Sept. 9, 1941. H. S. BROWN 2,255,241

APPARATUS FOR INCLINED EARTH DRILLING

Filed Feb. 12, 1940 6 Sheets-Sheet 1

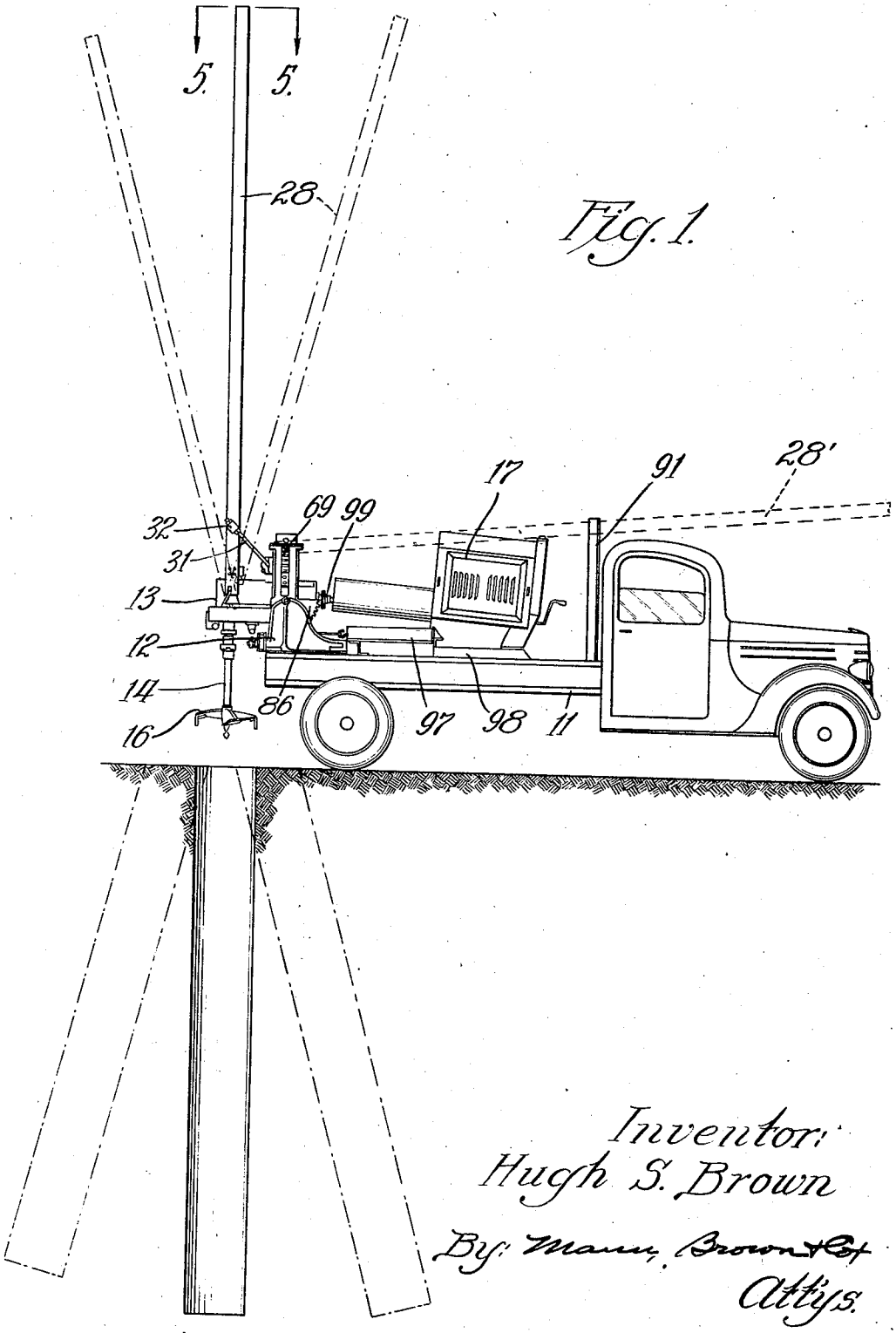

Fig. 1.

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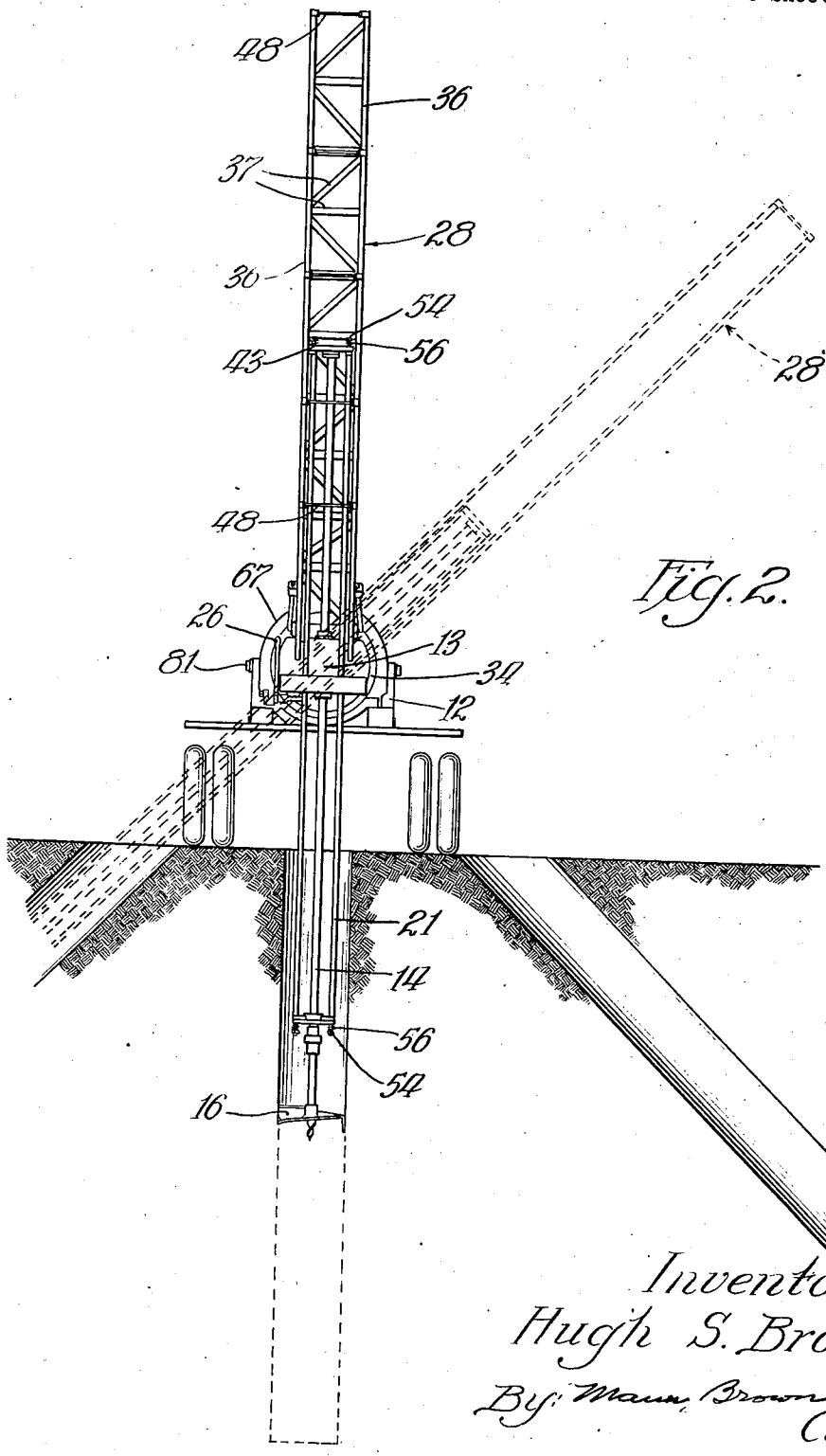

Fig. 2.

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APPARATUS FOR INCLINED EARTH DRILLING

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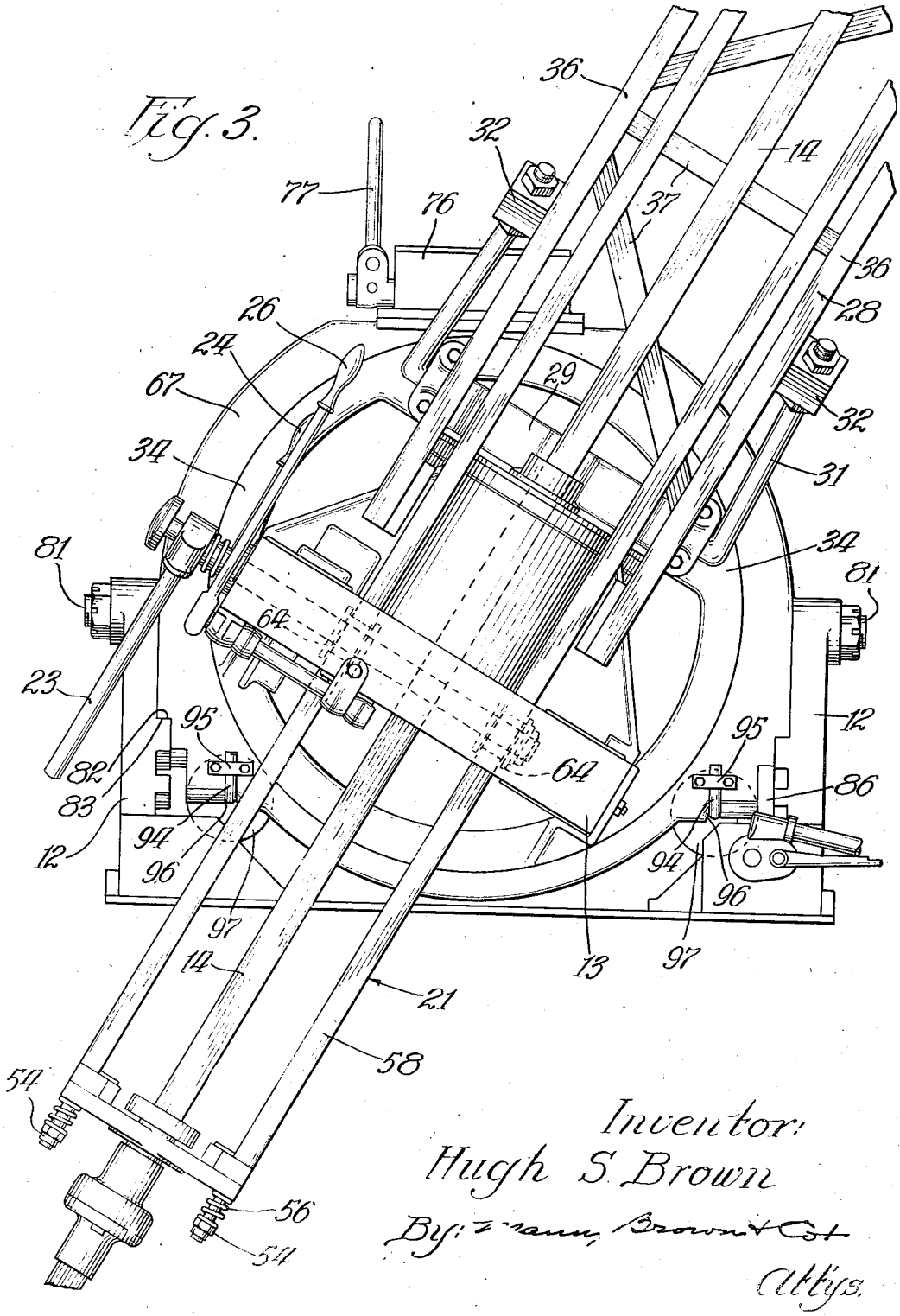
Fig. 3.



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APPARATUS FOR INCLINED EARTH DRILLING

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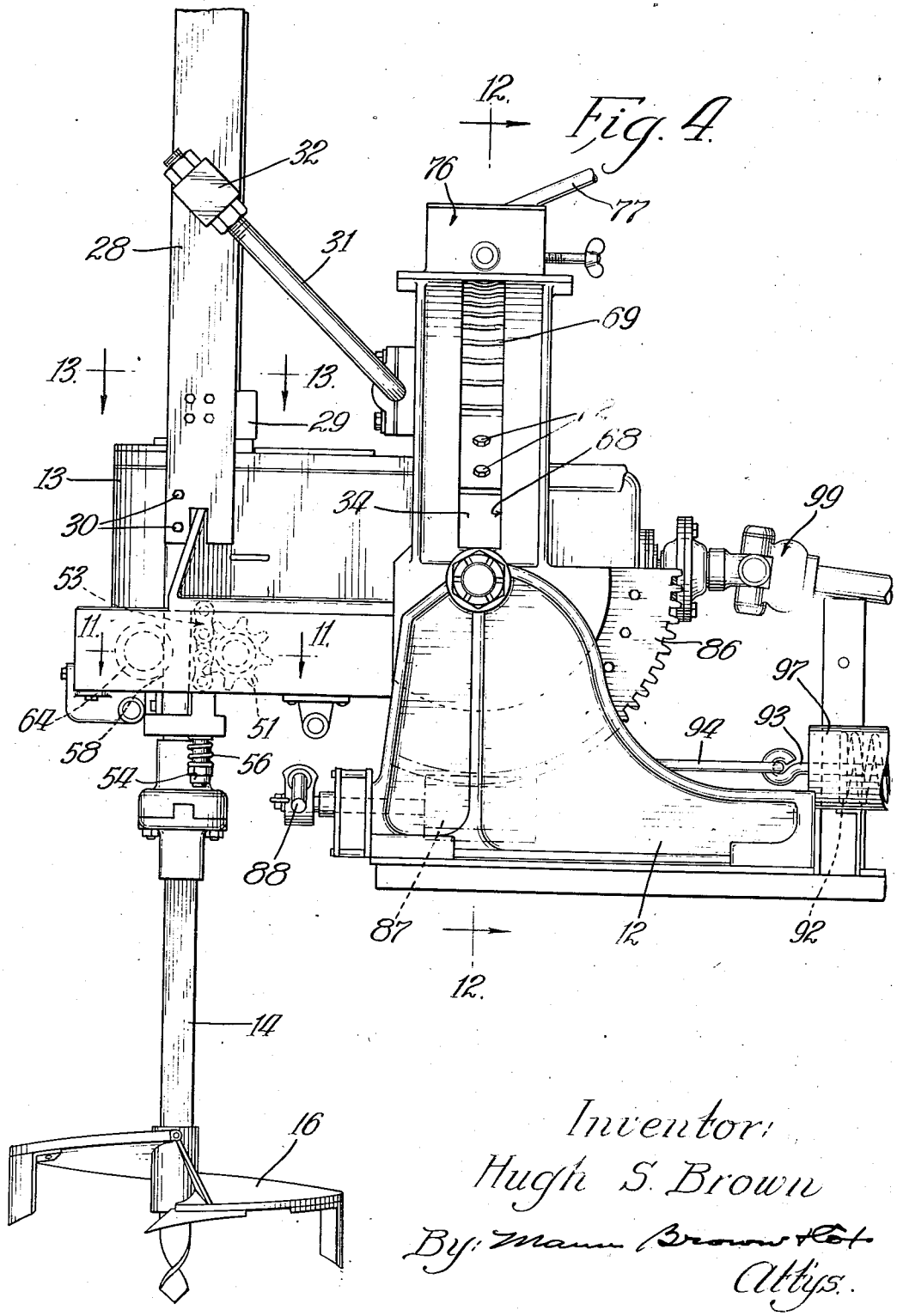
Fig. 4.



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APPARATUS FOR INCLINED EARTH DRILLING

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Fig. 6.

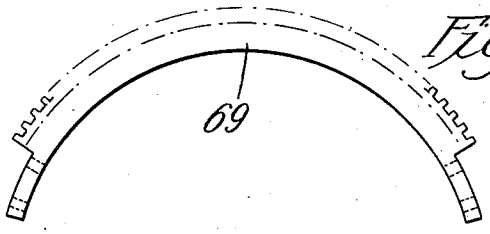


Fig. 7.

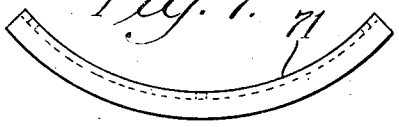


Fig. 8.

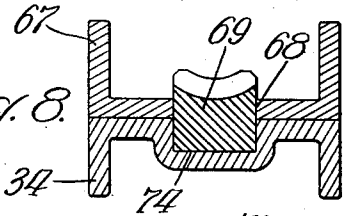


Fig. 9.

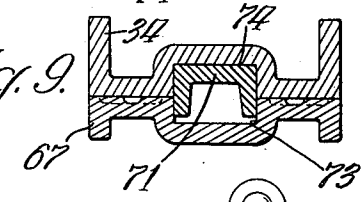


Fig. 10.

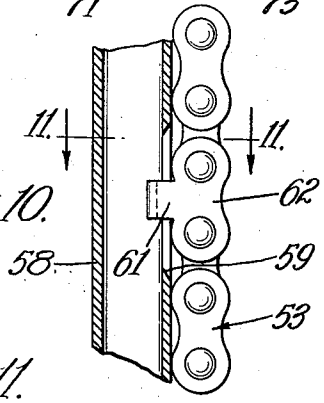


Fig. 11.

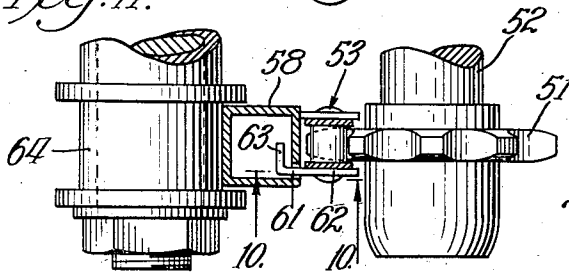
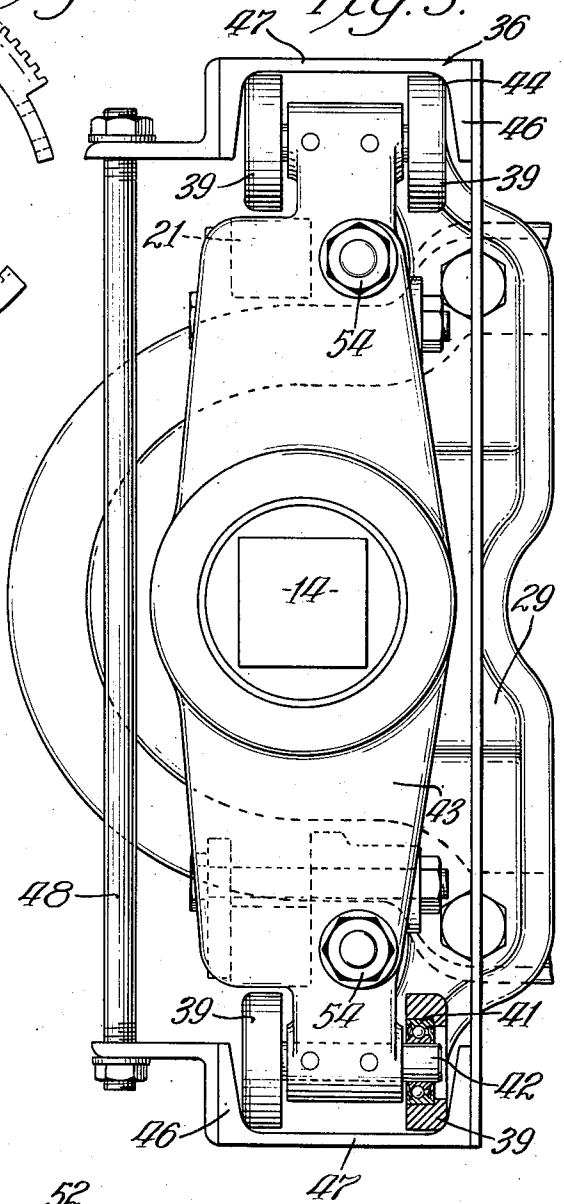


Fig. 5.



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APPARATUS FOR INCLINED EARTH DRILLING

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Fig. 12.

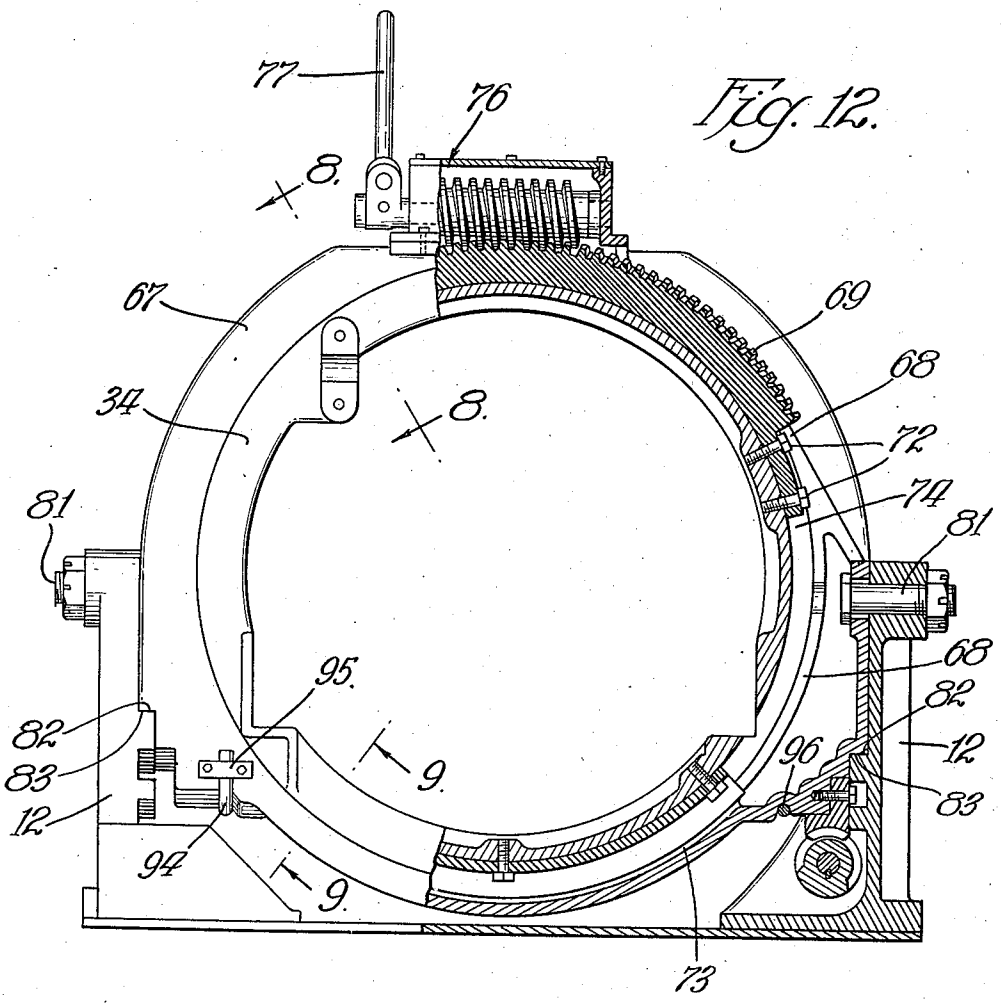
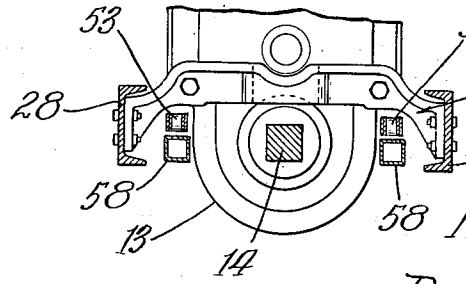


Fig. 13.



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Patented Sept. 9, 1941

2,255,241

UNITED STATES PATENT OFFICE

2,255,241

APPARATUS FOR INCLINED EARTH DRILLING

Hugh S. Brown, Harvey, Ill., assignor to The Hubron Company, Inc., Somerville, N. J., a corporation of New Jersey

Application February 12, 1940, Serial No. 318,538

19 Claims. (Cl. 255—31)

Earth drills made in accordance with my prior Patents Nos. 1,575,146, 1,674,189, 1,595,851, and 1,807,148 have proved very satisfactory and efficient for the purposes for which they were designed. Sometimes, however, it is desired to drill a hole at a rather steep angle. For example, in case of defense against aggression it is common practice to place mines under roads and bridges. According to the present invention the mines can be placed under the roads and bridges by drilling holes at an angle of say 45° and lowering the mines into the holes.

In providing equipment, and especially mobile equipment, for drilling deep holes at angles as wide as 45° from the vertical, various problems are introduced. For example, the spindle must be adequately braced so as to support the weight of the upwardly inclined portion thereof without undue flexing, the strain due to the weight of the remote end being very marked when the spindle is inclined at an angle of 45°. Furthermore, means must be provided to keep this weight from causing the tilting parts to bind, or even be torn loose from their mountings. Also, the chains used for raising and lowering the spindle have a decided tendency to sag, even though the spindle is braced. It is an object of the invention to overcome these difficulties.

In any earth drilling equipment, particularly that designed to be used in emergency for defense purposes, mobility is very important. According to the present invention the spindle can be tilted to nearly a horizontal angle so that it will lie along the top of the truck on which it is mounted, and furthermore it is counterbalanced so that it may be raised quite easily and rapidly by one man. The counterbalancing is particularly important in view of the weight involved in bracing the spindle.

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

Fig. 1 is a side elevation of the apparatus chosen for illustration of this invention, illustrating in dotted lines the 15° tilting forwardly and rearwardly and the collapsed position for transportation.

Fig. 2 is an end elevation illustrating in dotted lines a 45° position of drilling.

Fig. 3 is a fragmentary view corresponding to Fig. 2, showing the parts on a larger scale.

Fig. 4 is a fragmentary view corresponding to Fig. 1, showing the parts on a larger scale.

Fig. 5 is a fragmentary plan view looking down on the top of the carriage and frame and showing one roller in cross section.

Fig. 6 is a side view of a worm gear segment which is used for pivoting the drill assembly to the 45° position and also locks the two mounting rings or cradles in telescoped relation, the teeth of the segment being only diagrammatically shown.

Fig. 7 is a segment which assists the segment of Fig. 6 in its locking function.

Figs. 8 and 9 are fragmentary sectional views showing the manner in which the segments of Figs. 6 and 7 lock the cradles together, these figures being taken approximately on the lines 8—8 and 9—9 respectively of Fig. 12.

Fig. 10 is a fragmentary detail sectional view taken approximately on the line 10—10 of Fig. 11, showing the interlocking of the chain and the carriage.

Fig. 11 is a fragmentary horizontal sectional view taken approximately on the line 11—11 of Figs. 4 and 10.

Fig. 12 is a transverse vertical sectional view taken approximately on the line 12—12 of Fig. 4, showing particularly the cross section of the outer cradle, the conventional control head being removed therefrom for the sake of simplification.

Fig. 13 is a fragmentary sectional view taken approximately on the line 13—13 of Fig. 4, showing particularly a preferred shape for a bracket used for mounting the tower.

A preferred form of the invention has been chosen for illustration and description, in compliance with Section 4888 of the Revised Statutes, but persons skilled in the art will readily perceive other means for accomplishing the same results, and the claims are therefore to be construed as broadly as possible, consistent with the prior art.

The apparatus has been shown as mounted on a truck 11 and includes a pedestal 12, a control head 13, a spindle 14 carrying an earth bit 16 which is suitably driven by a motor 17. As seen in Figs. 2 and 3, the spindle 14 is rotatably journaled in a carriage 21. The carriage 21 and spindle 14 extend through the control head 13 and are longitudinally movable with respect thereto.

General operation of drill

In drilling a hole in the earth, the spindle 14 and the bit carried thereby are rotated by the motor 17, and the carriage 21 is released so that its weight will press the bit against and into the earth. In some conditions the weight of the carriage 21 will furnish a sufficient feeding force but, when desired, additional feeding force may

be applied manually through the handle 23. After the bit has dug a desired depth, say 8 to 18 inches, a clutch handle 24 is operated to stop the turning of spindle 14, and another clutch handle 26 is operated to cause the motor 17 to raise the carriage 21 with the spindle 14 and the earth bit. This draws up out of the hole the dirt which had been dug during the drilling movement. The handle 26 is operated to a declutching and braking position at which it holds the carriage 21 in its raised position. The handle 24 is now again operated to cause the motor to turn the spindle 14. The rotation of the spindle and the bit thereon causes the dirt above the bit to fly out in all directions by centrifugal force. The handle 26 is now operated to a third position which releases the brake so that the carriage 21 is released and a new drilling movement begins.

It is apparent from the foregoing description of the operation of the drill that the spindle 14 and its carriage 21 are raised and lowered for every few inches of depth to which the hole is dug. Furthermore, they must both be somewhat longer than the depth of the hole which is desired. Accordingly, with deep holes the spindle and carriage will extend a long distance above the head 13 when the spindle is raised above the ground and even during the first few feet of the drilling operation. This has not presented any difficulty in drilling operations in which the holes were nearly vertical because with the spindle 14 nearly upright there would not be sufficient flexing thereof to cause any trouble. However, with the drill now designed to drill a hole slanting as much as 45° from the vertical, various new problems are encountered, one of which is bracing the spindle 14 and carriage 21 so as to prevent flexing of the spindle 14 and tortion of the carriage 21, both of which would be very objectionable.

Carriage-guiding tower

One of the problems encountered in 45° drilling is solved by provision of the tower 28, the general nature of which is seen best in Fig. 2. This tower is secured at its lower end to the head 13 by being bolted to a bracket 29 which in turn is bolted to the head 13, as seen best in Fig. 13. Bolts 30 may further secure the tower 28 to the head or to a bracket thereon (not shown) extending out around the carriage 21. The tower is braced by a U-shaped brace 31 secured to lugs 32 on the tower 28 and to a remote portion of the control head 13 or, more accurately, to the inner cradle 34 by which the control head 13 is carried. The tower 28 includes longitudinal members 36 as well as suitable transverse bracing 37. As seen best in Fig. 5, the longitudinal members 36 are channel shaped with the channel sides facing inwardly. The term "channel shaped" is not intended to exclude I beams, although the latter are not necessary.

At the upper end of the carriage 21 four rollers 39 are rotatably carried—two on each side of the carriage 21. These rollers may be mounted in any suitable way but are preferably carried by conventional self-lubricating ball-bearing units 41 which in turn are mounted on shafts 42 carried by a yoke 43 of the carriage 21. The same top plate, it may be noted, journals the spindle 14 with a conventional ball-bearing mounting.

The rollers 39 preferably bear on the fillets 44 of the channel members 36, such fillets commonly being provided between the tapered flanges 46 and the base 47. By rolling on the mid portions of the fillets it is apparent that the rollers guide the carriage 21 for longitudinal movement while substantially preventing movement in any transverse direction.

For convenient assembly and disassembly of the parts the tower 28 may be braced on one side by removable bars 48. When these bars are removed and the rollers 39 run to a position beyond the end of the tower 28, the carriage 21 and tower 28 may be separated laterally.

Feed structure

The carriage 21 may be raised or lowered by means of a pair of sprockets 51, only one of which is shown, and which are mounted on a shaft 52. The shaft 52 may be driven in a raising direction by the motor 17 or in a feeding direction by hand or may be braked against movement or may be released from all control. The sprockets 51 each engage a chain 53 which extends the length of the carriage 21. Each chain is drawn tight by nuts 54 secured to draw bolts at opposite ends of the chain and bearing on springs 56 which provide a desired resiliency in the feeding and lifting of the carriage 21. Heretofore it has been sufficient to support such chains at their ends, but in drilling holes at a wide angle from the vertical these chains would tend to sag and cause considerable wear and other difficulty. According to the present invention they are floatingly anchored at frequent intervals. The floating anchors prevent sagging and at the same time permit the necessary slight longitudinal movement of the chain. This longitudinal movement is necessary in tightening the chain and in taking advantage of the resiliency provided by springs 56.

Heretofore the longitudinal members of carriages, such as the carriage 21, have been formed of T irons, but according to the present invention they are formed of square tubes 56, seen in cross section in Figs. 10 and 11. These tubes are provided with a series of slots 59 which may conveniently be cut therein by a rotating cutter of say 1¾ inches radius so as to provide slots of a minimum length of 1½ inches. Into each of these slots may extend a lug 61 formed as an extension of a side plate 62 of one of the chain links. The lug 61 has a locking flange 63 bent over on its end so that the lug cannot be withdrawn from the slot 59 while the side plate 62 is assembled on the chain. It thus follows that, no matter what the angle of inclination of the carriage 21, the chains 53 cannot sag materially away from the longitudinal tubular members 58. It has been found sufficient to provide the slots 59 and lugs 61 at intervals of 3' 5", though of course there may be wide variations from this distance.

The longitudinal tubular members 58 ride on rollers 64, shown in Fig. 11, for properly positioning the carriage 21 and for holding the chains 53 in proper engagement with sprockets 51.

Mounting of the control head

As seen in Fig. 3, the control head 13 is carried by an inner cradle or mounting ring 34 which is pivotally carried by an outer cradle or mounting ring 67, seen best in Fig. 12. The inner cradle 34 telescopes axially into the outer cradle 67 and is secured therein in the manner best explained with additional reference to Figs. 6 to 9. The outer cradle 67 has a slot 68 therein through which the key segments 69 and 71 of

Figs. 6 and 7 may be inserted and secured to the inner cradle 34 in any suitable manner, as by bolts 72. In assembly the inner cradle 34 will first be turned approximately upside down, at which time the key segment 71 will be inserted through slot 68 and bolted to cradle 34. The cradle will then be rotated back to its normal position, and key segment 69 will be inserted through slot 68 and bolted to cradle 34. It will be understood of course that although the slot 68 is only open along the angular distance required by movement of key segment 69, it is extended in the form of a groove 73 all around the cradle. The wall forming groove 73 joins the two parts of the cradle 67 into a rigid structure. It will also be observed from Figs. 8 and 9 that the key segments 69 and 71 fit into recess 74 in the inner cradle 34, so that independently of the bolts 72 the cradles are keyed against axial displacement.

The key segment 69 is a worm segment, the worm threads of which are exposed through the slot 68. A worm drive unit 76 is mounted on top of the cradle 67 with its worm gear (Fig. 12) engaging the worm segment 69. The worm drive unit 76 is provided with a handle 77 which is equipped with a reversible ratchet for rotating the worm in either direction, and thus drive the worm segment 69 and through it the inner cradle 34 and control head 13 and the drilling parts mounted thereon through an angle of 90°, namely 45° in either direction from the vertical. It is thus seen that one of the key segments serves also for a tilting worm.

In order to tilt the drilling unit in the opposite or forward and backward direction, the outer cradle 67 tilts about the longitudinal center of pins 81 which hold the cradle 67 in place on the pedestal 12. However, the pins 81 do not serve as bearings for the cradle 67, but to minimize wear the cradle 67 is provided with a bearing surface 82 of large diameter which bears on a complemental bearing portion 83 of pedestal 12, as seen best in Fig. 12.

Secured to the cradle 67 at one side thereof is a worm segment 86 which is engaged by a worm wheel 87. This worm wheel may be actuated in either direction by a handle 88 connected to the worm wheel 87 by a reversible latch. This worm gear drive may be used for tilting the drilling unit forwardly or backwardly for drilling with an angle of 15° in either direction, as seen in Fig. 1. It may also be used for tilting the drilling unit to substantially a horizontal position as seen at 28' in Fig. 1. In this position the tower 28 comes to rest on a stand 91.

Because of the height and weight of the tower 28 it has been found very desirable to counterbalance it as it approaches the horizontal position. Counterbalancing has been provided by a pair of springs 92—one on each side of the machine, each of which is compressed, as the tower 28 is lowered, by a piston 93 and flexible cable 94. The cables 94 are secured to the cradle 67 by clamps 95 and lie in guideways 96 in cradle 67. Although the full length of these guideways is not shown in the drawings, they extend through an arc approximately commensurate with the worm segment 86, seen in Fig. 4. Since the counterbalancing is not necessary when the tower is near the vertical position, the spring 92 and piston 93 may have a stroke too short for counterbalancing through the full movement and hence when the tower 28 is raised to say 30° from vertical the cables 94 may go slack. The springs 92 may desirably be housed in a casing 97 which may be anchored at its remote end to a base 98 for the motor 17.

The motor 17 is connected to the drilling unit through suitable universal joints 99, one of which is shown, and telescoping shaft therebetween.

Except as here described, the equipment may be substantially the same as that now well known in the industry, being on sale by the Buda Company of Chicago, Illinois. Because this apparatus, including particularly the control head 13 and its various controlling levers, is of standard production and is well known, it is not necessary to describe it in detail.

From the foregoing it is seen that an earth drill has been provided which is entirely practical and highly efficient for drilling deep holes at angles up to 45° from the vertical. The problems resulting from drilling at this angle have been adequately and economically solved. Furthermore, the equipment is highly mobile and it may be raised from its mobile position to its operative position by one man in a very short time.

I claim:

1. In an earth drill, a drilling spindle, a carriage rotatably mounting said spindle and mounted for longitudinal movement and at times disposed at a wide angle from the vertical, a flexible chain extending longitudinally along the carriage, a sprocket adapted to engage the chain to move the carriage longitudinally, and means for limiting the sagging of the chain comprising extensions carried by the chain and interlocking with the carriage.

2. An earth drill adapted to drill holes at a wide angle from the vertical, including a control head, a carriage movable longitudinally by the control head, a spindle extending through the control head and rotatably mounted on the carriage at widely spaced points on opposite sides of the control head, and a tower rigidly mounted on the control head and extending longitudinally of the carriage and upwardly from the control head and movably supporting the upper portion of the carriage therein.

3. An earth drill adapted to drill holes at a wide angle from the vertical, including a control head, a carriage movable longitudinally by the control head, a spindle extending through the control head and rotatably mounted on the carriage at widely spaced points on opposite sides of the control head, and a tower rigidly mounted on the control head and extending longitudinally of the carriage and upwardly from the control head and movably supporting the upper portion of the carriage therein, said control head being mounted on a mounting ring adjustably carried in a complemental annular carriage for tilting the drilling mechanism.

4. An earth drill adapted to drill holes at a wide angle from the vertical, including a control head, a carriage movable longitudinally by the control head, a spindle extending through the control head and rotatably mounted on the carriage at widely spaced points on opposite sides of the control head, and a tower rigidly mounted on the control head and extending longitudinally of the carriage and upwardly from the control head and movably supporting the upper portion of the carriage therein, said tower comprising inwardly facing channel members, the flanges of which form a guideway for the carriage.

5. An earth drill adapted to drill holes at a wide angle from the vertical, including a control

head, a carriage movable longitudinally by the control head, a spindle rotatably mounted on the carriage, and a tower rigidly mounted on the control head and extending longitudinally of the carriage and upwardly from the control head and movably supporting the upper portion of the carriage therein, said tower comprising inwardly facing channel members, the flanges of which form a guideway for the carriage, and the carriage having rollers thereon engaging said flanges.

6. An earth drill adapted to drill holes at a wide angle from the vertical, including a control head, a carriage movable longitudinally by the control head, a spindle rotatably mounted on the carriage, and a tower rigidly mounted on the control head and extending longitudinally of the carriage and upwardly from the control head and movably supporting the upper portion of the carriage therein, said tower comprising inwardly facing channel members having fillets connecting the flanges and the center web, and the carriage having on opposite sides thereof roller means positioned to roll on both fillets of one channel member whereby the roller means are guided against movement in all directions perpendicular to the longitudinal axis of the carriage.

7. In an earth drill, a drilling spindle, a carriage rotatably mounting said spindle, mounted for longitudinal movement and at times disposed at an angle from the vertical and including hollow longitudinal members, a flexible chain extending longitudinally along the carriage, a sprocket adapted to engage the chain to move the carriage longitudinally, and means for limiting the sagging of the chain comprising extensions carried by the chain and hooked in slots in the longitudinal members.

8. The combination of a chain and a chain holder having remote portions of the chain secured thereto and having an intermediate portion of the chain secured thereto by an extension carried by a link of the chain and hooked to the holder.

9. The combination of a chain and a chain holder having remote portions of the chain secured thereto and yieldably stretched thereon and having an intermediate portion of the chain secured thereto by an extension carried by a link of the chain and slidably hooked to the holder.

10. In an earth drill, a drilling spindle, a carriage rotatably mounting said spindle and mounted for longitudinal movement and at times disposed at a wide angle from the vertical, a flexible chain extending longitudinally along the carriage, a sprocket adapted to engage the chain to move the carriage longitudinally, and means for limiting the sagging of the chain comprising means interlocking the chain with the carriage.

11. In an earth drill, a control head, a drilling spindle passing therethrough, a carriage rotatably mounting said spindle and mounted for longitudinal movement with the spindle and at times disposed at a wide angle from the vertical, a flexible chain extending longitudinally along the carriage, a sprocket adapted to engage the chain to move the carriage longitudinally, means for limiting the sagging of the chain comprising extensions carried by the chain and interlocking with the carriage, and a tower rigidly secured to the control head and supporting the upwardly and outwardly projecting portion of the carriage.

12. An earth drill including a cradle adapted to tilt in a forward or rearward direction about an axis substantially therethrough, an inner mounting member through which the axis passes and which is carried by the cradle with pivotal movement about a second axis perpendicular to the first named axis, and a drilling unit carried by the inner mounting member and having a control head and a spindle carriage extending high above the control head; characterized by the provision of a tower extending longitudinally of the carriage above the control head and rigid therewith for movably bracing the carriage, and further characterized by having the inner mounting member with the drilling unit pivotable laterally through approximately 45° from the vertical position, the cradle and inner mounting member being annular to prevent binding or separation by the weight of the inclined tower.

13. An earth drill including a cradle adapted to tilt in a forward or rearward direction, an inner mounting member carried by the cradle with pivotal movement in a lateral direction, and a drilling unit carried by the inner mounting member and having a control head and a spindle carriage extending high above the control head, and including a chain stretched substantially the length of the carriage for engagement by a sprocket to move the carriage; characterized by the provision of means slidably anchoring the chain to the carriage intermediate the length of the chain, and the provision of a tower extending longitudinally of the carriage above the control head for movably bracing the carriage, and further characterized by having the inner mounting member with the drill unit pivotable laterally through approximately 45° from the vertical position, the cradle and inner mounting member being annular to prevent binding or separation by the weight of the inclined tower.

14. A tiltable mounting for a tower or the like, including inner and outer mounting rings, one of which is adapted to carry the tower and the other to be secured to support means, said rings being adapted to be telescoped together, and means securing said rings together including a worm segment secured after telescoping of the rings to the ring adapted to carry the tower, and engaging a slot through the other ring.

15. A tiltable mounting for a tower or the like, including an annular cradle having a slot therethrough extending circumferentially of the cradle at least approximately half of the periphery of the cradle and having a groove forming a continuation of the slot, opening on the inside of the cradle, and formed in part by a wall integral with the two portions of the cradle separated by the slot, and a mounting ring, adapted to carry the tower or the like, telescoped within the cradle and secured therein by oppositely positioned key means secured to the mounting member and extending into the slideway formed by the slot and groove.

16. A tiltable mounting for a tower or the like, including an annular cradle having a slot therethrough extending circumferentially of the cradle and having a groove forming a circumferential continuation of the slot, opening on the inside of the cradle, and formed in part by a wall integral with the two portions of the cradle separated by the slot, and a mounting ring, adapted to carry the tower or the like, telescoped within the cradle and secured therein by oppositely positioned key means secured to the mounting member and extending into the slideway formed by the slot and groove respectively, one part of the key means comprising a worm segment ex-

tending through the slot and adapted to be operated by a gear worm to tilt the tower.

17. An earth drill including a cradle adapted to tilt in a forward or rearward direction, an inner mounting member carried by the cradle with pivotal movement in a lateral direction, and a drilling unit carried by the inner mounting member and having a control head and a spindle carriage extending high above the control head; characterized by the provision of a tower extending longitudinally of the carriage above the control head and rigid therewith for movably bracing the carriage, and further characterized by having the inner mounting member with the drill unit and tower pivotable laterally from the vertical position, and by the provision of means operatively associated with the cradle for counterbalancing the tower as the cradle is tilted in a forward or rearward direction, said counterbalancing means being effective only after the tower has been tilted to an angle of approximately 30° whereby the counterbalancing means may have a relatively short stroke.

18. An earth drill including a cradle adapted to tilt in a forward or rearward direction, an inner mounting member carried by the cradle with pivotal movement in a lateral direction, and a drilling unit carried by the inner mounting member and having a control head and a spindle carriage extending high above the control head; characterized by the provision of a tower extending longitudinally of the carriage above the control head and rigid therewith for movably bracing the carriage, and further characterized by having the inner mounting member with the drill unit and tower pivotable laterally from the vertical position, and by the provision of means operatively associated with the cradle for counterbalancing the tower as the cradle is tilted in a forward or rearward direction; said counterbalancing means comprising flexible means attached to the cradle and engaging a generally arcuate portion thereof and a spring compressed by the flexible means.

19. An earth drill including a cradle adapted to tilt about a horizontal axis, an inner mounting member carried by the cradle with a pivotal movement about an axis perpendicular to said horizontal axis, and a drilling unit carried by the inner mounting member and having a control head, a spindle carriage extending through and at times high above the control head, and a drive shaft journaled in the drilling unit and extending rearwardly of the cradle; characterized by the provision of a tower extending longitudinally of the carriage above the control head and rigid therewith for movably bracing the carriage, and further characterized by having the inner mounting member with the drilling unit pivotable laterally through approximately 45° from the vertical position, the cradle and inner mounting member being annular to prevent binding or separation by the weight of the inclined tower.

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