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(54) **APPARATUS AND A METHOD FOR DRILLING BOREHOLES**

VORRICHTUNG UND VERFAHREN ZUM BOHREN

APPAREIL ET PROCEDE DE PER AGE DE TROUS DE FORAGE

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Description

[0001] The invention relates to apparatus and a method for use downhole and particularly relates to apparatus for inclusion in a drill string which is used to drill a borehole, and to a method of reducing the variation of a drill bit from an intended path in a borehole.

[0002] In the art of drilling boreholes, and particularly in relation to drilling boreholes for hydrocarbon exploration and production, it is well known to use drill bits located at one end of a drill string.

[0003] Conventionally, there are two basic methods which can be used to impart motion to the drill bit in order to operate it. The first method is to rotate the drill string from a drilling rig located at the surface. In this method of use of the drill string, the drill string can be likened to a rotating shaft, where the drill string may be many thousands of feet long. The second method includes use of a downhole motor which is located in the drill string just above the drill bit, and which provides power to rotate the drill bit.

[0004] In both of these existing methods of drilling a borehole, it is very difficult to maintain the drill bit on its intended path. For instance, if the intended path is vertically downwards, such as path 1 shown in Fig. 1, it is usual for the actual path of the drill bit to be in the form of a helix around the intended path, akin to a corkscrew path. The helix or corkscrew path can be seen in Fig. 1 as path 2 drilled by the drilling rig B. This helix or corkscrew path will mean that the drill bit and drill string must take a longer path than that intended.

[0005] Conventional methods and apparatus for reducing this problem include running a number of stabilisers spaced apart along the string, where the stabilisers contact the just-drilled borehole with spiral fluted fins, in an attempt to keep the string straight. However, this conventional method is extremely inefficient, since the stabilisers inevitably create drag on the progress of the string into the borehole, in the form of friction between the fins and the inner surface of the borehole.

[0006] Accordingly, it would be advantageous and desirable to reduce the helix or corkscrew path to a path which approaches that intended, with a reduced or obviated requirement for stabilisers, where a reduced helical or corkscrew path is shown in Fig. 1 as path 3.

[0007] A method and apparatus for preventing a well from deviating from a vertical line is described in US3,391,749, and a method and apparatus for controlling the direction of advance of a rotary drill is described in US5,439,064.

[0008] According to a first aspect, the present invention provides an apparatus for inclusion in a string having a longitudinal axis and having a drill bit located at one end, the apparatus comprising a body having a longitudinal axis which is substantially coaxial with the longitudinal axis of the string, a portion of the body having a cross-section where the centre of mass of the body on that cross-section is offset from the longitudinal axis of the string, wherein rotation of the portion of the body about its longitudinal axis produces a vibratory motion by the portion of the body to counteract vibration or deviation of the string from its intended path, characterised in that the vibratory motion is capable of being tuned by altering the distribution and/or location and/or amount of mass in the portion of the body by moving, inserting or removing one or more filling material elements from the body, said filling material elements being releasably secured to the body.

[0009] The invention thus provides a string having an eccentric weight e.g. offset from the axis.

[0010] According to a second aspect, the present invention provides a method of reducing the variation of a drill bit from an intended path in a borehole, where the drill bit is coupled to one end of a string having a longitudinal axis, the method comprising including a body in the string, where a portion of the body has a cross-section where the centre of mass of the body on that cross-section is offset from the longitudinal axis of the string; inserting the string into a borehole; wherein rotation of the portion of the body about its longitudinal axis produces a vibratory motion by the portion of the body to counteract vibration or deviation of the string from its intended path, characterised by tuning the vibratory motion by altering the distribution and/or location and/or amount of mass in the portion of the body by moving, inserting or removing one or more filling material elements from the body, said filling material elements being releasably secured to the body.

[0011] The invention has the advantage that rotation of the portion of the body about its longitudinal axis produces a vibratory action by the portion of the body.

[0012] The intended path is preferably straight.

[0013] Preferably, the mass of the body on that cross-section is distributed such that one half of the cross-section has a lower mass than the other half of the cross-section.

[0014] Optionally, the body is a tubular member, which typically comprises a throughbore which is in communication with a throughbore of the string.

[0015] Optionally, the portion of the tubular member comprises a non-uniform tubular cross-section, and preferably comprises a cavity which is typically formed along a length of the longitudinal axis of the tubular member.

[0016] The invention has the advantage that the cavity can be left empty, partially filled, or wholly filled with a filling material, in order to vary the centre of mass of the tubular member.

[0017] Optionally, the filling material is substantially secured within the cavity, and more preferably, the filling material is substantially secured (or its position in the cavity influenced) by a magnetic force.

[0018] Preferably the cavity is formed by removing a cover portion from the tubular member, and removing material from either, or both of, the tubular member or the cover portion. Preferably, the cover portion is re-

placed on the tubular member such that the cavity is formed in the space between the tubular member and the cover portion.

[0019] Preferably, the cover portion includes an aperture to permit access to the cavity, and more preferably to permit the filling material to be inserted into, or removed from, the cavity. Preferably, the apparatus further comprises a closure device to permit the aperture to be obturated.

[0020] Preferably, the cover portion is replaced on the tubular member by securing it to the tubular member. More preferably, the cover portion is secured to the tubular member by welding it thereto.

[0021] An embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:-

Fig. 1 is a schematic diagram of two boreholes being drilled;

Fig. 2 shows an exploded side view of an apparatus for use downhole in accordance with the present invention;

Fig. 3 shows an exploded perspective view of the apparatus of Fig. 2;

Fig. 4 shows a partial-cut-away side view of the apparatus of Fig. 2 assembled;

Fig. 5 shows a cross-sectional view across section AA of the apparatus of Fig. 4; and

Fig. 6 shows a partial-cut-away perspective view of the apparatus Fig. 2, fully assembled.

[0022] A downhole tool 10 is shown in Fig. 2, and which is intended for inclusion in a string (not shown), such as a drill string made up of a number of drill pipes, where the string is inserted into a borehole 3 (see Fig. 1) to be drilled by a drilling rig/platform A.

[0023] The tool 10 comprises a body 20, which has a tapered screw thread pin connection 18 at one end and a tapered screw thread box connection 19 at the other end, for inclusion in a drill string in a conventional manner. The body 20 also comprises a throughbore 25, which is shown in dotted phantom lines, and which is in fluid communication with the pin 18 and box 19 connections, thus allowing fluid, such as conventional drilling fluid, to flow through the body 20.

[0024] The lower half of the body 20 as shown in Fig. 2 is in the form of a standard tubular member, such as a drill pipe, and thus has a semi-circular outer circumference which is of the same diameter as the circular outer circumference of the box connection 19. The outer surface diameter of the box connection 19, and the semi-circular outer surface diameter of the lower half of the body 20, is 203.2mm (8 inches) and the inner diameter of the throughbore 25 is 73mm (2⅞ inches), which provides a side wall thickness of the lower half of the body 20 of 65.1mm ($2^{9}/_{16}$ inches).

[0025] A length, which is semi-circular in cross-section, of the upper half of the body 20 shown in Fig. 2 has been removed, although a semi-circular side wall portion 30 of the body 20 remains, thus ensuring that there is no fluid leak path from the throughbore 25 through the sidewall portion 30. The sidewall portion 30 has a thickness of 12.7mm (½ inch).

[0026] A cover 22 is shown in Fig. 2 and has a semi-circular cross-section of the same outer diameter as that of the lower half of the body 20 (that is 203.2mm (8 inches)). The sidewall thickness of the cover 22 is 12.7mm (½ inch).

[0027] In use of the downhole tool 10, the cover 22 is fitted onto the upper half of the body 20 as shown in Fig. 2, such that the outer circumference of the cover 22 is in line with the outer circumference of the pin connection 19. Therefore, there is a cavity formed between the inner circumference of the cover 22 and the outer circumference of the upper half of the body 20 as shown in Fig. 2. The cross-sectional radius of the cavity 32 is 41.3mm (1⅝ inch). The cover 22 is secured to the upper half of the body 20, as shown in Figs. 4, 5 and 6, and preferably the cover 22 is welded to the body 20. Preferably, the cover 22 is formed from same the material removed from the body 20 to form the upper half of the body 20.

[0028] An aperture 26 having a 38.1mm (1½ inch) diameter is formed through the sidewall of the cover 22, and in use, the aperture 26 is obturated by a plug 24.

[0029] Hence, the centre of mass of the body 20 through the cross-section shown in Fig. 5 does not coincide with the longitudinal axis of the downhole tool 10, since the lower half of the body 20 will have a greater collective mass than the upper half of the body 20.

[0030] The collective mass of the upper half of the body 20 can be increased by inserting a filling material 34 into the cavity 30 through the aperture 26. A suitable filling material is shown in Fig. 6 as a number of 1 inch diameter steel balls, collectively designated as 34. Thus, by varying the number of steel balls 34 retained within the cavity 32, the centre of mass of the body 20 can be altered.

[0031] The steel balls 34 can optionally be secured within the cavity 32 by attaching a permanent magnet 36 to the outer surface of the side wall portion 30.

[0032] The length, depth and width of the material removed from the upper half of the body 20 to form the side wall portion 30, the cover 22, and the resulting cavity 32 can be varied. Further, the number of one inch diameter steel balls 34 inserted into the cavity 32 can be varied, as can the location at which the downhole tool 10 is included in the string, depending on the formation through which it is required to be drilled.

[0033] Accordingly, when the body 20 is rotated, within the drill string, a vibratory action will be produced, since the downhole tool 10 will be rotating out of balance. Depending on the aforementioned variables, this vibratory action will tend to counterbalance the out of balance rotation of the drill bit, and thus reduce or preferably eliminate the variation of the drill bit from its intended path. The vibratory motion produced by the body

20 can be tuned to values chosen to counteract vibration or deviation of the string from its intended path. Accordingly, by reducing the vibration imparted to the end of the drill string by the out of balance rotation of the drill bit, the spiralling or helical action of the drill bit is reduced or optimally eliminated.

[0034] Further, the invention has the advantage that by providing a cavity 32 so that the centre of mass of a cross-section of the body 20 does not coincide with that of the downhole tool 10, or that of the string, the outer circumference of the body 20 has no upsets, and thus is flush with the outer circumference of the drill string.

[0035] If the downhole tool 10 is included in the string between a drilling motor and the drill bit, typical rotation speeds are likely to be in the region of 500 to 600 rpm.

[0036] If the rotation is provided to the drill bit by rotary drilling, that is by rotating the drill string from the drilling rig/platform, then typical rotation speeds of the drill string, and thus the body 20, are likely to be in the region of 80 to 150 rpm, but could be as high as 220 rpm.

[0037] Accordingly, by use of the present invention, the requirement for conventional stabilisers in the string is reduced or optimally obviated.

[0038] Modifications and improvements may be made without departing from the scope of the invention. For example, the cavity can be filled with filling material with a different density than the material forming the tool 10. Particularly, the filling material can be a denser material such as lead. Additionally, more than one cavity can be formed in the same portion of the tool 10, so as to allow increased control of variation of the string's path.

Claims

1. Apparatus (10) for inclusion in a string having a longitudinal axis and having a drill bit located at one end, the apparatus (10) comprising a body (20) having a longitudinal axis which is substantially coaxial with the longitudinal axis of the string, a portion (30) of the body (20) having a cross-section where the centre of mass of the body (20) on that cross-section is offset from the longitudinal axis of the string, wherein rotation of the portion (30) of the body (20) about its longitudinal axis produces a vibratory motion by the portion (30) of the body (20) to counteract vibration or deviation of the string from its intended path, **characterised in that** the vibratory motion is capable of being tuned by altering the distribution and/or location and/or amount of mass in the portion (30) of the body (20) by moving, inserting or removing one or more filling material elements (34) from the body (20), said filling material elements (34) being releasably secured to the body (20).

2. Apparatus (10) according to claim 1, wherein the offset of the centre of mass of the body (20) is provided by the body (20) further comprising a cavity (32) having an opening.

3. Apparatus (10) according to claim 2, wherein the body further comprises a cover portion (22) adapted to close the opening of the cavity (32).

4. Apparatus (10) according to any preceding claim, wherein the mass of the body (20) on that cross-section is distributed such that one half of the cross-section has a lesser mass than the other half of the cross-section.

5. Apparatus (10) according to any preceding claim, wherein the body (20) is a tubular member (20).

6. Apparatus (10) according to claim 5, wherein the tubular member (20) comprises a throughbore (25) which is in communication with a throughbore of the string.

7. Apparatus (10) according to either of claims 5 or 6, wherein the portion (30) of the tubular member (20) comprises a non-uniform tubular cross-section.

8. Apparatus (10) according to claim 2 or to any of claims 3 to 7 when dependent upon claim 2, wherein the cavity (32) is formed along a length of the longitudinal axis of the tubular member (20).

9. Apparatus (10) according to 2 or to any of claims 3 to 8 when dependent upon claim 2,wherein the filling material elements (34) are inserted into the cavity (32) or removed from the cavity such that the centre of mass of the tubular member (20) is varied.

10. Apparatus (10) according to claim 9, wherein movement of the filling material elements (34) within the cavity (32) is inhibited.

11. Apparatus (10) according to claim 10, wherein movement of the filling material elements (34) in the cavity (32) is inhibited by a magnetic force.

12. Apparatus (10) according to claim 3 or to any of claims 4 to 11 when dependent upon claim 3, wherein the cavity (32) is formed by removing the cover portion (22) from the tubular member (20), and removing material from at least one of the tubular member (20) and the cover portion (22).

13. Apparatus (10) according to claim 3 or to any of claims 4 to 12 when dependent upon claim 3, wherein the cover portion (22) is replaced on the tubular member (20) such that the cavity (32) is formed in the space between the tubular member (20) and the cover portion (22).

14. Apparatus (10) according to claim 3 or to any of

claims 4 to 12 when dependent upon claim 3, wherein the cover portion (22) includes an aperture (26) to permit access to the cavity (32).

15. Apparatus (10) according to claim 14, wherein the aperture (26) permits the filling material elements (34) to be inserted into, or removed from, the cavity (32).

16. Apparatus (10) according to either of claims 14 or 15, wherein the apparatus (10) further comprises a closure device (24) to permit the aperture (26) to be obturated.

17. Apparatus (10) according to any of claims 10 to 14, wherein the cover portion (22) can be replaced on the tubular member (20) and secured to the tubular member (20).

18. Apparatus (10) according to claim 13 or to any of claims 14 to 17 when dependent upon claim 13, wherein the cover portion (22) is secured to the tubular member (20) by welding it thereto.

19. A method of reducing the variation of a drill bit from an intended path (1) in a borehole, where the drill bit is coupled to one end of a string having a longitudinal axis, the method comprising including a body (20) in the string, where a portion (30) of the body (20) has a cross-section where the centre of mass of the body (20) on that cross-section is offset from the longitudinal axis of the string; inserting the string into a borehole; wherein rotation of the portion (30) of the body (20) about its longitudinal axis produces a vibratory motion by the portion (30) of the body (20) to counteract vibration or deviation of the string from its intended path, **characterised by** tuning the vibratory motion by altering the distribution and/or location and/or amount of mass in the portion (30) of the body (20) by moving, inserting or removing one or more filling material elements (34) from the body (20), said filling material elements (34) being releasably secured to the body (20).

20. A method according to claim 19, wherein the said portion of the body comprises a cavity (32).

21. A method according to claim 20, wherein the cavity (32) is covered with a cover portion (22).

22. A method according to any one of claims 19 to 21, wherein the mass of the body (20) on that cross-section is distributed such that one half of the cross-section has a lesser mass than the other half of the cross-section.

23. A method according to either of claims 20 or 21 or to claim 22 when dependent upon either of claims 20 or 21, wherein the body (20) is a tubular member (20) and the cavity (32) is formed along a length of the longitudinal axis of the tubular member (20).

24. A method according to claim 20 or to any of claims 21 to 23 when dependent upon claim 20, wherein the one or more filling material elements(34) are inserted into the cavity (32) such that the centre of mass of the tubular member (20) is varied.

Patentansprüche

1. Eine Vorrichtung (10) zum Einschluss in einem Strang, der eine Längsachse und einen an einem Ende befindlichen Bohrmeißel aufweist, wobei die Vorrichtung (10) einen Körper (20) mit einer Längsachse, die mit der Längsachse des Strangs im Wesentlichen koaxial ist, beinhaltet, wobei ein Abschnitt (30) des Körpers (20) einen Querschnitt aufweist, wobei der Massenschwerpunkt des Körpers (20) auf diesen Querschnitt von der Längsachse des Strangs versetzt ist, wobei die Drehung des Abschnitts (30) des Körpers (20) um seine Längsachse eine Schwingungsbewegung durch den Abschnitt (30) des Körpers (20) erzeugt, um der Schwingung oder Ablenkung des Strangs von seiner geplanten Bahn entgegenzuwirken, **dadurch gekennzeichnet, dass** die Schwingungsbewegung durch das Ändern der Verteilung und/oder der Position und/oder der Größe der Masse in dem Abschnitt (30) des Körpers (20) abgestimmt werden kann, indem ein oder mehrere Stützmaterialelement(e) (34) aus dem Körper (20) bewegt, eingeführt oder entfernt wird/werden, wobei die Stützmaterialelemente (34) an dem Körper (20) lösbar befestigt sind.

2. Vorrichtung (10) gemäß Anspruch 1, wobei die Versetzung des Massenschwerpunkts des Körpers (20) **dadurch** bereitgestellt ist, dass der Körper (20) ferner einen Hohlraum (32), der einen Durchlass aufweist, beinhaltet.

3. Vorrichtung (10) gemäß Anspruch 2, wobei der Körper ferner einen Abdeckungsabschnitt (22), der zum Verschließen des Durchlasses des Hohlraums (32) angepasst ist, beinhaltet.

4. Vorrichtung (10) gemäß einem der vorhergehenden Ansprüche, wobei die Masse des Körpers (20) auf diesem Querschnitt so verteilt ist, dass eine Hälfte des Querschnitts eine niedrigere Masse als die andere Hälfte des Querschnitts aufweist.

5. Vorrichtung (10) gemäß einem der vorhergehenden Ansprüche, wobei der Körper (20) eine röhrenförmige Komponente (20) ist.

6. Vorrichtung (10) gemäß Anspruch 5, wobei die röhrenförmige Komponente (20) eine Durchgangsbohrung (25) beinhaltet, die mit einer Durchgangsbohrung des Strangs in Verbindung steht.

7. Vorrichtung (10) gemäß einem der Ansprüche 5 oder 6, wobei der Abschnitt (30) der röhrenförmigen Komponente (20) einen nicht einheitlichen röhrenförmigen Querschnitt beinhaltet.

8. Vorrichtung (10) gemäß Anspruch 2 oder gemäß einem der Ansprüche 3 bis 7, wenn von Anspruch 2 abhängig, wobei der Hohlraum (32) entlang einer Länge der Längsachse der röhrenförmigen Komponente (20) gebildet ist.

9. Vorrichtung (10) gemäß Anspruch 2 oder gemäß einem der Ansprüche 3 bis 8, wenn von Anspruch 2 abhängig, wobei die Stützmaterialelemente (34) in den Hohlraum (32) eingeführt oder aus dem Hohlraum entfernt werden, so dass der Massenschwerpunkt der röhrenförmigen Komponente (20) variiert wird.

10. Vorrichtung (10) gemäß Anspruch 9, wobei eine Bewegung der Stützmaterialelemente (34) innerhalb des Hohlraums (32) verhindert wird.

11. Vorrichtung (10) gemäß Anspruch 10, wobei die Bewegung der Stützmaterialelemente (34) in dem Hohlraum (32) durch eine Magnetkraft verhindert wird.

12. Vorrichtung (10) gemäß Anspruch 3 oder gemäß einem der Ansprüche 4 bis 11, wenn von Anspruch 3 abhängig, wobei der Hohlraum (32) durch das Entfernen des Abdeckungsabschnitts (22) aus der röhrenförmigen Komponente (20) und das Entfernen von Material aus mindestens entweder der röhrenförmigen Komponente (20) oder dem Abdeckungsabschnitt (22) gebildet wird.

13. Vorrichtung (10) gemäß Anspruch 3 oder gemäß einem der Ansprüche 4 bis 12, wenn von Anspruch 3 abhängig, wobei der Abdeckungsabschnitt (22) auf der röhrenförmigen Komponente (20) wieder platziert wird, so dass der Hohlraum (32) in dem Zwischenraum zwischen der röhrenförmigen Komponente (20) und dem Abdeckungsabschnitt (22) gebildet wird.

14. Vorrichtung (10) gemäß Anspruch 3 oder gemäß einem der Ansprüche 4 bis 12, wenn von Anspruch 3 abhängig, wobei der Abdeckungsabschnitt (22) eine Öffnung (26) umfasst, um Zugang zu dem Hohlraum (32) zu ermöglichen.

15. Vorrichtung (10) gemäß Anspruch 14, wobei es die Öffnung (26) ermöglicht, die Stützmaterialelemente (34) in den Hohlraum (32) einzuführen oder aus diesem zu entfernen.

16. Vorrichtung (10) gemäß einem der Ansprüche 14 oder 15, wobei die Vorrichtung (10) ferner eine Verschlusseinrichtung (24) beinhaltet, um das Abdichten der Öffnung (26) zu ermöglichen.

17. Vorrichtung (10) gemäß einem der Ansprüche 10 oder 14, wobei der Abdeckungsabschnitt (22) auf der röhrenförmigen Komponente (20) wieder platziert wird und an der röhrenförmigen Komponente (20) befestigt werden kann.

18. Vorrichtung (10) gemäß Anspruch 13 oder gemäß einem der Ansprüche 14 bis 17, wenn von Anspruch 13 abhängig, wobei der Abdeckungsabschnitt (22) **dadurch** an der röhrenförmigen Komponente (20) befestigt ist, dass er daran angeschweißt ist.

19. Ein Verfahren zum Vermindern der Abweichung eines Bohrmeißels von seiner geplanten Bahn (1) in einem Bohrloch, bei dem der Bohrmeißel mit einem Ende eines Strangs, der eine Längsachse aufweist, gekoppelt ist, wobei das Verfahren Folgendes beinhaltet: das Einschließen eines Körpers (20) in dem Strang, wobei ein Abschnitt (30) des Körpers (20) einen Querschnitt aufweist, wobei der Massenschwerpunkt des Körpers (20) auf diesem Querschnitt von der Längsachse des Strangs versetzt ist; das Einführen des Strangs in ein Bohrloch; wobei eine Drehung des Abschnitts (30) des Körpers (20) um seine Längsachse eine Schwingungsbewegung des Abschnitts (30) des Körpers (20) erzeugt, um der Schwingung oder Ablenkung des Strangs von seiner geplanten Bahn entgegenzuwirken, **gekennzeichnet durch** das Abstimmen der Schwingungsbewegung, indem die Verteilung und/oder die Position und/oder die Größe der Masse in dem Abschnitt (30) des Körpers (20) geändert wird, indem ein oder mehrere Stützmaterialelement(e) (34) aus dem Körper (20) bewegt, eingeführt oder entfernt wird/werden, wobei die Stützmaterialelemente (34) an dem Körper (20) lösbar befestigt sind.

20. Verfahren gemäß Anspruch 19, wobei der Abschnitt des Körpers einen Hohlraum (32) beinhaltet.

21. Verfahren gemäß Anspruch 20, wobei der Hohlraum (32) mit einem Abdeckungsabschnitt (22) abgedeckt ist.

22. Verfahren gemäß einem der Ansprüche 19 bis 21, wobei die Masse des Körpers (20) auf diesem Querschnitt so verteilt ist, dass eine Hälfte des Querschnitts eine niedrigere Masse als die andere Hälfte

des Querschnitts aufweist.

23. Verfahren gemäß einem der Ansprüche 20 oder 21 oder gemäß Anspruch 22, wenn von einem der Ansprüche 20 oder 21 abhängig, wobei der Körper (20) eine röhrenförmigen Komponente (20) ist und der Hohlraum (32) entlang einer Länge der Längsachse der röhrenförmigen Komponente (20) gebildet ist.

24. Verfahren gemäß Anspruch 20 oder gemäß einem der Ansprüche 21 bis 23, wenn von Anspruch 20 abhängig, wobei das eine oder die mehreren Stützmaterialelement(e) (34) in den Hohlraum (32) eingeführt werden, so dass der Massenschwerpunkt der röhrenförmigen Komponente (20) variiert wird.

Revendications

1. Appareil (10) destiné à être inclus dans une garniture ayant un axe longitudinal et ayant un trépan situé à une extrémité, l'appareil (10) comportant un corps (20) ayant un axe longitudinal qui est substantiellement coaxial à l'axe longitudinal de la garniture, une portion (30) du corps (20) ayant une section transversale où le centre de masse du corps (20) sur cette section transversale est décalé par rapport à l'axe longitudinal de la garniture, dans lequel la rotation de la portion (30) du corps (20) autour de son axe longitudinal produit un mouvement vibratoire par la portion (30) du corps (20) pour neutraliser la vibration ou la déviation de la garniture de son chemin projeté, **caractérisé en ce que** le mouvement vibratoire peut être syntonisé en modifiant la répartition et/ou l'emplacement et/ou la quantité de masse dans la portion (30) du corps (20) en déplaçant, insérant ou retirant un ou plusieurs éléments de matériau de remplissage (34) du corps (20), lesdits éléments de matériau de remplissage (34) étant assujettis au corps (20) de façon détachable.

2. Appareil (10) selon la revendication 1, dans lequel le décalage du centre de masse du corps (20) est fourni par le fait que le corps (20) comporte de plus une cavité (32) ayant une ouverture.

3. Appareil (10) selon la revendication 2, dans lequel le corps comporte de plus une portion formant chape (22) adaptée pour fermer l'ouverture de la cavité (32).

4. Appareil (10) selon n'importe quelle revendication précédente, dans lequel la masse du corps (20) sur cette section transversale est répartie de façon à ce qu'une moitié de la section transversale ait une masse inférieure à celle de l'autre moitié de la section transversale.

5. Appareil (10) selon n'importe quelle revendication précédente, dans lequel le corps (20) est un organe tubulaire (20).

6. Appareil (10) selon la revendication 5, dans lequel l'organe tubulaire (20) comporte un alésage débouchant (25) qui est en communication avec un alésage débouchant de la garniture.

7. Appareil (10) selon soit la revendication 5, soit la revendication 6, dans lequel la portion (30) de l'organe tubulaire (20) comporte une section transversale tubulaire non uniforme.

8. Appareil (10) selon la revendication 2 ou n'importe lesquelles des revendications 3 à 7 lorsqu'elles dépendent de la revendication 2, dans lequel la cavité (32) est formée sur une longueur de l'axe longitudinal de l'organe tubulaire (20).

9. Appareil (10) selon la revendication 2 ou n'importe lesquelles des revendications 3 à 8 lorsqu'elles dépendent de la revendication 2, dans lequel les éléments de matériau de remplissage (34) sont insérés dans la cavité (32) ou retirés de la cavité de façon à faire varier le centre de masse de l'organe tubulaire (20).

10. Appareil (10) selon la revendication 9, dans lequel le déplacement des éléments de matériau de remplissage (34) au sein de la cavité (32) est inhibé.

11. Appareil (10) selon la revendication 10, dans lequel le déplacement des éléments de matériau de remplissage (34) dans la cavité (32) est inhibé par une force magnétique.

12. Appareil (10) selon la revendication 3 ou n'importe lesquelles des revendications 4 à 11 lorsqu'elles dépendent de la revendication 3, dans lequel la cavité (32) est formée en retirant la portion formant chape (22) de l'organe tubulaire (20), et en retirant du matériau d'au moins soit l'organe tubulaire (20), soit la portion formant chape (22).

13. Appareil (10) selon la revendication 3 ou n'importe lesquelles des revendications 4 à 12 lorsqu'elles dépendent de la revendication 3, dans lequel la portion formant chape (22) est replacée sur l'organe tubulaire (20) de façon à ce que la cavité (32) soit formée dans l'espace entre l'organe tubulaire (20) et la portion formant chape (22).

14. Appareil (10) selon la revendication 3 ou n'importe lesquelles des revendications 4 à 12 lorsqu'elles dépendent de la revendication 3, dans lequel la por-

tion formant chape (22) comprend un orifice (26) pour permettre l'accès à la cavité (32).

15. Appareil (10) selon la revendication 14, dans lequel l'orifice (26) permet aux éléments de matériau de remplissage (34) d'être insérés dans, ou retirés de la cavité (32).

16. Appareil (10) selon soit la revendication 14, soit la revendication 15, dans lequel l'appareil (10) comporte de plus un dispositif de fermeture (24) pour permettre l'obturation de l'orifice (26).

17. Appareil (10) selon n'importe lesquelles des revendications 10 à 14, dans lequel la portion formant chape (22) peut être replacée sur l'organe tubulaire (20) et assujettie à l'organe tubulaire (20).

18. Appareil (10) selon la revendication 13 ou n'importe lesquelles des revendications 14 à 17 lorsqu'elles dépendent de la revendication 13, dans lequel la portion formant chape (22) est assujettie à l'organe tubulaire (20) en la soudant à celui-ci.

19. Un procédé de réduction de la variation d'un trépan par rapport à un chemin projeté (1) dans un trou de forage, où le trépan est couplé à une extrémité d'une garniture ayant un axe longitudinal, le procédé comportant l'inclusion d'un corps (20) dans la garniture, où une portion (30) du corps (20) a une section transversale où le centre de masse du corps (20) sur cette section transversale est décalé par rapport à l'axe longitudinal de la garniture ; l'insertion de la garniture dans un trou de forage ; dans lequel la rotation de la portion (30) du corps (20) autour de son axe longitudinal produit un mouvement vibratoire par la portion (30) du corps (20) pour neutraliser la vibration ou la déviation de la garniture de son chemin projeté, **caractérisé par** la syntonisation du mouvement vibratoire en modifiant la répartition et/ou l'emplacement et/ou la quantité de masse dans la portion (30) du corps (20) en déplaçant, insérant ou retirant un ou plusieurs éléments de matériau de remplissage (34) du corps (20), lesdits éléments de matériau de rem plissage (34) étant assujettis au corps (20) de façon détachable.

20. Un procédé selon la revendication 19, dans lequel ladite portion du corps comporte une cavité (32).

21. Un procédé selon la revendication 20, dans lequel la cavité (32) est recouverte d'une portion formant chape (22).

22. Un procédé selon n'importe laquelle des revendications 19 à 21, dans lequel la masse du corps (20) sur cette section transversale est répartie de façon à ce qu'une moitié de la section transversale ait une masse inférieure à celle de l'autre moitié de la section transversale.

23. Un procédé selon soit la revendication 20, soit la revendication 21, ou selon la revendication 22 lorsqu'elle dépend de soit la revendication 20, soit la revendication 21, dans lequel le corps (20) est un organe tubulaire (20) et la cavité (32) est formée sur une longueur de l'axe longitudinal de l'organe tubulaire (20).

24. Un procédé selon la revendication 20 ou n'importe lesquelles des revendications 21 à 23 lorsqu'elles dépendent de la revendication 20, dans lequel ce ou ces éléments de matériau de remplissage (34) sont insérés dans la cavité (32) de façon à faire varier le centre de masse de l'organe tubulaire (20).

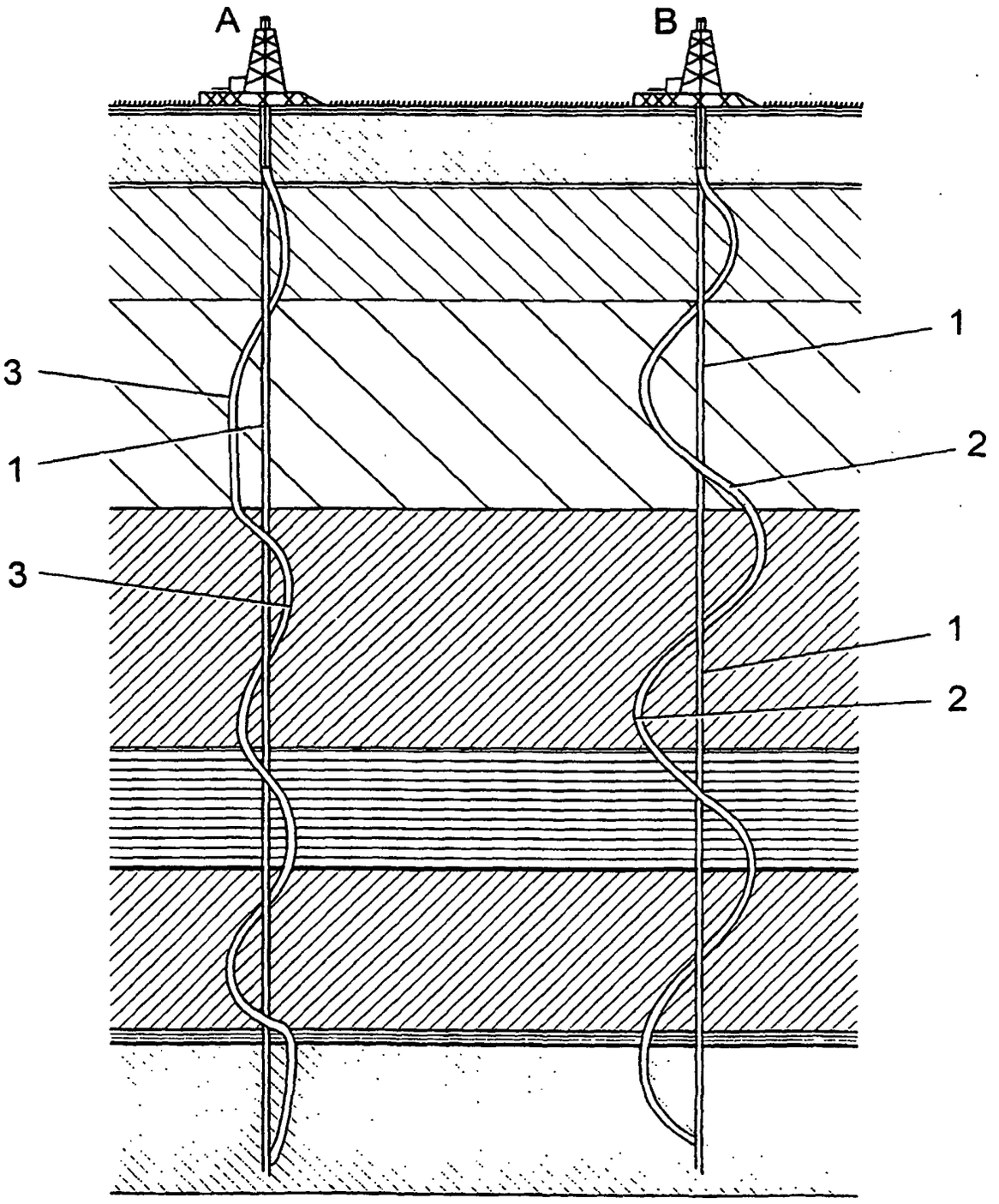


Fig. 1

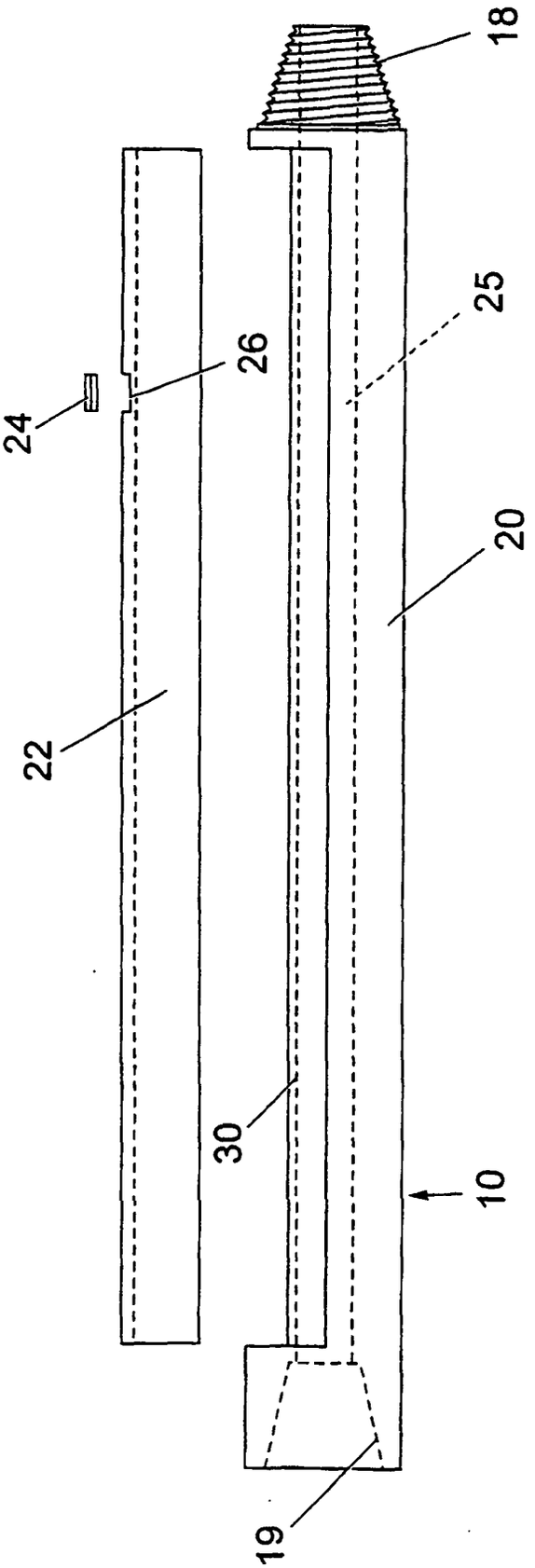


Fig. 2

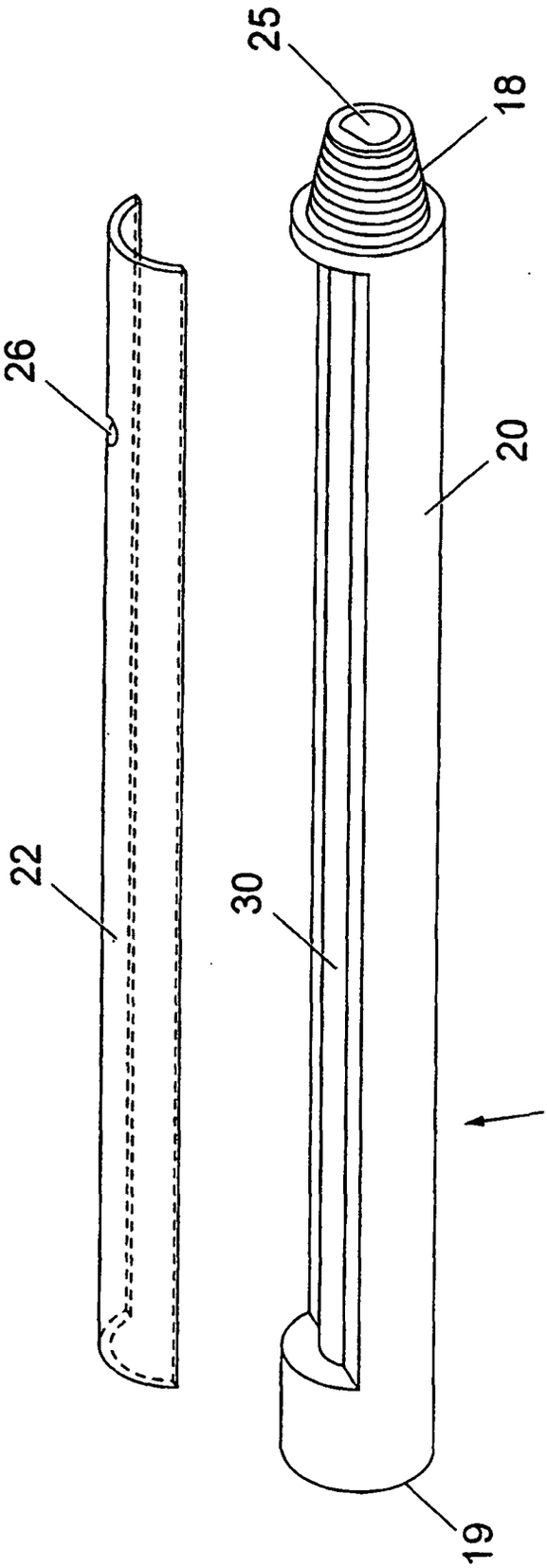


Fig. 3

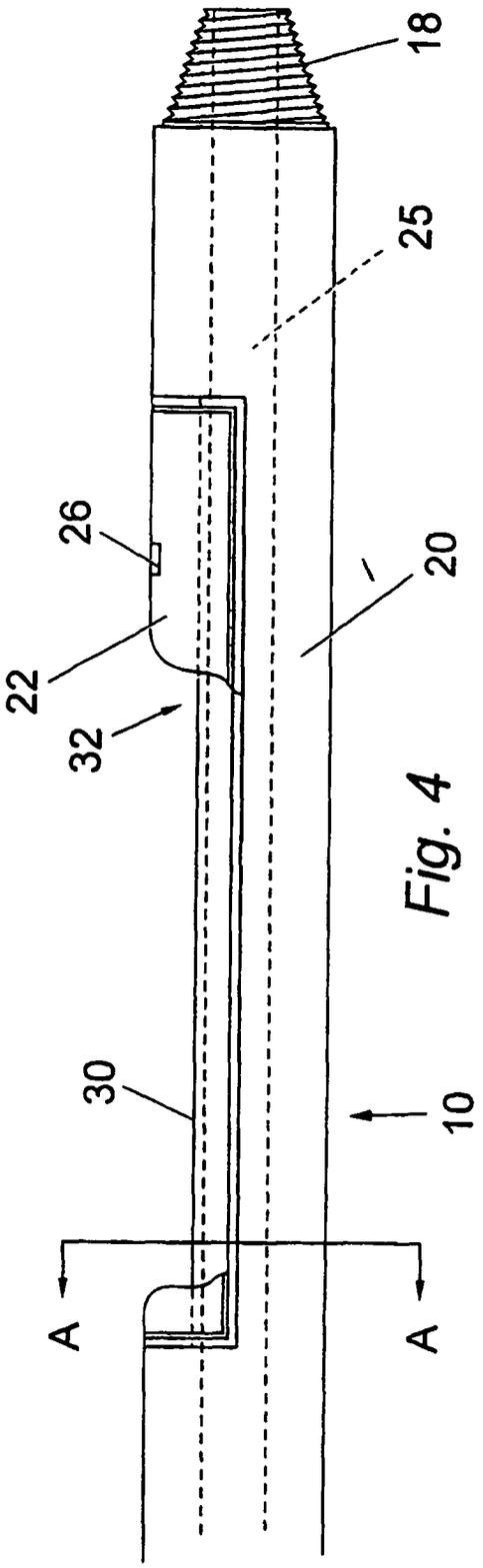
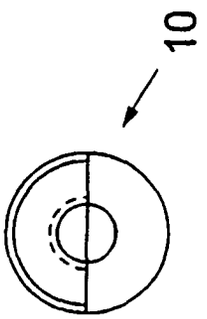


Fig. 4



SECTION A-A

Fig. 5

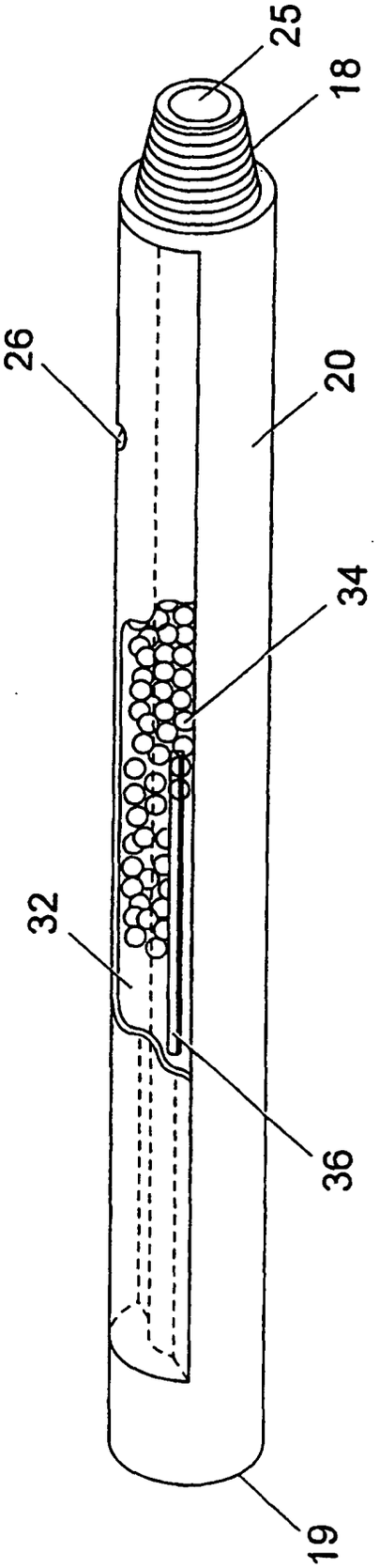


Fig. 6