

Jan. 25, 1966

B. R. GENBERG ETAL

3,231,032

APPARATUS FOR DRILLING IN EARTH COVERED ROCK

Filed April 5, 1960

3 Sheets-Sheet 1

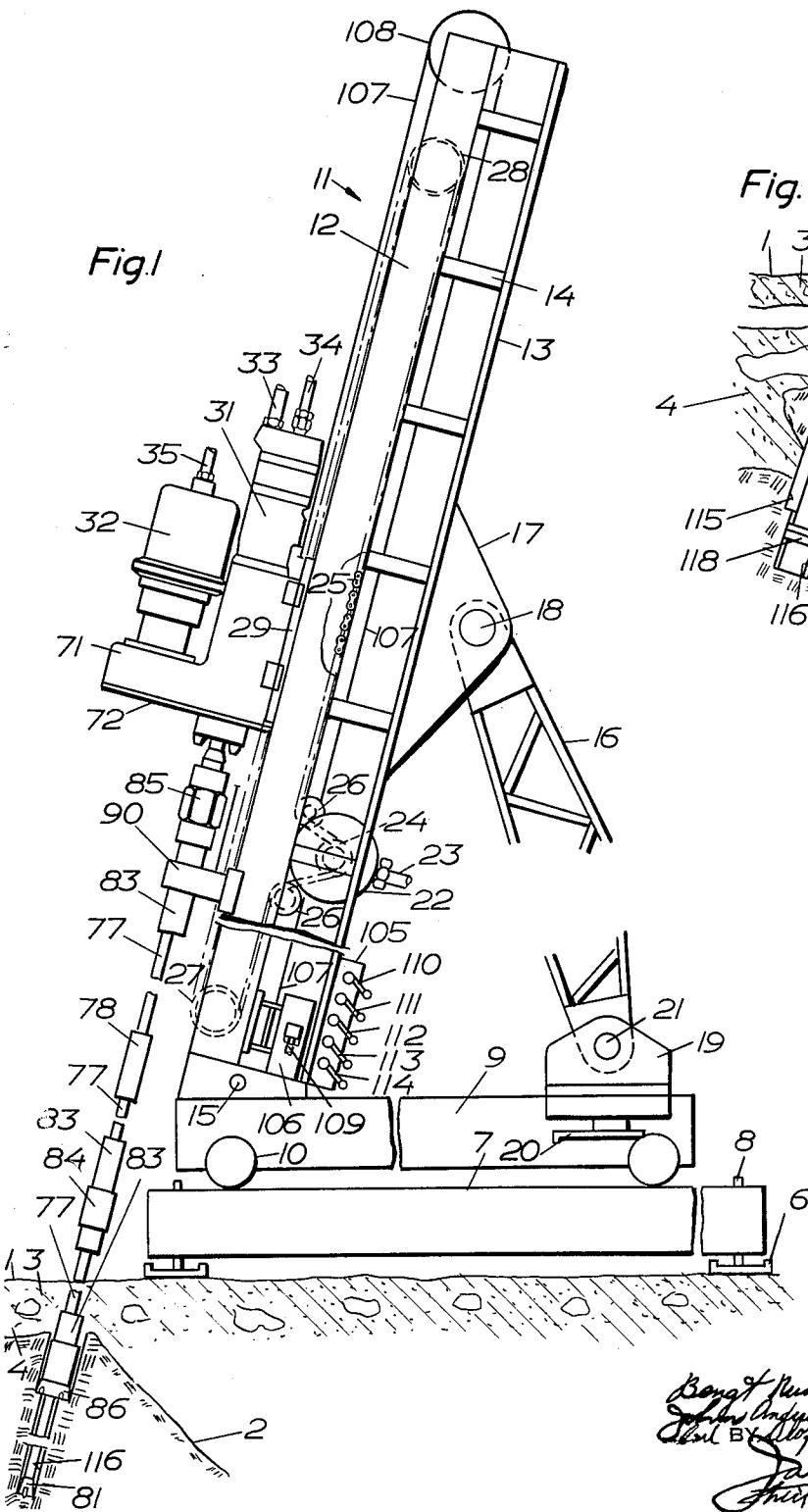
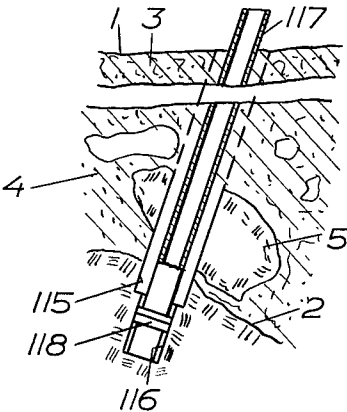


Fig. 2



INVENTORS
Bengt R. Genberg
James C. Markle
BY *[Signature]*
ATTORNEY

Jan. 25, 1966

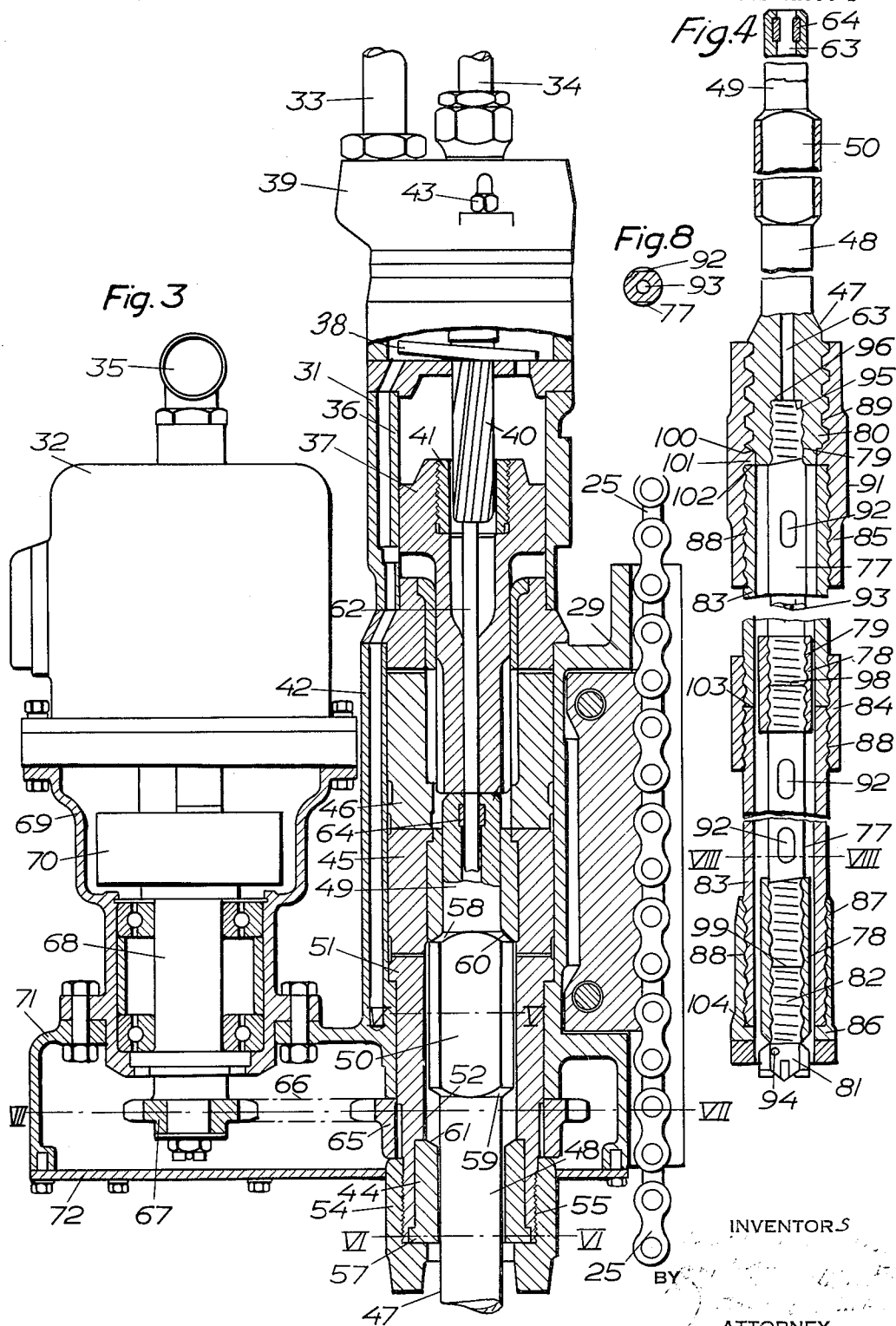
B. R. GENBERG ETAL

3,231,032

APPARATUS FOR DRILLING IN EARTH COVERED ROCK

Filed April 5, 1960

3 Sheets-Sheet 2



Jan. 25, 1966

B. R. GENBERG ETAL

3,231,032

APPARATUS FOR DRILLING IN EARTH COVERED ROCK

Filed April 5, 1960

3 Sheets-Sheet 3

Fig. 6

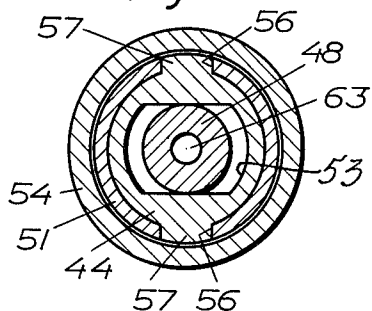


Fig. 5

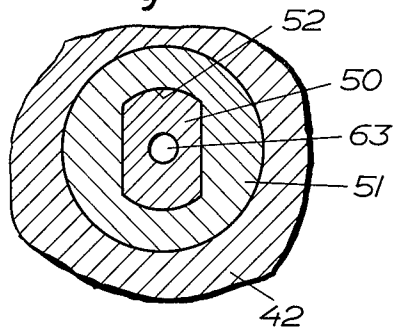
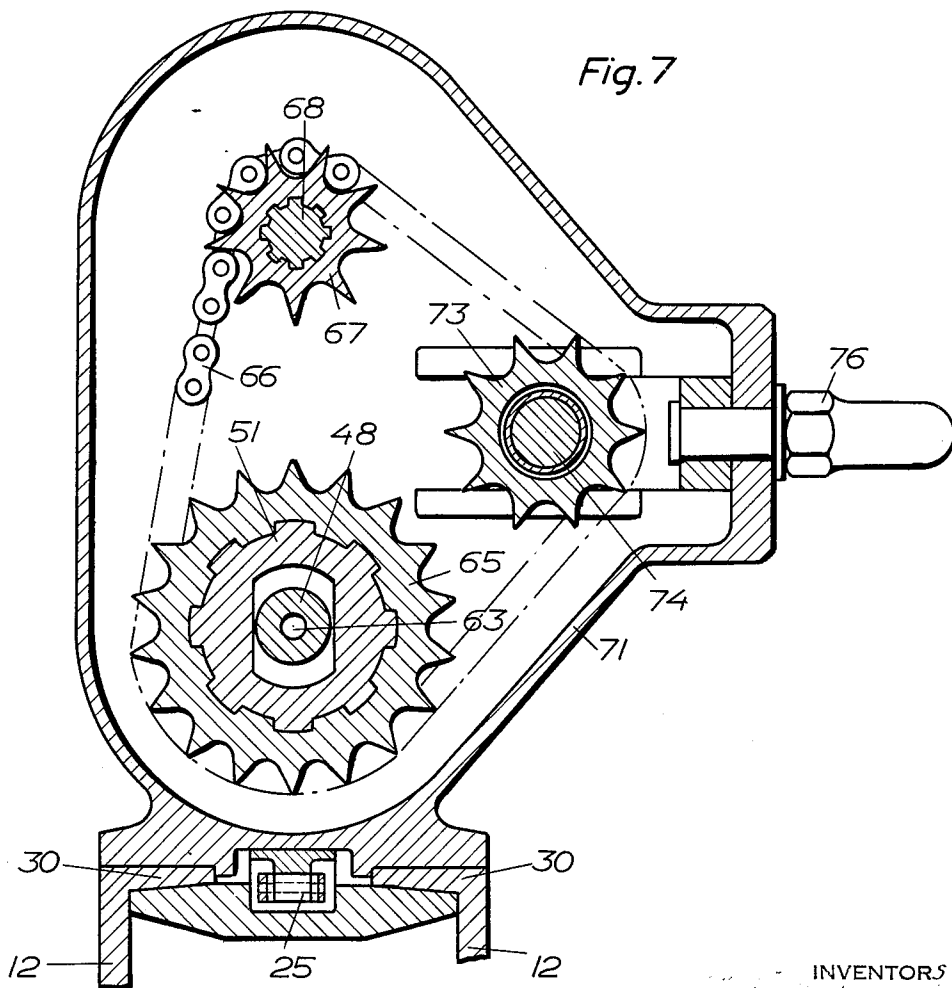


Fig. 7



INVENTORS
BY
ATTORNEY

1

2

3,231,032 APPARATUS FOR DRILLING IN EARTH COVERED ROCK

Bengt Rune Genberg, Norrköping, John Anders Hjalsten, Sandviken, and Carl Olov Lindgren, Nacka, Sweden, assignors to Atlas Copco Aktiebolag, Nacka, Sweden, a corporation of Sweden

Filed Apr. 5, 1960, Ser. No. 23,120
11 Claims. (Cl. 175-171)

This invention relates to apparatus for drilling in earth covered rock. For various purposes it is desirable to be able to drill rock without first removing the soilcap which often covers the rock. The apparatus according to the present invention may be used in connection with building of water ways, harbors, water power plant dams and canals, geological investigations, stabilizing of ground and injection of cement or other material in the ground, in rock or in dam structures, piling for building structures, and for other work. Diamond drills and percussion drills of various types have been suggested for work of the above type but have proved expensive or slow in operation. One object of the invention is to provide an apparatus for the above purpose which is capable of penetrating an earth layer of very varying composition which may contain hard clay, moraine, boulders, more or less solid rock or the like. The apparatus according to the invention provides a means for drilling through such an earth layer down to and into the underlying rock and for obtaining a clean hole all the way down which may be charged for blasting the rock and any large boulders or stiff earth layers covering the rock or used for other purposes, for instance for taking out samples of the ground or rock, for anchoring piles, for injection of cement or other stabilizing material or the like.

Other and more detailed objects of the invention and the several advantageous ways of carrying the invention into effect and achieving the advantages of its use will appear more fully as the ensuing portion of this specification proceeds.

In the accompanying drawings forming a part hereof one suitable embodiment of apparatus for carrying the invention into effect is shown by way of example, but without limitation, it being understood that the invention may be modified both as to apparatus and the method of utilizing the apparatus within the scope of the appended claims defining the invention.

In the drawings:

FIG. 1 is a side elevation of apparatus embodying the invention partly broken away in order to make possible the illustration of the complete apparatus on one sheet of drawing. FIG. 2 is a vertical section partly broken away of a completed hole through earth and a boulder and in the underlying rock. FIG. 3 is a vertical longitudinal section on a larger scale of a drill forming a part of the apparatus according to FIG. 1 and FIG. 4 is a longitudinal section of an adapter and of a drill rod and drill tube assembly used in connection with an apparatus of FIG. 1. FIG. 5 is a detail cross section on line V—V in FIG. 3, and FIG. 6 is a cross section on line VI—VI in FIG. 3. FIG. 7 is a section on line VII—VII in FIG. 3, and FIG. 8 is a section on line VIII—VIII in FIG. 4.

In FIGS. 1 and 2 numeral 1 indicates the upper surface of the soilcap covering a rock formation 2 which may have any irregular contour. It is sometimes convenient before starting a drilling operation with the apparatus according to the invention to remove a suitable part of the soilcap with conventional earth removing machines and to plane the earth, if desired, with bulldozers or other suitable machines to provide a fairly even surface on which the apparatus according to the invention may be mounted in a convenient manner according to the con-

ditions of the work and the depth and number of holes to be drilled. Naturally, such preparations of the ground are usually not necessary when the holes to be drilled are far apart, or when it is not desired to remove the soil as, for instance, in connection with investigation drilling and various types of injection drilling.

The illustrated apparatus is an example of an apparatus used for drilling in connection with the building of a canal. The upper part 3 of the soilcap may consist of comparatively soft ground and the deeper portions 4 may consist of hard clay or moraine which may contain large boulders as indicated at 5 in FIG. 2. It also often occurs that the rock covered by the earth is of a very poor quality so that it is necessary to drill down through loose rock a considerable distance before the solid rock is encountered.

The illustrated apparatus consists of a number of steel channels 6 provide on the ground parallel to each other and forming a track on which a frame 7 of suitable steel channels is movable on wheels 8. The transverse members of the frame 7 form a track for a frame 9 which is movable on wheels 10 on the frame 7 perpendicular to the direction in which the frame 7 is movable on the channel 6. The frame 9 carries a drill post comprising a drill guide and feed structure which is generally indicated by 11 and which may consist of 2 parallel steel channels 12 welded together with longitudinal steel members 13 by means of transverse stiffeners or webs 14 to form the rigid drill post, the length of which may, for instance, substantially be the same as the desired depth of the holes to be drilled. The drill post 11 is pivotally supported in a suitable way as at 15 on the frame 9 and two steel struts of suitable frame work 16 are provided for supporting the drill post 11 about half-way from the frame 9 to the top. The struts 16 may preferably be hingedly connected to a bracket 17 on the drill post by bolts 18 and to two brackets 19 clamped to the opposite side members of the frame 9 by suitable screw clamps 20, the brackets 19 supporting the members 16 by means of bolts 21. The drill post 11 carries a drill feed motor 22 which may consist of a reversible pneumatic motor supplied with compressed air through a hose 23 and containing a driving sprocket wheel 24 for a drill feed chain 25 which is carried over the sprocket wheel 24, idlers 26 in the feed motor housing, and over large idler wheels 27 and 28 at the bottom and top of the drill post 11. One of said idle sprocket wheels, preferably the wheel 27 may be provided with means for tensioning the chain 25 which means are well known in the art and are therefore not illustrated. The chain 25 is connected to a slide 29 which is movable on the flanges 30 of the channels 12 forming a part of the drill post.

The slide 29 carries a percussion drill comprising a percussion motor 31 and a reversible separate drill steel rotation motor 32. The percussion motor is provided with compressed air through a hose 33 and with flushing water through a hose 34 and the rotation motor is provided with compressed air for ahead and reverse rotation through two hoses 35. The percussion motor 31 contains in conventional manner a cylinder 36 accommodating a hammer piston 37 the reciprocation of which is controlled by a distributing valve 38 in the back head 39 of the motor in conventional manner. A conventional rifle bar 40 co-operates with a rifle nut 41 in the piston 37 to rotate the piston in order to avoid uneven wearing of the piston. The cylinder 36 is clamped together with a chuck casing 42 by means of side bolts 43 and the chuck casing 42 and cylinder 36 are rigidly secured to the slide 29.

The chuck casing contains a front bushing 44 and rear bushings 45, 46 in which an adapter 47 is mounted with cylindrical portions 48 and 49, respectively. The adapter 47 is rotatable in the rear bushings 45, 46 and has an inter-

mediate portion 50 between the cylindrical portions 48, 49 of non-circular cross section, for instance as obvious from FIG. 5, which fits into a chuck 51 rotatably mounted in the chuck casing 42. The chuck 51 has a non-cylindrical bore 52 through which the intermediate portion 50 is axially slidable but non-rotatable. The bushing 44 is provided with an opening 53 through which the portion 50 is axially slidable and which may be made to register with the opening 52 by suitable turning of the bushing 44. A lock nut 54 is screw threaded on the chuck 51 at 55 and the bushing 44 has projections or claws 57 cooperating with recesses 56 in the chuck 51 so that upon tightening of the nut 54 the bushing 44 may be locked in a position in which the opening 53 does not register with the opening 52. The bushing 44 thereby prevents the adapter 47 from being removed from the chuck 51. The portion 50 of the adapter forms a rear shoulder 58 and a front shoulder 59 cooperating with corresponding shoulders 60 on the bushing 45 and 61 on the bushing 44 and permitting axial forces to be transmitted from the feeding motor through the drill to the adapter for feeding or retraction of the drill rod assembly, respectively. Flushing water is supplied through the adapter through a flushing water tube 62 extending into a flushing water passage 63 in the adapter and sealed in the adapter by a suitable packing 64 so that a high flushing water pressure may be maintained. The hose 34 is connected to the flushing water tube 62 in conventional manner.

For rotation of the chuck 51 and the adapter 47 the chuck carries a sprocket wheel 65 driven by a chain 66 from a driving sprocket wheel 67 provided on a shaft 68 mounted in bearings in a casing 69 which contains a reduction gear transmission 70 driven by a reversible compressed air operated motor 32. The casing 69 is carried by a housing 71 forming a part of the chuck casing 42 and covered at the front end by a removable cover 72 which upon removal allows inspection and adjustment of the chain transmission 65, 66, 67. The chain 66 is carried over an idle sprocket wheel 67 mounted on a shaft 74 carried by a slide 75 which by means of a nut 76 may be adjusted in order to adjust the tension of the chain 66. The illustrated design makes it possible to replace the sprocket wheels 65 or 67 by other sprocket wheels in order to change the transmission ratio or the torque or speed of rotation of the chuck.

The drill rod assembly consists of the adapter 47 and a train of drill rods 77 provided with externally screw threaded ends with rounded screw threads and coupled together by means of coupling sleeves 78 provided with correspondingly rounded screw threads 79, said type of screw threads being commercially known under the trademark "Rope Thread." The adapter 47 provides a socket 80 which is provided with internal rounded screw threads as obvious from FIG. 4 to fit the end of a drill rod 77. A drill bit 81 provided with hard metal inserts and with a screw threaded shank 82 is connected to the extreme drill rod 77 by a similar coupling sleeve 78 having rounded screw threads. A train of drill tubes 83 is connected by means of sleeves 84 to each other and by means of a sleeve 85 to the adapter 47 and at the lower end of said train of tubes an annular drill bit 86 having a sleeve portion 87 is screw threaded on to the lower end of the extreme drill tube 83. The drill tubes 83 are provided with screw threaded ends 88 with rounded screw threads of the type known under the trademark "Rope Thread" and the engaging sleeves 85, 84 and 87 are threaded correspondingly. The sleeve 85 has a screw threaded portion 89 which may be of the same type but which is illustrated as a trapezoid screw thread engaging a corresponding screw thread on the outside of the socket 80 formed by the adapter 47. The sleeve 85 has a hexagonal external grip portion 91 and the rods 77 are provided with flats 92 close to the screw threaded ends to facilitate turning of the rods by means of suitable wrenches. The rods 77 are furthermore provided with a flushing passage 93 com-

municating with the passage 63 in the adapter 47 and terminating in flushing medium openings 94 in the central bit 81.

The percussion waves produced by the hammer piston 37 are transmitted to the adapter 47 and through a shoulder 95 in the socket end of the adapter to the end face 96 of the rear drill rod 77, further through the drill rods over the abutting end faces 98 of the various drill rods of the drill rod train and through the end face 99 of the drill bit shank 82 to the ground or rock. Furthermore, the percussion waves transmitted to the adapter are transmitted through shoulders 100 on the adapter through an internal flange 101 of the sleeve 85 to the flat end face 102 of the drill tube inserted in the sleeve 85 and further through the drill tubes and abutting end faces 103 of said tubes to a shoulder 104 in the ring drill bit 86 and through said bit to the ground or rock.

In order to facilitate handling of the apparatus according to the invention a control panel 105 is provided on the drill post 11 and furthermore an air hoist 106 provided with a cable 107 carried over a wheel 108 at the top of the drill post is provided for manipulating the drill tubes when it is not desired or convenient to use the feeding motor for this purpose. Said hoist may, of course, also be used during the erection of the drill post and when the drill post is taken down. Through a hose 109 compressed air is supplied to the hoist motor 106. The control panel 105 carries control valves not illustrated in the drawing and operated by handles 110, 111, 112, 113 and 114 controlling the reversible feed motor 22, the percussion motor 31, the flushing water, the reversible rotation motor 32 and the hoist 106.

Drilling of earth covered rock with the apparatus according to the invention is carried out in the following manner:

According to the condition of the ground and the depth of the earth layer on the rock one or more drill rods and a corresponding number of drill tubes are assembled with the central drill bit and the ring drill bit and with the adapter 47, the central drill bit 81 preferably extending a short distance ahead of the ring drill bit 86. The combined train of drill rods and drill tubes are forced down through the earth by means of the feeding motor 22 and with the rotation motor 32 in operation and flushing water turned on through the train of drill rods. When hard ground, a boulder or rock is encountered the percussion motor 31 is started and operated. When the assembled train has been driven down as long as possible, the percussion motor and the rotation motor are stopped and flushing is interrupted and the sleeve 85 is uncoupled from the uppermost drill tube 83. The uppermost drill rod 77 is gripped by means of a suitable wrench so as to prevent it from turning and the rotation motor 32 is reversed which unscrews the adapter from the uppermost drill rod 77. The drill is then retracted a suitable distance by means of the feeding motor 22. A sleeve 78 and a further drill rod 77 are screwed unto the end of the previously uppermost drill rod 77 and a section of the drill tube 83 with a pertaining sleeve 84 is slipped over the drill rod and coupled together with the uppermost drill tube 83. By means of the feeding motor 22 the adapter 47 is then again lowered and the uppermost drill tube 83 is connected to the socket 80 and the sleeve 85 by rotating the rotation motor 32 in ahead direction. Drilling may then be continued with the central drill bit and the ring drill bit as before. The above procedure is continued until the assembled trains of drill bits and rods and tubes has started to penetrate the rock 2 below the loose ground. Drilling is then usually continued until the ring drill bit has entered the solid rock a short distance, as indicated in FIG. 1 and at 115 in FIG. 1. When the ring drill bit 86 has entered the solid rock, for instance 5-10 inches, the drill is stopped and the sleeve 85 is uncoupled from the adapter 47 by loosening the trapezoid screw threads at 89. The train of drill rods may then be lifted by means of the

5

feed motor 22 and a further drill rod may be assembled and drilling continued by means of the central drill bit 81 only as indicated at 116 in FIG. 1, and such drilling is continued until it is obvious that the material encountered is the solid rock and not only a large boulder or the like.

When the hole 116 has reached the desired depth, the train of drill rods 77 and the central bit 81 are lifted by means of the feeding motor 22 which is then reversed. The train of drill tubes 83 is, however, left in the hole to protect the hole against earth and other material that would be likely to fill the hole. A smooth clean hole is now available all through the train of drill tubes 83 to the bottom of the hole 116 drilled by means of the central drill bit 81. A tube 117 of artificial resin or other cheap material and provided with a simple sealing ring 118 close to its lower end is pushed down through the train of tubes 83 into the hole 116 where the sealing ring 118 forms a seal with the walls of the hole 116 preventing sand and clay et cetera from entering the drill hole. When the tube 117 has been safely anchored in this way the cable 107 may be attached to the upper end or slide 90 of the train of drill tubes 83 in any suitable manner and the hoist 106 is then operated to pull the train of drill tubes 83 out of the ground leaving the plastic tube 117 or the like in the ground to provide a suitable hole for the provision of a charge of dynamite or other explosive. When a hole has been completed in this way, as illustrated in FIG. 2, the whole drill rig is moved to the next position on the wheels 10 or 8 as the case may be, whereupon drilling is continued as hereinabove described.

While the invention has been described above in connection with a drill rig for drilling a large number of holes over a considerable area, a more conventional drill rig, or a conventional drill carriage may naturally be used where ground conditions permit movement of such a drill rig or carriage over the ground and where the number of holes is limited. When it is desired to make ground investigation, sample collectors or other instruments may be carried down through the train of drill tubes when the central drill bit and the drill rods have been removed. The provision of plastic or other simple cheap tubes in the holes is only used when it is desired to blast the holes. Further modifications of the invention may be made within the scope of the following claims according to the prevailing conditions of the work to be carried out.

What we claim is:

1. In apparatus for drilling in earth covered rock with both a hollow drill tube and a drill rod coaxially operating within said drill tube and with both said drill tube and drill rod being driven for both rotary and axial percussive drilling movements, the combination which comprises percussion motor means for providing said axial percussive drilling movement, means for supporting said motor means for axial advancing and retracting movements toward and away from said earth covered rock to be drilled, rotary motor means for imparting said rotary movement and mounted on said support means for movement with said percussive motor means, a driving chuck coaxially aligned with said percussion motor means and in driven engagement with said rotary motor means to be rotated thereby, a drill rod and tube connecting adapter releasably engaged in said chuck but for axial movement with respect thereto, means on said adapter for receiving and transmitting axial percussive forces from said percussion motor means, additional means on said adapter in rotary driving engagement with said chuck for transmitting therefrom said rotary movement, first threaded connecting means on said adapter for engaging one end of said drill rod and for imparting rotary movement thereto, abutment surfaces on said adapter and substantially perpendicular to the axis thereof for directly transmitting percussive forces to said drill rod independently of said threaded connecting means, second threaded connecting means on said adapter for engaging said drill tube and for imparting said rotary movement thereto, and addi-

6

tional abutment surfaces on said adapter for directly transmitting percussive forces to said drill tube independently of said threaded connecting means, said second threaded connecting means being disposed coaxially around said first threaded connecting means and said drill rod and including means for disengaging said drill tube from said adapter for retracting and withdrawing said drill rod and said adapter from said drill tube.

2. Apparatus as recited in claim 1 in which said drill rod and said drill tube each comprises a plurality of interconnected axially extending segments successively joined together in end-to-end relation, and joining means for joining said segments together in said end-to-end relation.

3. Apparatus as recited in claim 2 which also includes a plurality of threaded sleeves for joining said segments of said drill rod and said drill tube, said threaded sleeves engaging correspondingly threaded ends of two adjacent segments forming connections therebetween for transmitting said rotary movement, and adjacent said segments each including abutment surfaces substantially perpendicular to the axis of said segments and in direct abutting engagement for transmitting percussive forces from one said segment to the next substantially independently of said sleeves, the outside diameter of said sleeves interconnecting segments of said drill rod being less than the inside diameter of said drill tube segments.

4. Apparatus as recited in claim 1 which also includes hoist means operating on said support means and operating independently of said motor means thereon for engaging and retracting said drill tube when disengaged from said adapter.

5. Apparatus as recited in claim 4 in which said hoist means includes a slide member on said supporting means for engaging the upper end of said drill tube when disengaged from said adapter.

6. Apparatus as recited in claim 1 in which all the elements recited therein are supported on a moveable carriage and including means for selectively positioning said supporting means for addressing said earth covered rock to be drilled at a variety of positions.

7. In apparatus for drilling in earth covered rock with both a hollow drill tube and a drill rod coaxially operating within said drill tube, both said drill tube and said drill rod comprising a plurality of segments, and including motor means for driving both said drill tube and drill rod for both rotary and axial percussive drilling movements, the combination which comprises chuck and adapter means for transmitting both said rotary and axial percussive movements to said drill tube and drill rod and for releasably and independently connecting said drill tube and drill rod into driving engagement with said motor means, said adapter means including releasable threaded connections for separately engaging said drill tube and drill rod and for transmitting said rotary motion thereto, cooperating abutment surfaces on said adapter means and said drill tube and said drill rod substantially perpendicular to the axes thereof and disposed in direct abutting relation when said drill tube and said drill rod are engaged by said threaded connections for transmitting said axial percussive movement from said adapter means directly to said drill tube and drill rod through said abutment surfaces and substantially independently of said threaded connections, and means for advancing and retracting said chuck and adapter means axially of said drill tube and drill rod, said threaded connection and abutment surfaces for said drill rod all being configured and disposed coaxially within said drill tube and said threaded connection and abutment surfaces thereof whereby axial advancing and retracting of said drill rod may occur within said drill tube and independently thereof when said drill tube is disengaged from said adapter means yet whereby both rotary and percussive drilling movements are transmitted simultaneously to both said drill tube and said drill rod whenever both are engaged with said adapter means.

8. Apparatus as recited in claim 7 in which said drill tube and drill rod each comprises a plurality of axially extending segments joined in end-to-end arrangement, and a plurality of threaded sleeve connectors for joining said segments in said end-to-end arrangement, and in which each of said segments includes abutment surfaces substantially perpendicular to the axis thereof and in direct abutting relation for transmitting axial percussive forces from one said segment to the next substantially independently of said sleeve connectors.

9. Apparatus as recited in claim 7 in which said threaded connection for engaging said drill rod with said adapter means includes an axial threaded recess in the lower end of said adapter means for receiving said drill rod therein, and in which said threaded connection for said drill tube includes a threaded sleeve around said adapter means for receiving a threaded end of said drill tube therein, and in which said abutment surfaces for transmitting said percussive forces are formed at the upper end of said threaded recess for said drill rod and in the upper portion of said threaded sleeve for said drill tube.

10. In apparatus for drilling in earth covered rock with both a hollow drill tube and a drill rod coaxially operating within said drill tube and having a driving chuck and motor means for driving both said drill tube and drill rod for both rotary and axial percussive drilling movements, a connecting adapter assembly for releasably connecting successive drill tubes and drill rods separately into driving engagement with said drive chuck and motor means, which comprises in combination a shank portion on said adapter for releasably engaging said chuck for substantial axial movement with respect thereto during said percussive drilling movements, means on said shank portion forming a driving engagement with said chuck for rotary driving movement therewith, a body portion on said adapter for receiving said drill tubes and drill rods, first connecting means adjacent the axis of said body portion for engaging one end of a drill rod therein for transmitting rotary movement to said drill rod, an annular abutment on said body portion substantially perpendicular to the axis thereof and adjacent said connecting means for directly engaging cooperating abutment surfaces on said drill rod for transmitting axial percussive forces directly thereto and independently of said connecting means, second connecting means on said body portion and disposed coaxially around said first connect-

ing means and said drill rod for engaging one end of a drill tube therein for transmitting rotary movement to said tube, and an annular abutment on said body portion and said second connecting means and substantially perpendicular to the axis thereof for directly engaging cooperating abutment surfaces on said drill tube for transmitting axial percussive forces directly thereto, the lower ends of said drill tube including an annular percussion drill bit for drilling a hole of at least as great a diameter as said drill tube and the lower end of said drill rod including a percussion drill bit for drilling a hole of a diameter at least as great as said drill rod, with the diameter of said drill rod being substantially as great as the internal diameter of said annular drill bit on said drill tube.

11. Apparatus as recited in claim 10 in which said first connecting means for said drill rod includes an axial recess in said body portion for receiving said drill rod therein and including said abutment disposed for directly engaging the upper end surface of said drill rod, and in which said second connecting means comprises an internally threaded sleeve in threaded engagement with said body portion and around the outside thereof for receiving the upper end of said drill tube and having a radially inwardly extending annular abutment directly engaging said body portion and the end surface of said drill tube for providing said direct transmission of percussive forces.

References Cited by the Examiner

UNITED STATES PATENTS

1,079,836	11/1913	Canfield	175—320 X
1,507,986	9/1924	Cavender	175—320 X
1,628,033	5/1927	Davis	175—320 X
1,882,906	10/1932	Renfer	175—405 X
2,292,867	8/1942	Charles	175—138 X
2,536,971	1/1951	Weyandt	175—138
2,598,454	5/1952	Smith	175—138 X
2,599,770	6/1952	Marcerou	175—403 X
2,684,229	7/1954	Bergstrom	175—171 X
2,701,122	2/1955	Grable	175—69
2,784,942	3/1957	Peck et al.	175—171
2,830,795	4/1958	Center	175—379
2,903,242	9/1959	Bodine	175—404 X
2,948,514	8/1960	Long	175—171 X
3,023,820	3/1962	Desvaux et al.	175—171 X

CHARLES E. O'CONNELL, *Primary Examiner.*