(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 352 979 A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 89307415.3

(22) Date of filing: 20.07.89

(51) Int. Cl.4: E21B 7/24 , E21B 25/00

(30) Priority: 28.07.88 GB 8818024

(43) Date of publication of application: 31.01.90 Bulletin 90/05

(84) Designated Contracting States: BE DE ES FR GB IT NL SE

(71) Applicant: The British Petroleum Company p.l.c.
Britannic House Moor Lane
London EC2Y 9BU(GB)

(72) Inventor: Bollands, Martin Arthur
9 Brackley Queens Road
Weybridge Surrey KT13 0VJ(GB)
Inventor: Chinery, David
The British Petroleum Company p.l.c.
Chertsey Road
Sunbury-on-Thames Middlesex, TW16 7LN(GB)
Inventor: Woolmington, Thimothy Ray
The British Petroleum Company p.l.c.
Chertsey Road
Sunbury-on-Thames Middlesex, TW16 7LN(GB)

(74) Representative: MacLeod, Malcolm et al
BP INTERNATIONAL LIMITED Patents Division Chertsey Road
Sunbury-on-Thames Middlesex TW16 7LN(GB)

(54) Variable amplitude drill.

(57) A vibratory core drill comprises a housing (11) adapted for connection to a drill string and a variable amplitude rotor (10) rotably mounted in the housing (11), the variable amplitude rotor (10) comprising a central shaft (1), an inner shell (2), the inner and outer shells (2) and (3) being capable of rotation relative to one another and capable of being locked in any desired relationship and released.

The variable amplitude rotor enables the amplitude of oscillation to be varied to cope with formations of different characteristics, eg, sand and clay.

The drill is suitable for use in drilling core samples for evaluating the mineral potential of deposits and for environmental monitoring to detect possible contamination.

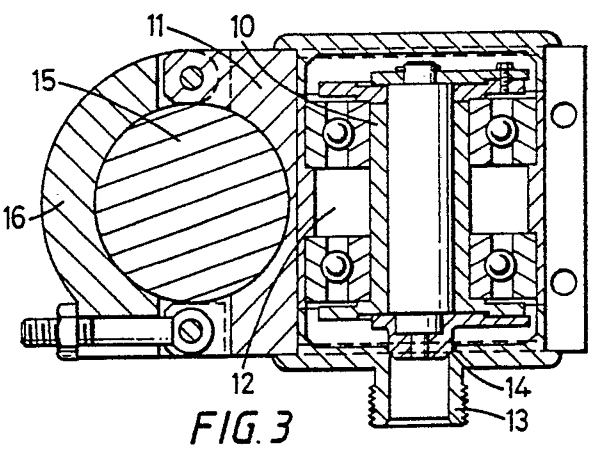


FIG. 3

EP 0 352 979 A2

VARIABLE AMPLITUDE DRILL

This invention relates to a variable amplitude drill suitable for use in vibratory drilling equipment for unconsolidated formations, such as soil, sand and gravel or similar materials.

Vibratory drilling is a known technique in which a formation is penetrated by vibrating a drill string without rotating it. The vibration is caused by the rotation of an eccentric or unbalanced rotor. This allows cores to be obtained with minimum disturbance from their in-situ condition. The drill string is fitted at its lower end with a bit, otherwise known as a shoe, to provide a cutting edge. The shoe is generally in the form of a hollow cone with a smoothly tapering exterior wall. The frequency of vibration is often in the sonic range, in which case the technique is known as sonic drilling.

British Patent Specification 2152100B discloses a vibratory, core drill apparatus comprising: a housing; an eccentric member rotatably mounted in the housing for vibrating the apparatus when the eccentric member is rotated about an axis of rotation, the eccentric member being sealingly received within the hollow interior of the housing so the hollow interior can hold an oil bath for the eccentric member; means for connecting a rotating power source to the eccentric member to rotate the eccentric member; and means for connecting to the housing a core drill barrel with a longitudinal axis so that the longitudinal axis is perpendicular to the axis of rotation of the eccentric member.

Whilst penetration in a suitable formation can be fast, conditions are often encountered where, either in the zone to be cored or in the overlaying formations, penetration is slow or indeed the drill may refuse. Reasons for refusal include: (1) congestion of the tube with core material which, due to friction on the inside of the tube, damps the vibrations, (2) friction between the outside of the tube and the formation which again attenuates the vibrations, and (3) inability of the shoe to break down the formation around its cutting edge so allowing it to be displaced from the contact zone and allowing the tube movement to progress.

Our GB 2181766A discloses and claims a drill shoe which is more effective in overcoming these problems than previously employed shoes.

However, problems still remain particularly when drilling through consecutive strata of different materials with different physical properties.

During drilling, the drill string oscillates in a sinusoidal fashion with an amplitude which is determined by the eccentricity of the rotor. This oscillation is transferred to the shoe except in the unlikely event of the shoe finding itself at a node. The oscillation is damped to some extent by the formation through which the drill string and shoe are drilling, but still remains to a greater or lesser extent.

A perceptible, but small, amplitude of oscillation is desirable to prevent the drill string from jamming in the hole.

A large amplitude, however, is undesirable because this effectively reduces the area of entry of the core sample to the shoe to that area which is common to the shoe in every position. The smaller the amplitude of the shoe, the greater is that proportion of the area of the shoe which is always open for the entry of core.

In loose materials such as running sand or gravel, the damping effect is less pronounced than in stiffer materials such as clay and tar sands.

Thus there are different requirements for different formations. For loose materials the natural amplitude (i.e. undamped) should be small since there is relatively little damping of the oscillation. For stiff formations the natural oscillation should be greater since the relatively greater damping effect of the formation reduces this to the desired smaller amplitude.

We have now devised a variable amplitude drill which enables the amplitude of oscillation to be varied to cope with formations of different characteristics.

This is achieved by making the position of the centre of gravity of the rotor variable.

According to the present invention there is provided a vibratory core drill comprising a housing adapted for connection to a drill string and a variable amplitude rotor mounted in the housing, the variable amplitude rotor comprising a central shaft, an inner shell adjacent to the shaft and an outer shell adjacent to the inner shell, the inner and outer shells being capable of rotation relative to one another and capable of being locked in any desired relationship and released.

Preferably both inner and outer shells are in the form of semi-cylinders.

The inner shell and the central shaft may be integral with one another.

The housing may be mounted directly above the drill string so that the axis of rotation of the rotor is perpendicular to the axis of the drill string.

While this configuration is suitable for simple drilling operations where cores from a shallow depth are required, it suffers from certain disadvantages where drilling to greater depths is concerned. One disadvantage is that the housing must be disconnected and removed each time it is necessary to add a further length of drill string. Another concerns core recovery. In order to retrieve recovered cores, a top-mounted housing must be removed each time to gain access to the drill string bore.

These problems are avoided by side-mounting the housing and passing the drill string through a clamp in the housing.

The resulting configuration may be orthogonal in that the axis of the drill string is vertical and that of the variable amplitude rotor is horizontal. However, this is not essential and the axis of the variable amplitude rotor may be at an angle to the horizontal or even vertical.

The rotor may be driven by a flexible cable attached to a prime mover, such as an internal combustion engine or it may be driven directly by a prime mover mounted on the housing.

Preferably both inner and outer shells are in the form of semi-cylinders.

For minimum amplitude when both shells are in the form of semi-cylinders, the shells should be positioned in the least unbalanced position, i.e. with one facing the other. For maximum amplitude the shells should be positioned in the most unbalanced position, i.e. with the inner resting within the outer. For intermediate amplitudes the shells can be positioned between the extremes.

The drill is suitable for use in drilling core samples for evaluating the mineral potential of deposits.

It may also be used for environmental monitoring since the core samples can be analysed to determine the extent of any contamination which may have occurred.

The invention is illustrated with reference to Figures 1 to 4 of the accompanying drawings wherein

Figure 1 is a section of the variable amplitude rotor in three positions,

Figure 2 is diagram showing the oscillation of a drill string,

Figure 3 is a plan view, partly in section, of a housing containing a variable amplitude rotor side mounted on a drill string and

Figure 4 is an isometric view of the same.

With reference to Figure 1, the variable amplitude rotor comprises a rotor shaft 1, a semi-cylindrical inner shell 2 and a semi-cylindrical outer shell 3.

(a) shows the rotor arranged for minimum amplitude for oscillation, (b) for intermediate amplitude and (c) for maximum amplitude.

With reference to Figure 2, the rotor assembly 4, schematically shown, is connected to a drill string 5 which in turn is connected to a core drilling shoe 6. The maximum out-of-balance oscillation is shown by line 7 and a reduced out-of-balance oscillation by line 8. The variable oscillation amplitude is shown by line 9.

The horizontal and vertical axes are not drawn to the same scale and to illustrate the point, the amplitudes are shown considerably exaggerated.

With reference to Figures 3 and 4, a variable amplitude rotor 10 is contained within an oil filled housing 11 and mounted on a bearing pack 12. The rotor 10 is driven by a cable drive (not shown) through a connector 13 sealed from the housing by means of an oil seal 14.

The housing 11 is clamped around a drill string 15 by means of a pivoted clamp 16.

When the clamp 16 is tightened, the housing 11 is firmly attached to the drill string 15. Vibration of the rotor 10 is transmitted to the drill string 15 and both move downwards during drilling.

When a new length of drill string is added, the housing 11 is supported, clamp 16 is slackened and the housing 11 is slid up to the top of the new length where it again secured by clamp 16 and the support released.

Claims

1. A vibratory core drill comprising a housing (11) adapted for connection to a drill string (15) characterised by the fact that a variable amplitude rotor (10) is mounted in the housing (11), the variable amplitude rotor (10) comprising a central shaft (1), an inner shell (2) adjacent to the shaft (1) and an outer shell (3) adjacent to the inner shell (2), the inner and outer shells (2) and (3) being capable of rotation relative to one another and capable of being locked in any desired relationship and released.

2. A vibratory core drill according to claim 1 wherein the inner and outer shells (2) and (3) are in the form of semi-cylinders.

3. A vibratory core drill according to either of the preceding claims wherein the inner shell (2) and the central shaft (1) are integral with one another.

4. A vibratory core drill according to any one of the preceding claims wherein the housing (1) is adapted to be mounted directly above the drill string (15) so that the axis of the rotation of the rotor (10) is perpendicular to the axis of the drill string (15).

5. A vibratory core drill according to any of claims 1 to 3 characterised by the fact that the housing (11) is adapted for side mounting to the drill string (15).

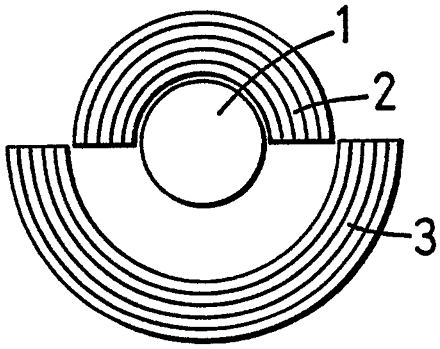
6. A vibratory core drill according to claim 5 wherein the housing (11) is adapted for orthogonal side mounting with the axis of the variable amplitude rotor (10) being horizontal.

7. A vibratory core drill according to claim 5 wherein the housing (11) is adapted for side

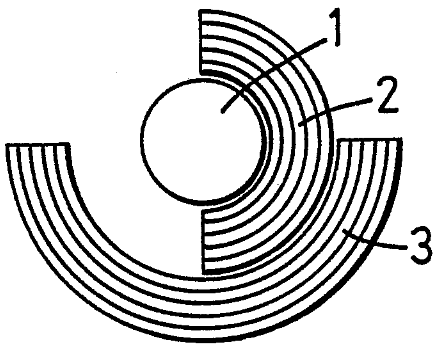
mounting with the axis of the variable amplitude rotor (10) being at an angle to the horizontal.

8. A vibratory core drill according to claim 7 wherein the axis of the variable amplitude rotor (10) is vertical.

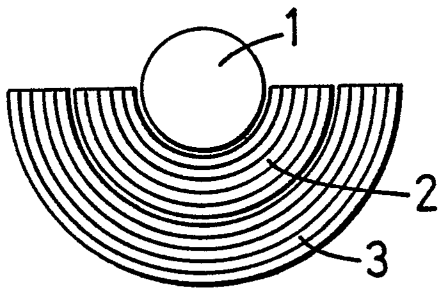
FIG.1



(a) Minimum Amplitude

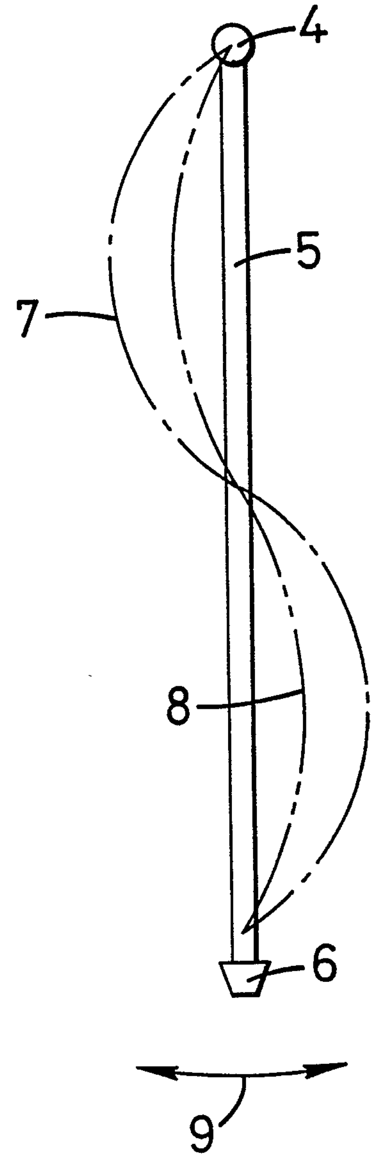


(b) Intermediate Amplitude



(c) Maximum Amplitude

FIG. 2



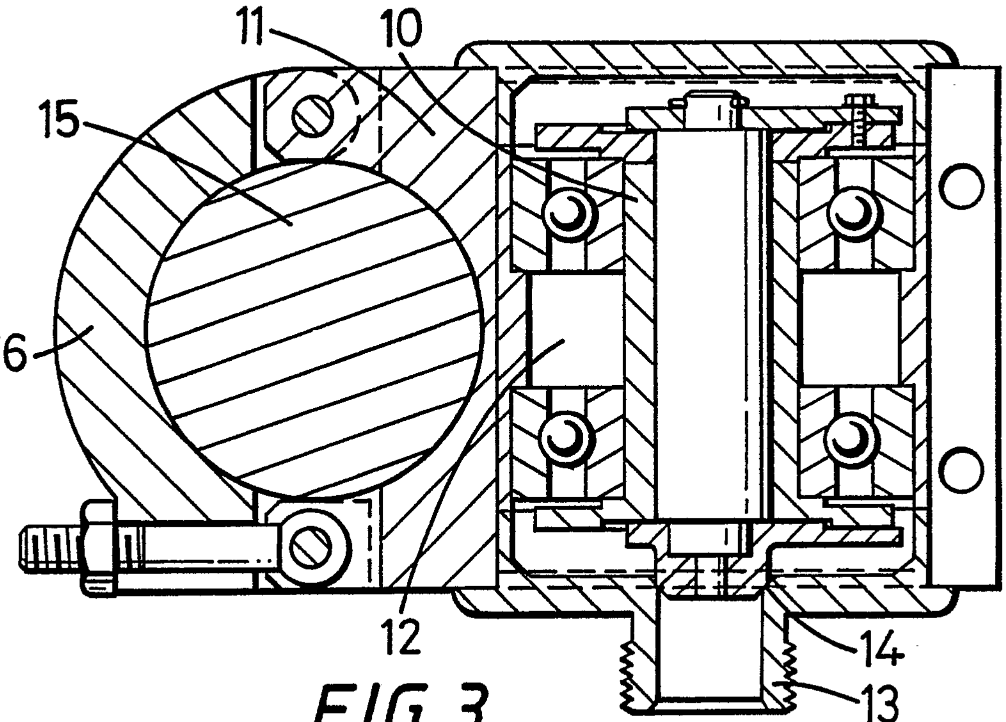


FIG. 3

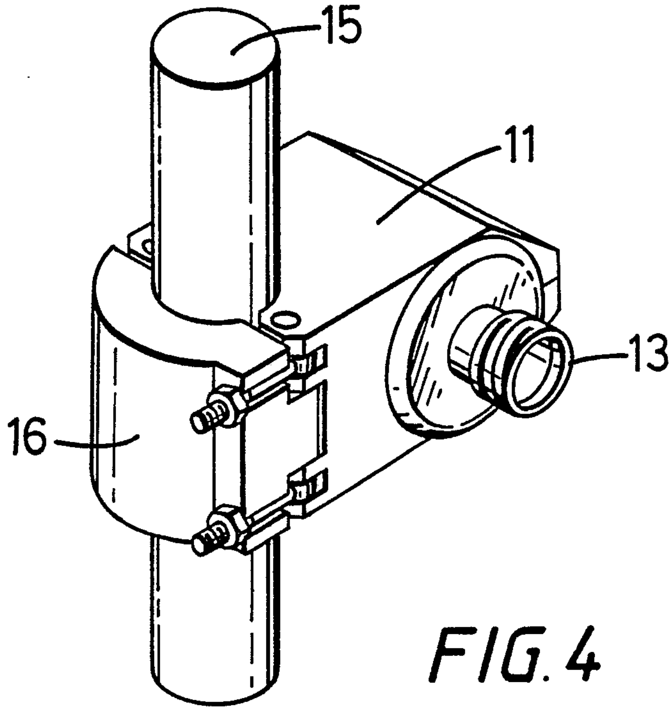


FIG. 4