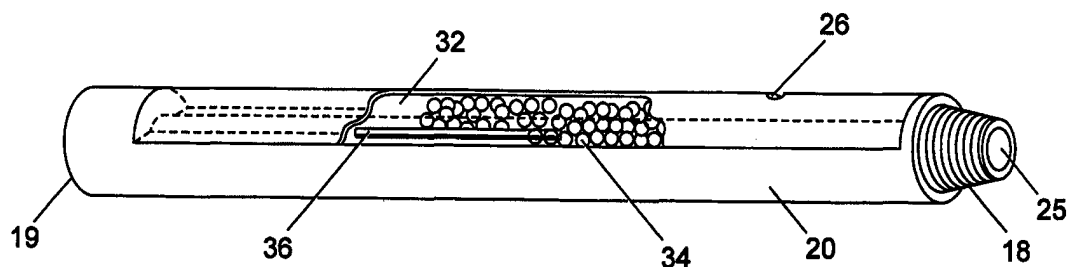




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/GB98/00739 (22) International Filing Date: 24 March 1998 (24.03.98)</p> <p>(30) Priority Data: 29/069,146 24 March 1997 (24.03.97) US 08/828,753 24 March 1997 (24.03.97) US 9725740.6 5 December 1997 (05.12.97) GB</p> <p>(71) Applicant (for all designated States except US): SIBILLE, Patrick, Neil [US/GB]; 28 Beaconsfield Place, Aberdeen AB15 4AA (GB).</p> <p>(72) Inventor; and (75) Inventor/Applicant (for US only): OWENS, Dewey, E. [US/US]; 6800 Clyve Road, Maurice, LA 70555-3334 (US).</p> <p>(74) Agent: MURGITROYD &amp; COMPANY; 373 Scotland Street, Glasgow G5 8QA (GB).</p>		<p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).</p> <p><b>Published</b> <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>

(54) Title: APPARATUS AND A METHOD FOR DRILLING BOREHOLES



## (57) Abstract

An apparatus (10) for inclusion in a string having a drill bit located at one end is described. The apparatus (10) comprises 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) 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. A method of reducing the variation of a drill bit from an intended path (1) in a borehole is also described, where the drill bit is coupled to one end of a string having a longitudinal axis. The method comprises the steps of including a body (20) in the string, where a portion 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. The string is inserted into a borehole, and at least the portion of the body (20) is rotated.

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## 1            APPARATUS AND A METHOD FOR DRILLING BOREHOLES

2

3            The invention relates to apparatus and a method for use  
4            downhole and particularly relates to apparatus for  
5            inclusion in a drill string which is used to drill a  
6            borehole, and to a method of reducing the variation of  
7            a drill bit from an intended path in a borehole.

8

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

13

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

24

25           In both of these existing methods of drilling a

1 borehole, it is very difficult to maintain the drill  
2 bit on its intended path. For instance, if the  
3 intended path is vertically downwards, such as path 1  
4 shown in Fig. 1, it is usual for the actual path of the  
5 drill bit to be in the form of a helix around the  
6 intended path, akin to a corkscrew path. The helix or  
7 corkscrew path can be seen in Fig. 1 as path 2 drilled  
8 by the drilling rig B. This helix or corkscrew path is  
9 caused by the drill bit and/or the drill string  
10 rotating out of balance. The helix or corkscrew path  
11 will mean that the drill bit and drill string must take  
12 a longer path than that intended.

13

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

23

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

29

30 According to a first aspect, the present invention  
31 provides an apparatus for inclusion in a string having  
32 a drill bit located at one end, the apparatus  
33 comprising a body having a longitudinal axis which is  
34 substantially coaxial with the longitudinal axis of the  
35 string, a portion of the body having a cross-section  
36 where the centre of mass of the body on that cross-

1 section is offset from the longitudinal axis of the  
2 string.

3

4 The invention thus provides a string having an  
5 eccentric weight e.g. offset from the axis.

6

7 According to a second aspect, the present invention  
8 provides a method of reducing the variation of a drill  
9 bit from an intended path in a borehole, where the  
10 drill bit is coupled to one end of a string having a  
11 longitudinal axis, the method comprising the steps of  
12 including a body in the string, where a portion of the  
13 body has a cross-section where the centre of mass of  
14 the body on that cross-section is offset from the  
15 longitudinal axis of the string;  
16 inserting the string into a borehole;  
17 and rotating at least the portion of the body.

18

19 The invention has the advantage that rotation of the  
20 portion of the body about its longitudinal axis  
21 produces a vibratory action by the portion of the body.

22

23 The intended path is preferably straight.

24

25 Preferably, the mass of the body on that cross-section  
26 is distributed such that one half of the cross-section  
27 has a lower mass than the other half of the cross-  
28 section.

29

30 Optionally, the body is a tubular member, which  
31 typically comprises a throughbore which is in  
32 communication with a throughbore of the string.

33

34 Optionally, the portion of the tubular member comprises  
35 a non-uniform tubular cross-section, and preferably  
36 comprises a cavity which is typically formed along a

1 length of the longitudinal axis of the tubular member.

2

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

7

8 Optionally, the filling material is substantially  
9 secured within the cavity, and more preferably, the  
10 filling material is substantially secured (or its  
11 position in the cavity influenced) by a magnetic force.

12

13 Preferably, the cavity is formed by removing a cover  
14 portion from the tubular member, and removing material  
15 from either, or both of, the tubular member or the  
16 cover portion. Preferably, the cover portion is  
17 replaced on the tubular member such that the cavity is  
18 formed in the space between the tubular member and the  
19 cover portion.

20

21 Preferably, the cover portion includes an aperture to  
22 permit access to the cavity, and more preferably to  
23 permit the filling material to be inserted into, or  
24 removed from, the cavity. Preferably, the apparatus  
25 further comprises a closure device to permit the  
26 aperture to be obturated.

27

28 Preferably, the cover portion is replaced on the  
29 tubular member by securing it to the tubular member.  
30 More preferably, the cover portion is secured to the  
31 tubular member by welding it thereto.

32

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

36

1           Fig. 1 is a schematic diagram of two boreholes  
2           being drilled;  
3           Fig. 2 shows an exploded side view of an apparatus  
4           for use downhole in accordance with the present  
5           invention;  
6           Fig. 3 shows an exploded perspective view of the  
7           apparatus of Fig. 2;  
8           Fig. 4 shows a partial-cut-away side view of the  
9           apparatus of Fig. 2 assembled;  
10          Fig. 5 shows a cross-sectional view across section  
11          AA of the apparatus of Fig. 4; and  
12          Fig. 6 shows a partial-cut-away perspective view  
13          of the apparatus Fig. 2, fully assembled.

14

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

20

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

30

31          The lower half of the body 20 as shown in Fig. 2 is in  
32          the form of a standard tubular member, such as a drill  
33          pipe, and thus has a semi-circular outer circumference  
34          which is of the same diameter as the circular outer  
35          circumference of the box connection 19. The outer  
36          surface diameter of the box connection 19, and the

1 semi-circular outer surface diameter of the lower half  
2 of the body 20, is 8 inches and the inner diameter of  
3 the throughbore 25 is  $2\frac{7}{8}$  inches, which provides a side  
4 wall thickness of the lower half of the body 20 of  $2\frac{9}{16}$   
5 inches.

6  
7 A length, which is semi-circular in cross-section, of  
8 the upper half of the body 20 shown in Fig. 2 has been  
9 removed, although a semi-circular side wall portion 30  
10 of the body 20 remains, thus ensuring that there is no  
11 fluid leak path from the throughbore 25 through the  
12 sidewall portion 30. The sidewall portion 30 has a  
13 thickness of  $\frac{1}{2}$  inch.

14  
15 A cover 22 is shown in Fig. 2 and has a semi-circular  
16 cross-section of the same outer diameter as that of the  
17 lower half of the body 20 (that is 8 inches). The  
18 sidewall thickness of the cover 22 is  $\frac{1}{2}$  inch.

19  
20 In use of the downhole tool 10, the cover 22 is fitted  
21 onto the upper half of the body 20 as shown in Fig. 2,  
22 such that the outer circumference of the cover 22 is in  
23 line with the outer circumference of the pin connection  
24 19. Therefore, there is a cavity formed between the  
25 inner circumference of the cover 22 and the outer  
26 circumference of the upper half of the body 20 as shown  
27 in Fig. 2. The cross-sectional radius of the cavity 32  
28 is  $1\frac{5}{8}$  inch. The cover 22 is secured to the upper half  
29 of the body 20, as shown in Figs. 4, 5 and 6, and  
30 preferably the cover 22 is welded to the body 20.  
31 Preferably, the cover 22 is formed from same the  
32 material removed from the body 20 to form the upper  
33 half of the body 20.

34  
35 An aperture 26 having a  $1\frac{1}{2}$  inch diameter is formed  
36 through the sidewall of the cover 22, and in use, the



1 aperture 26 is obturated by a plug 24.

2

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

8

9 The collective mass of the upper half of the body 20  
10 can be increased by inserting a filling material 34  
11 into the cavity 30 through the aperture 26. A suitable  
12 filling material is shown in Fig. 6 as a number of  
13 1 inch diameter steel balls, collectively designated as  
14 34. Thus, by varying the number of steel balls 34  
15 retained within the cavity 32, the centre of mass of  
16 the body 20 can be altered.

17

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

21

22 The length, depth and width of the material removed  
23 from the upper half of the body 20 to form the side  
24 wall portion 30, the cover 22, and the resulting cavity  
25 32 can be varied. Further, the number of one inch  
26 diameter steel balls 34 inserted into the cavity 32 can  
27 be varied, as can the location at which the downhole  
28 tool 10 is included in the string, depending on the  
29 formation through which it is required to be drilled.

30

31 Accordingly, when the body 20 is rotated, within the  
32 drill string, a vibratory action will be produced,  
33 since the downhole tool 10 will be rotating out of  
34 balance. Depending on the aforementioned variables,  
35 this vibratory action will tend to counterbalance the  
36 out of balance rotation of the drill bit, and thus

1 reduce or preferably eliminate the variation of the  
2 drill bit from its intended path. The vibratory motion  
3 produced by the body 20 can be tuned to values chosen  
4 to counteract vibration or deviation of the string from  
5 its intended path. Accordingly, by reducing the  
6 vibration imparted to the end of the drill string by  
7 the out of balance rotation of the drill bit, the  
8 spiralling or helical action of the drill bit is  
9 reduced or optimally eliminated.

10

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

18

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

23

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

30

31 Accordingly, by use of the present invention, the  
32 requirement for conventional stabilisers in the string  
33 is reduced or optimally obviated.

34

35 Modifications and improvements may be made without  
36 departing from the scope of the invention. For

1     example, the cavity can be filled with filling material  
2     with a different density than the material forming the  
3     tool 10. Particularly, the filling material can be a  
4     denser material such as lead. Additionally, more than  
5     one cavity can be formed in the same portion of the  
6     tool 10, so as to allow increased control of variation  
7     of the string's path.

8

9

1     CLAIMS:-

2

3     1.    Apparatus (10) for inclusion in a string having a  
4     drill bit located at one end, the apparatus (10)  
5     comprising a body (20) having a longitudinal axis which  
6     is substantially coaxial with the longitudinal axis of  
7     the string, a portion (30) of the body (20) having a  
8     cross-section where the centre of mass of the body (20)  
9     on that cross-section is offset from the longitudinal  
10    axis of the string.

11

12    2.    Apparatus (10) according to claim 1, wherein the  
13    mass of the body (20) on that cross-section is  
14    distributed such that one half of the cross-section has  
15    a lesser mass than the other half of the cross-section.

16

17    3.    Apparatus (10) according to either of claims 1 or  
18    2, wherein the body (20) is a tubular member (20).

19

20    4.    Apparatus (10) according to claim 3, wherein the  
21    tubular member (20) comprises a throughbore (25) which  
22    is in communication with a throughbore of the string.

23

24    5.    Apparatus (10) according to either of claims 3 or  
25    4, wherein the portion (30) of the tubular member (20)  
26    comprises a non-uniform tubular cross-section.

27

28    6.    Apparatus (10) according to any of claims 3 to 5,  
29    wherein the tubular member (20) further comprises a  
30    cavity (32).

31

32    7.    Apparatus (10) according to claim 6, wherein the  
33    cavity (32) is formed along a length of the  
34    longitudinal axis of the tubular member (20).

35

36    8.    Apparatus (10) according to either of claims 6 or

1 7, wherein a filling material (34) is inserted into the  
2 cavity (32) such that the centre of mass of the tubular  
3 member (20) is varied.

4

5 9. Apparatus (10) according to claim 8, wherein  
6 movement of the filling material (34) within the cavity  
7 (32) is inhibited.

8

9 10. Apparatus (10) according to claim 9, wherein  
10 movement of the filling material (34) in the cavity  
11 (32) is inhibited by a magnetic force.

12

13 11. Apparatus (10) according to any of claims 6 to 10,  
14 wherein the cavity (32) is formed by removing a cover  
15 portion (22) from the tubular member (20), and removing  
16 material from at least one of the tubular member (20)  
17 and the cover portion (22).

18

19 12. Apparatus (10) according to claim 11, wherein the  
20 cover portion (22) is replaced on the tubular member  
21 (20) such that the cavity (32) is formed in the space  
22 between the tubular member (20) and the cover portion  
23 (22).

24

25 13. Apparatus (10) according to either of claims 11 or  
26 12, wherein the cover portion (22) includes an aperture  
27 (26) to permit access to the cavity (32).

28

29 14. Apparatus (10) according to claim 13, wherein the  
30 aperture (26) permits the filling material (34) to be  
31 inserted into, or removed from, the cavity (32).

32

33 15. Apparatus (10) according to either of claims 13 or  
34 14, wherein the apparatus (10) further comprises a  
35 closure device (24) to permit the aperture (26) to be  
36 obturated.

1 16. Apparatus (10) according to any of claims 12 to  
2 15, wherein the cover portion (22) can be replaced on  
3 the tubular member (20) and secured to the tubular  
4 member (20).  
5

6 17. Apparatus (10) according to claim 16, wherein the  
7 cover portion (22) is secured to the tubular member  
8 (20) by welding it thereto.  
9

10 18. A method of reducing the variation of a drill bit  
11 from an intended path (1) in a borehole, where the  
12 drill bit is coupled to one end of a string having a  
13 longitudinal axis, the method comprising the steps of  
14 including a body (20) in the string, where a portion  
15 (30) of the body (20) has a cross-section where the  
16 centre of mass of the body (20) on that cross-section  
17 is offset from the longitudinal axis of the string;  
18 inserting the string into a borehole; and rotating at  
19 least the portion (30) of the body (20).  
20

21 19. A method according to claim 18, wherein rotation  
22 of the portion (30) of the body (20) about its  
23 longitudinal axis produces a vibratory motion by the  
24 portion (30) of the body (20).  
25

26 20. A method according to claim 19, wherein the  
27 vibratory motion is tuned to valves chosen to  
28 counteract vibration or deviation of the string from  
29 its intended path.  
30

31 21. A method according to claim 20, wherein the  
32 vibratory motion is tuned by altering the distribution  
33 and/or location and/or amount of mass in the portion  
34 (30) of the body (20).  
35

36 22. A method according to any one of claims 18 to 21,

1 wherein the mass of the body (20) on that cross-section  
2 is distributed such that one half of the cross-section  
3 has a lesser mass than the other half of the cross-  
4 section.

5  
6 23. A method according to any of claims 18 to 22,  
7 wherein the body (20) is a tubular member (20) and the  
8 portion (30) of the tubular member (20) comprises a  
9 cavity (32) which is formed along a length of the  
10 longitudinal axis of the tubular member (20).

11  
12 24. A method according to claim 23, wherein a filling  
13 material (34) is inserted into the cavity (32) such  
14 that the centre of mass of the tubular member (20) is  
15 varied.

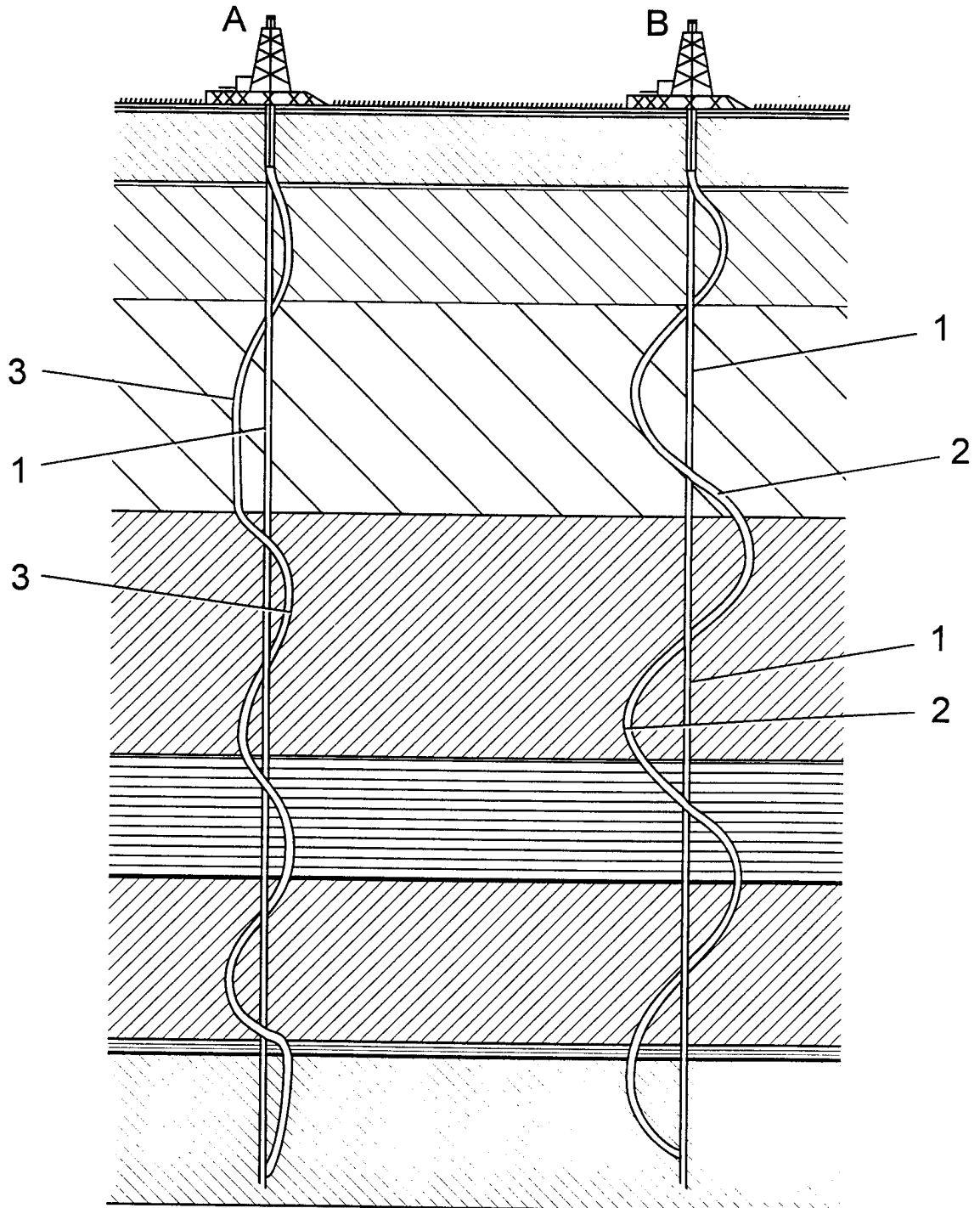


Fig. 1



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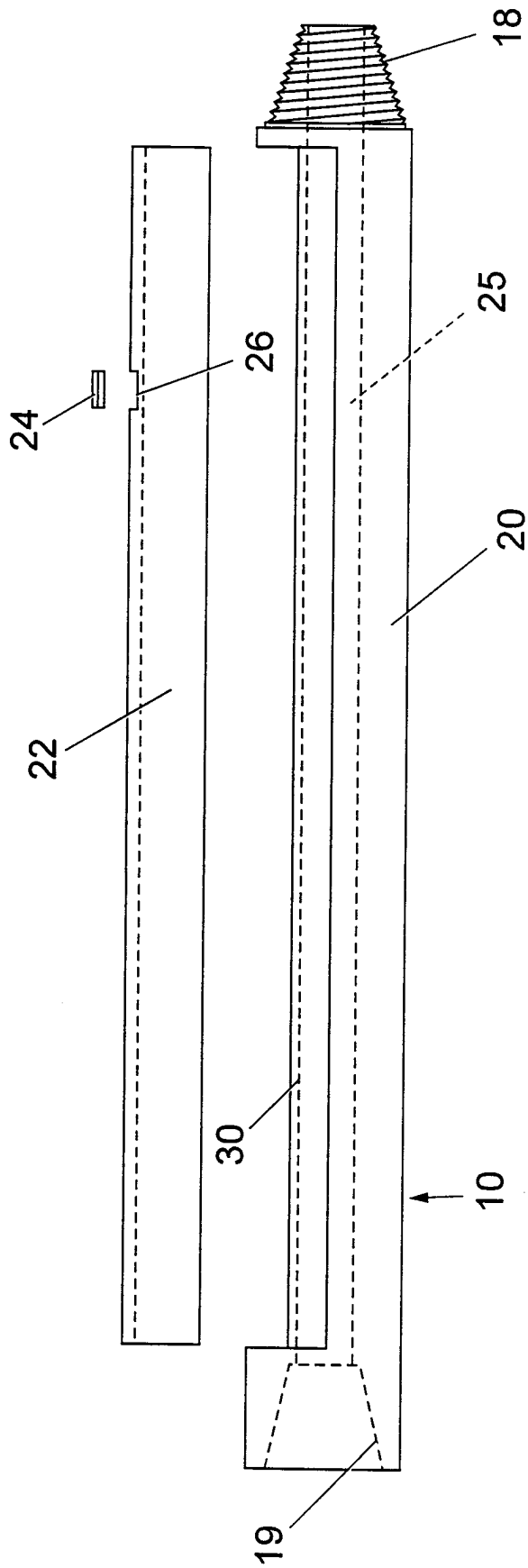


Fig. 2

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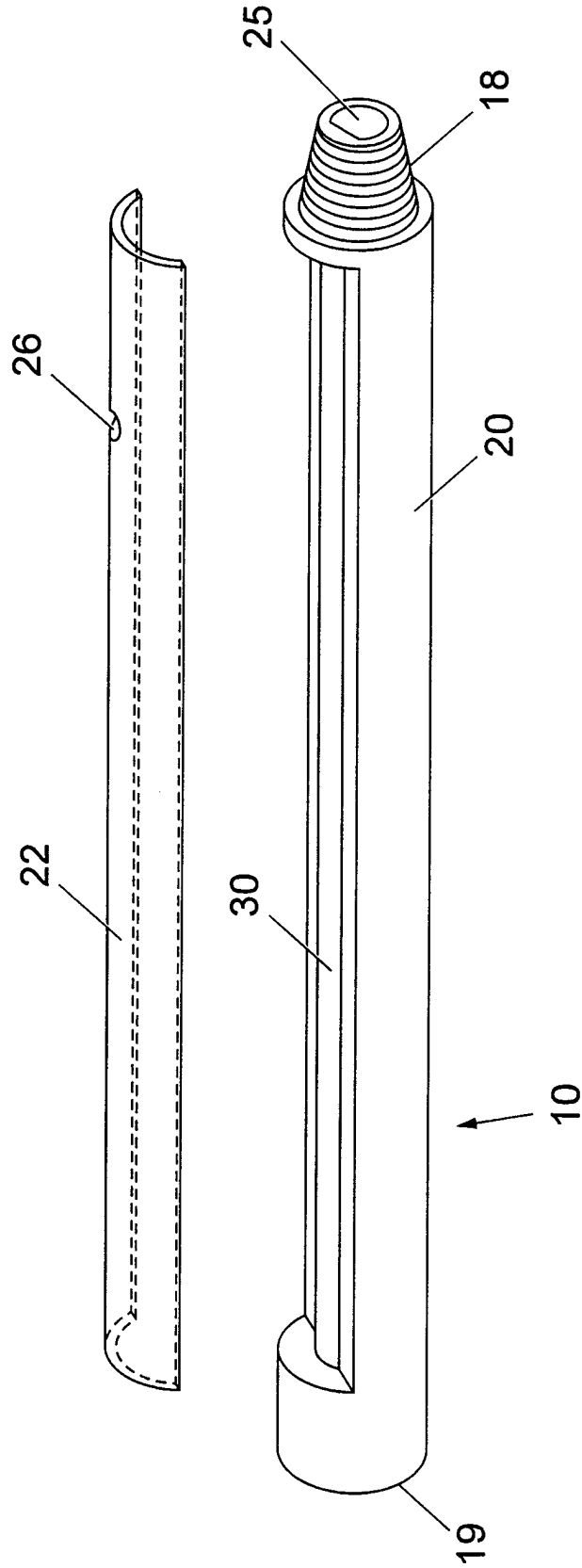


Fig. 3

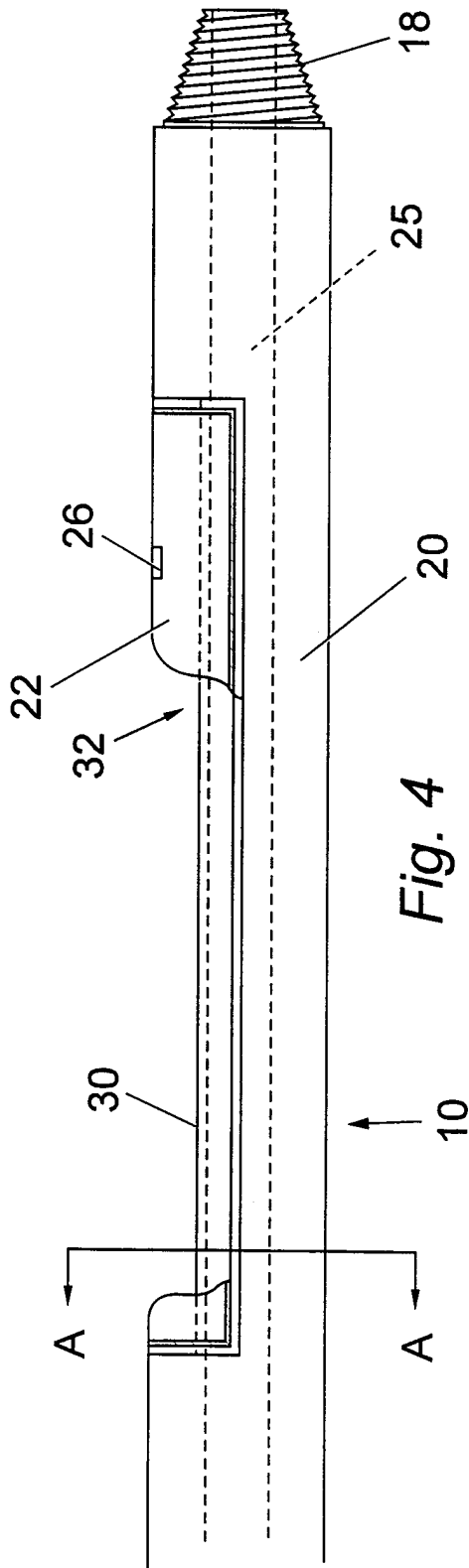
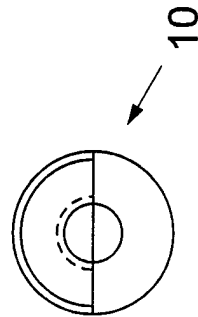


Fig. 4



SECTION A-A

Fig. 5

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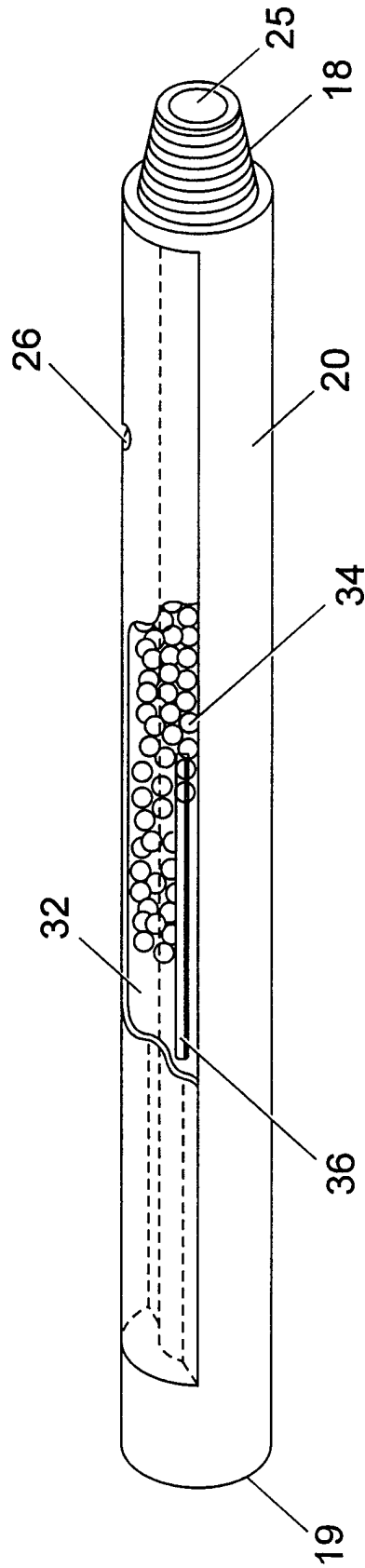


Fig. 6

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 98/00739

**A. CLASSIFICATION OF SUBJECT MATTER**  
 IPC 6 E21B7/10 E21B7/04 E21B17/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 040 619 A (JORDAN ET AL.) 20 August 1991 see column 4, line 53 - line 63; figure 3B	1-5
A	---	18
X	US 4 438 810 A (WILKINSON) 27 March 1984 see column 4, line 16 - line 54; figures 3,4	1,2
A	---	18
X	US 4 995 466 A (SNOW) 26 February 1991  see column 1, line 63 - column 2, line 15 see column 2, line 57 - line 65 see column 4, line 50 - column 5, line 23; figures 1,5-7,10	1-5, 18, 20, 22
A	---	6, 23
	-/--	

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Patent family members are listed in annex.

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Date of the actual completion of the international search

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International Application No

PCT/GB 98/00739

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