproket 96, and also connect the upper end of cylinder 101 with the vent 178, so that there will be no air pressure on either side of piston 153. Almost immediately the valve 174, being drawn down by spring 189, will connect supply conduit 134 with the lower end of cylinder 101, thus raising the piston 153 so that by merely raising the handle 188 again the auger may be given another upward boost.

With this arrangement it is seen that normally all of the feeding operation of cylinder 101 is controlled by the single valve 174. When desired to boost the auger upwardly it is merely necessary, first, to shift the valve 172, which is in the nature of a selector valve, and thereafter the system is adapted for boosting as frequently as may be desired by merely operating the handle 188 upwardly for each boost until the auger has been fully raised so that no more boosting is necessary. The handle 187 may be shifted back to the position shown, whereupon air is supplied above the piston 153 and the differential of pressure on the two faces of the piston, plus gravity, will cause the piston to return to the position shown, sprocket 96 being free to turn by virtue of the fact that the actuator 111 is connected to the vent 178.

It will be understood that the cylinder 101 may also be used for boosting when the cylinder 81 proves inadequate for the operation of the winch. In this instance repeated boosting is quite likely to be desirable. Under some conditions, in fact, it is possible that use of the boosting cylinder 101 for feeding will rarely be necessary while its use for boosting in the opposite direction will be desired quite often. Under these conditions the handle 187 of the selector valve 172 may be left in the upper position so that the equipment will be all ready for a boosting in the lifting direction.

It should be observed that in the Fig. 16 structure, as in Fig. 15, the useful movements of the piston are always controlled by venting air. The smoothness of the resulting control results from the fact that any tendency of the piston to jump when the load is released is checked by the pressure of air which has not yet been released.

This application is a continuation of applicant's copending application, Serial No. 410,623, filed September 12, 1941, for which the present application may later be substituted.

I claim as my invention:

1. Earth drilling apparatus including a drill spindle, means for rotating the drill spindle, and means for moving the drill spindle longitudinally including a chain forming an endless loop, a sprocket rotatably mounted and driving the chain by its rotation, a pinion rigid with the sprocket and of smaller diameter, a rack driving the pinion and through it driving the spindle a distance greater than the movement of the rack, a fluid-operated expansion cylinder for moving the rack in a direction to raise the spindle, a second cylinder, and means for connecting the second cylinder to the chain to drive the spindle downwardly with a movement slower compared to cylinder movement than its upward movement.

2. Earth drilling apparatus including a drill spindle, means for rotating the drill spindle, and means for moving the drill spindle longitudinally including a chain forming an endless loop, a sprocket rotatably mounted and driving the chain by its rotation, a pinion rigid with the sprocket and of smaller diameter, a rack driving the pinion and through it driving the spindle a distance greater than the movement of the rack, a fluid-operated expansion cylinder for moving the rack in a direction to raise the spindle, a second cylinder, means for connecting the second cylinder to the chain to drive the spindle downwardly with a movement slower compared to cylinder movement than its upward movement, and means for controlling each cylinder by controllably venting air from one side of the piston therein while the other side is under pressure.

3. Earth drilling apparatus including a drill spindle, means for rotating the drill spindle, and means for moving the drill spindle longitudinally including a chain forming an endless loop, a sprocket rotatably mounted and driving the chain by its rotation, a pinion rigid with the sprocket

and of smaller diameter, a rack driving the pinion and through it driving the spindle a distance greater than the movement of the rack, a fluid-operated expansion cylinder for moving the rack in a direction to raise the spindle, a second cylinder, and means for connecting the second cylinder to the chain to drive the spindle downwardly with a movement slower compared to cylinder movement than its upward movement comprising a second sprocket constantly in mesh with the chain but normally rotatably idle, and means for locking the sprocket and shifting it by operation of the second cylinder.

4. Earth drilling apparatus including a drill spindle, means for rotating the drill spindle, and means for moving the drill spindle longitudinally including a chain forming an endless loop, a first expansion cylinder and means to raise the spindle thereby, a second cylinder, and means for connecting the second cylinder to the chain to drive the spindle downwardly with a movement slower compared to second cylinder movement than the speed of its upward movement compared to the movement of the first cylinder.

5. Earth drilling apparatus including a drill spindle, means for rotating the drill spindle, and means for moving the drill spindle longitudinally including a chain forming an endless loop, a first expansion cylinder and means to raise the spindle thereby, a second cylinder, and means for connecting the second cylinder to the chain to drive the spindle downwardly with a movement slower compared to second cylinder movement than the speed of its upward movement compared to the movement of the first cylinder comprising a sprocket constantly in mesh with the chain but normally rotatable idly, and means for locking the sprocket and shifting it by operation of the second cylinder.

6. Earth drilling apparatus including a drill member, a chain associated with the drill member for moving it, and means for driving the chain including a shiftable carriage, a sprocket engaging the chain rotatably carried by the carriage and at times free to rotate, means for locking the sprocket with respect to the carriage, fluid-controlled means for locking the sprocket, fluid-controlled means for moving the carriage, while the sprocket is locked against rotation, and valve means for controlling the fluid and operative upon a single stroke first to actuate the locking means and then to actuate the shifting means.

7. Earth drilling apparatus including a drill member, a chain associated with the drill member for moving it, and means for driving the chain including a shiftable carriage, a sprocket engaging the chain rotatably carried by the carriage and at times free to rotate, means for locking the sprocket with respect to the carriage, fluid-controlled means for locking the sprocket, fluid-controlled means for moving the carriage, while the sprocket is locked against rotation, said valve means operative upon a return stroke first to release the locking means and then to shift the carriage back, and additional valve means operative to produce locking of the sprocket for the return movement only of the carriage moving means.

8. Earth drilling apparatus including a frame, a drill member carried by the frame for axial movement with respect to the frame, a chain connected with the drill member for moving it, and means for driving the chain including a feed head translatable with respect to the frame, a sprocket engaging the chain rotatably carried by the feed head, means for selectively locking the sprocket and releasing it for rotation with respect to the feed head, and means for translating the feed head, while the sprocket is locked against rotation, to actuate the chain and the drill member, and additional means for moving the drill member while the sprocket is free to rotate.

9. An earth drill including a frame, a drill spindle carried by the frame for movement with respect to the frame longitudinally of the spindle, means for moving the spindle longitudinally through its full withdrawal stroke including a piston-type expansion motor having a shorter stroke, and means for multiplying the range of movement connecting the motor with the spindle to move it a full stroke with one stroke of the motor, and means for moving the spindle less than its full stroke comprising an auxiliary piston-type expansion motor and means for selectively connecting it to the spindle to apply substantially the full force of the auxiliary motor toward moving the spindle through a short stroke in the feeding direction.

10. An earth drill including a frame, a drill spindle carried by the frame for movement with respect to the frame longitudinally of the spindle, means for moving the spindle longitudinally through its full withdrawal stroke including a chain connected with the spindle, a piston-type expansion motor having a shorter stroke, and means for multiplying the range of movement connecting the motor with the spindle to move it a full stroke with one stroke of the motor, and means for moving the spindle less than its full stroke comprising an auxiliary piston-type expansion motor and means for selectively connecting it to the spindle to apply substantially the full force of the auxiliary motor toward moving the spindle through a short stroke in the feeding direction including a sprocket constantly in mesh with the chain but normally rotatable idly and means including the auxiliary motor for locking the sprocket and shifting it longitudinally of the spindle.

HUGH S. BROWN.