

Dec. 14, 1954

S. D. HOWE
PORTABLE EARTH DRILL

2,696,972

Filed Jan. 26, 1951

4 Sheets-Sheet 1

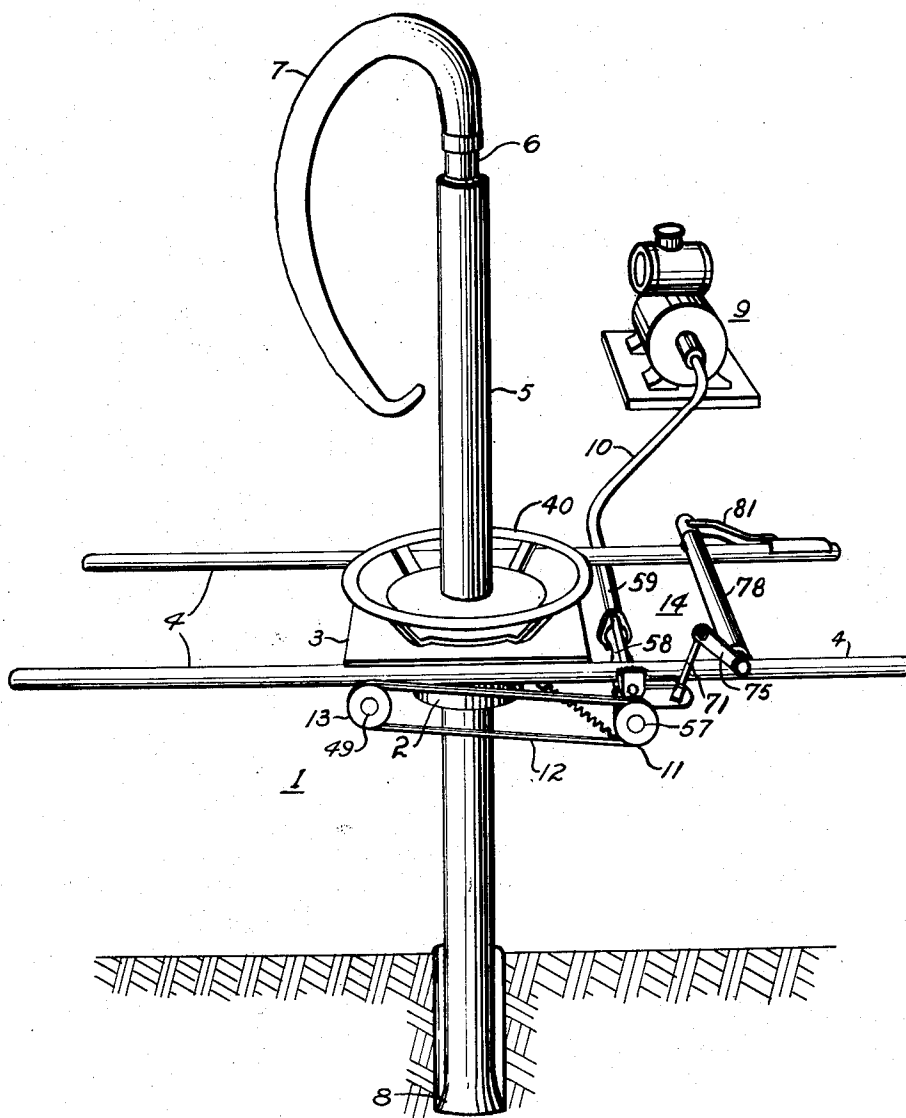


FIG. 1

SPENCER D. HOWE
INVENTOR.

BY
Harbert E. Birch
ATTORNEY

ATTEST:
Clarence R. Petty, Jr.

Dec. 14, 1954

S. D. HOWE
PORTABLE EARTH DRILL

2,696,972

Filed Jan. 26, 1951

4 Sheets-Sheet 2

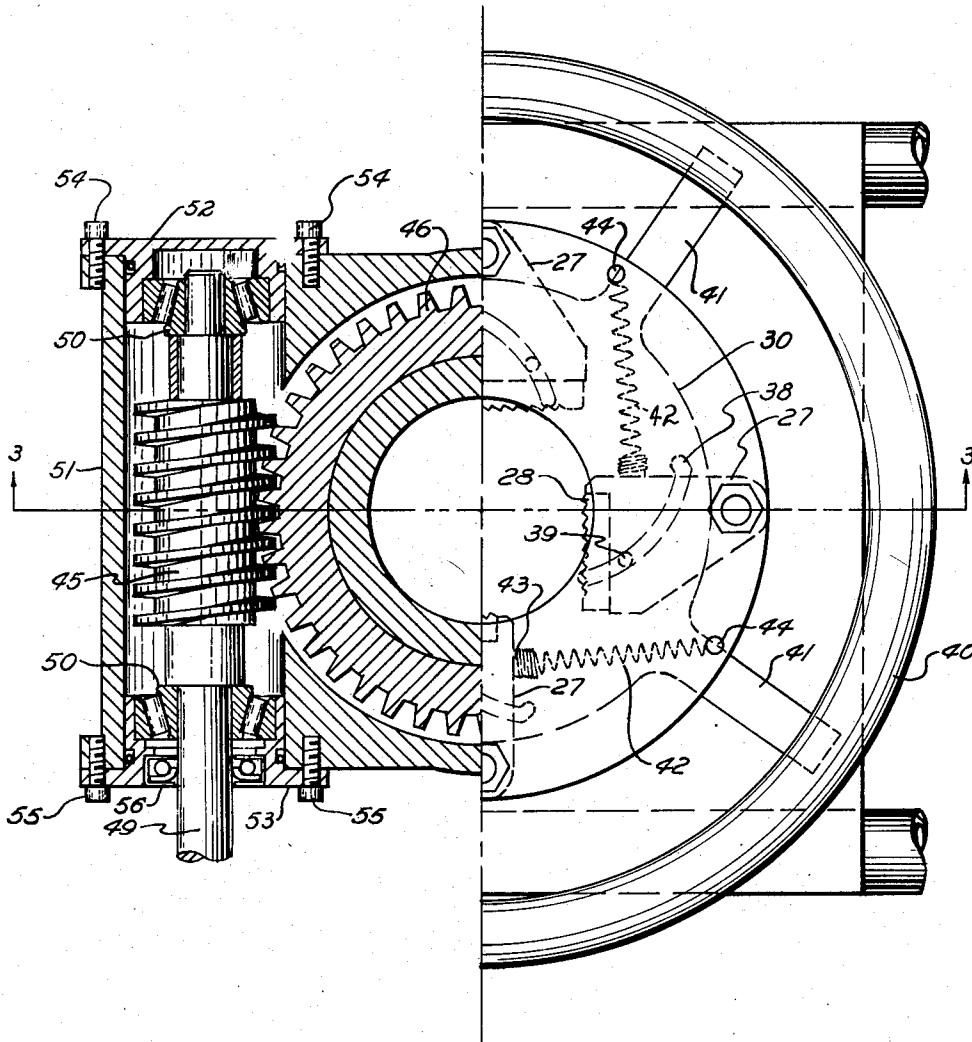


FIG. 2

SPENCER D. HOWE
INVENTOR.

BY

Robert E. Buck
ATTORNEY

ATTEST:

Clarence R. Ball

Dec. 14, 1954

S. D. HOWE

2,696,972

PORTABLE EARTH DRILL

Filed Jan. 26, 1951

4 Sheets-Sheet 3

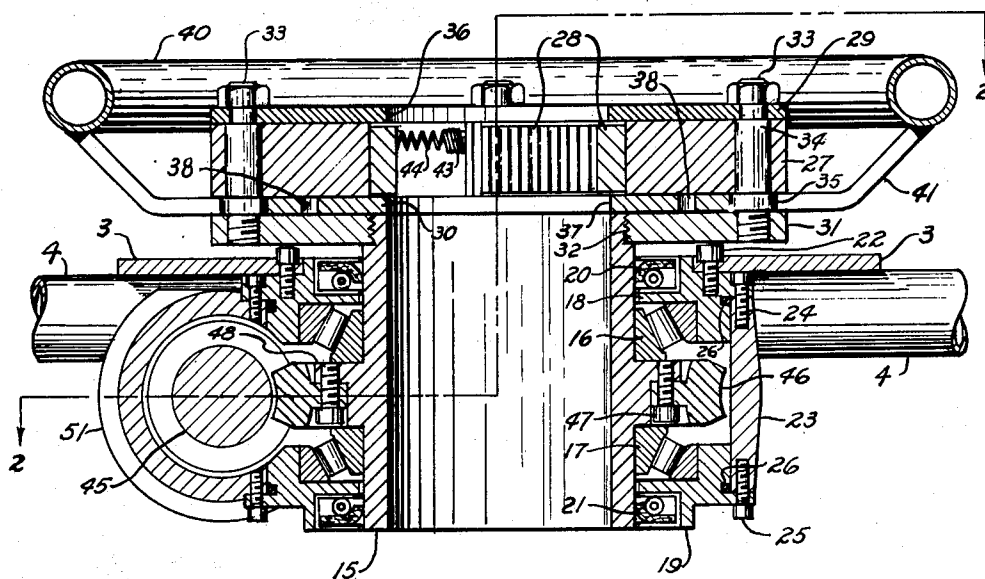


FIG. 3

SPENCER D. HOWE
INVENTOR.

BY

Robert E. Birch
ATTORNEY

ATTEST:

Chc revere R. Paddy, J.

Clarence R. Petty, Jr.

1

2,696,972

PORTABLE EARTH DRILL

Spencer D. Howe, Los Angeles, Calif., assignor to The Atlantic Refining Company, Philadelphia, Pa., a corporation of Pennsylvania

Application January 26, 1951, Serial No. 208,000

5 Claims. (Cl. 255—19)

This invention relates to an easily portable apparatus for earth boring, and more particularly to apparatus for boring relatively shallow bore holes into which explosive charges may be placed for detonation in connection with seismic exploration.

Prior to this invention, it was practically universal practice in the drilling of bore holes for seismic exploration purposes in marshy areas or other areas not easily accessible by truck-mounted drilling equipment to use makeshift drilling or boring equipment. This equipment usually consisted of a length of well casing, collapsed at its lower end to form a crude fish-tail bit, and one or more pipe wrenches of sufficient size to engage the casing. The drilling or boring operation was accomplished by workmen, who engaged the well casing with the wrenches, rotating the casing while simultaneously applying a downward thrust to cause it to penetrate the earth. Obviously, this is a slow and laborious operation, and when this method of boring is employed a great amount of time and physical energy of the workmen are consumed in providing even a relatively shallow bore hole. Yet, because only shallow holes are required for this work, and because it is desirable to have seismic exploration crews travel as light as possible so that they may move freely without being burdened by cumbersome and heavy equipment, it is impracticable to equip these crews with any of the known conventional earth-boring equipment. It is an object of this invention, therefore, to provide a lightweight drilling rig which will materially reduce the time and labor requirements in the boring of shallow holes, and yet which is small and light enough to be easily transported by seismic exploration crews without appreciably decreasing their mobility.

It is a further object of this invention to provide a portable drilling rig which may be easily supported in operating position by two men.

It is a further object of this invention to provide a light and easily transportable drilling apparatus which is capable of drilling shallow holes with a minimum expenditure of time and human effort.

Further objects and advantages of this invention will become apparent from the following description, taken in connection with the appended drawings.

Briefly, this invention consists of a portable drilling rig capable of being handled and supported in its operating position by two men. A collar, which forms a part of the rig, is provided with chuck means for engaging a drill stem, or a well casing utilized as a unitary drill stem and bit, and the collar is adapted, through the medium of suitable gearing also mounted on the rig, to be rotated by a source of power external to the rig to thereby cause the drill stem or well casing to rotate as required incident to the drilling operation. Therefore, since the drill stem or well casing is rotated mechanically, the operators are required only to provide a downward thrust on the rig to insure penetration of the drill. Handles are provided whereby the operators may grasp the rig to move it into place as well as to hold it while it is in operation. A control lever for engaging and disengaging the power source with respect to the gear train to the drill collar is mounted on one of the handles so that the operator may control rotation of the collar without releasing his hold on the rig.

In the attached drawings, Figure 1 is a perspective view of a preferred embodiment of this invention in position for operation with a well casing being used as a drill stem.

Figure 2 is a plan view, partly in section, of the central

2

portion of the drill rig shown in Figure 1 with the well casing removed, this drawing being particularly adapted to show details of the drill collar assembly.

Figure 3 is a sectional elevation taken on line 3—3 of Figure 2.

Figure 4 is a fragmentary plan view of the control lever end of the rig shown in Figure 1, showing one arrangement whereby a drive-shaft for connection to an external source of power is mounted on the drilling rig.

Figure 5 is a side elevation, partially in section, of that portion of the rig shown in Figure 4, showing details of the clutching arrangement whereby power from the drive-shaft pulley is transmitted to the driving belt.

Figure 6 is an end elevation of that portion of the rig shown in Figure 4.

Referring to the drawings, and particularly at this time to Figure 1, a portable drilling rig constructed in accordance with the teachings of this invention is generally designated by the numeral 1. A drill collar generally designated by the numeral 2, is mounted for rotation, as will be explained later, upon a flat mounting plate 3, which is in turn fixed, as for example by welding, to a pair of parallel support rods 4. In the particular embodiment of the invention shown, a section of well casing 5, connected by a suitable swivel 6 to a water or mud line 7, passes through collar 2 and is adapted to be rotated therewith. The well casing 5 shown in Figure 1 is being utilized as a unitary drill stem and drill bit, and for this purpose the lower end of well casing 5 is closed, or collapsed, to form a simulated fish-tail bit 8. Driving power for rotating collar 2 is supplied by an external source of power 9, which may be an electric motor, internal combustion engine, or any other suitable power source, through flexible shaft 10, driving pulley 11, belt 12, and driven pulley 13. Suitable linkage, designated generally by the numeral 14, is provided as a clutch activating means for controlling the connection between driving pulley 11 and belt 12, as will be explained in more detail later.

Referring now more specifically to Figures 2 and 3, it will be seen that hollow shaft 15 of drill collar 2 is rotatably supported by upper and lower tapered bearings 16 and 17, respectively. The inner race of each of these bearings is fixed to hollow shaft 15, and the outer races are mounted in upper and lower support rings 18 and 19, respectively. Bearings 16 and 17 are protected against the loss of lubricant and the entrance of dust and other foreign matter by grease seals 20 and 21 carried by support rings 18 and 19, respectively. Upper support ring 18 is attached to mounting plate 3, as for instance by bolts 22, and casing 23 is suspended from upper ring 18 as, for instance, by bolts 24, while similar bolts 25 serve to attach lower support ring 19 to the lower edge of casing 23. Packing rings 26 are employed to insure a sealed connection between support rings 18 and 19 and casing 23. By the above description, it is seen that hollow shaft 15 is rotatable with respect to upper and lower support rings 18 and 19, and casing 23, which are rigidly fixed to mounting plate 3, which is, in turn, welded or otherwise securely fixed to support rods 4.

Chuck means of drill collar 2 carried by hollow shaft 15 is provided for grasping well casing 5 which is passed through collar 2 as shown in Figure 1. This chuck means consists of a plurality of chuck jaws 27, having their inner edges serrated as at 28, pivotally mounted between upper chuck plate 29 and cam plate 30 of drill collar 2. Cam plate 30 rests on lower chuck plate 31, which is rigidly mounted on hollow shaft 15, as for instance by threaded engagement 32.

Upper and lower chuck plates 29 and 31 are held against relative movement by bolts 33 upon which are mounted spacers 34 and 35, to provide ample space between plates 29 and 31, so as not to bind chuck jaws 27 and cam plate 30. Each chuck jaw is pivotally mounted on a corresponding spacer 34 for limited rotation thereabout. It will be noted that upper chuck plate 29 and cam plate 30 are provided respectively with central openings 36 and 37 which are equal in diameter to, and are aligned with, the central opening through hollow shaft 15. In this connection, it is here pointed out that spacers 35, in addition to being of the proper thickness to prevent binding of cam plate 30 between jaws 27 and lower chuck

3

plate 31, are also made of such diameters as to bear loosely against the outside perimeter of cam plate 30 to thus keep the central opening 37 thereof in alignment with the opening through hollow shaft 15.

It will be noted, with special reference to Figure 2, that cam plate 30 is provided with a plurality of equally spaced and identical cam slots 38, equal in number to the number of chuck jaws 27. Also, attached to the bottom surface of each jaw 27, is a cam follower pin 39, which is adapted to engage a corresponding cam slot 38. Such being the case, it is obvious that rotation of cam plate 30 with respect to chuck plates 29 and 31 will, by virtue of the engagement between cam follower pins 39 and cam slots 38, cause chuck jaws 27 to pivot about spacers 34, consequently moving their inner serrated faces 28 either toward or away from the central opening through hollow shaft 15.

In the particular embodiment of the invention shown in Figure 2, counterclockwise rotation of cam plate 30 will cause each of the chuck jaws 27 to pivot in a clockwise direction about the spacer 34 upon which it is mounted, and thus to grip more tightly the well casing 5 passing through the central opening in the collar. For ease in manipulating cam plate 30, there is provided a hand wheel 40, which is connected to cam plate 30 by spokes 41, integral with, or attached to, cam plate 30. To insure positive clockwise rotation of the jaws 27 in response to counterclockwise rotation of cam plate 30, and to bias the serrated edges 28 of jaws 27 toward the opening through the drill collar 2, biasing springs 42 are provided. One such spring for each jaw is installed in tension between a pin 43, on each jaw, as shown in Figure 2, and a correlative anchor pin 44 mounted on upper chuck plate 29.

In addition to the fact, as pointed out above, that counterclockwise rotation of cam plate 30 will cause jaws 27 to grip the well casing passing through the central opening of the collar, it is obvious that clockwise rotation of the entire drill assembly about a well casing would also cause jaws 27 to grip said casing, and to tighten that grip as the well casing offered resistance to rotation with the assembly. For example, assuming that the drill assembly is in operating condition with a drill stem passing loosely through the central opening of the drill collar 2, if the assembly be rotated clockwise, the serrated edges 28 of jaws 27 will tend to drag on the drill stem. This will cause jaws 27 to rotate in a clockwise direction about the spacers 34, which in turn causes the serrated edge 28 of each jaw 27 to move in toward the center to grip the drill stem more tightly until the stem finally rotates with the assembly without slippage. In this case also, the springs 42 insure that the jaws 27 will be biased for clockwise rotation about their respective pivots to make their grip on the drill stem positive.

Conversely, if it is desired to release a drill stem held between jaws 27, this may be accomplished either by rotating cam plate 30 in a clockwise direction while holding the remainder of the assembly and the drill stem stationary, or by rotating the entire assembly in a counterclockwise direction while holding the drill stem stationary. In the first case, camming action of the slots 38 on the cam follower pins 39 will cause positive rotation of the jaws 27 about their respective pivots to cause serrated edges 28 to move outwardly away from the drill stem. In the second case, counterclockwise rotation of the assembly about the drill stem will cause the serrated edges 28 to drag on the drill stem. This dragging of the serrated edges 28 will likewise cause jaws 27 to rotate slightly in a counterclockwise direction about their respective pivots so that the serrated edges 28 will cease to grip the drill stem and will merely slip therearound.

Considering the above, it is seen, therefore, that drill collar 2 is provided with a one-direction clutching mechanism, adapted to grip a drill stem for positive rotation therewith when rotated in one direction, and to release said drill stem when rotated in the opposite direction.

In the embodiment of the invention herein described, hollow shaft 15 is adapted to be rotated by worm 45 through worm gear 46, which is attached as by bolts 47, or by any other suitable means, to flange 48 which is provided for that purpose on the external periphery of hollow shaft 15. Worm 45 is mounted on worm shaft 49, which is in turn rotatably mounted in bearings 50; and the entire worm assembly is enclosed in a worm housing generally designated by the numeral 51, which

4

may be formed integral with casing 23. The ends of worm housing 51 are closed by end plates 52 and 53 attached thereto as by bolts 54 and 55, respectively. In order to retain lubrication and prevent entry of dirt or other foreign matter into worm housing 51, a suitable grease seal 56 is provided in end plate 53 through which worm shaft 49 passes. As shown in Figure 1, the external end of worm shaft 49 has a pulley wheel 13 thereon which is adapted to be driven by belt 12.

Referring now more specifically to Figures 4, 5, and 6, it is seen that belt 12 is adapted to be driven by driving pulley 11 which is mounted on driving shaft 57. Driving shaft 57 is rotatably mounted in housing 58 as by bearings (not shown) carried in each end of said housing. As shown in Figure 6, housing 58 is rigidly fixed to shaft 39 by means of hangers 60 and 61, which are fixed to shaft 59 as for instance by welding and which are adapted to grip the ends of housing 58 by the tightening of bolts 62 and 63, respectively.

Shaft 59 is suspended between support rods 4 by means of hangers 64 which are welded or otherwise fixed to support rods 4, as shown in Figure 6. Each hanger 64 is drilled or otherwise provided with a hole in which a bushing 65 is mounted. Bolts 66, each having a smooth portion 67 and a threaded portion 68, are passed through bushings 65 and the threaded portions 68 are threaded into the internally threaded ends of shaft 59, as shown in Figure 6. The smooth portion 67 of each bolt 66 is in contact with the internal surface of the corresponding bushing 65. The fit between bushings 65 and the smooth portions 67 of bolts 66 is such that bolts 66 may rotate within bushings 65 with very little resistance. Thus, it is seen that housing 58, carrying shaft 57 on which pulley 11 is mounted, may swing in a limited arc around the axis of rotation of shaft 59. This swinging of housing 58 is the means whereby the transfer of power from shaft 57 through driving pulley 11 and belt 12 to driven pulley 13 is controlled. When housing 58 (and consequently pulley 11) is swung counterclockwise to the position shown in full lines in Figure 5, driving pulley 11 pulls belt 12 into tension and through belt 12 drives driven pulley 13. On the other hand, when housing 58 is in the position shown by the dotted lines in Figure 5, belt 12 is slack and, therefore imparts no driving power to driven pulley 13. Housing 58 is biased to the disengaged position (dotted position as shown in Figure 5) by tension spring 69, one end of which is fixed by any suitable means, not shown, to the appropriate support rod 4, and the other end of which is engaged by the bolt 63 associated with the hanger 61.

For the purpose of controlling the position of housing 58, hanger 61 is provided with an arm 70 formed integral therewith or otherwise attached thereto. One end of a bolt 71, both ends of which are threaded, is adjustably attached to arm 70 by any suitable means, such as bracket 72 and jam nuts 73 and 74. The other end of bolt 71 is similarly adjustably fixed to one end of arm 75 as by any suitable connection 76. The other end of arm 75 is welded or otherwise suitably attached to shaft 77, rotatably mounted in housing 78, which is secured as by welding to support rods 4, as shown in Figure 5. The end of shaft 77 remote from the end to which arm 75 is attached extends through the opposite end of housing 78 and is there encased in a sleeve 79 of approximately the same diameter as housing 78. Sleeve 79 is clamped to shaft 77 as by set screws 80, to preclude relative rotation between shaft 77 and sleeve 79. A lever 81 is fixed, as by welding, to sleeve 79, and at approximate right angles thereto, to serve as a means whereby sleeve 79 and consequently shaft 77 may be rotated with respect to housing 78. As most clearly shown in Figure 4, lever 81 is so located as to be readily accessible to the hand of an operator holding handle 82 of the drilling rig.

With special reference to Figures 4 and 5, it will be noted that when lever 81 is in the position shown by the full lines, that is, held against handle 82 with which it is associated, it operates through sleeve 79, shaft 77, arm 75, bolt 71, and arm 70, to hold housing 58 in the full line position, which, as mentioned above, causes pulley 11 to pull belt 12 into tension and thereby to impart to pulley 13 any driving force which may be exerted by pulley 11. Conversely, when lever 81 is released, spring 69, acting upon housing 58 by reason of its attachment to outboard hanger 61, causes housing 58 to swing to

5

the dotted line position, which releases the tension on belt 12 to thereby break the driving connection between pulleys 11 and 13. Also, arm 70 will swing to its dotted line position, carrying with it bolt 71 which, through arm 75, causes a counterclockwise rotation of shaft 77 to raise lever 81 into the dotted line position shown in Figure 5.

In the embodiment of the invention herein described, it is contemplated that power for operation will be supplied to drive shaft 57 as, for instance, by a flexible shaft 10 driven by a motor 9, as shown in Figure 1. Suitable means, as for instance threaded coupling 83, for connecting the housing of flexible shaft 10 to housing 58, is provided on the end of housing 58 opposite the end thereof at which pulley 11 is mounted.

In operation, drill collar 2 is slipped over the upper end of a well casing 5, the lower end of which has been fashioned into a simulated fish-tail bit 8. A suitable swivel 6 and a water or mud line 7 are then attached to the upper end of well casing 5. Cam plate 30 is rotated in a counterclockwise direction to insure the engagement of the serrated edges 28 of chuck jaws 27 with the outside surface of drill casing 5. Assuming that flexible shaft 10 is rotating under the influence of motor 9, one of the operators presses down on lever 81, thereby bringing driving pulley 11 into operative engagement with belt 12 so as to cause belt 12 to drive pulley 13, which in turn through worm 45 causes rotation of drill collar 2 as explained above. At this time, of course, the drilling rig is held by the operators in such a position that the drill casing 5 is in a vertical position with the simulated fish-tail bit 8 in contact with the earth. Also, during the time while collar 2 is rotating, the operators press downwardly on the rig to cause drill casing 5 to penetrate earth. Such being the case, it is obvious that the drilling rig will be carried toward the ground as drill casing 5 penetrates thereto; and therefore it will be necessary from time to time for the drilling rig to be raised to a higher position on the drill casing. At such times the operator having control of lever 81 releases it, to thereby stop rotation of collar 2 as described above; chuck plate 30 is rotated in a clockwise direction to disengage jaws 27 from contact with drill casing 5; and the rig is then raised to a new position higher up on the drill casing, after which cam plate 30 is again rotated in a counterclockwise direction to cause reengagement of the jaws 27 with the drill casing. Alternatively, instead of rotating cam plate 30 to release and re-grip drill casing 5, the entire rig may be rotated about drill casing 5 in a counterclockwise direction to cause jaws 27 to disengage said casing, as hereinbefore described, and restarting of the rotation of collar 2 will thereafter cause jaws 27 to grip casing 5. The operation of alternately drilling and then raising the rig on the well casing is repeated until substantially the entire length of casing has been bored into the earth, after which the swivel connection 6 is removed therefrom, another section of casing attached thereto, the swivel connection fixed to the top of said second casing, the rig engaged upon said second casing, and the same operation repeated thereupon as was carried out upon the first of said drill casings.

While the above description covers one embodiment of this invention, it is obvious that many minor changes may be made without departing from the spirit or scope thereof. Therefore, it is understood that this invention is not limited to the exact embodiment described above, but rather that it be limited only in accordance with the appended claims.

I claim:

1. A portable earth drill comprising a mounting plate, handle means comprising a pair of parallel support rods secured to said plate and extending at opposite ends thereof for supporting and manipulating said plate, a drill collar comprising a tubular member rotatably mounted on said plate, said drill collar also comprising chuck means having radially movable chuck jaws mounted on said tubular member and means mounted on said tubular member for relative movement with respect to said tubular member for moving said chuck jaws radially inwardly and outwardly from said tubular member into and out of engagement with a drill stem passed through said tubular member, a first shaft housing secured to said plate, a first drive shaft journaled in said housing, means connecting said first drive shaft and said tubular member for rotating said tubular member,

6

a second drive shaft housing, said housing being pivotally mounted on the handle means adjacent one end of said plate, a second drive shaft journaled in said second housing and adapted to be rotated through flexible means by a remote power source, coupling means interposed between said first drive shaft and said second drive shaft for rotating said first drive shaft from said second drive shaft and adapted to be operative when said second housing is in one position and to be inoperative when said second housing is pivoted to another position, and lever means mounted on said handles and connected to said second housing for selectively pivoting said second housing from said one position to another position.

2. A portable earth drill comprising a mounting plate, handle means comprising a pair of parallel support rods secured to said plate and extending at opposite ends thereof for supporting and manipulating said plate, a drill collar comprising a tubular member rotatably mounted on said plate, said drill collar also comprising chuck means having radially movable chuck jaws mounted on said tubular member and means mounted on said tubular member for relative movement with respect to said tubular member for moving said chuck jaws radially inwardly and outwardly from said tubular member into and out of engagement with a drill stem passed through said tubular member, a first shaft housing secured to said plate, a first drive shaft journaled in said first housing, transmission means connecting said first drive shaft and said tubular member for rotating said tubular member from said first drive shaft, a second drive shaft housing, said housing being pivotally mounted on the handle means adjacent one end of said plate, a second drive shaft journaled in said second housing and adapted to be rotated through flexible means by a remote power source, coupling means interposed between said first drive shaft and said second drive shaft for rotating said first drive shaft from said second drive shaft and adapted to be operative when said second housing is in one position and to be inoperative when said second housing is pivoted to another position, biasing means connected with said second housing for holding said second housing normally in said second position, and lever means mounted on said handles and operatively connected to said second housing for selectively pivoting said second housing to said one position against the force of said biasing means.

3. A portable earth drill comprising a mounting plate, handle means comprising a pair of parallel support rods secured to said plate and extending at opposite ends thereof for supporting and manipulating said plate, a drill collar comprising a tubular member rotatably mounted on said plate, said drill collar also comprising chuck means having radially movable chuck jaws mounted on said tubular member and means mounted on said tubular member for relative movement with respect to said tubular member for moving said chuck jaws radially inwardly and outwardly from said tubular member into and out of engagement with a drill stem passed through said tubular member, a first shaft housing secured to said plate, a first drive shaft journaled in said first housing, a first pulley on said first drive shaft, and transmission means connecting said first drive shaft and said tubular member for rotating said tubular member from said first drive shaft, a second shaft housing, said housing being pivotally mounted on the handle means adjacent one end of said plate, a second drive shaft journaled in said second housing and adapted to be rotated through flexible means by a remote power source, a second pulley on said second drive shaft, coupling means interposed between said first and second pulleys for rotating said first drive shaft from said second drive shaft and adapted to be operative when said second housing is in one position and to be inoperative when said second housing is in a second position, biasing means connected with said second housing for holding said second housing normally in said second position, and lever means mounted on said handles and connected to said second housing for selectively pivoting said second housing to said one position against the force of said biasing means.

4. A portable earth drill comprising a mounting plate, handle means comprising a pair of parallel support rods secured to said plate and extending at opposite ends thereof for supporting and manipulating said plate, a drill collar comprising a tubular member rotatably

mounted on said plate, said drill collar also comprising chuck means having radially movable chuck jaws mounted on said tubular member and means mounted on said tubular member for relative movement with respect to said tubular member for moving said chuck jaws radially inwardly and outwardly from said tubular member into and out of engagement with a drill stem passed through said tubular member, a first shaft housing secured to said plate, a first drive shaft journaled in said first housing, a first pulley on said first drive shaft, and transmission means connecting said first drive shaft and said tubular member for rotating said tubular member from said first drive shaft, a second shaft housing, said housing being pivotally mounted on the handle means adjacent one end of said plate, a second drive shaft journaled in said second housing and adapted to be rotated through flexible means by a remote power source, a second pulley on said second drive shaft, a drive belt operatively associated with said first and second pulleys for rotating said first drive shaft from said second drive shaft and adapted to be operative to couple said first and second pulleys when said second housing is pivoted to one position and to be inoperative when said second housing is pivoted to another position, and lever means mounted on said handles and connected to said second housing for selectively pivoting said second housing from one position to the other position.

5. A portable earth drill comprising a mounting plate, handle means comprising a pair of parallel support rods secured to said plate and extending at opposite ends thereof for supporting and manipulating said plate, a drill collar comprising a tubular member rotatably mounted on said plate, said drill collar also comprising chuck means having radially movable chuck jaws mounted on said tubular member and means mounted on said tubular member for relative movement with respect to said tubular member for moving said chuck jaws radially inwardly and outwardly from said tubular member into and out of engagement with a drill stem

passed through said tubular member, a first shaft housing secured to said plate, a first drive shaft journaled in said first housing, a first pulley on said first drive shaft, and transmission means connecting said first drive shaft and said tubular member for rotating said tubular member from said first drive shaft, a second shaft housing, said housing being pivotally mounted on the handle means adjacent one end of said plate, a second drive shaft journaled in said second housing and adapted to be rotated through flexible means by a remote power source, a second pulley on said second drive shaft, a drive belt operatively associated with said first and second pulleys for rotating said first drive shaft from said second drive shaft and adapted to be operative to couple said first and second pulleys when said second housing is pivoted to one position and to be inoperative when said second housing is pivoted to a second position, biasing means connected with said second housing for holding said second housing normally in said second position, and lever means mounted on said handles and connected to said second housing for selectively pivoting said second housing to said one position against the force of said biasing means.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
614,333	McCready	Nov. 15, 1898
1,200,612	Helm	Oct. 10, 1916
1,343,902	Chapman	June 22, 1920
1,507,294	Mercer	Sept. 2, 1924
1,876,126	Zerbe et al.	Sept. 6, 1932
2,016,667	Crowell	Oct. 8, 1935
2,201,733	Kollmann	May 21, 1940
2,214,370	Hassler	Sept. 10, 1940
2,287,450	Price	June 23, 1942
2,403,041	Beyerink	July 2, 1946
2,598,565	Lagant	May 27, 1952