Jan. 10, 1956 P. J. HARINCK 2,730,331

ROTARY MINING MACHINE

Filed Jan. 19, 1953 3 Sheets-Sheet 1

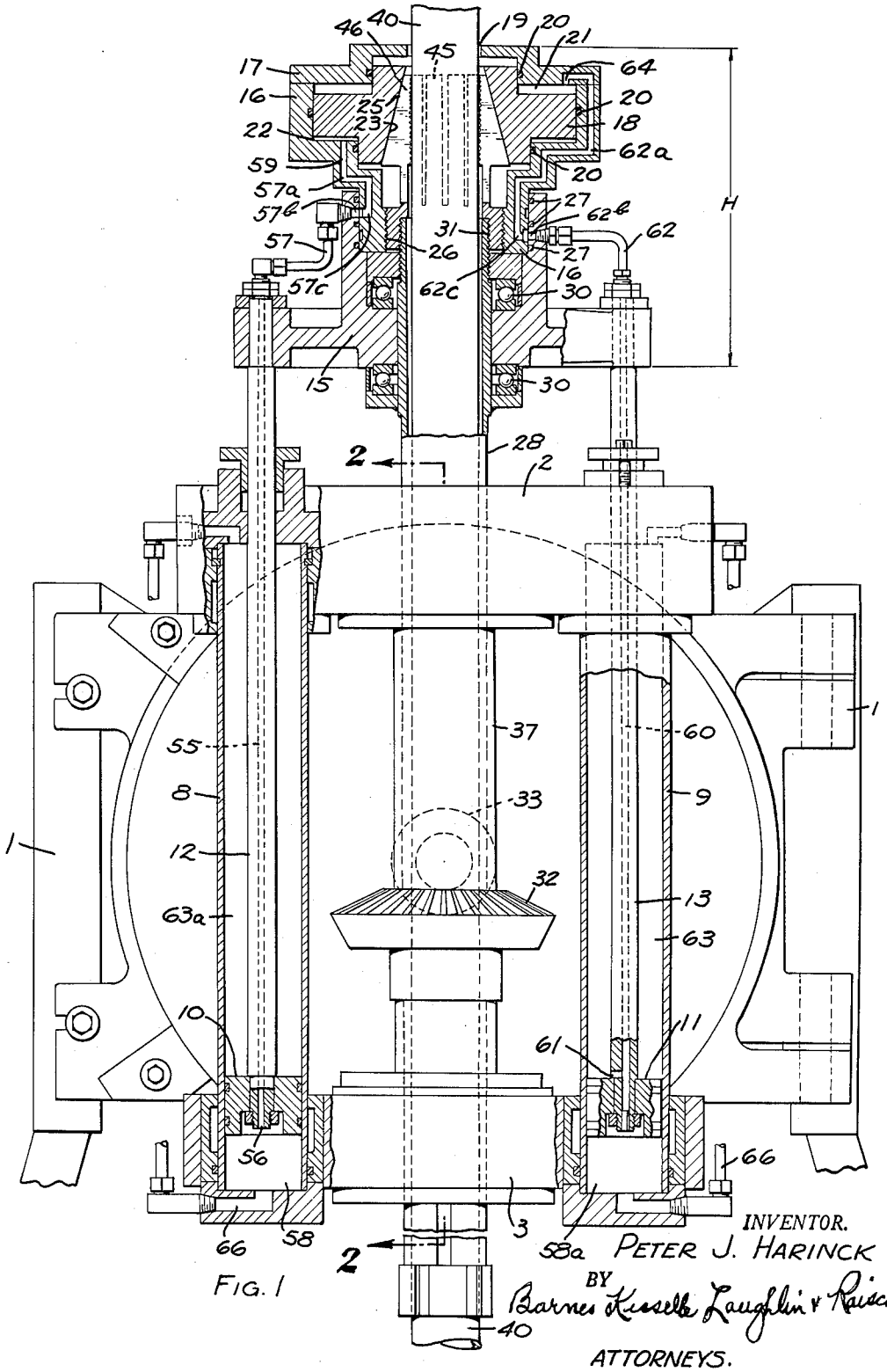

FIG. 1

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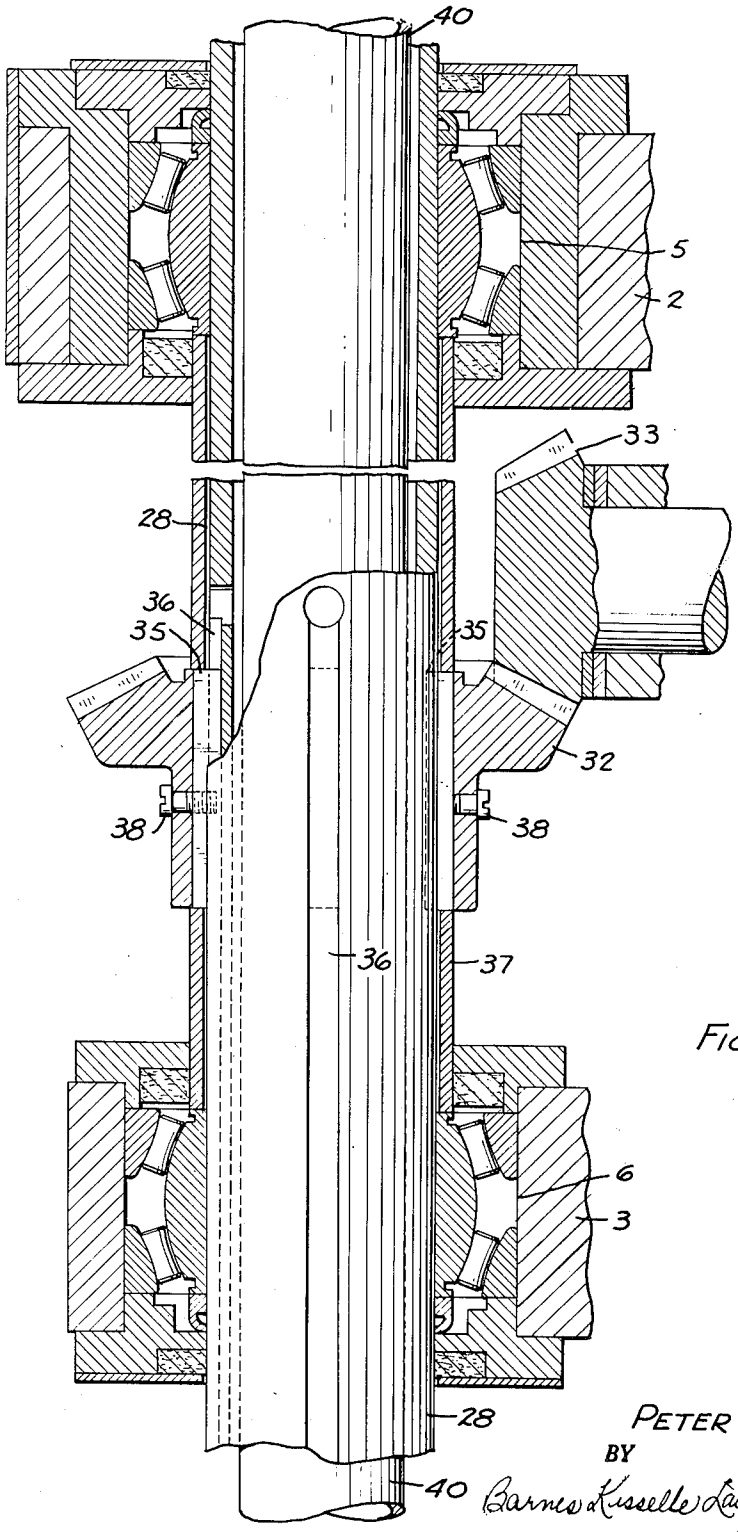

FIG. 2

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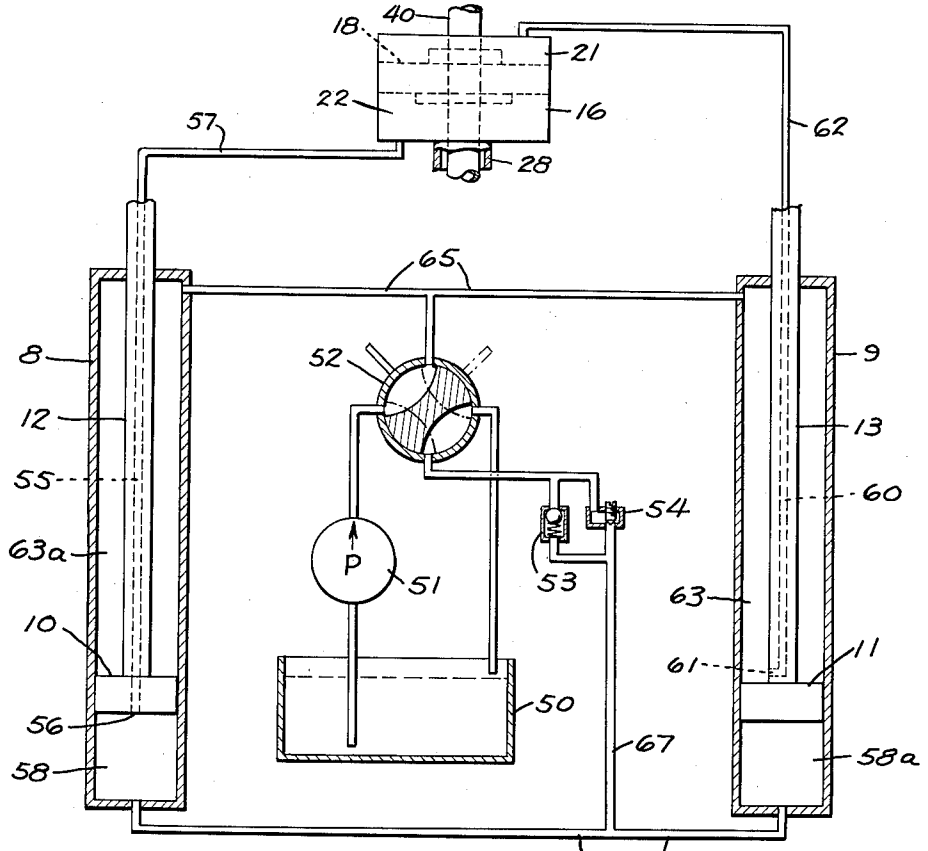

FIG. 3

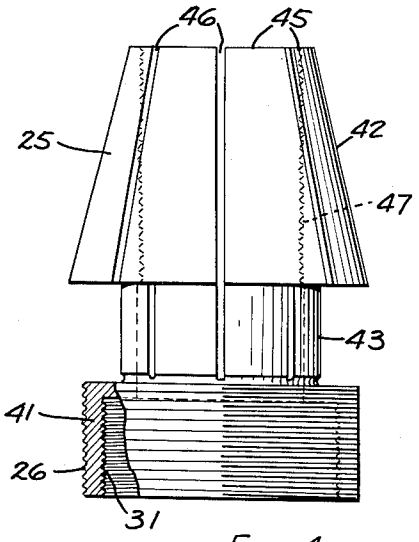

FIG. 4

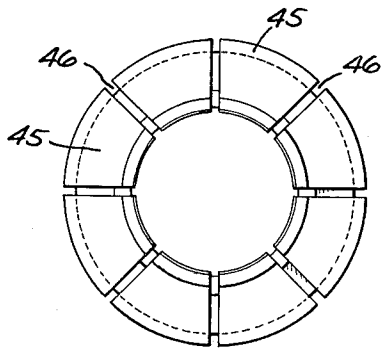

FIG. 5

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United States Patent Office

2,730,331

Patented Jan. 10, 1956

2,730,331

ROTARY MINING MACHINE

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Application January 19, 1953, Serial No. 332,062

6 Claims. (Cl. 255—22)

This invention relates to an apparatus for drilling holes into the earth such, for example, as core drilling to obtain subterranean samples in connection with mining operations or proposed mining operations.

In such an apparatus the depth of the bore and the length of the drill rod or pipe may be hundreds and even thousands of feet long. This is particularly true in some types of operations involved in test hole or core drilling.

In accordance with the invention, the drill rod, which is hollow and in the form of a pipe for core drilling, is rotated and is fed downwardly into the earth under pressure. The apparatus involves a chuck device for engaging the drill rod to rotate it and advance it into the earth and, obviously, the drill rod can only be advanced in a succession of relatively short stages. The chuck of the mechanism has a limited range of movement and following each increment of advance the chuck must be released from the drill rod and retracted and again applied to the drill rod. It is a primary purpose of this invention to provide a hydraulically actuated mechanism for advancing the drill rod into the earth as it is rotated and for retracting the chuck between increments of advancement wherein the hydraulic medium acts upon the chuck to engage it with and disengage it from the drill rod. When the hydraulic medium is applied in a manner to advance the drill rod into the earth, the pressure of the hydraulic medium is so conducted to the chuck so as to cause the chuck to engage the drill rod and when the hydraulic medium is applied to retract the chuck the pressure thereof disengages the chuck from the drill rod. Thus the chuck is automatically operated in a self-timing manner.

One embodiment of the invention is disclosed in the accompanying drawings:

Fig. 1 is a view partly in elevation and partly in section of an apparatus constructed in accordance with the invention.

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1.

Fig. 3 is a diagram of the hydraulic system.

Fig. 4 is a view of the chuck taken partly in elevation and partly in vertical section.

Fig. 5 is a plan view of the chuck.

The device has a frame 1 which includes an upper support member 2 and a lower support member 3. The upper support member supports an upper bearing member 5 and the lower support member supports a lower bearing member 6 as shown in Fig. 2. The support members 2 and 3 also support two cylinders 8 and 9 as shown in Fig. 1. Pistons 10 and 11 are disposed within the cylinders 8 and 9 respectively and are connected by piston rods 12 and 13 respectively to the cross member 15 of a drill head generally indicated at H. The drill head has a body member 16 which in turn has a cap 17, the body and cap constituting a cylinder. An actuator 18 is disposed pistonwise within the body member. The actuator 18 and the cylinder provided by the body member 16 and its cap 17 have three diameters as shown in Fig. 1 and an O-ring 20 is provided in each diameter which in turn provide a sealed

chamber 21 above the actuator and a sealed chamber 22 below the actuator. The actuator 18 has a tapered opening 23 within which is disposed a chuck 25. The chuck is secured to the body member by means of threads shown at 26. A rotary drive sleeve 28 extends through the cross member 15 and is journalled therein by bearings 30. The upper end of the rotary drive sleeve 28 is threadedly secured to the chuck 25 by threads shown at 31; hence the body member 16, the actuator 18, and the chuck 25, rotate with the sleeve 28 relative to the cross member 15 and are held from axial movement by the bearings 30. Seals of the O-ring type as shown at 27 are disposed between the body 16 and the cross member 15. The sleeve 28 extends through the upper bearing member 5 and the lower bearing member 6 and is journalled thereby to the upper support member 2 and the lower support member 3 respectively. The sleeve 28 is rotatably driven by the bevelled gear 32 which in turn is driven by the bevelled gear 33. The gear 32 has one or more keys 35 which engage one or more key slots 36 in the sleeve 28 thereby providing means for rotating the sleeve. A support sleeve 37 envelopes the drive sleeve 28, extends between the upper bearing member 5 and the lower bearing member 6 and is supported and secured into position thereby and is rotatable with the sleeve 28. The gear 32 is secured to the sleeve 37 by means of bolts 38 and is thereby held in proper position to be engaged by the drive gear 33 which may be driven by suitable means (not shown). A drill rod or drill pipe 40, which in effect is the shank of the drilling tool, is extended through the length of the sleeve 28 through the interior of the chuck 25 and through an opening 19 provided therefor in the cap 17.

Referring particularly to Figs. 4 and 5, the chuck 25 is a monolithic piece of metal having a base ring portion 41, a collet portion 42 and an interjacent neck portion 43. The base ring is threaded exteriorly as shown at 26 for engagement with the body member 16 and is threaded interiorly as shown at 31 for engagement with the rotary drive sleeve 28 as shown in Fig. 1. The collet portion is comprised of eight arcuate wedges 45 separated by eight slots 46. The sides of the collet portion taper inwardly from the bottom to top at an angle of approximately twelve and one-half degrees. The interior faces 47 of the collet wedges are roughened in order to permit the chuck in its closed position to engage the drill pipe 40 in a non-slip grip.

Referring to Fig. 1, the walls of the tapered opening 23 in the actuator 18 engage the tapered exterior surfaces of the collet portion 42 so that when the actuator is moved downwardly the collet wedges are forced laterally or radially inwardly and force the roughened interior faces 47 thereof into tight engagement with the drill pipe; when the actuator is moved upwardly and out of engagement with the chuck, the collet segments are permitted to disengage from the drill rod by their resilient action.

A hydraulic system is provided for reversibly moving the pistons 10 and 11 within the cylinders 8 and 9 respectively and for reversibly moving the actuator 18 within the body member 16. Refer especially to Fig. 3. The hydraulic system comprises a reservoir 50 in which hydraulic fluid may be stored, a pump 51, a four-way valve 52, a check valve 53 and a throttling valve 54 arranged in parallel, and various interconnecting pressure lines. A passageway 55 extends through the piston 10, through the length of the piston rod 12, and connects with the pressure line 57 which in turn connects with passageway 57*a* in body 16 (shown in Fig. 1). For this purpose, cross member 15 may have a port 57*b* connected with line 57 and aligned with an annular portion 57*c* of passageway 57*a*. Passageway 55 opens into closure 58 beneath the piston 10 through an orifice 56 and passageway 57*a* opens into closure 22 beneath the actuator

through an orifice 59 so that the two closures are in hydraulic communication.

A passageway 60 in the piston rod 13 has an orifice 61 communicating with the cylinder space 63 above the piston 11. The passageway 60 connects into lines 62 and 62a (Fig. 1) with passage 62a connecting into the cylinder space 21 above the actuator 18. In the drive position of the valve 52 shown in solid lines in Fig. 3 the pump 51 forces hydraulic fluid from the reservoir 50 through the valve, through the lines 65, and into the closures 63 and 63a thereby forcing the pistons 10 and 11 downwardly, that is, in a direction for advancing the drill rod. This is the drive stroke. This movement of the pistons forces fluid out of the closures 58 and 58a through the lines 66 and 67 to the valves 53 and 54. The check valve 53 compels the fluid to pass through the throttling valve 54 from where it passes through the valve 52 and returns to the reservoir. Adjustment of the throttle valve 54 controls the rate of flow of hydraulic fluid therethrough and hence controls the rate at which the pistons, and therefore the drill rod, is advanced. In the return position of the valve 52 shown in dotted lines, hydraulic fluid is forced by the pump 51 through the valve 52, through the valves 53 and 54, through the lines 67 and 66 and thence into the closures 58 and 58a, forcing the pistons 10 and 11 to move upwardly. This is the return or retracting stroke of the piston and is accomplished relatively quickly since the valve 53 is opened wide by pressure acting in the return direction. This movement of the pistons forces hydraulic fluid out of the closures 63 and 63a through the lines 65, through the valve 52 and into the reservoir 50.

During the drive stroke of the pistons 10 and 11 the pressure in the closures 63 and 63a is greater than the pressure in the closures 58 and 58a. Since the closure 58 is in communication with the closure 22 under the actuator and the closure 63 is in communication with the closure 21 above the actuator, during the drive stroke of the pistons the pressure in the closure 21 will be greater than the pressure in the closure 22 so that the actuator will be forced downwardly into engagement with the chuck 25. Similarly, during the return or retracting stroke of the pistons, the pressure in the closures 58 and 58a is greater than the pressure in the closures 63 and 63a and the pressure in the closure 22 will be greater than the pressure in the closure 21 so that the actuator 18 is forced upwardly out of engagement with the chuck.

Figs. 1 and 3 show the pistons 10 and 11 near the bottom of the drive stroke. At this time the pressure in the closure 63, 63a, and 21 is greater than the pressure in the closures 58, 58a, and 22 so that the actuator 18 is forced into tight engagement with the chuck 25, causing the chuck to grip the drill pipe 40 tightly. The drill pipe is thus caused to rotate with the chuck 25 which in turn is being rotated by the rotary drive sleeve 23. Simultaneously, by action of the pistons 10 and 11 acting through the piston rods 12 and 13 and the drill head H, the drill pipe is caused to advance whereby the drilling is accomplished. At the bottom of the drive stroke the valve 52 is shifted to the return position so that the pressure in the closures 58, 58a, and 22 becomes greater than that in the closures 63, 63a, and 21. This pressure reverse instantaneously forces the actuator 18 out of engagement with the chuck 25, permitting the segments thereof to disengage from the drill rod; and simultaneously, the pistons 10 and 11 are forced upwardly and carry the drill head upwardly in the return stroke. At the top of the return stroke, that is when the pistons 10 and 11 are near the top of the cylinders 8 and 9 respectively, the valve 52 is returned to the drive position. The relative pressures in the closures 58, 58a, and 22 and the closures 63, 63a, and 21 are again immediately reversed, the actuator 18 is again forced into engagement with the chuck 25, causing the chuck to take a new bite on the drill pipe 40, and causing the drill rod to again begin rotating; and simultaneously, a new drive stroke is begun whereby the drilling operation is resumed. Continued pressure in the closures 63 and 63a forces the pistons 10 and 11 downwardly until the drive stroke is completed, whereupon the cycle is repeated.

Thus a device is provided for causing a chuck to take a bite on the drill pipe, to rotate the drill rod, to advance it to a certain distance to then release the pipe and return to its original position, take a new bite on a pipe and again rotate it and advance it. It is particularly to be noted that the operation of the chuck is automatic in that it engages and releases the drill rod as the valve 52 is operated to cause downward or upward movement.

It should be understood that such terms as "upward," "downward," "beneath," etc., are used herein merely as convenient terminology and not as delimitations.

I claim:

1. An apparatus for boring a hole into the earth comprising, two drill rod advancing cylinders, a piston in each cylinder, a piston rod extending from each piston, a head to which the piston rods are connected, a hollow driving member journalled in the head, means for rotating the driving member, a chuck cylinder rotatably mounted on the head, a chuck piston in the chuck cylinder having an opening therethrough, seal means between the chuck piston and the ends of the chuck cylinder, a hollow chuck member secured to the driving member and having an expandable and contractable portion lying within the opening in the chuck piston, the driving member, the chuck cylinder, the chuck piston and the hollow chuck member adapted to have the drill rod of a boring tool extend therethrough, the expandable and contractable portion of the chuck member having external inclined surfaces, the walls defining the opening in the chuck piston having inclined surfaces operable on the inclined surfaces of the chuck member, means for supplying hydraulic medium under pressure, conduit means extending to opposite ends of the said advancing cylinders and to opposite ends of the chuck cylinder, and control means operable to introduce hydraulic medium to the said advancing cylinders to urge the said head with advancing movement and to introduce hydraulic medium to one end of the chuck cylinder to cause the chuck piston to shift and contract the said chuck portion into engagement with the drill rod, whereby the drill rod is rotated and urged into the earth, and operable to introduce hydraulic medium to the opposite ends of the advancing cylinders and the opposite end of the chuck cylinder for release of the chuck from the drill rod and retracting movement of the head.

2. An apparatus for boring a hole into the earth comprising, drill rod advancing cylinders, a piston in each cylinder, a piston rod extending from each piston, a head to which the piston rods are connected, a hollow driving member journalled in the head, means for rotating the driving member, a chuck cylinder rotatably mounted on the head, a chuck piston in the chuck cylinder having an opening therethrough, seal means between the chuck piston and the ends of the chuck cylinder, a hollow chuck member secured to the driving member and having a chuck portion, the driving member, the chuck cylinder, the chuck piston and the hollow chuck adapted to have the drill rod of a boring tool extend therethrough, the chuck portion and the chuck piston having co-acting parts for actuating the chuck portion to cause it to engage and disengage the drill rod, means for supplying hydraulic medium under pressure, conduit means extending to opposite ends of the advancing cylinders and to opposite ends of the chuck cylinder, and control means operable to introduce hydraulic medium to the advancing cylinders and to one end of the chuck cylinder to urge said head with advancing movement and cause the chuck piston to shift and actuate the chuck portion into engagement with the drill rod, whereby the drill rod is rotated and urged into the earth, and operable to intro-

duce hydraulic medium to the opposite ends of the advancing cylinders and the opposite end of the chuck cylinder for release of the chuck from the drill rod and retracting movement of the head.

3. The apparatus as recited in claim 2 characterized in that the chuck cylinder has an intermediate portion of relatively large diameter and end portions of relatively small diameter and the chuck piston has intermediate and end portions respectively fitting the intermediate and end portions of the chuck cylinder and seal means between the end portions of the chuck piston and the walls of the end portions of the chuck cylinder.

4. An automatic rotary drilling machine for drilling holes into the earth comprising, a base, a drill head, hydraulic cylinder and piston means connecting said base and drill head and being operable selectively to advance said drill head for drilling and to retract said drill head respectively by introducing hydraulic medium into one end end and the other end of said cylinder means, drive means rotatably mounted on said base, said drive means having a portion movable for advancing and retracting with said drill head and having a chuck fixed thereon, said drill head having a rotatable portion fixed on said movable portion of said drive means, means on said rotatable portion forming a cylinder means around said chuck, a piston in the latter said cylinder means for operating said chuck, the latter said cylinder means being open ended so that a drill pipe may project through said chuck, the latter said piston being hydraulically reciprocable to actuate said chuck for engagement and disengagement with a drill pipe therein by introducing hydraulic medium into one end and the other respectively of the last named cylinder means, the like-named ends of said two cylinder means being in hydraulic communication, whereby to advance and retract said drill head respectively when said chuck engages and disengages the drill pipe.

5. An automatic rotary drilling machine for drilling holes into the earth comprising, a base member, a drill head member, at least two hydraulic cylinders with pistons therein mounted on one of said members, piston rods on said pistons connected to said other member, said drill head being advanced for drilling and retracted by introducing hydraulic medium respectively in one end and the other end of said cylinders, drive means rotatably mounted on said base, said drive means having a portion movable for advancing and retracting with said drill head and having a chuck fixed thereon, said drill head having a rotatable portion fixed on said movable portion of said drive means, means on said rotatable portion forming a cylinder around said chuck and piston means therein engaging said chuck, the latter said cylinder being open ended to permit drill pipe to project through said chuck, the latter said piston being hydraulically reciprocable to actuate said chuck for engagement and disengagement with drill pipe therein by introducing hydraulic medium in one end and the other end respectively of the latter said cylinder, one of said piston rods having a passageway opening into said one end of the cylinder thereon, conduit means connecting said passageway and said one end of the latter said cylinder, the other piston rod having a passageway opening into said other end of the cylinder thereon, and conduit means connecting the latter said passageway and said other end of the latter said cylinder, whereby to advance and retract said drill head respectively when said chuck engages and disengages from the drill pipe.

6. An apparatus for boring a hole into the earth comprising, a head, a hollow rotary driving member journalled in the head and adapted to have the drill rod of a boring tool extend therethrough, a chuck member secured to the driving member, a cylinder for hydraulic medium journalled on the head concentrically with the driving member, a piston in the cylinder concentric with the driving member, both the cylinder and piston having openings for the passage of the drill rod therethrough, the piston being operable by hydraulic medium to cause engagement of the chuck member with the drill rod or to cause release of the chuck member from the drill rod, hydraulic motor means operable to move the head with advancing movement or to move the head with retracting movement, means for supplying hydraulic medium under pressure, conduit means for conveying hydraulic medium to the said hydraulic motor means and said cylinder, and a single control valve means operable to simultaneously introduce hydraulic medium to the said hydraulic motor means and said cylinder to cause advancing movement of the head and engagement of the chuck member with the drill rod, whereby the drill rod is rotated as it is advanced, and operable to simultaneously introduce hydraulic medium to said hydraulic motor means and said cylinder to shift the head with retracting movement and disengage the chuck member from the drill rod during the retracting movement of the head.

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