Jan. 14, 1964 E. O. PERSSON 3,117,634

GROUND BORERS

Filed Feb. 13, 1959 2 Sheets-Sheet 1

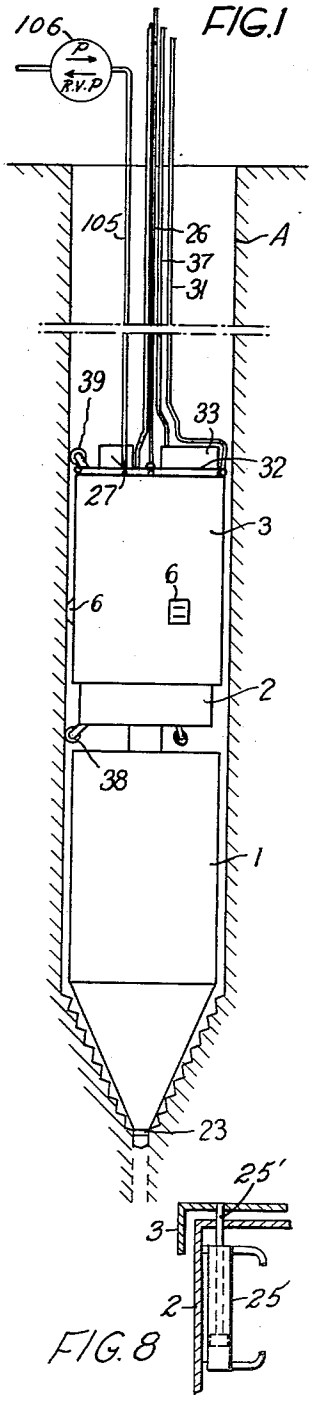


FIG. 1

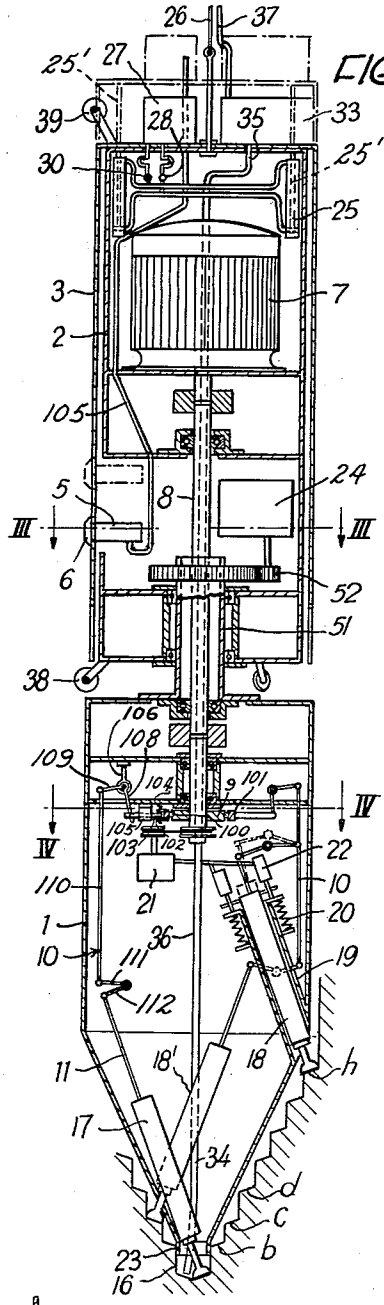


FIG. 2

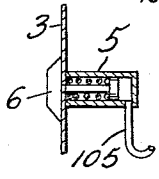


FIG. 6.

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FIG. 3

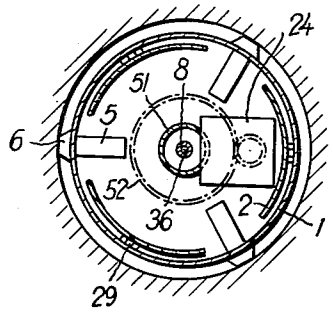


FIG. 5

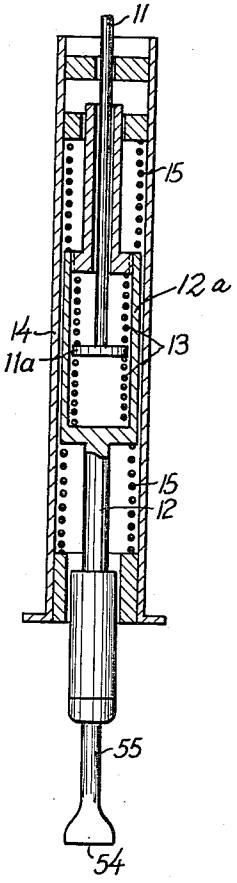
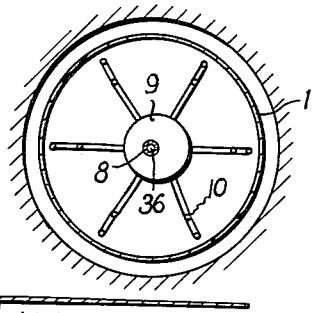


FIG. 4



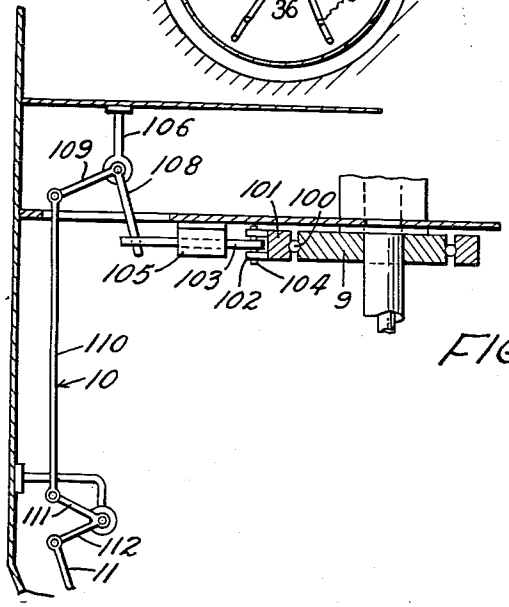


FIG. 7

United States Patent Office 3,117,634 Patented Jan. 14, 1964

3,117,634

GROUND BORERS

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Filed Feb. 13, 1959, Ser. No. 793,163
Claims priority, application Sweden Feb. 26, 1958
2 Claims. (Cl. 175—94)

This invention relates to a device for boring holes of great diameter in hard ground particularly solid rock, by means of a plurality of cooperating drills, and the object of the invention is to provide an improved construction of a boring device of this type. The borer according to the invention comprises, in combination, a hollow borer head having a plurality of hammer type drills the bits of which are located on an imaginary substantially conical surface, a carrier in which the borer head is mounted for rotation and which carries one or more electric motors for the drills, and a hollow guide member forming a shell for the carrier which is longitudinally displaceable therein.

An embodiment of the invention is described hereinbelow with reference to the annexed drawing in which FIG. 1 illustrates a lateral elevation of a borer placed in a bore-hole in working position, FIG. 2 a longitudinal section of the borer, FIG. 3 a section taken on the line III—III in FIG. 2, FIG. 4 a section taken on the line IV—IV in FIG. 2, FIG. 5 a longitudinal sectional view of one of the drills, FIG. 6 an enlarged detail view of one of the clamping members, FIG. 7 an enlarged detail of one of the linkage mechanisms for actuating the associated drill and FIG. 8 is an enlarged detail of one of the hydraulic cylinders interconnecting the carrier and guide sleeve.

Referring to the drawing, the borer comprises three main parts, namely, a hollow borer head 1 having mounted therein a plurality of cooperating drills, a carrier 2 in which the borer head 1 is mounted for rotation, and a hollow guide member 3 in which the carrier 2 is longitudinally displaceable and which is adapted to be locked to the wall of the bored hole A.

In the following description the borer is assumed to bore a vertical hole A, and the various directions indicated are related accordingly, but it will be understood that the bore holes may have any other direction, such as a horizontal one. In the working position, the guide member 3 is locked to the bore hole by means of clamping members 6 which are slidable inward and outward through openings in the wall of the guide member by means of hydraulic cylinders 5 which are connected to a fluid pressure pipe 105 from above the ground. As shown in FIG. 2, the fluid pressure supply pipe 105 passes through the interior of carrier 2 and through apertures in the upper end walls of guide member 3 and carrier 2 and is connected to a reversible delivery pump 106 situated above ground. Structural details of one of the three clamping members 6 and hydraulic cylinder 5 are shown in FIG. 6.

By means of a tubular shaft 51 the borer head 1 is mounted for rotation in the carrier 2. A motor 24 mounted in the carrier drives the tubular shaft by means of a gear transmission 52. Also mounted in the carrier 2 is an electric motor 7 for the drills provided in the borer head. One or more cam disks 9 in the form of eccentrics mounted in the borer head are rotated by the shaft 8 of the motor 7 to impart reciprocating movements to the drills. In the embodiment illustrated, six linkages 10 transmit the movement of the cam disk to the various drills. The arrangement may be such that one linkage drives a plurality of drills.

As shown in the larger scale view of FIG. 7, which

illustrates in further detail the construction of one of the linkages 10 and the manner in which it is actuated, a ring 101 with a ball bearing 100 is mounted on eccentric 9. Ring 101 is provided with lips 102 for each linkage 10, a push rod 103 being attached between these lips by means of a pin 104. Push rod 103 is longitudinally displaceable in a stationary guide member 105. On a bracket 106 there is mounted a bell crank lever, one arm 108 of which passes loosely through a hole in push rod 103. The other bell crank arm 109 is articulated to the upper end of a link rod 110. The lower end of rod 110 is articulated to one arm 111 of another bell crank lever and the other arm 112 of this latter lever is articulated to push rod 11. Movement of cam disc 9 thus transmits reciprocating movements to push rod 11 of each drill all as more particularly explained hereinafter with reference to FIG. 5.

The lower part of the borer head is in the form of a downwardly tapering cone. The drills extend obliquely with respect to the direction of advance of the borer and their shanks and bits project outside the borer head. The longitudinal axes of some or all of the drills are preferably located in planes which are parallel to the axis of the borer head and located laterally of said axis. The axes of some of the drills may be parallel to the axis of the borer head. The bits of the drills are located on a substantially conical surface. They are of the hammer type and each of the drills works upon a small part of the rock which has to be removed to form the bore hole. The drills are located stepwise along circles on different levels. For the sake of convenience all of the drills are not shown in the drawing. The different levels are indicated by the letters *b*—*h*, and one or more drills work on each level. The number of the drills which simultaneously work on the different levels is suitably chosen such as to have the drills remove substantially equal amounts of material. By way of example, six drills may be arranged on the uppermost levels, four drills on the two next following levels, etc. The drawing merely illustrates one drill 18 on the uppermost level, one drill 18′ on one of the lower levels, and a drill 17 at the point of the borer head.

The last-named drill serves to make a central pilot hole 16 for guiding the borer head. The drill 17 makes an angle with the axis of the borer head and is located in a manner such that one end of its cutting edge lies substantially on the axis of the borer head with the result that the diameter of the pilot hole 16 will be about twice the length of the cutting edge. The bottom end of the borer head 1 is provided with a guide collar or ring 23 adapted to enter the pilot hole 16. It should be noted that the drill 17 may be omitted if a narrow pilot hole, FIG. 1, having substantially the same diameter as the guide collar 23 is bored in advance in the rock.

The bits of the drills are suitable chisel edges extending substantially radially towards the axis of the borer head. On levels having two or more drills the cutting edges of such drills advantageously make alternate angles with the corresponding radius such that the lines through these edges cross each other. As a result thereof, the chips will be larger than if all of the edges would extend exactly radially.

FIG. 5 illustrates one of the drills operated by a linkage 10. Numeral 11 denotes a push rod which is articulated to the linkage. Numeral 54 denotes the bit and numeral 55 the shank which is secured to a slidable rod 12. A spring-case 12*a* is connected with the rod 12 and is slidably mounted in a casing 14. The push rod 11 has a disk-shaped abutment 11*a* inserted between two springs or resistant cushions 13 which bear on the respective end walls of the spring-case 12*a*. It will be seen that the

reciprocating movement of the push rod 11 will be transmitted to the spring-case and the tool 54, 55. On either side of the spring-case there are provided compression springs or resistant cushions 15 which keep the spring-case floating in the casing 14. The springs 15 are dimensioned such that the natural frequency of oscillation of the movable system 12, 13 is substantially equal to or somewhat lower than the frequency imparted to the push rod 11.

The drill casings 14 are advantageously rigidly secured to the borer head 1 except for the drill casings on the uppermost level. The last-named casings are inwardly displaceable to facilitate withdrawal of the borer from the bore hole. The uppermost drills are housed in guide sleeves 19 and acted upon by springs 20 which tend to move the drills inward into the borer head. Hydraulic cylinders 22 which receive fluid under pressure from a pump 21 or a fluid pressure conduit retain the drills in their working position against the action of the return springs 20. The supply of fluid under pressure may be controlled in a manner such that the drills are automatically advanced into working positions when the boring operation starts.

If, as illustrated, a vertical hole is to be bored, the carrier 2 is connected with a wire rope 26 by means of which the borer can be lifted or lowered. Secured to the top of the carrier 2 are hydraulic cylinders 25 comprising pistons and piston rods 25' which are connected, as shown in FIG. 8, with the guide member 3. The boring operation is performed step by step. To begin with, the carrier 2 and the borer head 1 are by means of the wire rope 26 kept in a position in which the drills are located slightly above the bottom of the bore hole. As shown in full lines in FIG. 2, the top wall of guide member 3 then engages the top wall of carrier 2 and the pistons 25' are retracted into their cylinders 25.

At the beginning of the boring operation, the guide member is locked to the wall of the bore hole by means of the clamping members 6. Thereupon the motor 7 is started and the rope 26 is slackened so that the entire structure will partly rest on the drills. As the drills are working their ways downwards during rotation of the borer head, liquid is expelled from the upper ends of cylinders 25 due to the fact that the carrier 2 is supported by the fluid cushions above the pistons of the cylinders. Liquid is forced upward into a container 27 through a conduit having a throttle valve 30 by means of which the pressure on the drills and the velocity of advance can be controlled. The carrier 2 is displaceable along substantially straight guides 29 and is thus prevented during the boring operation from rotation relative to the guide member 3. At the end of the downward movement the guide member 3 assumes the position relative to the carrier 2 indicated by dotted lines in FIG. 2. Now the motor is stopped and the clamping members 6 are released so that the guide member 3 can move downward by its own weight onto the carrier 2 depending from the rope until the parts again assume the positions shown in full lines in FIG. 2. During this movement, the cylinders 25 are refilled with liquid from the container 27 through the return pipe and the valve 30. The borer is now ready for the next boring step.

During the boring operation water is suitably supplied through a flexible pipe 31 and a spray ring 32 provided on top of guide member 3. The water flowing down carries along the chipped particles which mix with the water and are collected at the bottom of the bore hole. A mud pump 33 withdraws the mixture through flexible pipes 34, 35 and a tube 36 which extends through the motor shaft 8 and the motor 7, and through a flexible discharge pipe 37.

The carrier 2 and the guide member 3 have rollers 38 and 39, respectively, which guide the borer during its downward and upward movement through the bore hole. If the borer is used to make horizontal or slightly inclined

holes the rollers may be drivers. In case of bore holes which to a great extent deviate from the vertical direction, the cylinders 25 may be double-acting and adapted to be supplied with fluid under pressure. In this event, some modifications as to the washing out of the bore hole are necessary.

Means may be provided to guide the borer to some extent, for instance if the borer during operations tends to deviate from the intended straight direction of advance. To this end, the supply of fluid under pressure to the hydraulic cylinders 5 acting upon the clamping members 6 may be varied by remote control at the surface of the ground. The clamping members may be replaced by three vertically spaced apart pairs of clamping members. A signal responsive to the deviation can be given by an angle control member which indicates deviations from the intended direction of advance. By way of example, a weight or pendulum suspended in the carrier 2 in the form of an electrically conducting rod may be supplied with electric current at its suspension point. In the vertical position of the borer the pendulum is freely suspended, whereas upon deviation of the borer from the vertical position the pendulum is brought in engagement with one of plurality of contacts surrounding the lower end of the pendulum so as to close an electric circuit which gives a deviation-responsive signal that can be noticed above the surface of the ground. By variation of the supply of fluid under pressure to the cylinders 5 the borer can be restored to its proper position.

What I claim is:

1. Apparatus for boring in a step-by-step manner a hole of large diameter in hard ground comprising a vertically-arranged hollow guide member open at its lower end, clamping means connected to said guide member for releasably clamping said guide member to the walls of said hole, a carrier member mounted in said guide member for longitudinal displacement relative thereto, a hollow borer head colinearly arranged below and rotatably connected to the lower end of said carrier member, the lower end of said hollow borer head terminating in a converging conical portion having a central opening at the apex thereof, a hammer type drill mounted within said borer head and having a bit portion extending through said central opening to bore a central pilot hole in the ground, a guide collar surrounding said central opening and which extends into said pilot hole for guiding the lower end of said borer head during rotation thereof, a plurality of other hammer-type drills mounted within said borer head and having bit portions extending outwardly through axially-spaced openings in the conical portion of said borer head, means interconnecting said guide member and said carrier member and which provide for limited longitudinal movement of said carrier member relative to said guide member when said guide member is clamped to the walls of said hole, motor means secured to said carrier member for rotating said borer head relative to said carrier member, and means for axially reciprocating said drills relative to the openings in said borer head comprising an electric motor secured to said carrier member and having a rotary output shaft extending into said hollow borer head, cam means in said borer head connected to said motor shaft for rotation thereby, and linkage means in said borer head operable by said cam means to axially reciprocate said drills.

2. Apparatus as defined in claim 1 and further including roller means connected to said carrier member and to said guide member for engagement with the walls of said hole.

References Cited in the file of this patent

UNITED STATES PATENTS

1,287,477	Simpson	Dec. 10, 1918
1,484,065	Gould	Feb. 19, 1924

(Other references on following page)

5

UNITED STATES PATENTS

1,855,999	Shinn	Apr. 26, 1932
2,241,712	McNamara	May 13, 1941
2,400,853	Stilley	May 21, 1946
2,595,126	Causey	Apr. 29, 1952

6

2,637,527	Andrews	May 5, 1953
2,839,273	Holman et al.	June 17, 1958
2,859,941	Carroll et al.	Nov. 11, 1958

FOREIGN PATENTS

1,084,380	France	July 7, 1954