



Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) **EP 1 226 329 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention  
of the grant of the patent:

**17.12.2003 Bulletin 2003/51**

(21) Application number: **00964521.9**

(22) Date of filing: **06.10.2000**

(51) Int Cl.7: **E21B 17/10**

(86) International application number:  
**PCT/GB00/03829**

(87) International publication number:  
**WO 0102/7434 (19.04.2001 Gazette 2001/16)**

(54) **DRILL STRING MEMBER WITH BEARINGS**

BOHRSTRANGELEMENT MIT LAGERN

COLONNE DE FORAGE A ROULEMENTS

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE**

(30) Priority: **13.10.1999 GB 9924114**

(43) Date of publication of application:  
**31.07.2002 Bulletin 2002/31**

(73) Proprietor: **Appleton, Robert Patrick  
By Banchory, Aberdeenshire AB31 4NY (GB)**

(72) Inventor: **APPLETON, Robert, Patrick  
Aberdeenshire, AB31 4NY (GB)**

(74) Representative: **Allan, James Stewart et al  
Murgitroyd & Company  
165-169 Scotland Street  
Glasgow G5 8PL (GB)**

(56) References cited:  
**US-A- 1 877 395                   US-A- 5 148 876  
US-A- 5 261 498                   US-A- 5 339 910**

**EP 1 226 329 B1**

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

## Description

**[0001]** This invention relates to string member, and particularly one which is adapted to reduce drag and torque on the drill string.

**[0002]** In oil and gas well drilling it is generally known to rotate a drill string or a portion thereof in order to impart torque to the drill bit at the end. In addition, the drill bit is generally forced into and out of the bore hole as part of the drilling operation. Very often the frictional forces on the drillstring seize the string in the bore, and many solutions have been proposed to the problem of stuck drill string, as it involves great effort and lost production to remedy this. US 5,148,876, US 5,339,910, US 5,261,498 and US 1,877,395 describe devices over which the invention is characterised.

**[0003]** According to the present invention there is provided a drill string member according to claim 1.

**[0004]** The drill string member may be suitable for making up into a rotating or non-rotating drill string, to facilitate rotation in the bore or to facilitate axial displacement of non-rotating strings during their insertion into and withdrawal from the bore.

**[0005]** Preferably the body member and bearings may be attached to a stand of drillpipe. In some embodiments the bearing may be incorporated within the outer surface of the drillpipe, which forms the body.

**[0006]** In a preferred embodiment the body has a bearing race on its outer surface and one or more bearings which can move in the bearing race. Preferably the bearing race is an annular groove arranged perpendicular to the long axis of the body. Preferably there is more than one race provided and the races are preferably parallel to one another, and perpendicular to the axis of the body.

**[0007]** The races are preferably continuous so that the bearings are free to move through 360° of the race as well as being free to rotate on their axes in the race.

**[0008]** The bearings are preferably ball bearings (ie spheres). In such embodiments vertical drag and radial torque are reduced. Alternatively the bearings may be roller bearings (ie cylinders) or any suitable type of bearing.

**[0009]** The bearings are preferably retained in the race by overcentre side walls so that the bearings are permitted to protrude from the race beyond the outer surface of the body to a small extent in order to bear against the inner surface of a well bore or casing, and are preferably retained in place by a moveable sleeve which abuts the bearings on one side and by a shoulder which abuts the bearings on the other. The sleeve and shoulder preferably provide abutments which extend around the centre of the bearings so as to retain them in the bearing race when the tool is assembled. Alternatively the bearings may be retained by an first upper and a second lower sleeve.

**[0010]** Optionally there can be more than one sleeve. Each sleeve is typically provided with one or more seals

such as o-ring seals in order to restrict the ingress of drill cuttings and other debris.

**[0011]** The sleeve(s) are preferably spring-loaded so as to force the bearings into the race and to take up any play therein, and the loading of the spring is preferably adjustable.

**[0012]** In a preferred embodiment there are two sleeves or a multiple of two sleeves such as 4 or 6 etc. Most preferably a spring or other resilient buffer is provided between each pair of sleeves. Preferably the spring extends longitudinally or circumferentially between each pair of sleeves. At an opposite edge, each sleeve preferably has a shoulder which abuts the bearings. Preferably the spring(s) keep the sleeves in contact with the bearings.

**[0013]** A snap-on or shrink-on lock ring such as a heat sensitive shrink ring or a screw-on collar or lock ring or a circlip can be used to retain the sleeves, the bearings and optionally the spring forcing the sleeves against the bearings.

**[0014]** Preferably all components of the invention comprise steel. Most preferably contact surfaces of the components of the invention are protected with a hard facing material such as tungsten carbide.

**[0015]** Certain embodiments of the invention provide the advantage that the bearing races are self-cleaning thereby reducing the level of maintenance to free stuck bearings, and in certain embodiments all bearings can be released for cleaning by manipulation of very few parts of the apparatus.

**[0016]** An embodiment of the present invention will now be described by way of example and with reference to the accompanying drawings, in which:-

Fig 1 shows a side view of one embodiment of the invention;

Fig 2 shows a body of the Fig 1 embodiment;

Fig 3 shows an upper sleeve of the Fig 1 embodiment;

Fig 4 shows a lower sleeve of the Fig 1 embodiment;

Fig 5 shows a lock ring of the Fig 1 embodiment;

Fig 6 shows a bevel spring of the Fig 1 embodiment;

Fig 7 shows a bearing of the Fig 1 embodiment; and

Fig 8 shows a side view of a screw-on lock ring used with a different embodiment; and,

Fig. 9 shows a front view and sectional view of a further embodiment.

**[0017]** Referring now to the drawings, a drill string member has a tubular body 1 having a box and pin section at respective ends as is common in the art and a through bore 2. The tubular body 1 has an outer surface with a first bearing race 5 cut in an annular ring around the outer surface of body 1 perpendicular to the axis of the through bore 2. The first bearing race 5 is bounded on its upper surface by a shoulder 5s which extends in part downwards towards the lower end of the tool from the upper end of the race 5, the purpose of which will

be explained below. A second bearing race 6 of similar construction (apart from the upper shoulder 5s) is provided lower down the tool body 1, and annular grooves 10 are provided between the bearing races and below the second race 6 for receiving o-rings. A further annular groove 11 is provided below the lowermost o-ring groove for receiving a lock ring.

A first annular sleeve 15 comprises an annular band of steel with cupped upper and lower edges 16u, 16l. The cupped edges, 16u, 16l each have an outer shoulder 16s which extends upwardly and downwardly respectively of the sleeve 15.

**[0018]** A lower sleeve 20 has an upper cup 21 with a similar upwardly pointing shoulder 21s, and an inner rabbet 23 at its lower surface to receive a bevel spring to be described.

**[0019]** The bearing races 5 and 6, and the cups 16 and 21 on the sleeve 15 and 20 are faced with tungsten carbide or a similar hard facing material in order to withstand wear on the surfaces of the races and sleeves by the bearings.

**[0020]** The tool is assembled by placing o-rings 12 into annular grooves 10 and threading the upper sleeve 15 onto the lower end 11 of the body. The spherical bearings 25 are then inserted into the upper race 5, and are held in place by the overcentre opposing shoulders 5s on the body 1 and similar shoulders 16s on the upper sleeve 15. The upper sleeve 15 is wide enough to hold the bearings 25 in the upper race and provides a second shoulder 16s adjacent to the lower race 6. The lower sleeve 20 is then threaded onto the lower end 11 of the body and the bearings 75 can be inserted into and retained within the lower race 6 between the lower shoulder 16s of the first sleeve 15 and the upper shoulder 21s of the second sleeve 20 in a similar manner to the first set of bearings 25. The rabbet 23 accommodates an annular bevel spring 27 which is threaded onto the lower end of the body 11 in the same way, and the annular lock ring 30 of expandable metal is heated to expand its diameter, offered up onto the lower end of the body 11 and left to cool in place in the lowermost annular groove 11 until it engages with the groove and maintains the spring 27 in compression between it and the rabbet 23 on the lower sleeve 20.

**[0021]** By the upward force exerted on the lower sleeve 20 by the spring 27, the bearings 25 are pressed into the races 5, 6 and play is taken up, but the bearings 25 are free to move circumferentially around the annular races 5, 6 without much resistance.

**[0022]** In use, the bearings 25 protrude by around a third of their width from the races 5, 6 and the innermost surface of the well bore or casing etc is therefore contacted by the bearings 25 rather than the outer surface of the tool body 1. The freedom of the bearings 25 to move in the races 5, 6 means that less torque is needed to rotate the string due to the lower friction, and the upward and downward thrust on the string can similarly be enhanced due to the lower friction. Certain embodi-

ments of the invention permit the transfer of more power to the bit from the motor.

**[0023]** The o-rings 12 resist the ingress of drill cuttings etc behind the sleeves 15, 20 and the fact that the races 5, 6 are annular without impediment to circumferential movement of each ball around the annular ring of each race 5, 6 means that the races 5, 6 are self cleaning in the event that any drill cuttings or any debris enters them.

**[0024]** For maintenance, the ring 30 is heated to expand it and is thereafter removed from the groove 11, and the tool is stripped down in reverse process from its construction as described above.

**[0025]** The heat sensitive ring 30 can be replaced by a circlip and need not be completely annular.

**[0026]** A screw-on collar 31 with an internal screw thread can be used on a modified body 1a shown in Fig. 8 instead of a circlip or shrink ring 30. The inner threads on the collar 31, mates with co-operating threads on the outer surface of the body 1a below the lowermost o-ring groove 10, so that the collar 31 can be screwed onto the body 1a to retain the spring 27 and sleeve 20 in place.

**[0027]** Certain embodiments of the invention can provide a significant reduction in rotary torque and tripping drag, and can reduce casing wear. Some embodiments of the invention allow easier steering capability of strings, and need not have any restrictions on their operating temperature.

**[0028]** An alternative embodiment is shown in Fig. 9. The sleeves are provided in pairs 115, 120 and 150, 160. A circumferentially extending annular resilient buffer (not shown) or one or more separate longitudinally extending springs 153 are provided between suitable shoulders 151, 152 on each sleeve 115, 120. The springs 153 abut the shoulders 151, 152 which forces the opposite ends 116u of sleeve 115 and the lower end 116l of sleeve 120 into contact with the bearings 125 and 175 respectively. The spring mechanism thus ensures contact between the sleeves 115, 120 and the bearings 125, 175 even as the bearings 125, 175 wear and reduce in size through use. A similar buffer (not shown) or springs 154 are provided between the second pair of sleeves 150, 160 to provide a similar function. Features not described in this embodiment are similar to those as described for previous embodiments.

**[0029]** In certain embodiments maintenance of the apparatus may be performed infrequently as the apparatus functions adequately even when the bearings have been worn through use. Consequently, the cost to replace the bearings and on the time spent stripping down the apparatus to replace the bearings may be saved.

**[0030]** Modifications and improvements can be incorporated without departing from the scope of the invention.

**Claims**

1. A drill string member comprising:
- a body (1);  
 at least one bearing (25,75,125,175) protruding outwardly of the body for contact with a bore-hole;  
 at least one sleeve (15, 20, 115, 125, 150, 160) around the body **characterized in that** the bearing protrudes also outwardly of the sleeve and a resilient compression means (27,153,154) is adapted to push the sleeve along the body (15,20,115,125,150,160) against the bearing (25,75,125,175) to retain the bearing (25,75,125,175).
2. A drill string member as claimed in claim 1, wherein the at least one bearing (25,75,125,175) is held in a bearing race (5,6) on the body (1).
3. A drill string member as claimed in claim 2, wherein the bearing race (5,6) is an annular groove.
4. A drill string member as claimed in either claim 2 or claim 3, having more than one bearing race (5,6).
5. A drill string member as claimed in any one of claims 2 to 4, wherein the at least one race is perpendicular to the axis of the body (1).
6. A drill string member as claimed in any one of claims 2 to 5, wherein the at least one race is continuous.
7. A drill string member as claimed in any preceding claim, wherein the at least one bearing (25,75,125,175) is a sphere.
8. A drill string member as claimed in any one of claims 1 to 6, wherein the at least one bearing (25,75,125,175) is a cylinder.
9. A drill string member as claimed in any one of claims 2 to 8, wherein the at least one bearing (25,75,125,175) is retained in the at least one race (5,6) by overcentre side walls (5s) in the at least one race (5,6).
10. A drill string member as claimed in any preceding claim, wherein the at least one sleeve (15,20,115,125,150,160) abuts the at least one bearing (25,75,125,175) on at least one side.
11. A drill string member as claimed in any preceding claim, comprising more than one sleeve (15,20,115,125,150,160).
12. A drill string member as claimed in any preceding claim, wherein the at least one sleeve (15,20,115,125,150,160) is provided with one or more seals (12).
13. A drill string member as claimed in any preceding claim, wherein the resilient compression means (27, 153, 154) comprises a buffer.
14. A drill string member as claimed in any preceding claim, wherein the resilient compression means (27,153,154) is annular.
15. A drill string member as claimed in any preceding claim, wherein the resilient compression means (27,153,154) comprises at least one spring.
16. A drill string member as claimed in claim 15, wherein the spring is a bevel spring.
17. A drill string member as claimed in any preceding claim, wherein a retaining member (30,31) is used to retain the at least one sleeve (15,20,115,125,150,160).
18. A drill string member as claimed in claim 17, wherein the resilient compression means (27,153,154) extends between the retaining member and the sleeve or between first and second sleeves.
19. A drill string member as claimed in claim 14 wherein the retaining member (30,31) is a snap-on or shrink-on lock ring, a screw-on collar, a lock ring or a circlip.
20. A drill string member as claimed in any preceding claim, having a load adjustment mechanism for the resilient compression means.
21. A drill string member as claimed in claim 20, wherein the retaining member comprises a screw-on collar having threads which engage threads on the body, and having an edge in contact with the compression means.
22. A drill string member as claimed in any one of claims 2 to 21, wherein the at least one bearing (25,75,125,175) and/or the at least one race (5,6) are lubricated by mud ingress.
23. A drill string member as claimed in any one of claims 2 to 22, wherein the at least one bearing race (5,6) is self-cleaning.
24. A drill string member as claimed in any preceding claim, wherein the at least one bearing (25,75,125,175) can be released for cleaning.
25. A drill string member as claimed in any preceding

claim, comprising a length of drill pipe.

26. A drill string member as claimed in any one of claims 1 to 24, comprising a sub or sleeve (15,20,115,125,150,160) attachable to a length of drill pipe.

### Patentansprüche

1. Ein Bohrstrangteil, der Folgendes beinhaltet:

einen Körper (1);

mindestens ein Lager (25, 75, 125, 175), das nach außen zur Berührung mit einem Bohrloch vom Körper vorsteht;

mindestens eine Muffe (15, 20, 115, 125, 150, 160) um den Körper, **dadurch gekennzeichnet, dass** das Lager auch nach außen von der Muffe vorsteht und ein elastisches Komprimierungsmittel (27, 153, 154) angepasst ist, um die Muffe entlang dem Körper (15, 20, 115, 125, 150, 160) gegen das Lager (25, 75, 125, 175) zu drücken, um das Lager (25, 75, 125, 175) zu halten.

2. Bohrstrangteil gemäß Anspruch 1, wobei mindestens ein Lager (25, 75, 125, 175) in einem Lauftring (5, 6) auf dem Körper (1) festgehalten wird.
3. Bohrstrangteil gemäß Anspruch 2, wobei der Lauftring (5, 6) eine Ringnut ist.
4. Bohrstrangteil gemäß Anspruch 2 oder Anspruch 3, der mehr als einen Lauftring (5, 6) aufweist.
5. Bohrstrangteil gemäß einem der Ansprüche 2 bis 4, wobei der mindestens eine Ring senkrecht zur Achse des Körpers (1) liegt.
6. Bohrstrangteil gemäß einem der Ansprüche 2 bis 5, wobei der mindestens eine Ring kontinuierlich ist.
7. Bohrstrangteil gemäß einem der vorhergehenden Ansprüche, wobei das mindestens eine Lager (25, 75, 125, 175) eine Kugel ist.
8. Bohrstrangteil gemäß einem der Ansprüche 1 bis 6, wobei das mindestens eine Lager (25, 75, 125, 175) ein Zylinder ist.
9. Bohrstrangteil gemäß einem der Ansprüche 2 bis 8, wobei das mindestens eine Lager (25, 75, 125, 175) in dem mindestens einen Ring (5, 6) durch Sprungschaltseitenwände (5s) in dem mindestens einen Ring (5, 6) gehalten wird.

10. Bohrstrangteil gemäß einem der vorhergehenden Ansprüche, wobei die mindestens eine Muffe (15, 20, 115, 125, 150, 160) auf mindestens einer Seite an das mindestens eine Lager (25, 75, 125, 175) stößt.

11. Bohrstrangteil gemäß einem der vorhergehenden Ansprüche, der mehr als eine Muffe (15, 20, 115, 125, 150, 160) beinhaltet.

12. Bohrstrangteil gemäß einem der vorhergehenden Ansprüche, wobei die mindestens eine Muffe (15, 20, 115, 125, 150, 160) mit ein oder mehreren Dichtungen (12) versehen ist.

13. Bohrstrangteil gemäß einem der vorhergehenden Ansprüche, wobei das elastische Komprimierungsmittel (27, 153, 154) einen Puffer beinhaltet.

14. Bohrstrangteil gemäß einem der vorhergehenden Ansprüche, wobei das elastische Komprimierungsmittel (27, 153, 154) ringförmig ist.

15. Bohrstrangteil gemäß einem der vorhergehenden Ansprüche, wobei das elastische Komprimierungsmittel (27, 153, 154) mindestens eine Feder beinhaltet.

16. Bohrstrangteil gemäß Anspruch 15, wobei die Feder eine abgeschrägte Feder ist.

17. Bohrstrangteil gemäß einem der vorhergehenden Ansprüche, wobei ein Halteteil (30, 31) verwendet wird, um die mindestens eine Muffe (15, 20, 115, 125, 150, 160) zu halten.

18. Bohrstrangteil gemäß Anspruch 17, wobei sich das elastische Komprimierungsmittel (27, 153, 154) zwischen dem Halteteil und der Muffe oder zwischen der ersten und zweiten Muffe erstreckt.

19. Bohrstrangteil gemäß Anspruch 14, wobei der Halteteil (30, 31) ein aufsteckbarer oder schrumpfbarer Klemmring, eine aufschraubbare Einfassung, ein Klemmring oder ein Sicherungsbügel ist.

20. Bohrstrangteil gemäß einem der vorhergehenden Ansprüche, der einen Belastungseinstellmechanismus für das elastische Komprimierungsmittel aufweist.

21. Bohrstrangteil gemäß Anspruch 20, wobei der Halteteil einen aufschraubbare Einfassung mit Gewinden, die in Gewinde auf dem Körper eingreifen, aufweist, und der eine Kante, die mit dem Komprimierungsmittel in Berührung steht, aufweist.

22. Bohrstrangteil gemäß einem der Ansprüche 2 bis

21, wobei das mindesten eine Lager (25, 75, 125, 175) und/oder der mindestens eine Ring (5, 6) durch Schlammeintritt geschmiert werden.

23. Bohrstrangteil gemäß einem der Ansprüche 2 bis 22, wobei der mindestens eine Laufring (5, 6) selbstreinigend ist.

24. Bohrstrangteil gemäß einem der vorhergehenden Ansprüche, wobei das mindesten eine Lager (25, 75, 125, 175) zum Reinigen gelöst werden kann.

25. Bohrstrangteil gemäß einem der vorhergehenden Ansprüche, der eine Länge eines Gestängerohrs beinhaltet.

26. Bohrstrangteil gemäß einem der Ansprüche 1 bis 24, der ein Zwischenstück oder eine Muffe (15, 20, 115, 125, 150, 160), die an einer Länge des Gestängerohrs angebracht werden kann, beinhaltet.

## Revendications

1. Un élément formant train de tiges comportant :

un corps (1) ;

au moins un roulement (25, 75, 125, 175) faisant saillie vers l'extérieur du corps pour être en contact avec un trou de forage ;

au moins un manchon (15, 20, 115, 125, 150, 160) autour du corps **caractérisé en ce que** le roulement fait saillie également vers l'extérieur du manchon et un moyen de compression élastique (27, 153, 154) est adapté pour pousser le manchon le long du corps (15, 20, 115, 125, 150, 160) contre le roulement (25, 75, 125, 175) afin de retenir le roulement (25, 75, 125, 175).

2. Un élément formant train de tiges tel que revendiqué dans la revendication 1, dans lequel ce roulement (25, 75, 125, 175) au moins est maintenu dans un chemin de roulement (5, 6) sur le corps (1).

3. Un élément formant train de tiges tel que revendiqué dans la revendication 2, dans lequel le chemin de roulement (5, 6) est une rainure annulaire.

4. Un élément formant train de tiges tel que revendiqué dans soit la revendication 2, soit la revendication 3, ayant plus d'un chemin de roulement (5, 6).

5. Un élément formant train de tiges tel que revendiqué dans n'importe laquelle des revendications 2 à 4, dans lequel ce chemin au moins est perpendiculaire à l'axe du corps (1).

6. Un élément formant train de tiges tel que revendiqué dans n'importe laquelle des revendications 2 à 5, dans lequel ce chemin au moins est continu.

7. Un élément formant train de tiges tel que revendiqué dans n'importe quelle revendication précédente, dans lequel ce roulement (25, 75, 125, 175) au moins est une sphère.

8. Un élément formant train de tiges tel que revendiqué dans n'importe laquelle des revendications 1 à 6, dans lequel ce roulement (25, 75, 125, 175) au moins est un cylindre.

9. Un élément formant train de tiges tel que revendiqué dans n'importe laquelle des revendications 2 à 8, dans lequel ce roulement (25, 75, 125, 175) au moins est retenu dans ce chemin (5, 6) au moins par des parois latérales à arc-boutement (5s) dans ce chemin (5, 6) au moins.

10. Un élément formant train de tiges tel que revendiqué dans n'importe quelle revendication précédente, dans lequel ce manchon (15, 20, 115, 125, 150, 160) au moins aboute avec ce roulement (25, 75, 125, 175) au moins sur au moins un côté.

11. Un élément formant train de tiges tel que revendiqué dans n'importe quelle revendication précédente, comportant plus d'un manchon (15, 20, 115, 125, 150, 160).

12. Un élément formant train de tiges tel que revendiqué dans n'importe quelle revendication précédente, dans lequel ce manchon (15, 20, 115, 125, 150, 160) au moins est muni d'un ou de plusieurs joints étanches (12).

13. Un élément formant train de tiges tel que revendiqué dans n'importe quelle revendication précédente, dans lequel le moyen de compression élastique (27, 153, 154) comporte un tampon.

14. Un élément formant train de tiges tel que revendiqué dans n'importe quelle revendication précédente, dans lequel le moyen de compression élastique (27, 153, 154) est annulaire.

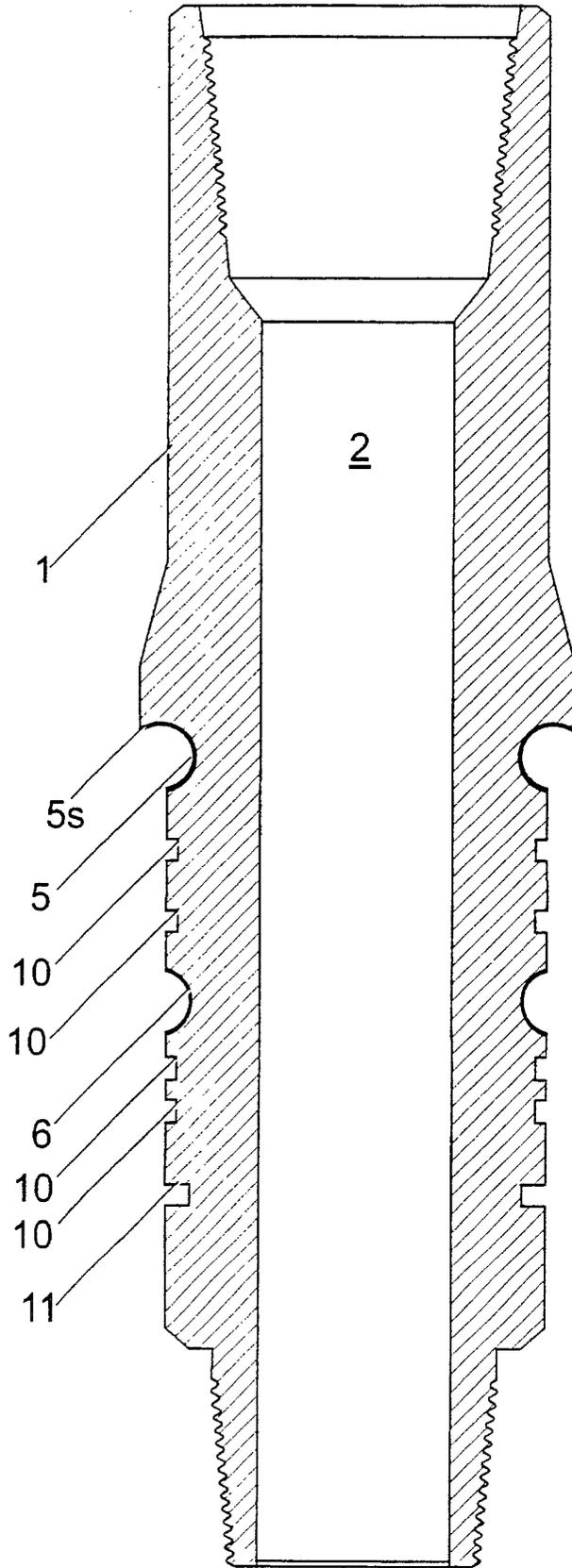
15. Un élément formant train de tiges tel que revendiqué dans n'importe quelle revendication précédente, dans lequel le moyen de compression élastique (27, 153, 154) comporte au moins un ressort.

16. Un élément formant train de tiges tel que revendiqué dans la revendication 15, dans lequel le ressort est un ressort conique.

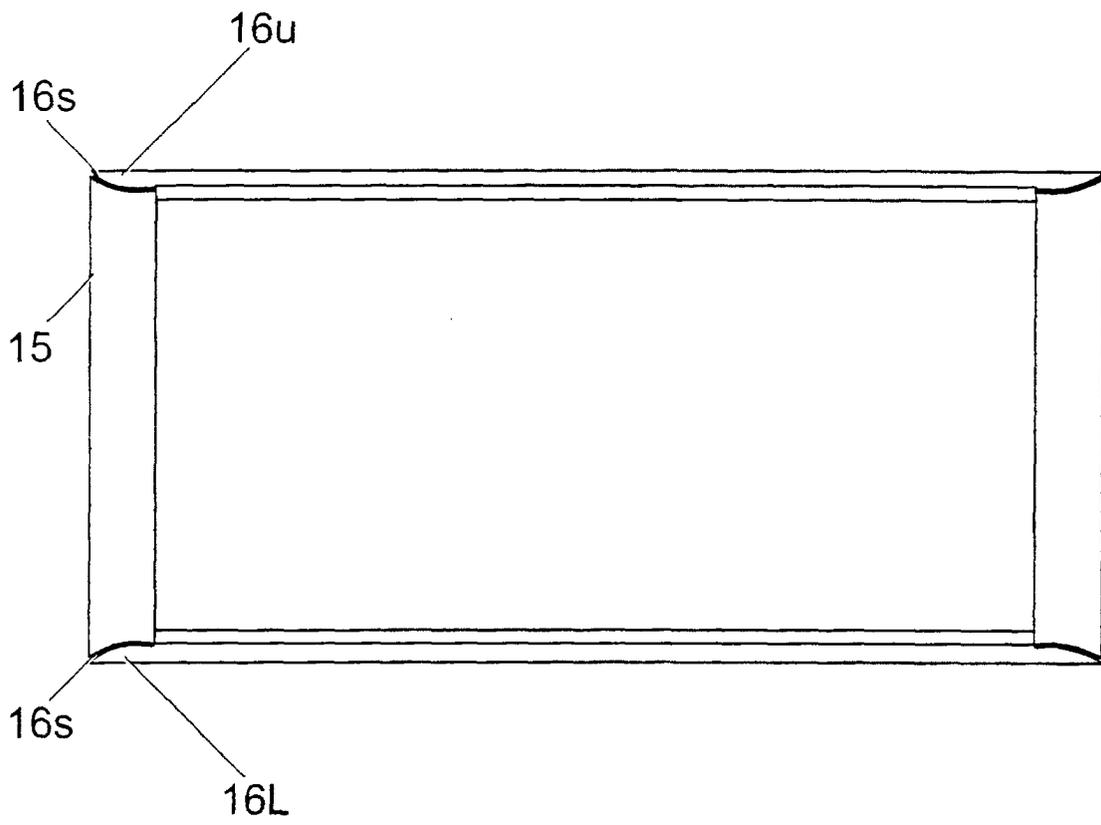
17. Un élément formant train de tiges tel que revendiqué

- qué dans n'importe quelle revendication précédente, dans lequel un élément de retenue (30, 31) est utilisé pour retenir ce manchon (15, 20, 115, 125, 150, 160) au moins. 5
- 18.** Un élément formant train de tiges tel que revendiqué dans la revendication 17, dans lequel le moyen de compression élastique (27, 153, 154) s'étend entre l'élément de retenue et le manchon ou entre des premier et deuxième manchons. 10
- 19.** Un élément formant train de tiges tel que revendiqué dans la revendication 14, dans lequel l'élément de retenue (30, 31) est un anneau de verrouillage encliquetable ou fretté, un collet vissable, un anneau de verrouillage ou un circlip. 15
- 20.** Un élément formant train de tiges tel que revendiqué dans n'importe quelle revendication précédente, ayant un mécanisme d'ajustement de charge pour le moyen de compression élastique. 20
- 21.** Un élément formant train de tiges tel que revendiqué dans la revendication 20, dans lequel l'élément de retenue comporte un collet vissable ayant des filets qui mettent en prise des filets sur le corps, et ayant un bord en contact avec le moyen de compression. 25
- 22.** Un élément formant train de tiges tel que revendiqué dans n'importe laquelle des revendications 2 à 21, dans lequel ce roulement (25, 75, 125, 175) au moins et/ou ce chemin (5, 6) au moins sont lubrifiés par admission de boue. 30  
35
- 23.** Un élément formant train de tiges tel que revendiqué dans n'importe laquelle des revendications 2 à 22, dans lequel ce chemin de roulement (5, 6) au moins est autonettoyant. 40
- 24.** Un élément formant train de tiges tel que revendiqué dans n'importe quelle revendication précédente, dans lequel ce roulement (25, 75, 125, 175) au moins peut être libéré pour être nettoyé. 45
- 25.** Un élément formant train de tiges tel que revendiqué dans n'importe quelle revendication précédente, comportant une longueur de tige de forage.
- 26.** Un élément formant train de tiges tel que revendiqué dans n'importe laquelle des revendications 1 à 24, comportant un accord double femelle ou manchon (15, 20, 115, 125, 150, 160) pouvant être rattaché à une longueur de tige de forage. 50  
55

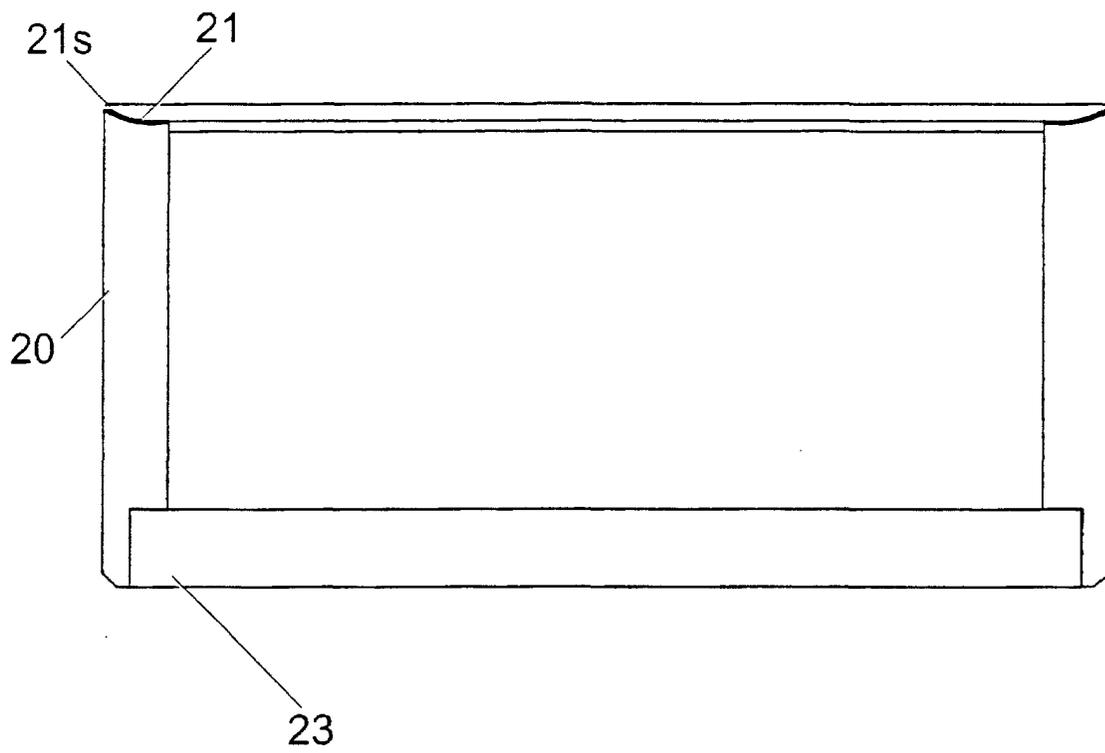




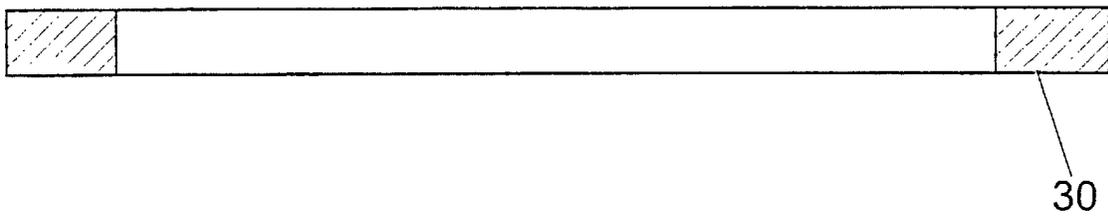
*Fig. 2*



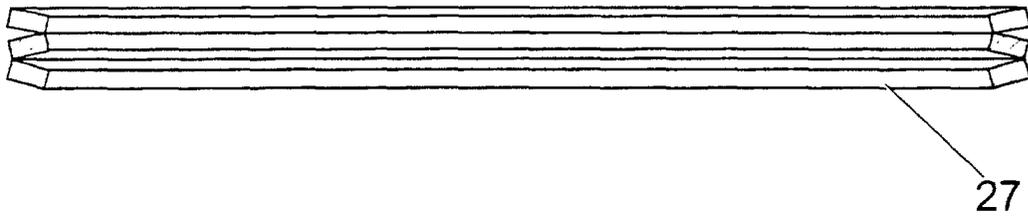
*Fig. 3*



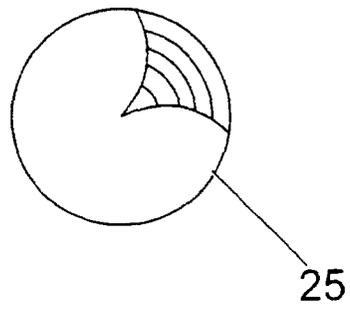
*Fig. 4*



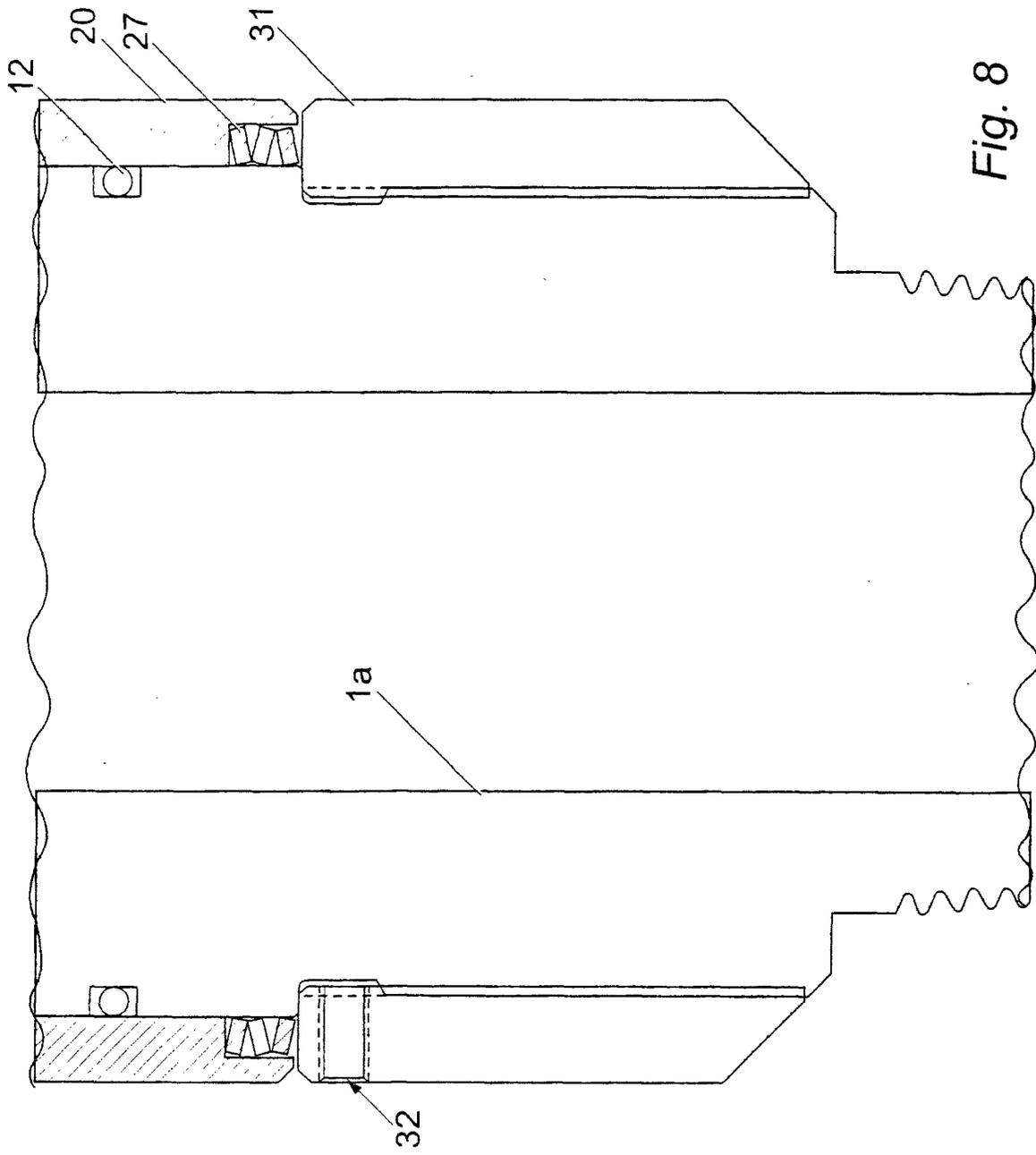
*Fig. 5*



*Fig. 6*



*Fig. 7*



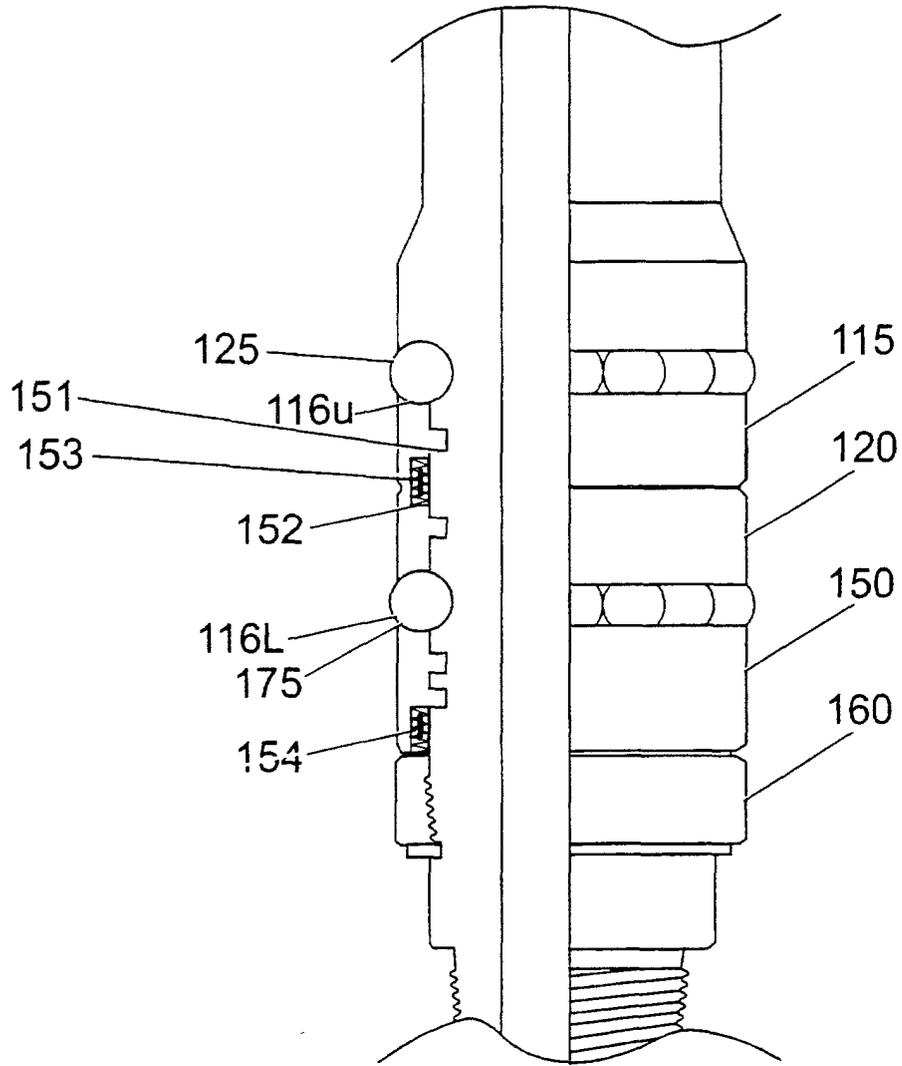


Fig. 9