



(19) **United States**
(12) **Patent Application Publication** (10) **Pub. No.: US 2003/0136587 A1**
Boulet (43) **Pub. Date: Jul. 24, 2003**

(54) **SHAPED ELEMENT FOR ROTARY
DRILLING EQUIPMENT, AND A DRILLROD
INCLUDING AT LEAST ONE SHAPED
ELEMENT**

Publication Classification

(51) **Int. Cl.⁷** **E21B 10/44**
(52) **U.S. Cl.** **175/323**

(75) **Inventor: Jean Gilbert Boulet, Paris (FR)**

Correspondence Address:
SUGHRUE MION, PLLC
2100 PENNSYLVANIA AVENUE, N.W.
WASHINGTON, DC 20037 (US)

(73) **Assignee: S.M.F. INTERNATIONAL**

(21) **Appl. No.: 10/345,196**

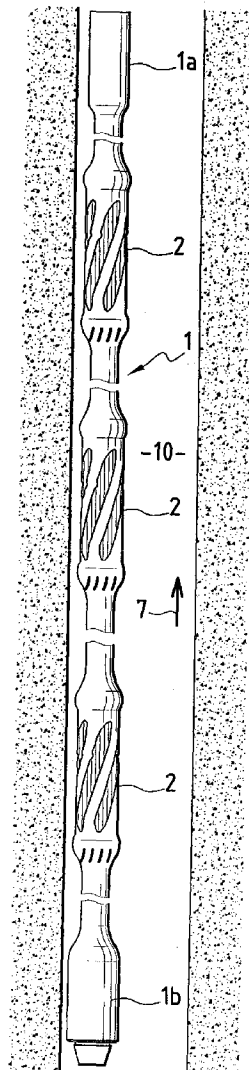
(22) **Filed: Jan. 16, 2003**

(30) **Foreign Application Priority Data**

Jan. 18, 2002 (FR)..... 02 00 648

(57) **ABSTRACT**

The shaped element has at least one stirring and entrainment zone in which the outside surface of the shaped element has recessed portions and projecting portions configured substantially in the form of helices about the axis of rotation of the drillrod, said portions being wound in a direction such as to encourage the flow of a drilling fluid in the upward direction in an annular space between the drillrod and the wall of a borehole under the effect of the drillrod rotating. The angle of inclination of the helices in which the recessed portions and the projecting portions of the shaped element are configured increases in the flow direction of the drilling fluid in the annular space.



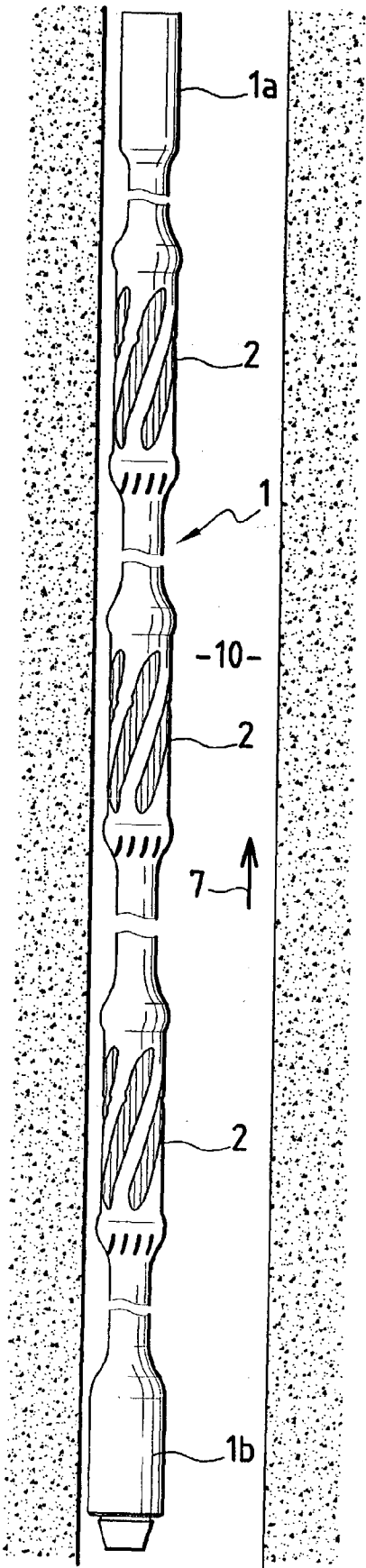
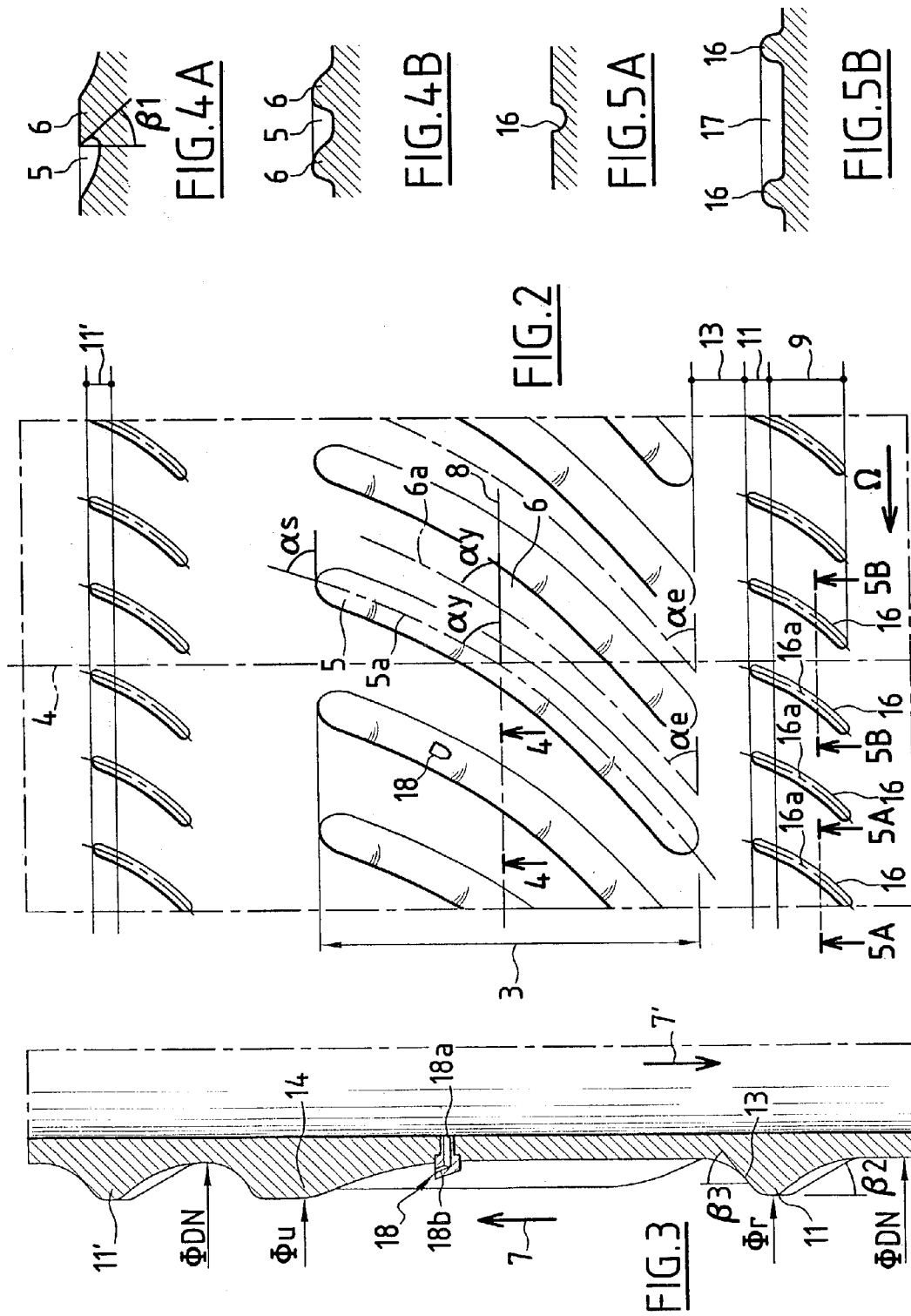


FIG.1



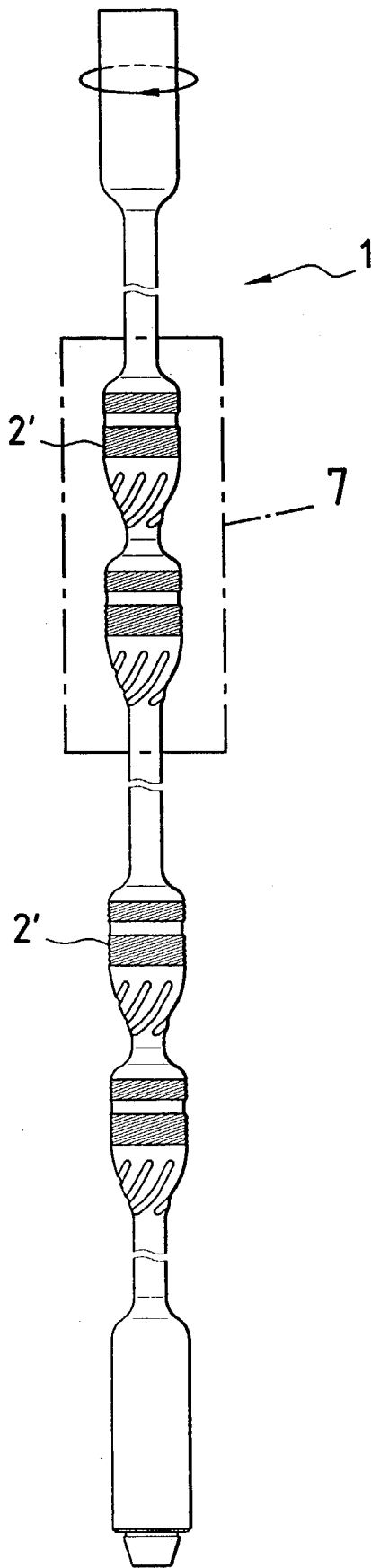


FIG.6

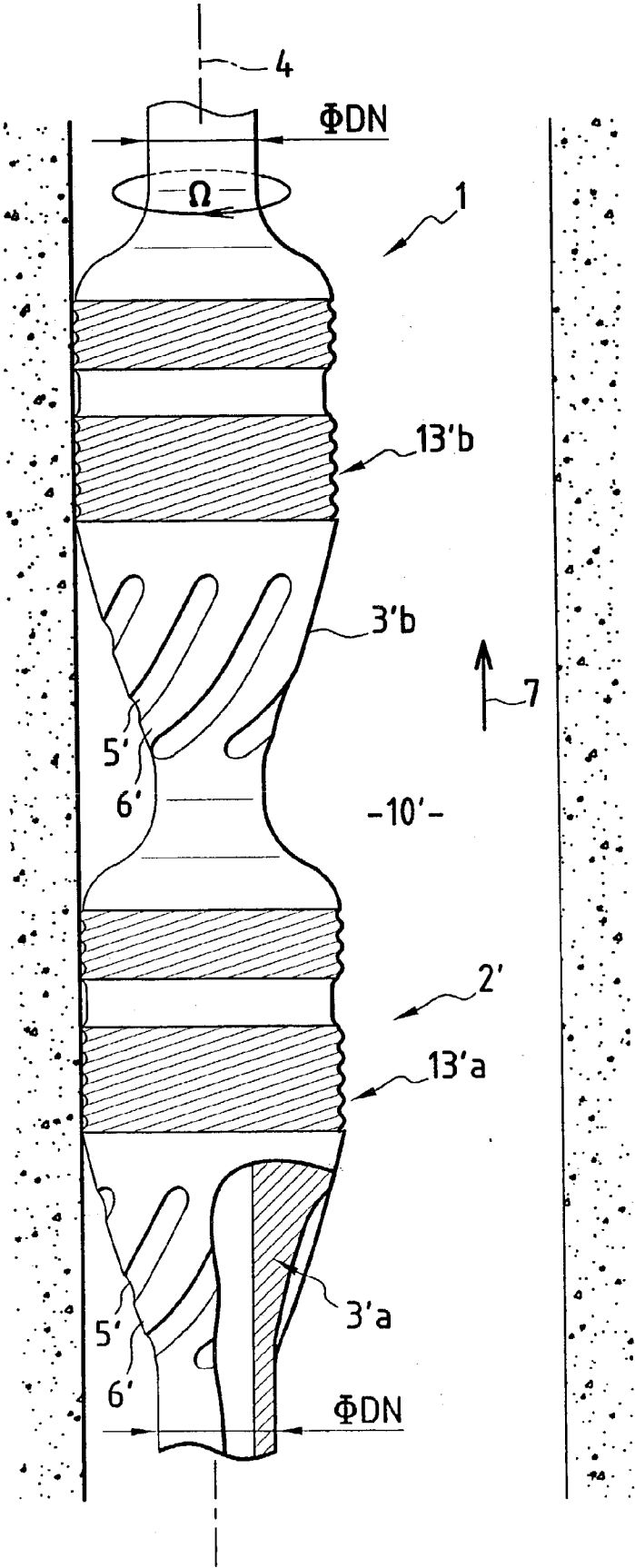


FIG. 7

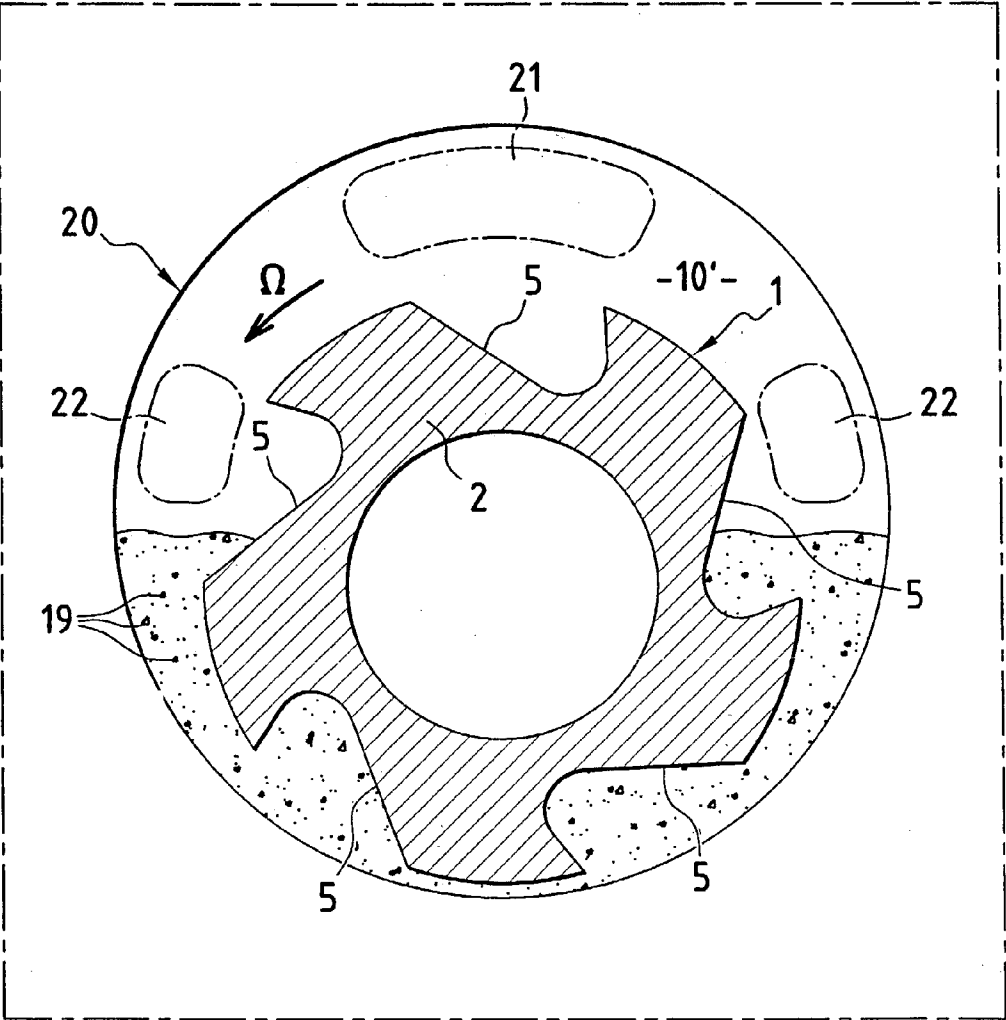


FIG. 8

SHAPED ELEMENT FOR ROTARY DRILLING EQUIPMENT, AND A DRILLROD INCLUDING AT LEAST ONE SHAPED ELEMENT

[0001] The invention relates to a shaped element for rotary drilling equipment.

BACKGROUND OF THE INVENTION

[0002] In the field of prospecting and operating petroleum deposits, strings of rotary drillrods are used that are made up of rods and possibly other tubular elements depending on drilling requirements, which rods and elements are assembled end to end.

[0003] Such drill strings can be used in particular to make deflected boreholes, i.e. boreholes in which the inclination of the borehole can be caused to depart from the vertical and in which the azimuth direction can be varied while drilling is taking place.

[0004] With deflected boreholes of large departure including segments that are horizontal or practically horizontal, friction torque due to the rotation of the drill string can reach very high values during drilling. Friction torque can compromise the equipment used or drilling objectives. Furthermore, it is often very difficult to raise the cuttings produced by the drilling, given the way the cuttings produced in the borehole tend to settle, in particular in the highly inclined portion of the borehole. This leads to the borehole being poorly cleaned, to an increase in the coefficient of friction between the rods of the drill string inside the borehole, and to an increase in the contact surface areas between the rods and the walls of the borehole.

[0005] In order to reduce the coefficient of friction and the contact area between the drill string and the walls of the borehole, and in order to improve the cleaning of the borehole and the removal of cuttings in the drilling fluid, proposals have been made in French patent application No. 97/03207 for a drillrod having at least one bearing zone with a central bearing portion and two end segments on either side of the central bearing zone, the outside surface of each end segment having at least one groove disposed in a helical configuration and of a cross-section that presents an undercut portion. The bearing zone of the drillrod which is of diameter greater than the diameter of the end segments and which can come into contact with the wall of the borehole serves to reduce friction to some extent between the drillrod and the wall of the borehole. The end portions which have hydraulic profiles serve to activate circulation of the drilling fluid and to unstuck cuttings that have become stuck to the wall of the borehole.

[0006] French patent No. 99/01391 proposes a shaped element for rotary drilling equipment, which element is generally in the form of a body of revolution on the axis of rotation of the drilling and with projecting portions and recessed portions in radial directions at its outside surface in configurations that are substantially helical in shape having the same axis as the axis of rotation of the drilling equipment and in which the projecting portions and the recessed portions present at least one geometrical and dimensional characteristic which varies along the axial direction of the element, at least over a portion of the length of said shaped element.

[0007] The recessed portions or grooves disposed in helices in the shaped element are preferably of a transverse flow

section on a plane perpendicular to the axis of the drillrod that tapers in the axial direction and in the flow direction of the drilling fluid in the drilling annulus.

[0008] Such shaped elements present distinct advantages when they are used on a drill string being used for directional drilling, but it has been found that in some cases it can be desirable to further improve the stirring and entrainment effect on the drilling fluid and on the cuttings in the drilling annulus.

OBJECT AND SUMMARY OF THE INVENTION

[0009] The object of the invention is to provide a shaped element for rotary drilling equipment, the element being generally in the form of a body of revolution of axis coinciding with the drilling axis of rotation and having an outside surface with projecting portions and recessed portions extending in radial directions perpendicular to the axis in configurations that are substantially helical about the axis of the shaped element so as to produce an effect of controlled stirring and accelerated rise of a drilling fluid with cuttings in an annular space between the shaped element of the drilling equipment and the wall of a borehole while the drilling equipment is rotating, said shaped element presenting improved properties of stirring the drilling fluid and the cuttings and of entraining the drilling fluid in the drilling annulus.

[0010] For this purpose, each helix along which the projecting portions and the recessed portions of the shaped element are disposed has an angle of inclination relative to a plane perpendicular to the axis of the shaped element that increases in the axial flow direction of the drilling fluid in the annular space, i.e. upwards when the drilling equipment is in its operating position, the axial flow of the drilling fluid being accelerated along the projecting portions and the recessed portions because of the direction of rotation of the drillrod.

[0011] The invention also relates to other characteristics of the shaped element which, combined with the projecting and recessed portions of varying inclination in accordance with the invention make it possible further to increase the stirring effect and the entrainment effect on the drilling fluid and the cuttings in the drilling annulus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] In order to make the invention well understood, there follows a description made with reference to the accompanying figures of two embodiments of a drill string including examples of shaped elements in accordance with the invention.

[0013] FIG. 1 is a side elevation view of a drillrod having three shaped elements of the invention, in its working position in a borehole.

[0014] FIG. 2 is a developed view of a shaped element of the drillrod shown in FIG. 1.

[0015] FIG. 3 is an axial half-section view of the shaped element shown in FIG. 2 in developed form.

[0016] FIG. 4A is a cross-section view on 4-4 of FIG. 2 showing a portion of the section of the shaped element in a first embodiment.

[0017] FIG. 4B is a cross-section view on 4-4 of FIG. 2 showing a second embodiment of a portion of the cross-section of the shaped element.

[0018] FIG. 5A is a cross-section view on 5A-5A of FIG. 2 showing a first embodiment of the cross-section.

[0019] FIG. 5B is a section view on 5B-5B of FIG. 2 showing the cross-section of a portion of the shaped elements, in a second embodiment.

[0020] FIG. 6 is an elevation view of a drillrod having two shaped elements in a second embodiment.

[0021] FIG. 7 is a side elevation view shown partially in section of a shaped element in the drillrod shown in FIG. 6.

[0022] FIG. 8 is a cross-section view of a drillrod including a shaped element of the invention, in its in-service position in a borehole.

MORE DETAILED DESCRIPTION

[0023] FIG. 1 shows a drillrod given overall reference 1 which drillrod comprises three shaped elements 2 of the invention in three zones that are spaced apart along the axial direction of the rod.

[0024] In conventional manner, the drillrod comprises a female coupling 1a at one of its ends (its top end) and a male coupling 1b at its bottom end, the couplings being constituted by frustoconical threaded portions enabling the successive rods 1 of a drill string to be connected together.

[0025] FIG. 2 shows a segment of the rod constituting a shaped element 2, this figure being on a larger scale and in developed form.

[0026] The rod segment constituting the shaped element 2 mainly comprises a zone 3 extending over the major fraction of the length of the shaped segment for the purpose of stirring a drilling fluid around the drillrod 1 inside a borehole in the annular space 10 that exists between the outside surface of the drillrod and the wall of the borehole, as shown in FIG. 1.

[0027] In the zone 3, the outside surface of the drillrod is generally cylindrical in shape, having the same axis as the drilling axis 4 of the drillrod and having recessed portions 5 and projecting portions 6 extending in continuous manner along the full length of the stirring and turbulence zone 3 of the shaped element.

[0028] The recessed portions 5 are constituted in the form of grooves of cross-section that may have the shape shown in FIG. 4A (first embodiment) or in FIG. 4B (second embodiment).

[0029] The projecting portions 6 are in the form of blades lying between two successive recessed portions or grooves 5.

[0030] The grooves 5 and the blades 6 present respective axes 5a, 6a disposed helically about the same axis as the axis 4 of the drillrod and turning in a direction for encouraging the drilling fluid to rise in the annulus 10, given the direction of rotation of the drillrod (arrow Ω in FIG. 2).

[0031] In the invention, the helices 5a and 6a are of inclination that increases in the flow direction of the drilling fluid in the drilling annulus (arrow 7), i.e. going upwards

when the drillrod 1 is in its operating position inside a borehole, said inclination being taken relative to a transverse plane perpendicular to the axis 4 of the drillrod.

[0032] In FIG. 2, there can be seen the trace, in the plane of the figure, of a cross-section plane 8 together with the tangents to the helices 5a and 6a of a groove 5 and of a blade 6 in the stirring zone 3 of the shaped element. The tangents to the helices 5a and 6a constituting the axes or mid-lines of the grooves 5 and of the blades 6 form an angle α_y with the plane of trace 8 in FIG. 2, which angle is the angle of inclination of the helix at the cross-section plane of trace 8 at ordinate position y (along the direction of the axis 4 of the drillrod).

[0033] In the invention, α_y increases with increasing y, with the ordinates of the points of the drillrod along the direction of the axis 4 increasing upwards, i.e. in the direction 7 of drilling fluid flow in the annulus 10.

[0034] In particular, the angles of inclination α_s of the helices 5a and 6a at the inlet to the zone 3 are smaller than the angles of inclination α_s of the helices at the outlet from the stirring and entrainment zone 3 of the drillrod.

[0035] As can be seen in FIG. 4A, the grooves 5 may be of a shape in cross-section such as that described and claimed in French patent application No. 97/03207, said shape making it possible to bail out the drilling fluid present in the annulus 10 of the borehole vigorously given that the section of the groove 5 presents in particular an undercut portion defined by a straight line portion of the section making an angle β_1 with the direction perpendicular to the axis 4 of the drillrod, along the outer edge of the section 5 disposed towards the back of the groove relative to the direction of rotation Ω of the drillrod about its axis or rotation 4 (FIG. 2).

[0036] In addition, the grooves disposed helically about the drillrod serve to entrain the drilling fluid and the cuttings within the annulus 10 in an upward direction as shown by arrow 7, due to the rotation of the drillrod.

[0037] The increasing slope of the helices in the upward direction entrains the drilling fluid at increasing speed in the annulus and provides an increased sweeping effect of the borehole. As a result, the field of speeds inside the annulus 10 is modified, the speeds being modified in absolute value and in direction along the direction y of the axis 4 of the drillrod and of the shaped element 2. The increase in the inclination of the helices in the direction y can be modulated as a function of the operating conditions of the drillrod.

[0038] In addition, the sections s_y of the grooves 5 decrease in the direction of the arrow 7, i.e. in the direction of increasing ordinate values y. The decreasing sections s_y of the grooves 5 can be obtained either because the grooves 5 are of depth that decreases in the direction of increasing ordinate values y, or because the grooves are of width that decreases in the direction of increasing ordinate values, or indeed because they present both depth and width that decrease.

[0039] Each projecting portion 6 or blade is disposed between two successive grooves 5, and because of the decreasing section and width of the grooves 5, these portions are of section and width that increase in the direction of

increasing ordinate values y (or the fluid flow direction in the annulus **10** as represented by arrow **7**).

[0040] As can be seen in **FIG. 4B**, in cross-section the grooves **5** may be asymmetrical in shape without any undercut portion, the effect of bailing out and stirring the drilling fluid nevertheless being less intense than it is with the grooves of the first embodiment as shown in **FIG. 4A** where there is an undercut portion. The grooves in the second embodiment are easier to machine, and they nevertheless enable a satisfactory bailing out and stirring effect to be obtained because of the presence of the blades **6** between pairs of successive grooves **5**. As in the first embodiment, the grooves **5** may be of section, depth, and/or width that tapers in the direction **7** in which fluid flows in the annulus **10** (the direction in which ordinate values y increase), the blades **6** being correspondingly of section and of width that increase.

[0041] As can be seen in **FIG. 2**, upstream from the stirring and entrainment zone **3** relative to the flow direction **7** of the drilling fluid, the shaped element **2** has in succession: a prior stirring zone **9**; a hydraulic pre-loading zone **11**; and a turbulent zone **13**.

[0042] As can be seen in **FIG. 3**, the pre-loading zone **11** is constituted by a portion of the drillrod that has a diameter Φ_r that is perceptibly greater than the maximum diameter of the drillrod **1** in the stirring zone **3**. On the outside surface of the drillrod, the zone **11** may be defined by a toroidal surface, as shown in particular in **FIGS. 1 and 3**, with the maximum diameter Φ_r then being the diameter of the middle portion of the toroidally-shaped zone **11**.

[0043] The connection between the pre-loading zone **11** of the drillrod and the stirring zone **3** is made via the "turbulence" zone **13** in which the drillrod presents a tapering diameter following a curved surface of section as shown in **FIG. 3**.

[0044] The pre-loading zone **11** runs into the ordinary portion of the drillrod below the shaped element **2** via the prior stirring zone **9** of diameter that increases in the direction of increasing ordinate values y (or in the flow direction **1** of the drilling fluid in the annulus **10**) and of curved longitudinal section that is substantially analogous to the longitudinal section of the turbulent zone **13**, as can be seen in **FIG. 3**. The inclination of the curved portion of the prior stirring zone **9** relative to a direction parallel to the axis **4** of the drillrod, where it connects with the pre-loading zone **11**, is less than the inclination of the curved portion connecting the turbulence zone **13** to the bearing zone (angle $\beta_2 \leq \beta_3$, see **FIG. 3**).

[0045] On either side of the shaped element **2**, the ordinary portion of the drillrod presents a nominal diameter Φ_{DN} .

[0046] The shaped element **2** also connects with the ordinary portion of the drillrod **1** of nominal diameter Φ_{DN} , at its downstream end, via a bearing zone **4** where the rod has a maximum diameter Φ_u that is perceptibly greater than or equal to the diameter Φ_r of the upstream pre-loading zone **11** (which can in some cases also constitute a bearing zone).

[0047] The diameters Φ_r and Φ_u are perceptibly greater than the nominal diameter Φ_{DN} of the ordinary portion of the drillrod, with the pre-loading zone **11** and the bearing zone **14** constituting two radially-projecting zones, respectively in the upstream and downstream portions of the shaped element **2**.

[0048] In the prior stirring zone **9**, and in the pre-loading zone **11**, the shaped element **2** has hollow portions or projecting portions **16** that are spaced apart from one another in the circumference direction of the drillrod and each of which is disposed along a helix **16a** of inclination relative to a plane extending transversely to the drillrod that increases in the direction of increasing ordinate values y , in the same manner as the helices **5a** and **6a** of the grooves and projecting portions **5** and **6** of the stirring zone **3**.

[0049] When the portions **16** are recessed portions in the radial direction and constitute grooves, their section, their depth, and/or their width may be constant or tapering in the direction of increasing ordinate values y . When the portions **16** are projecting portions, their section and/or their width may be constant or increasing in the direction of increasing ordinate values y . Their height may decrease in the direction of increasing ordinate values y .

[0050] This produces an increased entrainment effect on the drilling fluid in the initial stirring zone **9** and in the pre-loading zone **11**.

[0051] Furthermore, the presence of the curved surface in the zones **9** and **11** which present increasing diameter in the flow direction of the fluid gives rise to the stream lines of the fluid separating from the drillrod, with these stream lines then being delivered with turbulent flow from the pre-loading zone **11** into the turbulence zone **13** where the drilling fluid establishes vortices that are favorable for mixing and entraining drilling cuttings in the drilling fluid, which fluid is then taken up by the main entrainment and stirring zone **3**.

[0052] **FIG. 5A** shows the cross-section of grooves **16** placed in helices and constituting recessed portions of the prior stirring zone **9** and of the pre-loading zone **11**, in a first embodiment. The grooves **16** present depth and width, and thus section, that are generally constant in the fluid flow direction **7** or the direction of increasing ordinate values y . Nevertheless, the width and/or the depth, and thus the section, of the grooves **16** may also decrease in the direction of increasing ordinate values. The grooves **16** are obtained by machining the outside surface of the drillrod in the vicinity of the curved surface coupling the ordinary portion of the drillrod with the toroidal bearing zone **11**.

[0053] **FIG. 5B** relates to a second embodiment in which projecting portions **16** constitute ribs following helical paths around the axis of the drillrod. The inclination of the helical paths followed by the ribs **16** increases in the direction of increasing ordinate values. In addition, the width of the ribs **16** may decrease and/or their height may decrease in the direction of increasing ordinate values y , such that the cross-section of the recessed zones **17** between two projecting portions **16** decreases in the direction of increasing ordinate values y . This gives rise to transverse flow of the drilling fluid, thereby increasing turbulence and stirring.

[0054] The pre-loading zone **11** makes it possible to deflect the drilling fluid outwards, thereby encouraging cuttings to rise in the annulus **10**. In addition, like the zone **9**, the pre-loading zone **11** serves to create pre-stirring of the drilling fluid and the cuttings prior to the zone **3**.

[0055] The pressure of the drilling fluid is also raised (pre-loading) in the zone **11**.

[0056] A second loading zone 11' analogous to the above-described zone 11 may be situated downstream from the bearing zone 14 (in the flow direction 7 of the fluid in the annulus 10) in order to reinforce the cutting-rising effect. This additional zone constitutes a post-loading zone for the device.

[0057] For this purpose, downstream from the radial projecting portion 14 of the drilling device, there is provided a second radially-projecting portion constituting zones analogous to the stirring zone 9 and to the pre-loading zone 11 situated at the upstream end of the device.

[0058] FIGS. 2 and 3 also show a nozzle 18 which is inserted and fixed in the wall of the tubular drillrod 1 in the stirring and entrainment zone 3.

[0059] By way of example, the nozzle 18 may be placed in the bottom and in the middle portion of a groove 5 in the stirring and entrainment zone 3. The nozzle 18 has a first duct or inlet channel 18a extending substantially in a radial direction of the drillrod, opening out into the inside space of the tubular drillrod 1, and a second duct 18b or outlet channel communicating with the inlet channel 18a and extending substantially axially or slightly inclined towards the outside of the drillrod 1 in an upward direction. The outlet channel 18b opens out into the annulus 10 outside the drillrod via a top end portion of the nozzle 18 that points upwards.

[0060] The drilling fluid flowing downwards in the inside space of the tubular drillrod 1 (arrow 7') is at a pressure that is significantly higher than the pressure of the drilling fluid flowing upwards in the drilling annulus 10 outside the drillrod (arrow 7). As a result, the drilling fluid is entrained from the inside of the inlet channel 18a of the nozzle 18 and then ejected upwards via the outlet channel 18b inside the groove 5 in which the nozzle 18 is fixed. This increases the flow speed and the stirring of the fluid, with one or more nozzles being used that are preferably disposed inside one or more stirring and entrainment grooves 5 in the zone 3 of the shaped element 2 of the drillrod.

[0061] FIG. 6 shows a drillrod given overall reference 1 and comprising two dual shaped elements of the invention, constituting a variant embodiment and referenced 2'.

[0062] As can be seen in FIG. 7, the shaped element 2' of the drillrod 1 is made in dual form and comprises in succession, going upwards: a first stirring and entrainment zone 3'a, a first mechanical activation and bearing zone 13'a, a second activation and entrainment zone 3'b, and a second mechanical activation and bearing zone 13'b.

[0063] The stirring and entrainment zones 3'a and 3'b are made in accordance with the invention, i.e. they have grooves 5' separated by blades 6' disposed along helices of angle relative to a transverse plane perpendicular to the axis 4 of the drillrod that increases in the flow direction 7 of the drilling fluid in a drilling annulus 10 outside the rod 1. The widths and/or depths, and thus the cross-sections of the grooves 5' may decrease in the flow direction 7 of the drilling fluid in the annulus 10 so as to increase turbulence and produce a fluid-bearing effect.

[0064] In addition, the stirring zones 3'a and 3'b are also made in the form of deflection zones in accordance with French patent application No. 01/05752, the outside surface

of the drillrod in the stirring and entrainment zones 3'a and 3'b that are inclined relative to the axis 4 of the drillrod presenting a meridian line in an axial plane that goes away from the axis 4 of the shaped element 2 and of the drillrod 1 in the flow direction 7 of the drilling fluid in the annulus, i.e. in the upward direction when the drillrod is in its operating position in a borehole.

[0065] This produces a stirring effect that is increased because a component in the radial direction is added to the speed of the drilling fluid entrained by the grooves 5' and by the projecting portions 6' of the stirring and entrainment zones 3'a and 3'b.

[0066] A circular arrow Ω shows the direction in which the drillrod rotates when in operation in a borehole. The ordinary portion of the drillrod of diameter Φ_{DN} is shown on either side, i.e. upstream and downstream of the shaped element 2'.

[0067] In the mechanical activation and bearing zones 13'a and 13'b, the shaped element 3' presents a maximum diameter that is significantly greater than the diameter Φ_{DN} . In the zones 13'a and 13'b, the outside surface of the shaped element is machined so as to present two successive portions of greatest diameter separated by a middle portion of smaller diameter.

[0068] The two portions of greatest diameter in the mechanical activation and bearing zones 13'a and 13'b are machined so as to present at least one continuous helical groove at a small angle of inclination, generally less than 30° relative to planes extending transversely to the drillrod and perpendicularly to the axis 4, such that the two portions of the mechanical activation and bearing zones 13'a and 13'b on either side of the middle zone without a helical groove are of a shape that is analogous to a threaded element with successive threads that are substantially helical in shape. This produces an effect of entraining the fluid in the bearing zone when the drillrod is rotating in the direction shown by arrow Ω (Archimedes' screw effect) and a fluid bearing effect where the drillrod bears via the bearing zones 13'a and 13'b.

[0069] FIG. 8 shows a cross-section of a shaped element 2 of a drillrod 1 across a stirring zone such as the stirring zone 3 in which the shaped element 2 has asymmetrical grooves 5 possibly including undercut portions serving to bail out the drilling fluid out thoroughly from the annulus 10 inside the borehole 20 when the drillrod is rotating in the direction of arrow Ω . In the annulus 10, the drilling fluid entrains the cuttings 19 produced by the drilling inside and along the grooves 5 of the stirring and entrainment zone 3 of the shaped element. As it rotates inside the borehole 20, the drillrod 1 approaches the edge of the borehole such that the annulus 10 is of with that varies in the circumferential direction of the drillrod.

[0070] FIG. 8 is a cross-section through the drillrod seen from the bottom of the borehole, the flow of drilling fluid in the drilling annulus causing the cuttings 19 to be entrained taking place in a direction that is perpendicular to the section plane of FIG. 8, towards the back of the plane of FIG. 8.

[0071] The provision of the stirring and entrainment zone 3 on the shaped element of the drillrod of the invention makes it possible to bail out and entrain upwards the drilling fluid and the cuttings 19 so that circulation of the drilling

fluid and the cuttings in the annulus **10** takes place preferentially in the zone **21** where the outside surface of the drillrod is at its furthest away from the wall of the borehole **20**, and not in the zones **22** where the drilling annulus **10** does not present maximum width. The dispositions of the invention thus serve to obtain an ideal distribution of vertical entrainment speeds in the annulus **10** around the drillrod.

[0072] Similarly, the pre-loading zone **11** serves to establish a speed gradient and thus a pressure gradient in the flow of drilling fluid in the annulus **10** so as to direct the flow preferentially towards the zone **21**.

[0073] The shaped element of the invention thus makes it possible to optimize stirring and entrainment of the drilling fluid and the cuttings inside the annulus, in particular in deflected boreholes that present portions that are practically horizontal.

[0074] The invention is not limited strictly to the embodiments described above.

[0075] Certain variant embodiments of the shaped element can be devised by a plurality of stirring zones, loading zones, and/or pre-loading zones, and entrainment zones with a plurality of mechanical activation and bearing zones such as those described above.

[0076] The invention applies to any element of a string of drillrods and in particular to those elements of a string of drillrods that are used for directional drilling.

What is claimed is:

1/ A shaped element for rotary drilling equipment such as a drillrod, the element being generally in the form of a body of revolution of axis coinciding with the drilling axis of rotation and having an outside surface with projecting portions and recessed portions extending in radial directions perpendicular to the axis in configurations that are substantially helical about the axis of the shaped element so as to produce an effect of controlled stirring and accelerated rise of a drilling fluid with cuttings in an annular space between the shaped element of the drilling equipment and the wall of a borehole while the drilling equipment is rotating, wherein each helix along which the projecting portions and the recessed portions of the shaped element are disposed has an angle of inclination relative to a plane perpendicular to the axis of the shaped element that increases in the axial flow direction of the drilling fluid in the annular space, i.e. upwards when the drilling equipment is in its operating position, the axial flow of the drilling fluid being accelerated along the projecting portions and the recessed portions because of the direction of rotation of the drillrod.

2/ A shaped element according to claim 1, wherein, in the flow direction of the drilling fluid in the annular space, the recessed portions of the shaped element constituted by grooves present a decrease in at least one of width in a circumferential direction of the shaped element and depth in a radial direction perpendicular to the axis of the shaped element, and thus present a decrease in cross-section in a plane perpendicular to the axis of the shaped element.

3/ A shaped element according to claim 1, further comprising, on either side in the axial direction of a stirring and entrainment zone in which the shaped element presents projecting portions and recessed portions disposed in helices, a pre-loading zone in which the drillrod presents a portion projecting radially outwards, and a bearing zone in

which the drillrod also presents a portion projecting radially outwards with a maximum diameter greater than the maximum diameter of the shaped element in the stirring and entrainment zone and greater than the nominal diameter of the drillrod in its ordinary portions disposed on either side in the axial direction of the shaped element.

4/ A shaped element according to claim 1, including a second loading zone or post-loading zone analogous to the pre-loading zone, said second loading zone being situated downstream from the bearing zone in the flow direction of the drilling fluid in the annular space.

5/ A shaped element according to claim 3, further comprising, on either side of the pre-loading zone disposed upstream of the stirring and entrainment zone in the flow direction of the drilling fluid in the annular space, a prior stirring and entrainment zone situated upstream and a turbulence zone situated downstream in the flow direction of the drilling fluid in the annular space, the outside surface of the shaped element presenting a diameter that increases in the flow direction of the drilling fluid in the prior stirring and entrainment zone and a diameter that decreases in the flow direction of the drilling fluid in the annular space in the turbulence zone.

6/ A shaped element according to claim 5, further comprising, in the prior stirring and entrainment zone and in the pre-loading zone, at least one of a plurality of recessed elements and a plurality of projecting elements spaced apart in the circumferential direction of the shaped element, configured in helices about the axis of the shaped element with an angle of inclination relative to a transverse plane perpendicular to the axis of the shaped element that increases in the flow direction of the drilling fluid in the annular space.

7/ A shaped element according to claim 6, further comprising, in the prior stirring and entrainment zone and in the pre-loading zone, recessed portions constituted by grooves machined in helices in the outside surface of the shaped element of the drillrod.

8/ A shaped element according to claim 6, further comprising, in the prior stirring and entrainment zone, projecting portions constituted by ribs configured in helices between which the outside surface of the shaped element of the drillrod is machined to constitute the recessed portions.

9/ A shaped element according to claim 1, further comprising, at least in a stirring and entrainment zone having recessed portions and projecting portions configured in helices, at least one nozzle passing through a tubular wall of the shaped element of a drillrod between an internal central space for a flow of drilling fluid in the drillrod and the annular space outside the shaped element of the drillrod, the nozzle comprising an inlet channel extending substantially radially perpendicularly to the axis of the shaped element of the drillrod and opening out into the inside space of the shaped element of the drillrod, and an outlet channel communicating with the inlet channel and opening out to the outside of the shaped element of the drillrod, the outlet channel being directed in a direction that is substantially parallel to the axis of the shaped element in the flow direction of the drilling fluid in the annular space, i.e. upwards when the drillrod is in its operating position.

10/ A shaped element according to claim 1, comprising at least one stirring and entrainment zone having recessed portions and projecting portions configured in helices about the axis of the shaped element, and in axial alignment with

the at least one stirring and entrainment zone, it further comprises at least one mechanical activation and bearing zone in which the drillrod presents a maximum diameter and has, in its outside surface, at least one helical groove.

11/ A shaped element according to claim 10, wherein the at least one mechanical activation and bearing zone comprises, in the direction of the axis of the shaped element of the drillrod, a first portion of maximum diameter of the drillrod machined in its outside surface to form at least one substantially continuous helical groove analogous to a

thread, a middle zone of diameter smaller than the maximum diameter of the drillrod and without any helical groove, and a second portion of maximum diameter of the drillrod machined in its outside surface to present at least one substantially continuous helical groove.

12/ Drilling equipment such as a drillrod including at least one shaped element according to claim 1.

* * * * *