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DEVICE AND METHOD FOR THE RAPID EXECUTION OF BORE-HOLES IN ALL TYPES OF GROUND

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Fig.3

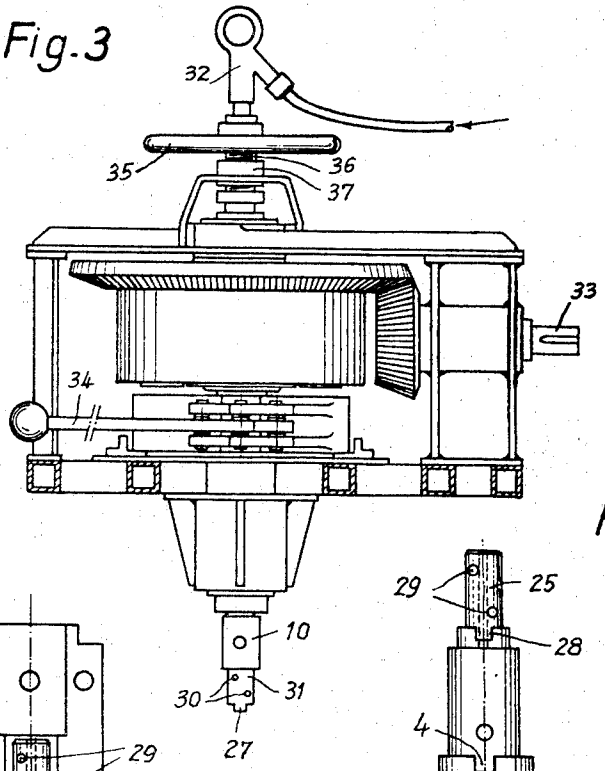


Fig.1

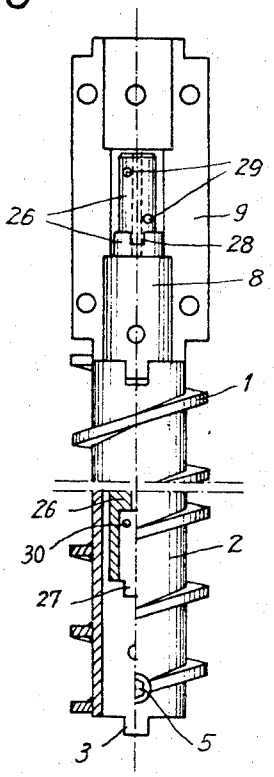
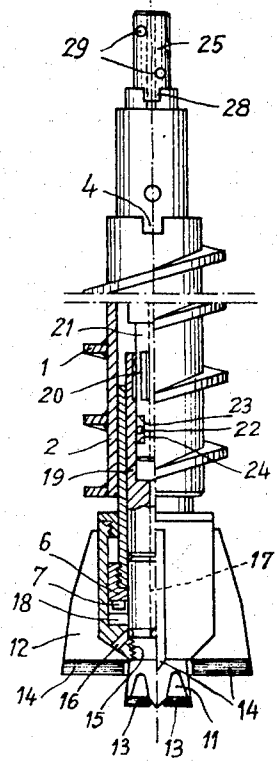


Fig.2



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DEVICE AND METHOD FOR THE RAPID EXECUTION OF BOREHOLES IN ALL TYPES OF GROUND

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ABSTRACT OF THE DISCLOSURE

A drilling apparatus including a drill stem disposed in an auger, and drive means for driving the drill stem and auger at different speeds. A working tool is operatively connected to the drill stem, and cam means are provided on the auger and the working tool and are adapted to impart a reciprocal movement to the tool upon a relative rotation between the drill stem and auger.

There exist numerous methods of boring adapted to the nature of the ground through which it is desired to pass.

In rocky ground, drilling is carried out either by percussion with the aid of driving equipment, used dry or with water, of mining drills with air or water; or by rotation, making use of the rotary system using clear water or sludge, with boring machines having tools using shot, tungsten carbide or diamonds for example.

In soft ground, the most generally employed method is driving by means of a boring-bit, either dry or with injection of water, which eliminates the necessity of assembling and dismantling of the drilling gear for the use of the drag for cleaning the borehole.

When the land has little cohesion, it is coffered internally by means of tubes which are driven in by percussion, simultaneously or not with the drilling operation. Another method which is less frequently employed is the use of continuous augers based on the principle of the Archimedean screw. These augers work without water supply and give very good results from the point of view of drilling progress in land whether coherent or not, on condition that it is not desired to find the exact location in depth of the sample of ground brought to the surface.

In the case where the ground has friable layers from top to bottom, with or without cohesion, alternating with rocky layers, and where it is not desired for various reasons (too great losses, blocking-up of the water intakes, difficulties of installation of the equipment, etc.) to utilize sludge, a first solution in the case of the percussion, rotary, rotating boring machine equipment, consists in driving a tube at the same time as the boring tool, through formations of different consistencies. For this purpose, it is appropriate to provide at the foot of the column of tubing a toothed shoe projecting with respect to the outer diameter of the tubing. This shoe has the function of an annular cutter and should play the same part as mine-boring cutters actuated by compressed air.

This solution has the following disadvantages:

(1) It is difficult, in certain ground formations to impart to the tube a circular motion for the purpose of facilitating the uniform attack of the shoe in the ground;

(2) The shock transmitted to the shoe by the weight striking on the head of the tubing column is deadened and all the more so as the column increases in length, with the result that the drilling efficiency becomes increasingly low;

(3) In the case of ground having a considerable gripping force on the tubes, it becomes impossible to push the latter sufficiently deep, which makes it necessary to employ telescopic tubing;

(4) Even in the case of ground which does not have a large gripping force on the tubes, when once the drilling is finished there is always a certain difficulty in extracting the tubes, which results in considerable loss of time;

(5) It should be observed that the use of any one of these equipments with injection of water under pressure in order to force upwards the drilling debris, results in the moisture conditions of the ground being considerably modified. If it is desired to measure in situ the resistivity of the ground in depth, the results obtained are absolutely inaccurate.

A second solution consists of the use of continuous helicoidal augers equipped at their base with a boring-bit with blades which cut the bottom of the hole before the material separated from the ground is engaged by the sloping blade of the auger.

This solution has a number of drawbacks:

(1) In heterogenous ground such as alluvials composed of elements of very varied sizes, the tool tears out the elements instead of cutting them, which results in the necessity of having an auger with a large pitch and a substantial width of blade of the helix, for the purpose of forcing upwards the large elements, which involves a non-useful increase in the driving power;

(2) The speed of rotation of the helicoidal auger is slow, so as to make it possible to obtain a high torque with a driving motor having a reasonable output. This speed of rotation is incompatible with the high speed required by the boring-bit with blades, in order to obtain a high drilling efficiency;

(3) For the purpose of obtaining rapid progress of drilling in certain formations of hard rock, there is an advantage in making use of their fragility and therefore employing percussion methods. Unfortunately, the conventional helicoidal auger does not permit of the use of this method.

Briefly summarized, the drilling apparatus of the present invention comprises a first and second drive means adapted to rotate at different speeds; a hollow rotating extraction cutting auger operatively connected to said first drive means; a drill stem disposed in said auger and operatively connected to said second drive means; a working tool; connecting means operatively connecting said tool to said drill stem to permit relative axial movement therebetween; first and second cam means fixed to said auger and to said tool, respectively, said first and second cam means being disposed in a facing relationship; and means to control the relative axial position of said auger and said drill stem to move said cam means to and from a reciprocal contact position in which a corresponding reciprocal movement is imparted to said tool.

To this end, the auger, divided-up into elements of variable lengths compatible with its use, assembled together by screwing, keying or by any other known method of assembly, comprises a hollow core on which is wound one or more turns projecting slightly with respect to the outer diameter of the hollow core.

The lower extremity of the core of the auger is provided with an annular piece having on its lower face teeth forming the first cam means, said face teeth having inclined or rounded faces, that is to say alternations of hollows and bosses so as to form for example, the profile which is obtained with balls of steel or any other material mounted in the ring at regular or irregular intervals.

The upper extremity of the core is provided with a driving head adapted for rigid fixing in rotation to a mechanism rotating at low speed.

The drilling tool comprises blades capable of working equally well by simple rotation or by rotation-percussion. This tool is made-up of two parts: a central portion which drills in the first place a centering pilot-hole in

the ground; and an annular portion boring the drilling hole to a diameter slightly greater than the outer diameter of the helicoidal auger. This part of the working tool comprises an annular internal part which is the replica of that fixed under the hollow core of the helicoidal auger, but in which the profile with teeth having inclined or rounded faces is turned upwards to form the second cam means.

The two parts forming the tool are fixed together by a thread or any other system of ensuring their coupling.

The central portion of the tool which is itself fixed to the annular part, as stated above, is driven by a hollow shaft having in consequence a central conduit, this shaft rotating inside the helicoidal auger. An intermediate piece can be inserted between the central portion of the tool and the hollow shaft. This has the purpose of permitting the tool to oscillate up and down with a small amplitude, without this oscillation being transferred to the driving shaft. This intermediate part may be, by way of example, similar to the sliding coupling of a splined shaft and hub.

The driving shaft is divided into elements of lengths corresponding to those of the elements of the auger. In the drilling tool are formed passage holes communicating with the central conduit of the driving shaft or of the intermediate piece. The upper extremity of the driving shaft is provided with a coupling member capable of being fixed to a driving mechanism rotating at high speed. This member is provided at its upper portion with a rotating injection head which communicates through a flexible pipe with an injection pump.

The above-mentioned means to control the relative axial position of the auger and the drill stem is located at the head of the assembly.

The invention is also applicable to methods of utilization of the device and to details of construction which are brought out in the description which follows below of one form of construction illustrated by way of example by the accompanying drawings, in which:

FIGURE 1 shows a partial cross-sectional view of the upper element of an auger intended for mounting on a driving device;

FIGURE 2 is also a partial section showing the lower extremity element of the auger, equipped with its cutting tools;

FIGURE 3 shows a driving device, the motor of which has not been shown.

As can be seen from FIGURES 1 and 2, a flat steel strip **1** is wound in a spiral of short pitch on the hollow core **2** of the auger. The steel strip is fixed to the core by welding or by any other known process. For the easy use of this auger, the latter is divided into elements of more or less great length. These are assembled to each other by a coupling with claws **3** and slots **4** which correspond, completed by a screw **5** passing through two elements at the level of their engagement. It will be understood that use can be made of any other known system of assembly.

The base of the hollow core **2** of the last element (FIGURE 2) terminates at its lower portion in an annular member **6** of treated steel of high strength, provided on its lower face with teeth **7**, the profile of which is similar to the teeth of a ratchet wheel. The upper portion of the hollow core is provided with a driving head **8** which, in the case of the leading auger element, is fixed by means of a sleeve **9** with bolted bushes to the shaft **10** of a driving device such as that shown in FIGURE 3, rotating at low speed.

The drilling tool comprises a central portion **11** and an annular portion **12**. These two portions both carry at their lower parts the blades **13** and **14** and are assembled by a threaded portion **15** or any other known system. For the lubrication of their blades, they are provided with holes or passages **16** communicating with an axial conduit **17** in the central portion **11**.

The central portion **11**, in which the base of the blades **13** is lower than the base of the blades **14** of the annular portion **12**, is intended to cut a centering pilot-hole in the ground. The central portion **11** of the tool has an internal annular ring of teeth **18** of treated steel of high strength, which is similar to the teeth **7** terminating the base of the hollow core of the auger but is distinguished from the latter by the fact that it is turned and faces upwards.

The central portion of the tool is rigidly fixed by means of threading or by any other known system of assembly to a sleeve **19** capable of sliding in the hollow core **2**. This sleeve is mounted with sliding splines **20** on a hollow splined shaft **21**. In order to prevent the sleeve **19** from leaving the hollow shaft **21**, a stop-member **22** fixed rigidly to the splined sleeve **19** by threading or by any other known system, is capable of moving vertically between two stops **23** and **24** provided on the hollow shaft **21**, while leaving the sleeve a certain freedom of vertical movement. The splined hollow shaft **21** is rigidly fixed at its upper portion **25** by threading or by any other known system with a drilling gear.

This drilling gear, which can rotate in the axis of the augers, is constituted by hollow rods **26** assembled to each other by sleeves with the aid of a coupling device constituted by lugs **27** engaged in the corresponding slots **28** and by screws or studs (not shown) engaged in holes **29** and **30** passing through the male and female sleeve portions, it being possible to replace this arrangement by any other known system (FIGURE 1).

The upper portion of the hollow drilling gear (FIGURE 1) is rigidly fixed by means of the above coupling device with another shaft **31** rotating at high speed inside the first shaft **10** of the driving device shown in FIGURE 3. To this end, this second shaft **31** is provided at its extremity with a socket pierced with holes **30** and is terminated by lugs **27** corresponding to the slots **28** of the upper portion of the elements of the drilling gear.

One of the two driving shafts **10** and **31** is adjustably mounted in height with respect to the other, the adjustment being effected for example by means of a system of a screw **36** and nut **37** actuated by a hand-wheel **35**.

The central conduit is the drilling gear communicates by an axial conduit formed in the second shaft and through the intermediary of a rotary joint (not shown) with a water-injection head **32**. By this means, the rotating drilling gear does not cause any movement of rotation of the injection head **32** and the height-regulating device **35**, **36** and **37**.

The driving device shown in FIGURE 3 is itself actuated by a motor (not shown) the shaft of which is coupled directly or through the intermediary of a conventional transmission to the input shaft end **33** of the device. This latter is effected in the form of a double change or a double speed-varying gear which enables the speeds of the hollow concentric output shafts **10** and **31** to be regulated independently of each other. This device is even provided in such manner that it enables the direction of rotation of the drilling gear to be reversed. A lever **34** mounted on the device itself permits the control of the speeds and the reversal of the direction of rotation.

An appropriate frame supports the driving device and the auger.

The whole of this drilling equipment according to the invention can be put into operation following two methods to which the invention is also applicable. In one, the boring tool works solely in rotation and in the other it works by rotation-percussion.

In the first method, the height of the driving shaft **31** of the drilling gear is adjusted with respect to that of the auger in such manner that the internal toothed ring **18** of the tool does not come into contact with the toothed ring **7** located under the hollow core of the auger.

By causing the tool and the auger to rotate at their respective speeds, the tool lubricated by injection water passing out through the passages **16** first attacks the ground by wear and reduces it to fine elements. These are then

engaged by the auger which raises these elements to the surface of the ground.

If it is desired to take samples intact, the central portion **11** of the tool is freed from its annular portion **12**. The assembly comprising the internal shaft **21** and the central tool **11** is removed and is replaced by a core-sample tool which takes the place of the central tool.

In the second method, the vertical position of the driving shaft of the driven gear is regulated with respect to that of the auger, this time in such manner that the internal toothed ring **18** of the tool comes into contact with the toothed ring **7** located under the hollow core of the auger. By causing the tool and the auger to rotate at their respective speeds, the teeth or projections of the ring **18** fixed to the tool slide over those of the ring **7** fixed to the hollow core of the auger, and the tool is then given small vertical alternating movements which produce successive shocks of the tool on the ground. The frequency of the shocks can be increased if the tool and the auger are rotated in opposite directions. These opposite movements furthermore facilitate the handling of the ground crushed by the blade **1** of the auger.

The device according to the invention and the methods for its application which make it possible to drill in all types of ground, offer the following particular advantages:

(1) At equal depths with respect to conventional augers, this improved auger does not necessitate large driving power. In fact, by virtue of the different speeds of the tool and the auger, the tool can be rotated at high speed while the auger rotates at a low speed, this auger absorbing an average power with a high torque. As the tool reduces the materials to fine elements, it is no longer necessary to have an auger comprising a large pitch and a considerable width of helix in order to bring up the materials. This results in a reduction of the power required.

(2) It is possible to make use of percussion for passing through certain types of ground.

(3) The hollow core of the auger which serves as a tubing moves readily in ground which has a large gripping force by virtue of its helix **1** which plays the part of a stirrer-mixer. The drilling can be carried out deeply and the removal of the whole gear is easy.

(4) In the case of use of percussion, the successive shocks have their origin above the tool and are transmitted directly to the ground without being deadened. This method makes it possible to obtain a shock frequency which is particularly high when the tool and the auger are rotating in opposite directions. The association of these two effects makes it possible to obtain a high efficiency.

(5) Water is employed solely as a simple lubricant and does not serve in any manner to bring up the drilling debris; it is therefore retained in a very restricted volume of ground and for this reason practically does not modify the resistivity of the ground in depth.

(6) It is possible with a simple adjustment and without the necessity of dismantling and reassembling the gear, to change-over, according to the ground to be bored, from drilling by rotation to drilling by rotation-percussion. This results in a very great flexibility of operation.

(7) The device can work in all positions.

What I claim is:

1. A drilling apparatus comprising first and second drive means adapted to rotate at different speeds; a hollow rotatable extraction cutting auger operatively connected to said first drive means; a rotatable drill stem disposed in said auger and operatively connected to said second drive means; a working tool; connecting means operatively connecting said tool to said drill stem to permit relative axial movement therebetween; first and second cam means fixed to said auger and to said tool, respectively, and disposed in a facing relationship; and means to control the relative axial position of said auger and said drill stem to move said cam means to and from a reciprocal contact position in which a corresponding reciprocal movement is imparted to said tool upon rotation of said auger and said drill stem.

2. The apparatus of claim **1**, wherein said drill stem comprises an axial water injection conduit opening to the exterior by at least one passage formed in said tool.

3. The apparatus of claim **1**, wherein said first and second cam means are each constituted by a ring provided on one of its faces with projecting portions with inclined surfaces and arranged in such a manner that when the rings are in contact, the inclined surfaces of one ring slide over those of the other, thus imparting said reciprocal movement to said tool.

4. The apparatus of claim **1**, wherein said drive means comprises an input shaft, two hollow and concentric output shafts adapted to be coupled, one to the auger and the other to the drill stem, and a speed varying box and gear system permitting a reversal of direction of rotation of said output shafts.

5. The apparatus of claim **1**, wherein the drill stem and the auger are each composed of assembled sections.

6. The apparatus of claim **1**, wherein said tool is composed of a centering boring bit around which are disposed the blades of an annular boring bit.

7. The apparatus of claim **1**, wherein said tool is composed of an annular boring bit equipped with a central core sample tool.

8. The apparatus of claim **1**, wherein said connecting means is in the form of a supporting rod fixed to said tool and coupled to the extremity of said drill stem by a sliding coupling with splines, said axial movement being limited by means of a stop member fixed to said rod and engaged between two end-of-travel abutments provided in said drill stem.

9. The apparatus of claim **1**, wherein said connecting means is in the form of a supporting rod fixed to said tool and coupled to the extremity of said drill stem by a sliding coupling with splines, said axial movement being limited by means of a stop member fixed to said drill stem and engaged between two end-of-travel abutments provided in said rod.

References Cited

UNITED STATES PATENTS

701,547	6/1902	Davis	175—171
2,701,124	2/1955	Pronio	175—170
2,764,387	9/1956	Dionisotti	175—173 X
2,950,087	8/1960	Gregory	175—171 X

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