ABSTRACT
A borer comprises a hammer, a spindle connected to rotate with a rotatable table, and a vibrator connected between the hammer and a support for vibrating the hammer. The spindle is free to rotate with respect to the support. A flexible coupling is arranged between the support and the table.

13 Claims, 2 Drawing Figures
UNIVERSAL DRILLING MACHINE

The present invention relates to borers. Conventional borers are of several types depending upon the nature of the material, for example, soil, which it is desired to bore. Thus, when taking core samples in soft ground, a borer which applies a static thrust to a drilling tool is used. Such a borer may be driven alternately from either side of a mean position in order to obtain what is generally called a “tacking” effect. Other borers are used for boring more or less hard material. One such borer comprises a vibrating part, the vibrations of which are generated mechanically or electromagnetically. In this case boring is accomplished either by purely vertical movement or by vertical movement combined with torsional movement of a drilling tool. Another conventional borer comprises a rotating part, for example, a rotating table, rigidly connected with a spindle on which is mounted a succession of rods at the end of which there is a drilling tool. In this case, the boring is accomplished by the rotating part, possibly, assisted by thrust forces.

These conventional borers do not lend themselves readily to boring all kinds of materials. Moreover, it is very often necessary, during the course of sinking a hole, to change the drilling tool when strata which differ in composition are encountered. The result of these disadvantages is a considerable loss of time and the expenditure of a considerable labour effort.

Furthermore, the conventional borers are heavy, occupy a considerable space, and it is essential to have a source of considerable power to operate them.

The present invention seeks to provide a borer which does not have the disadvantages of the conventional borer and which can be used to bore into all kinds of materials.

According to the present invention, there is provided a borer comprising: percussion means; a spindle connected to a rotatable table; vibrator means connected with the percussion means and a support member mounted on the spindle, the spindle being free to rotate with respect to the support member; and flexible coupling means arranged between the support member and the table.

Means for driving the borer may be disposed adjacent to the table.

Preferably, the spindle is axially movable with respect to the table.

The support member may have a flange disposed about the spindle, bearing means being disposed therebetween, the said flange having at least one support member means for the flexible coupling means. Resilient means may be provided between the vibrator means and the flange.

Preferably the resilient means are such that, in operation, the frequency of vibration of the vibrator means and the percussion means is greater than the inherent frequency of vibration of the table.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:

FIG. 1 is a diagrammatic elevation of a borer according to the present invention, mounted on a vehicle, and FIG. 2 is a sectional view of the borer of FIG. 1.

FIG. 1 shows diagrammatically a borer according to the present invention mounted on a vehicle. A hydraulic unit 2 arranged to be driven by an engine (not shown) of the vehicle, is mounted thereon. A control panel 3, whose controls are mainly electrical, is like

wise provided on the vehicle. The control panel permits the borer to be manually or automatically controlled. A positioning apparatus is located on the vehicle. The positioning apparatus may assume a working position (shown in heavy lines) or an inoperative position (shown in dotted lines) for transport purposes. The positioning apparatus includes a jack 4 pivoted at 5 to the vehicle. A rod 6 of the jack is rigidly connected to an angle plate 7 which, in turn, is fixed to a mast 8 arranged to guide and support a borer 9. The plate 7 is connected by way of a jack 10 to a lever 11 pivoted on an angle plate 12 which is also fixed to the mast 8.

On both the plate 7 and the lever 11 are provided two pulleys 13, 14 respectively. A traction cable 15 passes over these pulleys and is connected to a winch 16 mounted on the vehicle 1. A stabilising jack 17 is rigidly mounted on the vehicle 1. On the rod of the jack 17 are means 18 for retaining a train of rods 19 and a boring or drilling tool (not shown).

At the top of the mast 8 is a pulley 20 over which passes a cable or chain 21. The chain 21 is fixed at 24 to the borer 9 and passes over one or a plurality of pulleys 22 carried by an angle plate 23 pivotally mounted on the vehicle.

As shown in FIG. 2, the borer 9 comprises a rotating table 25 consisting of a casing 26 inside which is a gear wheel 27. The gear wheel 27 meshes with a gear wheel 28 of smaller diameter. The gear wheel 28 is mounted on a driving spindle 29 which is supported from the casing 26 by bull bearings 30. The spindle 29 is rotated by a hydraulic axial piston engine 31 of variable capacity. The engine 31 is fed by a pump which is likewise of variable capacity. The capacities of the pump and of the engine 31 may be remotely controlled by one and the same single control means (not shown). Thus, it is possible to vary the speed of rotation of the spindle 29 over a wide range whilst always using the maximum power produced by the main engine, for example, that of the vehicle.

The gear wheel 27 is mounted on a drive shaft 32 within which there is a hollow spindle 33. The drive shaft 32 is rigidly supported from a casing 35 by means of a plurality of roller bearings 36. On its outer periphery, the spindle 33 has splines 34 adapted to cooperate with splines 35 provided on the inside surface of the drive shaft 32. Thus, the spindle 33 is capable of axial displacement with respect to the gear wheel 27 and, therefore, with respect to the table 25, and yet it is rotated by the gear wheel 27.

The spindle 33 is connected to a body 37 extending from a solid annular flange 38 by means of roller bearings 39, for example, roller thrust bearings. The bearings 39 are capable of absorbing vibrational forces and the repeated shocks of percussion experienced by the borer. The flange 38, which follows any axial displacement of the spindle 33, has a series of holes 40, 41 distributed around its periphery adjacent the body 37. Engaged in each of four holes 40 is a rod 42 fixed with a boss end 43 provided on the casing 26 and a thrust member 44. On either side of the flange 38 rubber washers 45 are fitted onto each rod 42. Axial movement of the flange 38 is limited by stops 43a, 44a on the respective boss end 43, and by the thrust members 44.

Screwed into each of four holes 41 is one end of a rod 46. A spring 47, of a stiffness different from that of a plurality of washers 49, surrounds each rod 46. The springs 47 work in a traction-compression manner and
are disposed in such a way that adjacent springs are of opposite hand.

Each spring 47 is fixed at its one end to a ring 48 rigidly connected with the flange 38 and at its other end to a ring 49 rigidly connected with a casing 52 of a vibrator 50. The casing 52 likewise comprises a ring 51 through which the rods 46 pass and on which the vibrator 50 is capable of being guided and retained in position by means of nuts 53. In this way, it is possible to control the distance between the vibrator 50 and the annular flange 38.

The vibrator 50 is constituted by the casing 52 which is traversed by two parallel shafts 54, 55. The shafts 54, 55 rotate in opposite directions and each carries an eccentric member 56, 57 respectively. The shafts 54, 55 are driven by one or more hydraulic motors (not shown) coupled together mechanically. The speed of rotation of the hydraulic motors can be regulated with accuracy. The shape of each eccentric member 56, 57 is adjusted to obtain a maximum kinetic moment for a given weight and yet a minimum size for the vibrator 50. For this purpose, each eccentric member is constituted by a steel matrix in which small cylinders of a very heavy metal, such as, for example, calcined tungsten carbide or uranium lead, are housed symmetrically with respect to the axis of rotation. Thus, by aligning the vibrator 50 and the spindle 33, it is possible to ensure that the forces produced by vibration of the vibrator 50 are parallel to the axis of the spindle, in order to derive maximum advantage from the vibration. Screwed with a slight pitch into a lower part 58 rigidly mounted to the casing 52, is a striker or hammer member 60. The connection between the casing 52 and the part 58 is strengthened by two reinforcing plates 59. The hammer 60 is driven by a hydraulic motor 61 located above the vibrator 50 and an axially sliding rod 62 fitted with splines 63 which engage corresponding splines in the part 58. The rod 62 is coxial with the spindle 33.

The hammer member 60 has a head 64 housed in a cavity 65 provided in the upper part of the spindle 33. The head 64 has an annular rebated edge 66. By virtue of the rebated edge 66, it is possible instantaneously to regulate the distance between an end face 64a of the head 64 and the adjacent surface of the cavity 65. This adjacent surface is at least partially covered by a treated metal pad 67.

In operation, when the hammer member 60 is sufficiently close to the pad 67, a regular striking procedure is established, and this striking procedure tends to move the spindle 33 axially. This causes consequential movement of the train of rods 19 and the drilling tool itself. However, in view of the fact that the washers 45 have considerable flexibility with respect to the springs 47, used to suspend the vibrator 50, with the result that the frequency of inherent vibration of the assembly is suspended by the springs is very small with respect to the frequency of vibration of the vibrator 50, it follows that only a very small part of the inherent vibration is transmitted to the casing 26.

A part of the cavity 65 is closed over the head 64 of the hammer member 60 and has, on its surface adjacent the head, a treated metal part 69. Thus upward movement of the head is reversed by successive impacts of the edge 66 on the metal part 69.

The lower end of the spindle 33 is provided with screw threading 70 for connection with the train of rods 19 or the drilling tool. A rotatable connector 71 has a passageway 72 therein which is arranged to be positioned opposite an orifice 73 provided in the spindle 33. It is through the passageway 72 that flushing liquid passes when necessary. The connector 71 is resiliently mounted by an elastic block 74 from a connecting piece 75 fixed to the casing 26.

It will be appreciated that all the operations performed by conventional borers may be performed by the borer described above.

If the vibrator 50 is locked to the rods 46 and the head 64 is positioned in the cavity 65 so that the amplitude of vibration of the vibrator is such that there is no contact between either the head 64 and the pad 67, or the edge 66 and the part 69, then all the vibration of the vibrator is transmitted to the spindle 33 via the rods 46, the flange 38 and the bearings 39. In many cases, this vibration may be sufficient to cause penetration of the drilling tool in contact with material, for example, soil, to be drilled.

Similarly, it is possible to drill through soil merely by rotation of the spindle or by such rotation in combination with vibration of the hammer member 60.

It should be noted that, by virtue of the stops 43a, 44a, the vibrator 50 is protected against excessive static thrust forces.

We claim:

1. A universal drilling machine comprising: percussion means, a rotary spindle mounted on a table to be engaged by said percussion means, a support member supportingly mounted on the rotary spindle for free rotation with respect to the rotary spindle, vibrator means connected to the percussion means and the support member, and flexible coupling means arranged between the support member and the table and driving means for said percussion means, said vibrator means and said spindle.

2. A universal drilling machine as claimed in claim 1 in which said spindle is axially movable with respect to the table.

3. A universal drilling machine as claimed in claim 1 in which the support member has a flange disposed about the spindle and including bearing means disposed between the said flange and said spindle wherein said flange includes a portion supportingly engaged with the flexible coupling means.

4. A universal drilling machine as claimed in claim 1 including stop means for limiting axial movement of said flange with respect to said table.

5. A universal drilling machine as claimed in claim 1 in which the vibrator means is positionably guided by a plurality of rods along which the vibrator means is capable of being retainably positioned by nuts.

6. A universal drilling machine as claimed in claim 1 in which the vibrator means rests on the support means by means of a plurality of springs surrounding guide rods extending from the support means.

7. A universal drilling machine as claimed in claim 1 in which said driving means comprises hydraulic driving means of variable capacity.

8. A universal drilling machine as claimed in claim 1 in which said flexible coupling means comprise shock absorbing surrounding rods extending from the clearance openings in the flange of the support means and stop means on the rod means on the side of the flange opposite said table, said washers being disposed on either side of said flange.
9. A universal drilling machine as claimed in claim 1 additionally including resilient connecting means provided between the vibrator means and the flange of said support member.

10. A universal drilling machine as claimed in claim 9 in which the resilient means comprises a plurality of springs, adjacent springs being of opposite hand.

11. A universal drilling machine as claimed in claim 1 in which the percussion means includes a head, and means for adjusting the distance between the head and the spindle.

12. A universal drilling machine as claimed in claim 11 in which the head is screwed to the vibrator means and a bore extends through the head mounted in said bore to move coaxially with respect to the spindle within said bore and a driving motor connected to said rod for axially positioning the rod with respect to the spindle.

13. A universal drilling machine as claimed in claim 11 including a cavity in the spindle, the percussion head being axially displaceable within the cavity.
CERTIFICATE OF CORRECTION

Patent No. 3,786,874  Dated January 22, 1974

Inventor(s) Alain Jodet et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 3, --, a rod is -- is inserted after "head".

Column 6, line 5, --is-- is inserted after "motor".

Signed and sealed this 11th day of February 1975.

(Seal)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,786,874 Dated January 22, 1974
Inventor(s) Alain Jodet et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 62, --washers-- is inserted after "absorbing".

Signed and sealed this 19th day of November 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR. C. MARSHALL DANN
Attesting Officer Commissioner of Patents