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(54) DRIFTING SYSTEM

(57) Disclosed is a drifting system (300) comprising a drifting element (100) having a wall (114) defining a through flow passage (102) extending in an axial direction (104) of the drifting element and a catcher sub having a through hole. In accordance with embodiment of the herein disclosed subject matter the catcher sub has a seat for receiving the drifting element (100) in the through hole. The through flow passage (102) of the drifting element (100) has a first cross section of flow (106) in a first axial region (108) of the drifting element (100) and has a second, smaller cross section of flow (110) in a second axial region (112) of the drifting element (100) located downstream the first axial region (108). Further, the wall (114) of the drifting element (100) has a lateral outlet (116) extending from the through flow passage (102) in the second axial region (112) and/or from the through flow passage (102) at a location upstream the second axial region (112) through the wall.

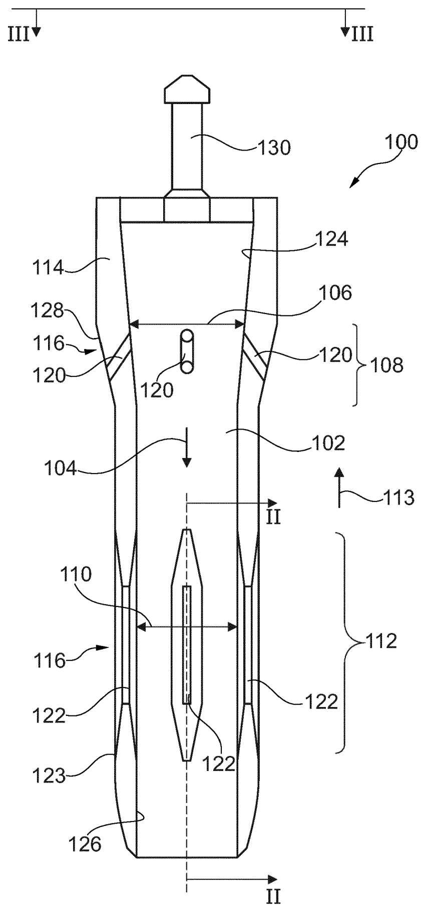

Fig. 1

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Description

FIELD OF INVENTION

[0001] The herein disclosed subject matter relates to the field of drifting systems.

BACKGROUND

[0002] In order to drill a well through the earth's crust, a drillstring is assembled above a drill bit. Typically, drillstring comprises of bottom-hole assembly positioned directly above the bit and followed by drillpipe all the way up to the rotary table or top drive. In a rotary drilling mode, a drillstring is used to transfer the rotary motion from the surface equipment to drill bit, thereby causing the drill bit to rotate and penetrate formation. In a sliding drilling mode, drill string does not rotate whereas the rotary motion of the bit is caused by mud motors or rotary steerable systems assembled as part of bottom-hole assembly above the drill bit. Whether in rotary or slide drilling mode, once the planned Total Depth (TD) of each section of the well has been achieved, the standard drilling practice is to trip the drill string out of hole one stand at a time (generally each stand is equal to 3 joints of drill pipe or approximately 93 feet long) and during this process a manual drifting of each stand is performed once the stand is racked back on the rig derrick. The drifting of the drillstring is essential in order to ensure that no debris or obstructions are present inside the drillstring bore. The presence of any such debris or obstruction if not detected and removed could lead to very expensive remedial work if the drillstring is run back in the hole for setting a liner or screen or for drilling of the next section of the well.

[0003] Drifting every stand on the rig is a time consuming practice and the deeper the well the longer it would take to drift every stand on the rig. Secondly and more importantly is the potential risk associated with raising the often heavy drift about 93ft above the rig floor and dropping it from this height down through each stand, hence giving rise to possibility of a drop object on the rig floor which could have catastrophic consequences for safety of personnel present on the rig floor during this operation.

[0004] One solution to this problem is to perform the drifting of the drillstring while the entire drillstring is still inside the well. This would result in much faster drifting of the entire drillstring and it would also remove the safety hazard associated with drifting at heights above the rig floor. The drifting is generally performed inside the drillpipe hence there is no requirement to drift any component located below the drillpipe, for this reason, it would be advantageous to have a device installed directly below the lower last joint of drillpipe in the drillstring in order to capture the drift which would be dropped inside the drillstring from the rig floor.

[0005] EP 1 611 312 B1 discloses a method of checking for restrictions in a string of tubing, the method comprising providing a profile in the tubing string and providing a drift member adapted to engage with said profile. The drift member comprises a generally cylindrical body and a hardened nozzle ring that is in sealing engagement with the inner wall of the body of the drift member. A drift sub and an external configuration of the body are as such that the body is substantially a sealing fit within the drift sub such that any fluid passing through the string from the surface must then pass through the nozzle and will therefore experience a pressure drop. The restriction introduced into the string bore by the nozzle is reflected at surface by a readily identifiable increase in pump pressure which indicates to the operators on the surface that the body has engaged with the drift sub and that the pipe string is substantially free of obstruction and restriction. Radial flow ports are provided in the body between its leading end and the nozzle ring. If the leading end should encounter an annular pipe restriction, preventing flow between the exterior of the leading end and a pipe wall, fluid may still pass through the flow ports.

SUMMARY

[0006] In view of the above-described situation, there exists a need for a drifting system with improved characteristics.

[0007] This need may be met by the subject matter according to the independent claims. Advantageous embodiments of the herein disclosed subject matter are described by the dependent claims.

[0008] In the following, exemplary embodiments of the herein disclosed subject matter are described, any number and any combination of which may be realized in an implementation of the herein disclosed subject matter.

[0009] According to an embodiment of a first aspect of the herein disclosed subject matter there is provided a drifting system comprising: a drifting element having a wall (in particular a tubular wall) defining a through flow passage, the through flow passage extending in an axial direction of the drifting element; and a catcher sub having a through hole; the catcher sub having a seat for receiving the drifting element in the through hole (in particular the seat is located in the through hole); the through flow passage having a first cross section of flow in a first axial region of the drifting element; the through flow passage having a second cross section of flow in a second axial region of the drifting element; the first axial region being located upstream the second axial region; the second cross section of flow being smaller than the first cross section of flow; and the wall of the drifting element having a lateral outlet extending from the through flow passage in the second axial region and/or from the through flow passage at a location upstream the second axial region through the wall.

[0010] According to embodiments of the first aspect, the drifting system is adapted for providing the functionality of one or more of the aforementioned embodiments and/or for providing the functionality as required by one or more of the aforementioned embodiments, in particular of the embodiments of the second, third and fourth aspect disclosed herein.

[0011] According to an embodiment of a second aspect of the herein disclosed subject matter there is provided a method of operating a drifting system according to the first aspect, the method comprising: pumping the drifting element down a drill string containing the catcher sub; and monitoring a pressure in the drillstring above the drifting element.

[0012] According to embodiments of the second aspect, the method is adapted for providing the functionality of one or more of the aforementioned embodiments and/or for providing the functionality as required by one or more of the aforementioned embodiments, in particular of the embodiments of the first, third and fourth aspect disclosed herein.

[0013] According to an embodiment of a third aspect of the herein disclosed subject matter there is provided a drifting element comprising: a wall defining a through flow passage extending in an axial direction of the drifting element; the through flow passage having a first cross section of flow in a first axial region of the drifting element; the through flow passage having a second cross section of flow in a second axial region of the drifting element; the first axial region being located upstream the second axial region; the second cross section of flow being smaller than the first cross section of flow; and the wall of the drifting element having a lateral outlet extending from the through flow passage in the second axial region and/or from the through flow passage at a location upstream the second axial region through the wall.

[0014] According to embodiments of the third aspect, the drifting element is adapted for providing the functionality of one or more of the aforementioned embodiments and/or for providing the functionality as required by one or more of the aforementioned embodiments, in particular of the embodiments of the first, second and fourth aspect disclosed herein.

[0015] According to an embodiment of a fourth aspect of the herein disclosed subject matter there is provided a catcher sub for catching a drifting element according to the third aspect or an embodiment thereof, the catcher sub comprising: a through hole; and a seat for receiving the drifting element in the through hole.

[0016] According to embodiments of the fourth aspect, the catcher sub is adapted for providing the functionality of one or more of the aforementioned embodiments and/or for providing the functionality as required by one or more of the aforementioned embodiments, in particular of the embodiments of the first, second and third aspect disclosed herein.

[0017] These aspects of the herein disclosed subject matter are based on the idea that a bypass flow through the lateral outlet may reduce the pressure behind (i.e. upstream) the drifting element when pumping drilling fluid through the drillstring. Numerous other advantageous may be achieved with embodiments of the herein disclosed subject matter.

[0018] According to an embodiment, the catcher sub has at least one closure element closing the lateral outlet of the drifting element when the drifting element is received in the seat. The closure element may lead to a pressure spike in the drilling fluid in the drillstring which may be detected by monitoring the pressure in the drillstring. The pressure spike may arise due to the interruption of bypass flow through the lateral outlet. Interruption of the bypass flow through the lateral outlet may lead to a pressure spike which is easily distinguished from a rather gradual pressure increase due to landing of the drifting element on an obstruction in the drillstring. According to an embodiment of, the drifting element has an outer diameter which is smaller than the inner diameter of the drillstring. Hence, when the drifting element lands on an obstruction, drilling fluid is capable of exiting the lateral outlet and continuing down the drillstring.

[0019] According to an embodiment, the closure element is a surface portion e.g. of the catcher sub facing the lateral outlet when the drifting element is received in the seat. For example, according to a further embodiment the surface portion may be adapted for contacting the drifting element around each port of the lateral outlet. According to a further embodiment, the surface portion of the catcher sub forming the closure element for at least part (e.g. for some of the ports) of the lateral outlet conforms to the shape of an outer surface of the drifting element around the ports. If the closure element is provided by a surface portion of the catcher sub, the closure element may be provided at low costs. According to an embodiment, the surface portion forming the closure element may be part of a tubular surface portion, e.g. part of a cylindrical surface portion where the surface portion extends in axial direction. According to a further embodiment, the surface portion may be parallel to the axial direction or, in another embodiment, angled or curved with regard to the axial direction.

[0020] According to an embodiment, the lateral outlet is configured for generating through the lateral outlet a flow which is uniformly distributed about a circumference of the drifting element. The uniformly distributed flow laterally exiting the drifting element during pumping down the drifting element through the drillstring may assist in centering the drifting element in the drillstring. According to an embodiment, the lateral outlet comprises at least two outlet ports of identical cross section of flow; and the at least two ports are evenly spaced about an outer circumference of the drifting element.

[0021] According to an embodiment, the drifting element (and/or the catcher sub) may be configured so as to provide a gradual transition between different cross sections of flow. For example, the transition may be provided by a conical surface portion.

[0022] Generally herein, a conical surface portion is not to be understood as necessarily referring to a cone in a mathematical sense, although this is not excluded in an embodiment. Rather, in the sense of this application a conical surface portion is generally a surface portion which provides a gradual change of a cross section of flow that is at least partially (e.g. entirely) defined by the conical surface portion. For example, with regard to an axial direction of the catcher sub or the drifting element (i.e. to a direction of flow through the catcher sub/the drifting element), the conical surface portion may e.g. be curved, straight but slanted, or configured in any other suitable way which provides a gradual change of the respective cross section of flow. Further, while in some embodiments the conical surface portion is continuous in a circumferential direction, in other embodiments the conical surface portion may be discontinuous in circumferential direction.

[0023] According to an embodiment, the lateral outlet comprises at least one outlet port extending through the wall from the through flow passage in the first axial region of the drifting element. According to an embodiment, in the first axial region the through flow passage has a conical cross-section of flow which is narrowing in a downstream direction. In such a case, the lateral outlet port extends from the conical portion of the through flow passage through the wall. According to an embodiment, the drifting element has an outer conical surface portion, particularly in the first axial region; and the catcher sub has an inner conical surface portion forming the seat and being adapted for receiving the outer conical surface portion to thereby catch the drifting element. According to an embodiment, the inner conical surface portion of the catcher sub is only slightly angled with regard to the axial direction. For example, according to an embodiment the angle which the inner conical surface portion of the catcher sub forms with the axial direction is within a range between 2 degrees and 30 degrees or, in another embodiment, between 3 degrees and 10 degrees.

[0024] According to a further embodiment, the lateral outlet comprises at least one outlet port extending through the wall from the through flow passage in the second axial region of the drifting element. Apparently, an outlet port extending from the through flow passage in the second axial region also leads to a bypass flow through this outlet port. In accordance with an embodiment, the outlet port extending from the through flow passage in the second axial region is configured according to one or more embodiments described above with regard to an outlet port extending from the through flow passage in the first axial region. For example, the bypass flow stemming from the second axial region of the through flow passage may be adapted to center the drifting element with regard to the drillstring during pumping down of the drifting element.

[0025] In accordance with the above described embodiments of, the lateral outlet comprises at least one first outlet port extending from the through flow passage in the first axial region and at least one second outlet port extending from the through flow passage in the second axial region. According to an embodiment, the accumulated cross section of flow of the at least one first outlet port is smaller than the accumulated cross section of flow of the at least one second outlet port. This may improve stabilization of the drifting element with regard to the axial direction of the drillstring. It is noted that due to the small spacing of both types of ports (first and second outlet ports) the individual pressure spikes generated by interrupting the bypass flow through the at least one first outlet port and the at least one second outlet port occur simultaneously on the relevant timescale and hence only a single pressure spike is detected. Herein, stabilization of the drifting element means stabilization of the travel of the drifting element down the drillstring.

[0026] According to an embodiment, the lateral outlet comprises at least two outlet ports with respective port openings on the outer surface of the drifting element, wherein the port openings on the outer surface of the drifting element are spaced from each other in axial direction and/or in circumferential direction. Such a configuration of the lateral outlet may further improve stabilization of the drifting element with regard to the axial direction.

[0027] According to an embodiment, at least one outlet port has a tapered cross-section at least in an axial section plane, wherein tapered cross section opens up towards the through flow passage. According to an embodiment, one or more of the outlet ports have a rectangular cross-sectional shape when viewed along the port through the wall. According to a further embodiment, one or more of the outlet ports have a circular cross-sectional shape when viewed along the port through the wall.

[0028] According to an embodiment, the through flow passage of the drifting element is a free passage without any obstructing elements. According to other embodiments, structural elements may be located in the through flow passage or in the path to the through flow passage. For example, according to an embodiment the drifting element comprises a central fish neck which allows wireline retrieval of the drifting element.

[0029] According to an embodiment, the seat of the catcher sub is formed by an inner surface portion of the catcher sub which defines a gradually decreasing cross section of flow in downstream direction. Compared to a stepwise change of a cross section of flow, a gradual change of the cross-section of flow avoids edges which may damage the drifting element. This may enable reliable operation of the drifting system even after multiple reuse of the same drifting element.

[0030] According to an embodiment, the catcher sub has an inner conical surface portion forming the seat. Hence, in accordance with an embodiment the inner conical surface portion forming the seat opens (i.e. its cross-section of flow widens) in the upstream direction.

[0031] For example, according to an embodiment the inner conical surface portion forms an angle with an upstream direction wherein the angle is smaller than 60 degrees, smaller than 40 degrees or even less.

[0032] According to an embodiment, the through flow passage of the drifting element has a clearance diameter which is larger than a diameter of an activation seat of a tool that is located downstream the catcher sub. In such a case, a method of operating the drifting system comprises: pumping the drifting element down the drillstring until an increase in the monitored pressure indicates landing of the drifting element in the seat of the catcher sub; and pumping an activation element (e.g. a ball) for the tool down the drillstring and through the through flow passage of the drifting element into the activation seat of the tool.

[0033] Generally, it is noted that conical surfaces portions lead to a rather gradual change of a cross section of flow may have the advantage that turbulences in the flow of drilling fluid and abrasion (e.g. washout) in the drifting system can be maintained on a low level or even avoided.

[0034] The drifting system described herein may be used to conduct post drilling drifting of a drillstring prior to tripping the drillsting out of hole. The drifting system may be used e.g. in the oil, gas and mining industries.

[0035] Embodiments of the herein disclosed subject matter have the advantage that a conical (e.g. tapered) external geometry of the drifting element allows the drifting element to sit against a similarly shaped (e.g. similarly tapered) internal profile of the catcher sub. This design allows the safe capturing and/or containment of the drifting element inside the catcher sub yet the conical internal geometry of the catcher sub does not present any obstruction to any device being lowered through the drillstring bore which may need to pass through catcher sub and/or through the drifting element. Furthermore, the absence of any shoulder or ledge in the internal bore of the catcher sub reduces the risk of damaging the catcher sub, the drifting element or any other device being lowered through the catcher sub.

[0036] In the above there have been described and in the following there will be described exemplary embodiments of the subject matter disclosed herein with reference to a drifting system, a drifting element, a catcher sub, and a method of operating a drifting system. It has to be pointed out that of course any combination of features relating to different aspects of the herein disclosed subject matter is also possible. In particular, some features have been or will be described with reference to apparatus type embodiments whereas other features have been or will be described with reference to method type embodiments. However, a person skilled in the art will gather from the above and the following description that, unless otherwise notified, in addition to any combination of features belonging to one aspect also any combination of features relating to different aspects or embodiments, for example even combinations of features of apparatus type embodiments and features of the method type embodiments are considered to be disclosed with this application. The aspects and embodiments defined above and further aspects and embodiments of the herein disclosed subject matter are apparent from the examples to be described hereinafter and are explained with reference to the drawings, but to which the invention is not limited.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037]

Fig. 1 shows a drifting element in accordance with embodiments of the herein disclosed subject matter.

Fig. 2 shows a cross-sectional view of a part of the drifting element of Fig. 1 as indicated by line II-II in Fig. 1.

Fig. 3 shows an elevated view of the drifting element of Fig. 1 from above, indicated by line III-III in Fig. 1.

Fig. 4 shows a catcher sub according to embodiments of the herein disclosed subject matter.

Fig. 5 shows a drifting system according to embodiments of the herein disclosed subject matter, wherein a drifting element is received (has landed) in a seat of a catcher sub, and a part of a downhole tool connected to the drifting system.

DETAILED DESCRIPTION

[0038] The illustration in the drawings is schematic. It is noted that in different figures, similar or identical elements are provided with the same reference signs. Accordingly, the description of similar or identical features is not repeated in the description of subsequent figures in order to avoid unnecessary repetitions. However, it should be understood that the description of these features in the preceding figures is also valid for the subsequent figures unless noted otherwise.

[0039] Figure 1 shows a drifting element 100 in accordance with embodiments of the herein disclosed subject matter.

[0040] The drifting element 100 has a through flow passage 102 extending in an axial direction 104 of the drifting element 100. The through flow passage 102 has a first cross section of flow 106 in a first axial region 108. In accordance with an embodiment, the first axial region 108 is located upstream a second axial region 112. In this regard it is noted that the arrow at 104, indicating the axial direction, is pointing in downstream direction, i.e. in the direction of the flow of drilling fluid when the drifting element is pumped through a drillstring. Accordingly, an upstream direction 113 is the direction opposite to the downstream direction. Further, the through flow passage 102 has a second cross section of flow 110 in a second axial region 112. In accordance with an embodiment, the through flow passage 102 is defined by a tubular wall 114.

[0041] According to a further embodiment, the tubular wall 114 comprises a lateral outlet 116 extending from the through flow passage 102 in the second axial region 112 and extending from the through flow passage 102 in the first axial region. In accordance with an embodiment, the lateral outlet 116 comprises at least one first outlet port 120 (e.g. four first outlet ports 120 as shown in Fig. 1) extending from the through flow passage in the first axial region 108 through the wall 114 to an outer surface of the drifting element 100, e.g. to an outer conical surface portion 128. In accordance with a further embodiment, the lateral outlet 116 comprises at least one second outlet 122 (e.g. four second outlet ports 122 as shown in Fig. 1) extending from the through flow passage 102 in the second axial region 112 through the wall 114 to an outer surface of the drifting element 100, e.g. to an outer cylindrical surface portion 123.

[0042] In accordance with an embodiment, the lateral outlet 116 is configured for generating through the lateral outlet 116 a flow which is uniformly distributed about a circumference of the drifting element 100. In accordance with an embodiment, shown in Fig. 1, this uniformly distributed flow is generated by the following measures: First, an identical cross section of flow of the first outlet ports 120 and an identical cross section of flow of the second outlet ports 122. (Nevertheless, the cross section of flow of the first outlet ports 120 and the cross section of flow of the second outlet ports 122 may be different, as shown in Fig. 1.) Second, an even spacing of the first outlet ports 120 about an outer circumference of the drifting element 100 and an even spacing of the second outlet ports 122 about the outer circumference of the drifting element 100. However, it should be understood that a flow which is uniformly distributed about the circumference of the drifting element 100 may be achieved by other measures. Anyway, the uniformly distributed flow may help in centering the drifting element with regard to the drillsting during pumping down the drifting element 100 through the drillstring.

[0043] In accordance with an embodiment, upstream the second axial region 112 the wall 114 of the drifting element 100 comprises an inner conical surface portion 124 which opens up in the upstream direction 113, as shown in Fig. 1. In accordance with an embodiment, at least part of the inner conical surface portion 124 is provided in the first axial region 108. In accordance with an embodiment, the inner conical surface portion 124 leads to the larger cross section of flow 106 in the first axial region 108 compared to the cross section of flow 110 in the second axial region 112.

[0044] In accordance with an embodiment, at least in the second axial region 112, e.g. downstream the inner conical surface portion 124, the wall 114 comprises an inner straight surface portion 126 parallel to the axial direction 104, e.g. in the form of an inner cylindrical surface portion.

[0045] According to an embodiment, the drifting element has an outer conical surface portion 128 which is adapted for engaging a seat of a catcher sub described below. According to an embodiment, the outer conical surface portion 128 forms an (acute) angle with respect to the axial direction 104, e.g. an angle of about 5 to 25 degrees. Such a small acute angle 128 reduces abrasion of the outer surface of the drifting element. According to a further embodiment, the outer conical surface portion 128 extends over at least 5% of, e.g. over at least a 10% or at least 15% of the total length of the drifting element 100. Such an extended outer conical surface portion may provide improved stabilization of the drifting element 100 during its downward travel through the drillstring.

[0046] In accordance with an embodiment, at least one of the outlet ports, e.g. the first outlet ports 120, as shown in Fig. 1, extend at an acute angle to the axial direction 104 which acute angle is smaller than 90 degrees. According to another embodiment, at least one of the outlet ports, e.g. the second outlet ports 122, as shown in Fig. 1, extend at an angle to the axial direction 104 which is 90 degrees (e.g. these ports may extend in a radial direction).

[0047] In accordance with an embodiment, the drifting element 100 comprises a fish neck 130.

[0048] Fig. 2 shows a cross-sectional view of part of a part of the drifting element 100 of Fig. 1 as indicated by line II-II in Fig. 1.

[0049] In accordance with an embodiment, at least one of the outlet ports in the wall 114, e.g. the second outlet ports 122, as shown in Fig. 1, has a conical cross-section at least in an axial section plane which corresponds to the drawing plane in Fig. 2), wherein the conical cross section opens up towards the through flow passage 102, as shown in Fig. 2. The conical cross-section in the axial section plane may in an embodiment corresponds to an angled inner surface 132 of the outlet port 122 which angled inner surface 132 forms an acute angle 134, 136 with the axial direction 104. The conical cross-section in the axial section plane, i.e. parallel to the axial direction 104, avoids highly angled surfaces transverse the axial direction 104, thereby reducing abrasion of an inner edge 133 of the outlet port due to the flow of drilling fluid.

[0050] Fig. 3 shows an elevated view of the drifting element 100 of Fig. 1 from above, indicated by line III-III in Fig. 1.

[0051] In an embodiment where the first outlet ports 120 extend from the inner conical surface portion 124, the first outlet ports 120 provide an opening 135 pointing in upstream direction (i.e. out of the drawing plane of Fig. 3). Hence, a flow of drilling fluid in downstream direction (towards the drawing plane of Fig. 3) is directly received by the openings 135 and guided, through the outlet port 120, to the lateral surrounding of the drifting element 100, resulting in a bypass flow 136 of drilling fluid. As mentioned above with regard to Fig. 1, due to the configuration of the first outlet ports 120, the bypass flow 136 is uniformly distributed about the outer circumference 137 of the drifting element 100.

[0052] In accordance with an embodiment, the inner conical surface portion 124 is continuous in a circumferential direction 139.

[0053] In accordance with an embodiment, the fish neck 130 is attached to the drifting element 100 by at least two struts 138 e.g. four struts 138 as shown in Fig. 1. According to a further embodiment, the fish neck 130 and the struts 138 may be omitted, resulting in a non-obstruction (not shown in Fig. 3) of the through flow passage 102 through the drifting element 100.

[0054] Fig. 4 shows a catcher sub 200 according to embodiments of the herein disclosed subject matter.

[0055] In accordance with an embodiment, the catcher sub 200 comprises a through hole 202 and a seat 204 for receiving the drifting element 100. In accordance with an embodiment, the seat 204 is provided in the form of an inner conical surface portion which is adapted for receiving the outer conical surface portion 128 of the drifting element 100 (see Fig. 1). According to an embodiment, the seat 204 is adapted so as to form a first closure element closing the first outlet ports 120 of the drifting element 100 (not shown in Fig. 4) if the drifting element 100 is received in the seat the 204.

[0056] According to an embodiment, downstream the seat 204 the catcher sub comprises an inner cylindrical surface portion 208. For example, according to an embodiment, the downstream end 206 of the inner conical surface portion (seat 204 in Fig. 4) is axially abutting the inner cylindrical surface portion 208. In accordance with an embodiment, the inner cylindrical surface portion 208 is adapted so as to form a second closure element closing the second outlet ports 122 of the drifting element 100 (not shown in Fig. 4) if the drifting element 100 is received in the seat 204.

[0057] According to an embodiment, downstream the inner cylindrical surface portion 208 the catcher sub 200 comprises a further inner conical surface portion 210. According to an embodiment, the cross section of flow of the further conical surface portion 210 increases in downstream direction. According to a further embodiment, the catcher sub 200 comprises a further inner cylindrical surface portion 212 downstream the (first) inner cylindrical surface portion 208.

[0058] According to an embodiment, upstream the seat 204 the catcher sub 200 comprises a further, third inner cylindrical surface portion 214. Upstream the third cylindrical surface portion is a further conical surface portion 216 connecting an upper thread portion 218 at an upstream end of the catcher sub 200 with the further conical surface portion 216. At its downstream end the catcher sub 200 comprises a lower thread portion 220. The upper thread portion 218 and the lower thread portion 220 are provided for screw connecting the catcher sub to the drillstring.

[0059] Fig. 5 shows a drifting system 300 according to embodiments of the herein disclosed subject matter, wherein a drifting element is received (has landed) in a seat of a catcher sub, and a part of a downhole tool 308 connected to the drifting system 300 (connection not shown in Fig. 5).

[0060] According to an embodiment, the drifting element 100 of the drifting system 300 is a drifting element similar to the drifting element described with regard to Fig. 1. Further in accordance with an embodiment, the catcher sub 200 of the drifting system 300 is the catcher sub as described with regard to Fig. 4.

[0061] According to a general embodiment, an inner surface portion 204, 208 of the catcher sub 200 and an opposing outer surface portion 128, 123 of the drifting element 100 are adapted to contact each other in a contact area 302, 304 in order to block the outlet ports 120, 122 in the contact area 302, 304.

[0062] For example, according to an embodiment, the inner conical surface portion 204 of the catcher sub 200 and the outer conical surface portion 128 of the drifting element (not shown in Fig. 4) are adapted to contact each other in a contact area 302. According to an embodiment, in the contact area 302 the inner conical surface portion 204 of the catcher sub 200 conforms to the outer conical surface portion 128 of the drifting element. According to an embodiment, the contact area 302 is blocking at least some of the outlet ports of the lateral outlet, e.g. the outer openings of the first outlet ports 120. Hence, in such an embodiment the seat 204 of the catcher sub acts as a closure element which closes (e.g. blocks) at least part of the lateral outlet (i.e. the first outlet ports in the embodiment shown in Fig. 5) of a drifting element when the drifting element is received in the seat 204.

[0063] Further, according to an embodiment the inner cylindrical surface portion 208 of the catcher sub and the outer cylindrical surface portion 123 in the second axial region 112 of the drifting element 100 are adapted to contact each other in a contact area 304 if the drifting element 100 is received in the seat 204.

[0064] In accordance with an embodiment, the drifting element 100 shown in Fig. 5 differs from the drifting element 100 shown in Fig. 1 in that the drifting element 100 in Fig. 5 does not comprise a fish neck 130 and struts 138 (see Fig. 3). Accordingly, the drifting element 100 shown in Fig. 5 has an unobstructed through flow passage 102 with a clearance diameter corresponding to the smallest cross-section of flow of the through flow passage 102, e.g., in an embodiment shown in Fig. 5, the clearance diameter corresponding to the inner diameter of the inner cylindrical surface portion 126.

[0065] It is noted that an unobstructed through flow passage 102 allows for passing a suitably sized activating element 312, e.g. an activation ball, through the through flow passage 102 to a downhole tool 308 (e.g. a circulation sub) which is located downstream the catcher sub 200. It is noted that in such a case usually the seat 310 of the downhole tool 308 has a smaller diameter than the seat 204 of the catcher sub 200. In such a case, the method of operating the drifting system 300 may comprise pumping the drifting element 100 down the drillstring, monitoring the pressure in the drillstring above the drifting element and, if a pressure spike generated by the drifting element 100 upon landing in the catcher sub is detected (indicating the absence of an obstruction in the drillstring), pumping an activating element 312 for the tool down the drillstring and through the through flow passage 102 of the drifting element into the seat 310 of the downhole tool 308. Hence, after the drifting the drillstring and activation of the downhole tool may be performed without retrieval of the drifting element. Due to the advantageous drifting system 300 according to embodiments of the herein disclosed subject matter, a reliably detectable pressure spike is generated in the drillstring upon landing of the drifting element 100 in the catcher sub 200 even if the drifting element 100 has a large clearance diameter 314 which allows the activating element 312 to pass the drifting element 100.

[0066] Further, it is noted that a retrieval of the drifting element is possible even without fish neck. For example, a hook assembly (not shown) may be configured to expand after passing through the through flow passage 102 of the drifting element 100, thereby a catching a lower edge 306 of the drifting element 100, thus allowing retrieval of the drifting element 100 e.g. by means of a wireline attached to the hook assembly. In other embodiments of, the drifting element 100 may stay in the catcher sub until the whole drillstring together with the catcher sub is tripped out of the bore hole (well).

[0067] Finally it is noted that any conical surface portion described herein, of either the drifting element or the catcher sub, may according to respective embodiments form an acute angle with the axial direction which is less than 30 degrees and preferably less than 20 degrees or even less than 10 degrees. According to an embodiment, for a conical surface portion which is curved with regard to the axial direction, the above requirement is fulfilled for any point of the curved surface portion. In this regard, it should be understood that, in order to provide a "conical" surface portion, the acute angle with the axial direction is larger than 0 degrees, e.g. larger than 2 degrees or larger than 4 degrees. An acute angle as described above leads to a reduced abrasion of the catcher sub and/or the drifting element.

[0068] By avoiding or at least reducing abrasion of the catcher sub and/or the drifting element, the drifting system according to embodiments of the herein disclosed subject matter provides low variations in the pressure response over time (i.e. over a plurality of uses of the drifting system). This facilitates a reliable detection of the landing of the drifting element in the seat of the catcher sub and hence the operation of the drifting system.

[0069] It should be noted that the term "comprising" does not exclude other elements or steps and the "a" or "an" does not exclude a plurality. Also elements described in association with different embodiments may be combined. It should also be noted that reference signs in the claims should not be construed as limiting the scope of the claims.

[0070] Further, it should be noted that while the exemplary drifting system or parts thereof shown in the drawings include a particular combination of several embodiments of the herein disclosed subject matter, any other combination of embodiment is also possible and is considered to be disclosed with this application.

[0071] In order to recapitulate some of the above described embodiments of the present invention one can state:

Disclosed is a drifting system 300 comprising a drifting element 100 having a wall 114 defining a through flow passage 102 extending in an axial direction 104 of the drifting element and a catcher sub having a through hole. In accordance with embodiment of the herein disclosed subject matter the catcher sub has a seat for receiving the drifting element 100 in the through hole. The through flow passage 102 of the drifting element 100 has a first cross section of flow 106 in a first axial region 108 of the drifting element 100 and has a second, smaller cross section of flow 110 in a second axial region 112 of the drifting element 100 located downstream the first axial region 108.

[0072] Further, the wall 114 of the drifting element 100 has a lateral outlet 116 extending from the through flow passage 102 in the second axial region 112 and/or from the through flow passage 102 at a location upstream the second axial region 112 through the wall.

Claims

1. Drifting system (300) comprising:

a drifting element (100) having a wall (114) defining a through flow passage (102) extending in an axial direction (104) of the drifting element (100); and
a catcher sub (200) having a through hole (202);
the catcher sub (200) having a seat (204) for receiving the drifting element (100) in the through hole (202);
the through flow passage (102) having a first cross section of flow (106) in a first axial region (108) of the drifting element (100);
the through flow passage (102) having a second cross section of flow (110) in a second axial region (112) of the drifting element (100);
the first axial region (108) being located upstream the second axial region (112);
the second cross section of flow (110) being smaller than the first cross section of flow (106); and
the wall (114) of the drifting element (100) having a lateral outlet (116) extending from the through flow passage (102) in the second axial region (112) and/or from the through flow passage (102) at a location upstream the second axial region (112) through the wall (114).

2. Drifting system according to claim 1, the catcher sub (200) having at least one closure element (204, 208) closing the lateral outlet (116) of the drifting element (100) when the drifting element (100) is received in the seat (204).

3. Drifting system according to the preceding claim, the closure element (204, 208) being a surface portion of the catcher sub (200) facing the lateral outlet (116) when the drifting element (100) is received in the seat (204).

4. Drifting system according to any one of the preceding claims, the lateral outlet (116) being configured for generating through the lateral outlet (116) a flow (136) which is uniformly distributed about a circumference of the drifting element (100).

5. Drifting system according to the preceding claim, the lateral outlet (116) comprising at least two outlet ports (120, 122) of identical cross section of flow; and the at least two outlet ports (120, 122) being evenly spaced about an outer circumference (137) of the drifting element (100).

6. Drifting system according to any one of the preceding claims, the lateral outlet (116) comprising at least one outlet port (120) extending through the wall (114) from the through flow passage (102) in the first axial region (108) of the drifting element (100).

7. Drifting system according to the preceding claim, the drifting element (100) having an outer conical surface portion (128), particularly in the first axial region (108); the catcher sub (200) having a conical inner surface portion forming the seat (204) and being adapted for receiving the outer conical surface portion (128) to thereby catch the drifting element (100).

8. Drifting system according to any one of the preceding claims, the lateral outlet (116) comprising at least one outlet port (122) extending through the wall (114) from the through flow passage (102) in the second axial region (112) of the drifting element (100).

9. Drifting system according to any one of claims 5 to 8, wherein at least one outlet port (120, 122) has a conical cross-section at least in an axial section plane, wherein conical cross section opens up towards the through flow passage (102).

10. Drifting element comprising:

a wall (114) defining a through flow passage (102) extending in an axial direction (104) of the drifting element (100);
the through flow passage (102) having a first cross section of flow (106) in a first axial region (108) of the drifting element (100);
the through flow passage (102) having a second cross section of flow (110) in a second axial region (112) of the drifting element (100);
the first axial region (108) being located upstream the second axial region (112);
the second cross section of flow (110) being smaller than the first cross section of flow (106); and
the wall (114) of the drifting element (100) having a lateral outlet (116) extending from the through flow passage (102) in the second axial region (112) and/or from the through flow passage (102) at a location upstream the second axial region (112) through the wall (114).

11. Catcher sub for catching a drifting element (100) according to claim 10, the catcher sub (200) comprising:

a through hole (202); and
a seat (204) for receiving the drifting element (100) in the through hole (202).

12. Catcher sub according to the preceding claim, the catcher sub (200) having an inner conical surface portion forming the seat (204).

13. Catcher sub according to any one of claims 11 or 12, the inner conical surface portion forming an angle with an upstream direction (113) and the angle being smaller than 60 degrees.

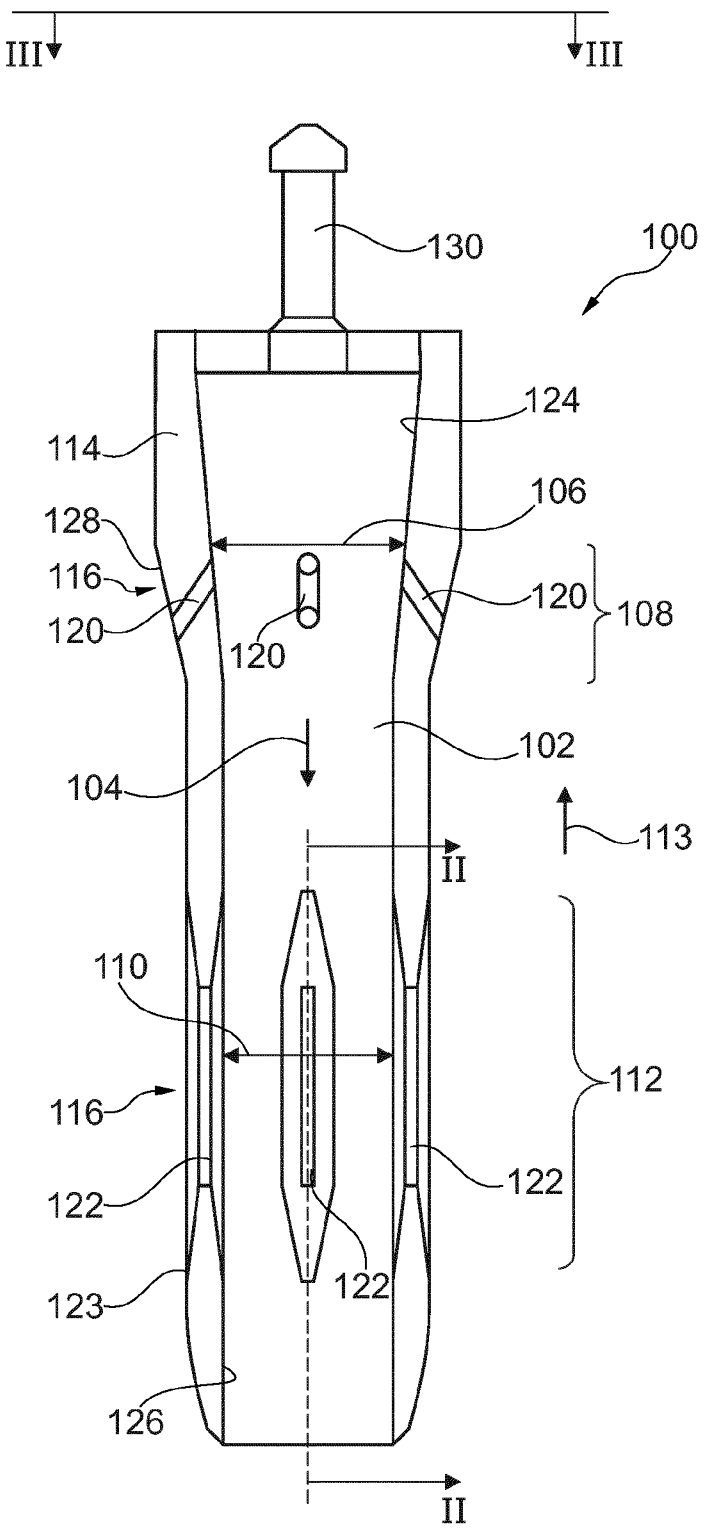
14. Method of operating the drifting system according to any one of claims 1 to 9, the method comprising:

pumping the drifting element (100) down a drill string containing the catcher sub (200); and
monitoring a pressure in the drillstring above the drifting element (100).

15. Method according to the preceding claim, wherein the through flow passage (102) of the drifting element (100) has a clearance diameter (314) which is larger than a diameter of an activation seat (310) of a tool (308) that is located downstream the catcher sub (200), the method comprising:

pumping the drifting element (100) down the drillstring until an increase in the monitored pressure indicates landing of the drifting element (100) in the seat (204) of the catcher sub (200);
pumping an activation element (312) for the tool (308) down the drillstring and through the

through flow passage (102) of the drifting element (100) into the activation seat (204) of the tool (308).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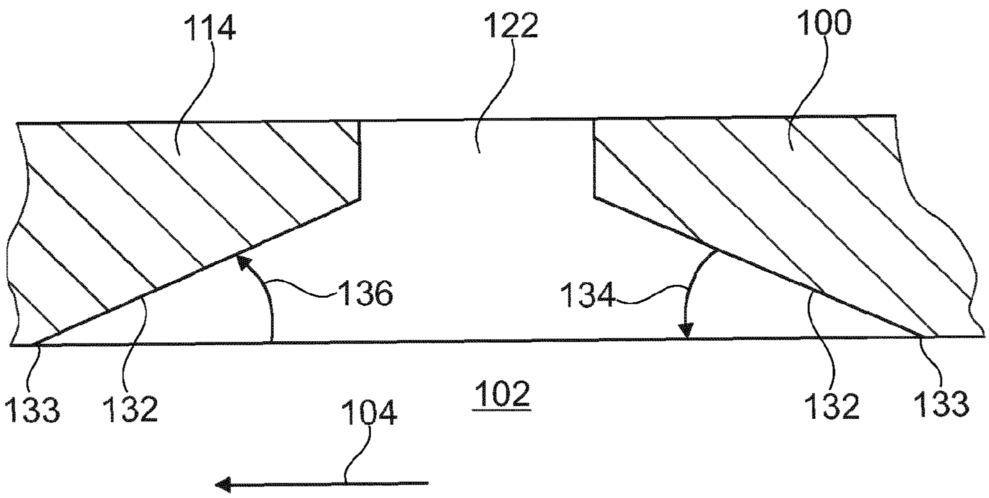
II

Fig. 1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104

Fig. 2

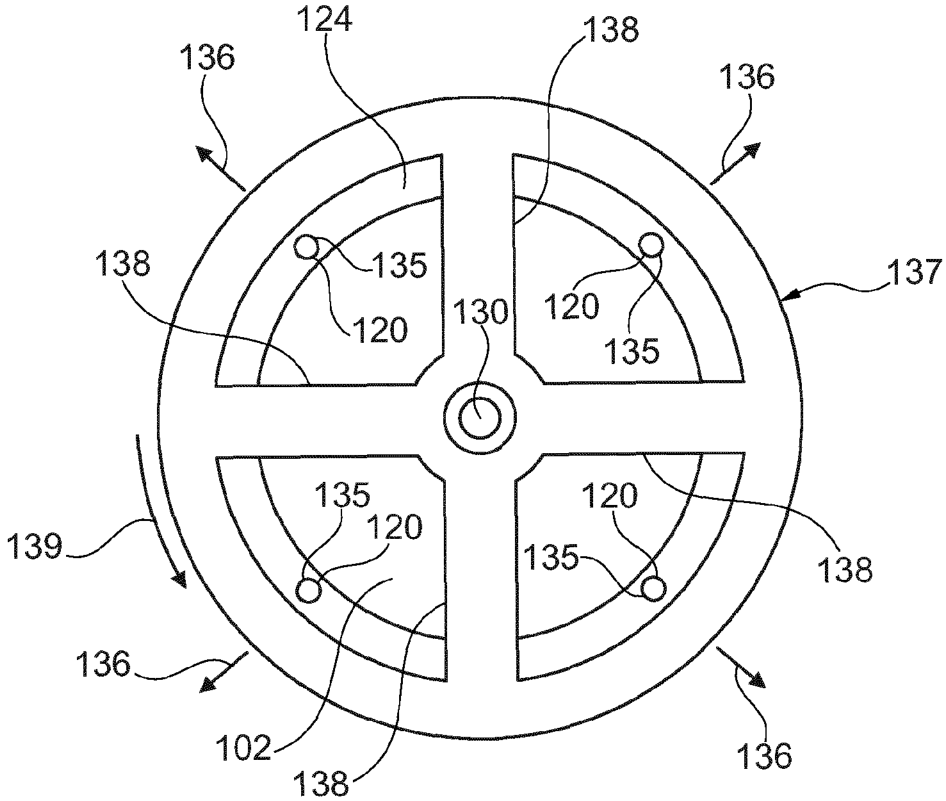
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Fig. 3

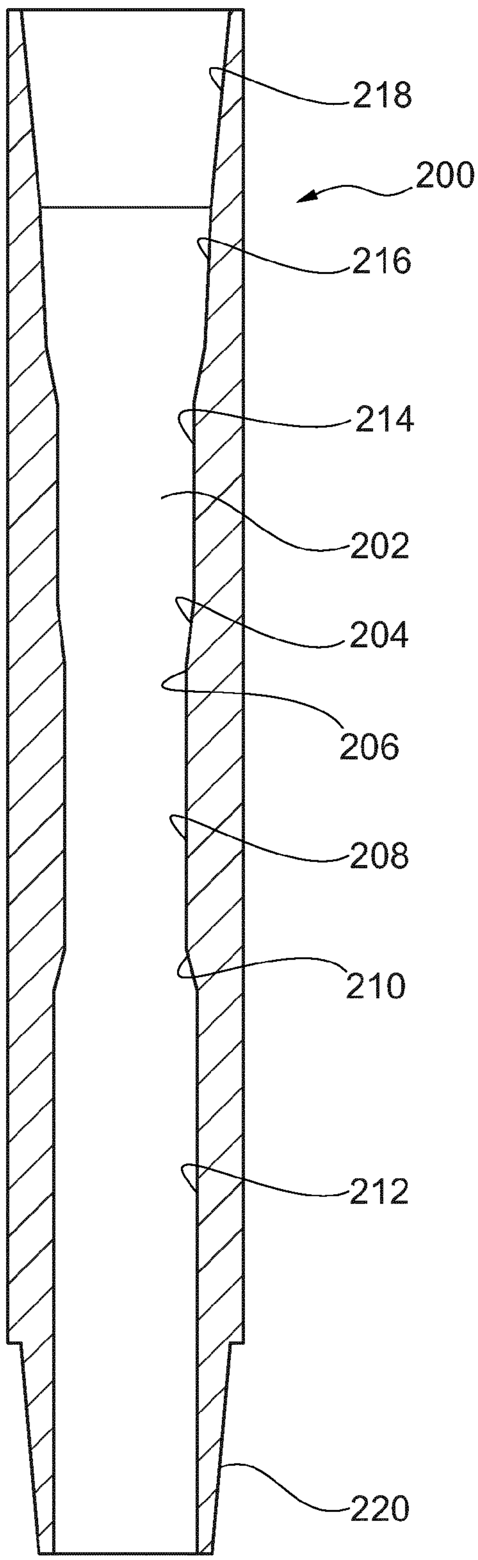
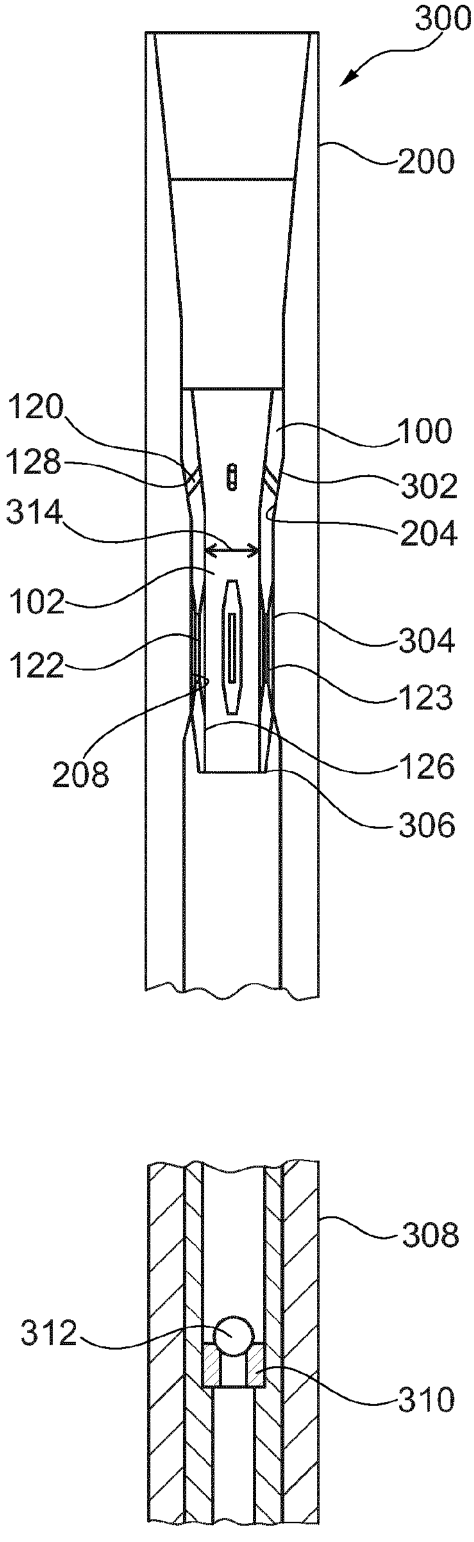


Fig. 4


300
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120
100
128
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314
204
102
304
122
123
208
126
306
308
312
310

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 15 17 3630

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 November 2015	Morrish, Susan

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13-11-2015

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