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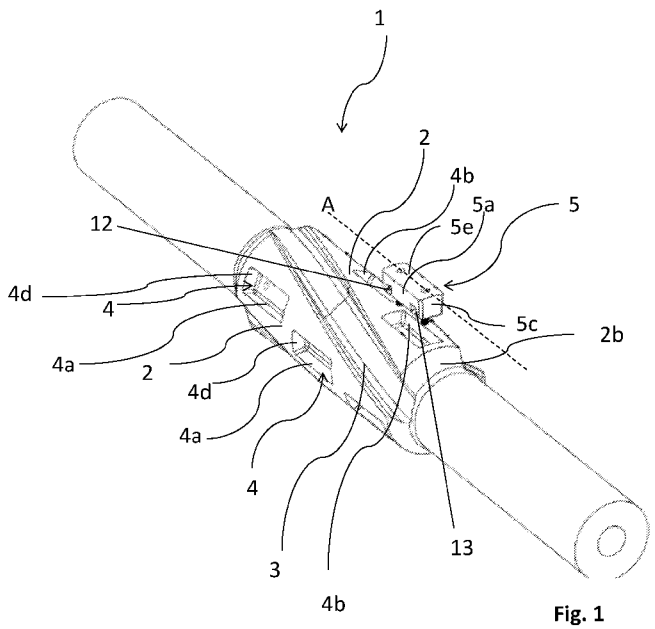

Fig. 1

(57) Abstract: The present invention relates to a downhole tool assembly comprising : - a tool body (1), (101) comprising at least one pocket (4),(104) for insertion of a cartridge (5), (105) and; - at least one cartridge (5), (105); said cartridge (5), (105) being fastened in the pocket (4), (104) in at least two different locations by respective fastening elements (8), (9); (108), (109) to be screwed into said pocket (4), (104), characterized in that said cartridge comprises abutment means (62), (72); (162), (172); (14), (15); (114), (115) for constraining the movement of each fastening element (8), (9), (108), (109) in its axial direction and away relative to the tool body (1) (101), and in that the dimensions of said cartridge relative to the dimensions of said pocket are selected such that there is a clearance fit between said cartridge and said pocket, such that said cartridge (5), (105) is insertable into the pocket or removable from said pocket following a single direction, and gets blocked into the pocket when the said cartridge is tilted to an angle exceeding a predetermined angle relative to said single direction. In other aspects, the present invention relates to a method for inserting said cartridge into said pocket and to a method for removing said cartridge from said pocket.

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A Downhole tool assembly and a method for assembling and disassembling it.

The present invention is related to a down-hole tool assembly, comprising a tool body comprising at least one pocket for insertion of a cartridge, and at least one cartridge, said cartridge being fastened in the pocket in at least two different locations by respective bolts which are screwed into the tool body, said bolts having a bolt shaft and a bolt head, said bolt shaft extending through a hole in the cartridge and being screwed into a threaded hole in the tool body, while the bolt head is in contact with a contact surface of the cartridge.

More particularly, the present invention also relates to a down-hole tool assembly used for reaming or stabilizing purposes.

This invention also relates to a method for assembling and a method for disassembling such a down-hole tool assembly.

In a process of drilling a wellbore, a drill bit is attached to a drill string which is rotated from the surface for drilling the wellbore. During the drilling process, the path of the wellbore may be deviated intentionally or unintentionally. An efficient control on the tool direction and on the quality of the borehole is essential while drilling a wellbore. Because the gauge of a drill bit is generally bigger than the gauge of the drill string pipes, the drill string is provided by a plurality of stabilizer tools having substantially the same gauge as the drill bit, for centralizing the drill string in the wellbore. A stabilizer tool comprises a tool body provided with upper connection means and lower connections means for connecting with the connections of the pipes of the drill string. The stabilizer further comprises a plurality of blades providing contacting surfaces with the wellbore, the contacting surfaces being large enough to prevent or minimize penetration in the walls of the wellbore. The blades rise from the surface of the tool body and are distributed at the periphery of the tool body such that deep and large channels are provided for flow circulation and cuttings evacuation. A good stabilizer should reduce both friction and drag while drilling the wellbore. Many stabilizers are known in the art and some stabilizer may be made of ultra hard matrix of tungsten carbide as disclosed in US patent n° 7878273 of the applicant. Optionally, the upper section of the stabilizer may be provided by a

back-reaming section so as to allow the stabilizer to be used as a reamer when pulling the stabilizer out of the borehole.

Some other stabilizers known in the art comprise stabilizer assemblies or stabilizer pads detachably connected with the tool body. Document EP1650400 discloses a stabilizer tool comprising a stabilizer blade. The stabilizer blade comprises a stabilizing part and a mounting part. The mounting part projects downwards from the stabilizing part and has two opposed ends engaging wall forming with the horizontal an angle of about 75 degrees. Mounting part is inserted into a slot with mounting blocks on both sides of the mounting part. The mounting blocks are provided with sloping engaging walls which mate with the engaging walls of the mounting part.

Document US6776247 discloses another stabilizer tool wherein a stabilizer pad is inserted into a pocket by interference fit. The stabilizer pad comprises a lateral slot containing a washer and an abutment surface opposed to the washer, both washer and abutment surface being at the center of the stabilizer pad and between which a head bolt is positioned and screwed on the tool body. The underside of the head bolt bears against the washer which allows the bolt to retain the pad in the pocket, and the axially outer surface of the head bolt bears against the abutment surface provided by an opening for allowing access to a key both for tightening the pad and for releasing the pad.

Alternatively or in combination with stabilizers, reamers tools or roller reamers tools are inserted at a plurality of location of the drill string. Reamer tools comprise a reamer body provided with upper and lower connection means for connection with the pipes of the drill string and with reaming blades bearing reaming inserts for reaming the borehole such that the gauge of the borehole is substantially uniform along sections of the wellbore.

Roller reamers tools comprise a roller reamer body provided with connection means for connection with the pipes of a drill string. The Roller reamer body further comprises at least one pocket for receiving a roller reamer cartridge assembly. A roller reamer cartridge assembly generally comprises a shaft and a hollowed cylindrical roller disposed about the shaft such that it can rotate around the shaft, the roller being provided with reaming inserts. Roller reamer

cartridge assembly have to be serviced or replaced periodically. Roller reamers cartridge assemblies are prone to worn and are detachably connected to the tool body.

It is desirable to provide a safe and simple attachment means for detachably connecting a roller reamer cartridge or a stabilizer cartridge to a tool body.

Generally, stabilizer pads, reamer pads or roller reamer cartridge assemblies are fastened on a tool body by means of screws. Under repeated vibrations during the process of drilling, there's a possibility that some screw unscrew and that the stabilizer or the roller reamer cartridge assembly comes off and break away.

Document WO2004042184 discloses a rotary roller reamer comprising a pocket for receiving a roller reamer assembly including a plurality of components forming a single cartridge. The cartridge comprises a crushing roller mounted around a shaft and between two retaining means. A first retaining means or plug is fastened on a first side of the shaft by a connector screw fastened coaxially to the shaft. The first retaining means comprises an elongated slot arranged on a sidewall and having an upper section allowing the head of the connector screw to pass there through. The upper section of the elongated slot further comprises a threaded section for receiving a threaded plug. The first retaining means further comprises a fastener receiving cavity or "T-slot" that opens through a sidewall opposite to the elongated slot, and also into the base of the retaining means. An aperture is located at the top of the first retaining means for allowing to a key driver to pass there trough for fastening a fastening screw arranged in the fastener receiving cavity on the pocket. A second retaining means is fastened to a second side of the shaft opposite to the first side. The second retaining means comprises a cavity for receiving the second end of the shaft. A threaded hole is made at the base of the second retaining means and is arranged to be perpendicular to the axis of the shaft and to be coaxial to a threaded bore made on the shaft, for fastening a screw to prevent rotation of the shaft. The second retaining means further comprises a lug and a tapering side wall adapted to mate with a recess made into the pocket for preventing the cartridge to move. Only the first retaining means is fastened to the bottom of the pocket by means of a screw. A plurality of steps are required to install the cartridge into the pocket. Firstly, the roller has to be arranged around the

shaft with the second retaining means fastened on the second end of the shaft, and the first retaining means arranged in a first position wherein the head of the connector screw is at the bottom of the elongated slot, leaving the upper section of the elongated slot accessible or in other words uncovered by the shaft. A fastening screw is also arranged into the faster receiving cavity. The cartridge in this first configuration is inserted in the pocket by tilting the cartridge to mate the lug of the second retaining means into the recess made in the pocket. Then a plug is fastened into the upper threaded section of the elongated slot, and the screw arranged into the faster receiving cavity of the first retaining means is screwed in the threaded hole made in the pocket. The abutments arranged up to the screw head of the fastening screw in the fastener receiving cavity prevents the screw to escape from the retaining cavity, but undesired unscrewing of the fastening screw may cause the first retaining means to lift up, as the screw head will push against the abutments, which can result to the loss of the cartridge.

US application n° 13/692901 (publication number US2013/012644) discloses a roller reamer tool including a reamer body and a roller reamer connected to the reamer body with ball and sockets connectors. Instead of disposing a roller reamer around a shaft around which the roller reamer cutter rotates, ball and sockets connectors are located at both ends of the roller reamer which comprises pockets for insertion of the ball socket connectors. Upon rotation of the roller reamer, ball and sockets connectors are prone to wear and friction against the pocket of the reamer cutter. The roller reamer tool comprises a lubrication system, wherein the socket connectors include fluid channels from the center passageway to allow the drilling fluid to lubricate mating surfaces of the ball socket connectors and the pockets of the roller reamer. Such a lubrication means seems not very appropriated and the drilling fluid may provide corrosion and increase wearing of these mating surfaces.

US patent n° 4548284 discloses a roller ball retention system for a roller reamer assembly. A roller is mounted around a shaft such that two extremities of the shaft protrude are located outside of the roller. Each extremity of the shaft is clamped between the bottom of a pocket and a mounting cap. The mounting caps are installed within sockets made in the pocket, both sockets and mounting caps comprising facing ball races in which is inserted a set of balls. Each mounting cap comprises two channels connected to the ball races and the balls are inserted

through one of the channels. The ball races and channels are filled by balls and both channels are then closed by a screw. Such a system is rather complicated, comprises a lot of pieces and it is mandatory to provide a set of two screws on both caps for confining the ball into their ball races.

Document WO2008006146 discloses a rotary roller reamer comprising a pocket for receiving a roller reamer assembly including a plurality of components forming a single cartridge. The cartridge is inserted in the pocket by interference fit and is secured by two bolts. A cartridge inserted in a pocket by interference fit may be sometimes hard to remove, since the tool body may be subjected to high constraint and temperature in the wellbore.

Document US 4497384 discloses some embodiments of a reamer tool. A first embodiment of the reamer tool comprises a roller cartridge arranged in a pocket. The roller cartridge comprises a roller arranged about a shaft and secured between two blocs. The two blocks are inserted into respective sockets by interference fit. Interference fit means that the blocks are forced into their respective socket such that the fastening between the blocks and the socket is achieved by friction. There is therefore no clearance between the blocks and their respective socket. The dimensions of the blocks are slightly wider than the dimensions of the socket, and the insertion of a block into a socket by interference fit is generally realized by heating one or two mating parts. A first block of the cartridge is then fastened to the pocket by a first pair of bolts, and the opposite block is fastened to the pocket by a second pair of bolts. The opposite ends of the pocket both comprise a slot for inserting a curved wedge block for removing the said cartridge. When it is desired to remove the roller cartridge from the pocket, the bolts are removed and then the curved wedge block is inserted in the slot. Hammering the wedge block makes the wedge block acting as a lever on the cartridge to force the roller cartridge out of the pocket. Such a roller cartridge is submitted to mechanical stress while running in a wellbore and while insertion and removal of the roller cartridge. The slots arranged on both ends of the pocket may weaken the tool body.

A second embodiment of the tool of document US 4497384 discloses a stabilizer that comprises a pocket in which is fastened a lower blade element, an upper blade element and a

block which are inserted in the same pocket by interference fit and screwed by means of two bolts per elements. The lower blade element includes at its lower end and close to its base, an interlock means in the form of a lug that is accommodated in a mating interlock means in the form of a recess in the lower end at the base of the pocket. The middle section of the upper end of the lower blade element comprises a second interlock means in the form of a recess for mating with an interlock means in the form of a projection made on the middle section of the lower end of the upper blade element. The upper blade element further comprises another recess for mating with another interlock means in the form of a projection made on the block. Each of the blade elements has approximately parallel sides that are dimensioned so as to form an interference fit with the parallel sides of the accommodating pocket. Because of that, the insertion of the lower blade element into the pocket and the mating of its lug into the recess at the bottom of the pocket is not easy to do. The insertion of the upper blade element into the pocket such that the interlock means of the upper blade element mates with the recess of the lower blade element present also some difficulties. The same situation is encountered for the insertion of the block into the pocket such that the interlock means mate the recess of the upper blade element.

The upper end of the pocket comprises a slot facing the upper end of the block and allowing the insertion of a pry out tool or curved wedged block for firstly removing the block. The removal of these blade elements and block has to be performed in a certain sequence of steps. A first step is to remove all the bolts, then to introduce the pry out tool into the slot for using the pry out tool as a lever to tilt and push the block out of the pocket, then using again the pry out tool to tilt the upper blade element and pushing it out from the pocket and repeating the same step for the lower blade element.

Document US2013/0133954 discloses a roller reamer that comprises a tool body and a cartridge inserted into a pocket. The cartridge comprises a roller mounted around a bearing pin having its both ends included in two retention block. The cartridge is first inserted into the pocket, then a pair of wedge blocks are screwed on both side of the cartridge and inside the pocket to maintain the cartridge inside the pocket. Each retention block includes a back angled axial face opposing the bearing pin and facing the wedge block. The back angled face is not

axial but tilted away from a non-zero angle. The wedge block includes a corresponding forward angled axial face facing towards the bearing pin and the retention block. The wedge blocks provide a superior axial force to maintain the cartridge in the pocket, however, if a bolt unscrews for example under vibrations, the cartridge may be lost.

There is a need for a down-hole tool with tool elements or assemblies easily removable and which doesn't comprise the drawbacks of the down-hole tools of the prior art. The aim of this invention is to provide a downhole tool assembly fulfilling this need.

This has been achieved by providing a downhole tool assembly comprising a tool body comprising at least one pocket for insertion of a cartridge and at least one cartridge, said cartridge being fastened in the pocket in at least two different locations by respective bolts which are screwed into the tool body, said bolts having a bolt shaft and a bolt head, said bolt shaft extending through a hole in the cartridge and into a threaded hole in the tool body, while the bolt head is in contact with a contact surface of the cartridge, wherein the cartridge comprises abutment means for constraining the movement of each bolt in its axial direction and away from the tool body such that each bolt is retained in its hole when it is at least partially loosened, and wherein the dimensions of the cartridge relative to the dimensions of the pocket are such that there is a total clearance (C) between two opposite sides of the cartridge and the respective pocket walls facing said sides, such that $C \leq \sqrt{X^2 + Y^2} - X$, where C is the total pocket clearance, X is the dimension of the cartridge between said opposite sides, and Y is the depth of the pocket.

The total clearance (C) is the sum of two clearances which can be equal, but the two clearances may however also be different: a first clearance C1 and a second clearance C2 which differs from the first one, the sum of the two clearances (C1 + C2) being said total pocket clearance (C).

The opposite sides of the cartridge can have a flat surface but one or both surfaces can also have a curved surface of any shape. When the cartridge has an elongated form with relatively flat sides the opposite sides of the cartridge can be end sides substantially extending in

direction which is perpendicular to the axial or longitudinal direction of the cartridge, or can be lateral sides substantially extending in said axial or longitudinal direction.

In such a downhole tool assembly, a cartridge can be inserted into a pocket or can be removed from it according to a preferred direction, parallel to the pocket walls facing the sides of the cartridge, whereas this insertion or removal is blocked when the cartridge is tilted to an angle exceeding a maximum angle of 10 degrees with respect to said preferred direction. In a preferred embodiment said maximum angle is 5 degrees, more preferably said maximum angle is 2 degrees.

In a preferred embodiment of the downhole tool assembly according to this invention, the total clearance (C) between the two opposite sides of the cartridge and the respective pocket walls facing said sides is a clearance fit.

The clearance between the lateral sides of the cartridge and the walls of the pocket is essential to provide an easier removal of the cartridge from the tool body when compared to down-hole tools of the prior art in which he cartridges are inserted in the pocket by interference fit.

The clearance between the pocket and the cartridge in combination with the conception of the cartridge has the further advantage that it provides a safety means in case of unintentional loosening of the fixing means. When one of the fastening elements loosens, it will unscrew and move in a direction away from the tool body. The fastening element will abut against said abutment means and push the cartridge into a tilted position in the pocket, so that the cartridge will wedge itself inside the pocket and any further movement of the cartridge away from the body and any further unscrewing of the bolt is prevented.

For example when the cartridge is fixed by means of two bolts, it could happen that one of these bolts is self-loosening due to vibrations or any other reason, while the other bolt remains fastened. In that situation the partially unscrewed bolt abuts against the abutment means and pushes the cartridge into a tilted position in the pocket so that the cartridge wedges itself inside the pocket and any further movement of the cartridge and any further unscrewing of the loosened bolt is prevented.

In a preferred embodiment of the downhole tool assembly, two of said locations are provided along an axis intersecting said two opposite sides.

When two opposite sides of the cartridge having the prescribed clearance (C) with respect to the pocket walls facing these sides, also are at opposite ends of an axis of fixation (i.e. the axis along which the fastening elements are provided), the abovementioned effect of the invention is further increased.

The sides intersected by the axis are to be considered opposite sides of the cartridge, even if these sides are not the end sides of a cartridge having an elongated shape. The axis determines which sides of the cartridge are to be considered as opposite sides. The direction of the axis is thus not necessarily coinciding with the longitudinal axis of the cartridge but could make any angle with it. The direction of the axis could even be perpendicular to the longitudinal axis of the cartridge.

In a particular embodiment of this downhole tool assembly, the fastening elements are provided in a respective hole in the cartridge and the abutment means are arranged in the holes, such that a passage is left for reaching the fastening element.

In another preferred embodiment of this downhole tool assembly, at least one fastening element is a bolt having a bolt shaft and a bolt head, said bolt shaft extending through a hole in the cartridge into a threaded hole in the tool body, while the bolt head is in contact with a contact surface of the cartridge. Advantageously, said cartridge hole comprises a first section into which the bolt head is introduced, and a second section through which the bolt shaft extends, the second section having a transverse dimension which is smaller than the transverse dimension of the first section, such that a first shoulder part is formed which constitutes said contact surface for the bolt head.

Preferably, the tool body comprises at least one pair of threaded holes in a bottom wall of the pocket, the cartridge comprises respective holes at corresponding locations, so that each cartridge hole is aligned with a respective threaded hole in the tool body, and the cartridge is fixed by means of respective bolts extending through each of said aligned holes.

It is also preferred to provide a clearance between the bolt head and said abutment means, which is maximum 15% of the largest transverse dimension of the bolt head. When the bolt head has a circular shape, said transverse dimension is the diameter of the bolt head

In a particular embodiment, the abutment means is arranged in the hole in the cartridge, such that a passage is left for reaching the bolt head. Preferably, the abutment means comprises a retaining ring which is inserted in the hole. The abutments means may be permanently fixed inside the hole.

In a most preferred embodiment, said hole in the cartridge comprises a first section into which the bolt head is introduced, a second section through which the bolt shaft extends, the second section having a transverse dimension which is smaller than the transverse dimension of the first section, such that a first shoulder part is formed which constitutes a contact surface for the bolt head, and a third section, at the side facing away from the tool body, having a transverse dimension which is smaller than the transverse dimension of the first section, such that a second shoulder part is formed which constitutes said abutment means for the bolt head.

In a particular embodiment, a T-shaped slot is provided in a side face of the cartridge, said slot opening into the first and the second section of the hole, such that the bolt can be introduced in the hole through said T-shaped slot, into a position in which the bolt head is situated between the first and the second shoulder part, while the bolt shaft extends through the second section of the hole.

In another preferred embodiment, the edges of the cartridge are chamfered and the edges of the pocket are rounded.

The tool body may also have an outermost surface which is formed by raised portions in a form of blades or ribs extending longitudinally, spirally or helically along a section of the tool body, such that two adjacent raised portions define a flow path there between, while the pockets are formed into said raised portions.

The downhole tool assembly according to this invention preferably comprise at least one cartridge which is a roller assembly or a stabilizing pad or a reamer pad.

The aim of this invention is also achieved by providing a method for assembling a downhole tool assembly according any one of the preceding claims, said method comprising the steps of

- providing a tool body comprising at least one pocket for insertion of a tool cartridge and a pair of threaded holes;
- inserting a cartridge into said pocket, said cartridge having respective holes at locations corresponding to the locations of said threaded holes, and a respective first and second bolt inserted into the corresponding holes of the cartridge, said bolts having a bolt shaft and a bolt head, said bolt shaft extending through said hole in the cartridge, the cartridge comprising abutment means for constraining the movement of each bolt in its axial direction and away from the tool body such that each bolt is retained in its hole when it is at least partially loosened,
  said cartridge and said pocket having relative dimensions such that there is a total clearance between two opposed sides of the cartridge and the pocket walls facing said sides, such that $C \leq \sqrt{X^2 + Y^2} - X$, where C is the total pocket clearance, X is the length of the cartridge between said opposed sides, and Y is the depth of the pocket, and
- fixing the cartridge in the pocket by means of said first and said second bolt,
  - by alternately screwing a partial length of the first bolt into a threaded hole and screwing a partial length of the second bolt into the other threaded hole, or
  - by synchronously screwing the first bolt and the second bolt into their respective threaded holes,

  at least until the bolt heads are in contact with a contact surface of the cartridge.

When the bolts are alternately tightened or are tightened simultaneously, the cartridge is urged to move in a direction which is substantially parallel to the walls of the pocket because of the presence of the abutment means.

The invention also relates to a method for disassembling a down-hole tool assembly according to this invention, said downhole tool comprising a tool body comprising at least one pocket and a pair of threaded holes, a tool cartridge inserted into said pocket being fixed by means of a first and a second bolt extending through holes in the cartridge and screwed into a respective threaded hole in the tool body, said method comprising the step of alternately unscrewing a partial length of the first bolt and unscrewing a partial length of the second bolt out of its threaded hole, or synchronously unscrewing the first bolt and the second bolt.

The aim of the invention is also achieved by providing a downhole tool assembly having the features mentioned in the first paragraph of this description, wherein said cartridge comprises abutment means for constraining the movement of each fastening element in its axial direction and away relative to the tool body, such that each bolt is retained in its hole when it is at least partially loosened, and in that the dimensions of said cartridge relative to the dimensions of said pocket are selected such that there is a clearance fit between said cartridge and said pocket, such that said cartridge is insertable into the pocket or removable from said pocket following a single direction, and gets blocked into the pocket when said cartridge is tilted to an angle exceeding a predetermined angle relative to said single direction.

Preferably, said cartridge is fixed by means of two bolts such that, when a bolt is self-loosening, the at least partly unscrewed bolt abuts against the abutment means and pushes the cartridge into a tilted position in the pocket such that the cartridge wedges itself into the pocket and any further movement of the cartridge and any further unscrewing of the loosened bolt is prevented.

The invention will now be explained in more detail by means of the following more detailed description of a possible embodiment of a downhole tool package according to the present invention. The described embodiment is only an example and can therefore by no means be seen as a limitation of the scope of protection or of the area of application of the invention.

Reference numerals are used in this detailed description to refer to the attached figures, in which:

- Figure 1 shows a perspective view of an embodiment of a downhole tool assembly according to the present invention, comprising a stabilizing pad;
- Figure 2 shows a longitudinal cross section of the downhole tool assembly shown in figure 1;
- Figure 3A is a schematic presentation of the cross section of the tool body of the downhole tool assembly and a side schematic view of a cartridge of the downhole tool assembly;
- Figure 3B is a more enlarged schematic presentation of a part of the cross section of figure 2, when the bolts are removed;
- Figure 4 is a schematic presentation of an alternative embodiment of the downhole tool assembly comprising a stabilizing pad;
- Figure 5 shows a perspective view of an embodiment of a downhole tool assembly according to the present invention, comprising a roller reamer cartridge.
- Figure 6 shows a longitudinal cross section of the downhole tool assembly shown in figure 5, the reamer cartridge being fixed in the pocket of the tool body;
- Figure 7 shows a longitudinal cross section of the downhole tool assembly shown in figure 6, wherein the reamer cartridge is shown outside the pocket;
- Figure 8 is an enlarged schematic presentation of a longitudinal cross section of the tool body and a side schematic view of the fixed reamer cartridge of the downhole tool of figure 5; and
- Figure 9 is a schematic presentation of an alternative embodiment of a roller reamer cartridge.

A first embodiment of a downhole tool assembly is described with reference to figures 1, 2, 3A and 3B. This downhole tool assembly is a stabilizer tool assembly comprising a tool body (1) of which the outermost surface comprises raised portions (2) in the form of ribs extending helically along a section of the tool body (see figure 1). The raised portions (2) have tapered

extremities (2a),(2b). Two adjacent raised portions (2) define a flow path (3) in between the raised portions.

A number of pockets (4) is formed into each of those raised portions (2). Each pocket (4) forms a recess in the outermost surface of the tool body (1).

This stabilizer tool assembly further comprises a single cartridge inserted into each pocket (4). In this first embodiment of the invention, this cartridge is a stabilizer pad (5).

The stabilizer pad (5) has an elongated shape defining an axial direction (A), with a rectangular top side (5e), preferably forming a rounded surface, and a rectangular bottom side (5f), preferably flat, two lateral sides (5a), (5b) extending in said axial direction and two parallel end sides (5c),(5d) extending in a direction perpendicular to said axial direction (A), which will be called the longitudinal sides (5a),(5b) and the transversal sides (5c),(5d) respectively.

The stabilizer pad (5) comprises two holes (6),(7) located in the vicinity of a respective extremity of the stabilizer pad (5).

A bolt (8), (9) is inserted into each hole (6),(7) and is screwed into a respective threaded hole (10), (11) in the bottom wall (4e) of the pocket (4). Each bolt (8),(9) comprises a bolt head (8a), (9a) and a bolt shaft (8b),(9b).

The holes (6),(7) in the cartridge (5) comprise abutments for constraining the bolts (8),(9) from axial movement away from the tool body (1), as will be explained below.

Each pocket (4) has two facing walls (4a),(4b) extending in the axial direction (A) and two parallel walls (4c),(4d) extending in a direction perpendicular to said axial direction (A), which will be called the longitudinal pocket walls and the transversal pocket walls respectively. Each pocket has a flat bottom surface at a predetermined depth (Y) relative to the surface of the raised portion (2). The edges of the bottom surface are preferably rounded and the edges of the cartridge are preferably tapered in order to reduce stress of the cartridge against the pocket.

The stabilizer pad (5) has a length (X) – the dimension in axial direction – which is smaller than the axial distance between the transversal pocket walls, such that a small clearance is obtained between each of the transversal sides (5c),(5d) of the stabilizer pad (5) and the transversal pocket wall (4c),(4d) facing it. The two clearances (C/2) are equal and the sum of both partial clearances (C/2) is called the total pocket clearance (C). According to the invention, the total pocket clearance (C) is smaller than or equal to $\sqrt{X^2 + Y^2} - X$. The relevant dimensions (X),(Y),(C/2) have been indicated on figure 3B, in which, for reasons of clarity, the width (C/2) of the clearances and the transverse dimensions of the holes (6),(7) are drawn much greater than in reality.

This total pocket clearance (C) allows insertion of the stabilizer pad (5) into the pocket (4) and the removal of the stabilizer pad (5) out of the pocket according to a preferred direction parallel to the walls (4a),(4b),(4c),(4d) of the pocket (4), and blocking the stabilizer pad (5) when the stabilizer pad (5) is tilted to an angle exceeding a particular maximum angle. Depending on the specific construction requirements of the downhole tool, this maximum angle can be any angle below 10 degrees. In some circumstances the maximum titling angle of the stabilizer pad (5) can be any angle below 5 degrees or even below 2 degrees.

The bottom side (5f) of the cartridge (5) is in contact with the bottom wall (4e) of the pocket (4). The height (h) of the stabilizer pad (5), i.e. the cartridge dimension measured from this bottom side (5f) in a direction perpendicular to it, is such that the major part of the cartridge (5) is inserted in the pocket (4). It is preferred (see figure 3B) that the depth (Y) of the pocket (4) is at least 50% of the height (h) of the cartridge (5).

In an embodiment of the present invention, the total pocket clearance (C) between the pocket (4) and the stabilizer pad (5) is a clearance fit. The term “clearance fit” means that two toleranced mating parts will always leave a space or clearance when assembled, as opposed to interference fit where two toleranced mating parts will always interfere when assembled.

The holes (6), (7) in the stabilizer pad (5) open in the top side (5e) and the bottom side (5f) and comprise three aligned cylindrical sections (6a),(7a); (6b),(7b);(6c),(7c). A first section (6a),(7a) having the largest diameter is provided inside the cartridge material and is connected to a

second section (6b),(7b) opening in the bottom side (5f) and a third section (6c),(7c) opening in the top side (5e) of the cartridge (5). The diameters of the second (6b),(7b) and third sections (6c),(7c) is smaller than the diameter of the first section (6a),(7a). The change of diameters occurs in a stepwise manner such that a first shoulder part (61),(71) and a second shoulder part (62),(72) are formed at the bottom side and at the top side of the first section (6a),(7a) respectively.

The bolt heads (8a), (9a) are placed in the first section (6a),(6b) of the respective holes (6),(7), while the bolt shafts (8b),(9b) extend through the second sections (6b),(7b) and their ends are screwed into the threaded holes (10),(11) in the bottom wall (4e) of the pocket (4).

The bolts (8),(9) can be introduced in the first (6a),(7a) and second sections (6b),(7b) of their holes (6),(7) through a respective T-shaped slot (12), (13) opening in a lateral side (5a) of the stabilizer cartridge (5), as shown in figure 3A. This slot (12),(13) opens into the first (6a),(7a) and the second section (6b), (7b) of the holes, such that each bolt can be introduced in through a T-shaped slot, into a position in which the bolt head (8a),(9a) is situated between the first (61),(71) and the second shoulder part (71),(72), while the bolt shaft (8b),(9b) extends through the second section of the hole.

The first shoulder part (61),(71) constitutes a contact surface for the bolt head (8a),(9a).

The head of the tightened bolt (8),(9) is in contact with this contact surface and exerts a holding force onto the stabilizer pad (5). The second shoulder part (62),(72) constitutes an abutment surface for the bolt head (6a),(7a), such that a partially or wholly loosened bolt (8),(9) is retained in its hole and is prevented from leaving the hole (6),(10);(7),(11).

The clearance between the top surface of the bolt head (8a), (9a) and the second shoulder part (62),(72) is preferably inferior to10 % of the diameter of the bolt head (8a),(9a). The clearance between the bolt head and the wall of the first cylindrical section (6a) is preferably inferior to 10% of the diameter of the bolt head (8a), (9a).

The third section (6c),(7c) of the holes (6),(7) leaves a passage through which the bolt heads (8a),(9a) can be reached in order to tighten or untighten the bolts (6),(7). For example a tool such as a screwdriver or an Allen key can be inserted through this passage.

In an alternative embodiment of the stabilizer tool, shown in figure 4, the holes (6),(7) only have a first section (6a),(7a) opening in the top side (5e) of the stabilizer pad (5) and a second section (6b),(7b) having a smaller than the first section (6a),(7a), opening in the bottom side (5f). In each hole (6),(7) a first shoulder part (61),(71) is formed which constitutes a contact surface for the bolt head (8a),(9a).

The bolt heads (8a), (9a) are introduced in the first section (6a),(7a) in contact with the contact surface, while the bolt shafts (8b),(9b) extend through the second section (6b), (7b) and their ends are screwed into the threaded holes (10),(11) in the bottom wall (4e) of the pocket (4). The heads of the tightened bolts exert a holding force onto the stabilizer pad (5).

In this embodiment (figure 4), the abutment is formed by a retaining ring (14),(15) which is inserted into each hole (6),(7) and which can be permanently joined to the hole by a welding or a brazing process.

Alternatively, the retaining ring is a removable snap ring (114),(115) as shown in figure 9 for a downhole tool assembly comprising a roller reamer cartridge. This embodiment will be described below in more detail.

The edges of the pocket (4) are rounded for minimizing stresses on the tool body (1) and the stabilizer pad (5) is chamfered for facilitating its insertion into the pocket (4).

A second embodiment of a downhole tool assembly is described with reference to figures 5 to 9. This downhole tool assembly is a roller reamer tool assembly comprising a tool body (101) of which the outermost surface comprises raised portions (102) in the form of ribs extending longitudinally along a section of the tool body (see figure 5). The raised portions (102) have tapered extremities (102a),(102b). Two adjacent raised portions (102) define a flow path (103) in between the raised portions.

A pocket (104) is formed into each of those raised portions (2). Each pocket (104) forms a recess in the outermost surface of the tool body (101).

This roller reamer tool assembly further comprises a single cartridge inserted into each pocket (4). In this second embodiment of the invention, this cartridge is a roller reamer cartridge assembly (105).

This cartridge (105) has an elongated shape defining an axial direction (B) comprising a first block (1050) and a second block (1051), a shaft (1052) arranged between the first and the second block, and a hollowed cylindrical roller reamer (1053) provided with reaming inserts (1054) and arranged to rotate about said shaft (1052).

Each first (1051) and second block (1052) is fastened to the shaft (1053) by means of screws, by interference fit or by any other means, such that all the pieces of the roller reamer cartridge assembly form a single cartridge (105) of fixed dimensions.

The cartridge (105) comprises two end parts formed by the first block and the second block, and an intermediate part formed by the cylindrical roller reamer (1053) in between those blocks and protruding beyond the lateral sides formed by the lateral sides of the blocks.

The sides of the blocks extending in the axial direction (B) form respective lateral sides (105a),(105b) of the cartridge (105),. The end sides of the blocks extending in a direction perpendicular to said axial direction (B) form respective end sides (105c),(105d) of the cartridge (105), extending in parallel planes. The top surface of the blocks is curved and comprises reaming inserts (1054).

A portion of the roller reamer cartridge (105) protrudes beyond the surface of the raised portions (102), and a major portion of the roller reamer cartridge is inserted into the pocket (104). Preferably, at least 50 % of the cartridge (105) is inserted into the pocket (104).

Each pocket (104) has a shape which corresponds to the bottom shape of the cartridge (105), allowing the cartridge (105) to be inserted in the pocket, leaving a small clearance between the cartridge sides and the pocket walls facing these sides.

The pocket (104) walls (104a),(104b) face the lateral walls (105a),(105b) of the cartridge (105). The pocket walls (104c),(104d) facing the end walls (105c),(105d) of the cartridge are parallel. Each pocket has a flat bottom surface located at a predetermined depth (Y).

The cartridge (5) has a length (X) – the dimension in axial direction – which is smaller than the axial distance between the pocket walls, such that a small clearance is obtained between each of the end sides (105c),(105d) of the stabilizer pad (5) and the pocket wall (4c),(4d) facing it. The two clearances (C/2) are equal and the sum of both partial clearances (C/2) is called the total pocket clearance (C). According to the invention, the total pocket clearance (C) is smaller than or equal to $\sqrt{X^2 + Y^2} - X$. The relevant dimensions (X),(Y),(C/2) have been indicated on figure 6.

In such a downhole tool assembly, the roller reamer cartridge can be inserted into a pocket or can be removed from it according to a preferred direction, parallel to the pocket walls facing the sides of the cartridge, whereas this insertion or removal is blocked when the cartridge is tilted to an angle exceeding a maximum angle of 10 degrees with respect to said preferred direction. In a preferred embodiment said maximum angle is 5 degrees, more preferably said maximum angle is 2 degrees.

This cartridge (105) is fixed in the pocket (104) by means of two bolts (108),(109) in the same way as the stabilizing pad (5) of figures 2, 3A and 3B.

Two holes (106), (107) are provided in a respective block (1051),(1052) of the roller reamer cartridge (105). The holes (106),(107) open in the top side and the bottom side and comprise three aligned cylindrical sections (106a),(107a); (106b),(107b);(106c),(107c). A first section (106a),(107a) having the largest diameter is provided inside the cartridge material and is connected to a second section (106b),(107b) opening in the bottom side, and a third section (106c),(107c) opening in the top side of the cartridge (105). The diameters of the second (106b),(107b) and third sections (106c),(107c) is smaller than the diameter of the first section (106a),(107a). The change of diameters occurs in a stepwise manner such that a first shoulder part (161),(171) and a second shoulder part (162),(172) are formed at the bottom side and at the top side of the first section (106a),(107a) respectively.

The bolt heads (108a), (109a) are placed in the first section (106a),(106b) of the respective holes (106),(107), while the bolt shafts (108b),(109b) extend through the second sections (106b),(107b) and their ends are screwed into the threaded holes (110),(111) in the bottom wall of the pocket (104).

The bolts (108),(109) can be introduced in the first (106a),(107a) and second sections (106b),(107b) of their respective hole (106),(107) through a respective T-shaped slot (112), (113) opening in a lateral side (105a) of the cartridge (105), as shown in figure 8.

This slot (112),(113) opens into the first (106a),(107a) and the second section (106b), (107b) of the holes, such that each bolt (108),(109) can be introduced through a T-shaped slot, into a position in which the bolt head (108a),(109a) is situated between the first (161),(171) and the second shoulder part (171),(172), while the bolt shaft (108b),(109b) extends through the second section of the hole.

The first shoulder part (161),(171) constitutes a contact surface for the bolt head (108a),(109a). The head of the tightened bolt (108),(109) is in contact with this contact surface and exerts a holding force onto the cartridge (105). The second shoulder part (162),(172) constitutes an abutment surface for the bolt head (106a),(107a), such that a loosened bolt (108),(109) is prevented from leaving the holes (106),(110);(107),(111).

The clearance between the top surface of the bolt head (108a), (109a) and the second shoulder part (162),(172) is preferably inferior to 15 % of the diameter of the bolt head (108a),(109a). The clearance between the bolt head (108), (109) and the wall of the first section (106a), (107a) is preferably inferior to 15% of the diameter of the bold head.

The third section (106c),(107c) of the holes (106),(107) leaves a passage through which the bolt heads (108a),(109a) can be reached in order to tighten or untighten the bolts (106),(107). For example a tool such as a screwdriver or an Allen key can be inserted through this passage.

In an alternative embodiment of this tool, shown in figure 9, the holes (106),(107) only have a first section (106a),(107a) opening in the top side of the cartridge (5) and a second section (106b),(107b) having a smaller than the first section (106a),(107a), opening in the bottom side.

In each hole (106),(107) a first shoulder part (161),(171) is formed which constitutes a contact surface for the bolt head (8a),(9a). In this embodiment (figure 9), the abutment is formed by a snap ring (114),(115) which is inserted into a groove in each hole (106),(107). The groove (116),(117) for inserting the snap ring (114),(115) is formed in the walls of the first section (106a),(107a) of the holes (106),(107), in the vicinity of the top of the hole.

Alternatively, the abutment is formed by a retaining ring which is inserted into each hole (106),(107) and which is permanently joined to the hole by a welding or a brazing process (see figure 4).

The edges of the pocket (104) are rounded for minimizing stresses on the tool body (101) and the cartridge (105) is chamfered for facilitating its insertion into the pocket (104).

This roller reamer assembly also comprises a down-hole positive pressure equalizing lubrication system as described in applicant's patent EP1818500B1.

In a third embodiment (not shown in the drawings), the down-hole tool assembly according to the invention is a reamer tool comprising a tool body provided with at least one pocket, forming a recess in the outermost surface of the tool body, and further comprising a single cartridge inserted into the pocket. This single cartridge is a reamer pad comprising reaming inserts such as for example polycrystalline diamond cutters (PDC) arranged in a direction to ream the borehole upon rotation of the down-hole tool assembly, or tungsten carbide inserts (TCI), preferably having a dome shaped outermost portion or a truncated dome shaped outermost portion arranged on the outermost surface of the reamer pad and extending in a perpendicular direction relative to that outermost surface.

This reamer pad has an elongated shape and comprises a pair of holes preferably located at the vicinity of both extremities of the pad. A pair of bolts is inserted into the holes of the reamer pad and is screwed into the tool body, in one of the ways described above. The abutments for the bolts are also obtained in one of the ways described above. The relevant dimensions of the reamer pad and the pocket are also determined as described above, so as to have a total pocket clearance (C) according to the present invention.

In order to assemble a downhole tool assembly, such as a stabilizer tool, a reamer tool or a roller reamer tool as described herein above, two bolts (8),(9);(108),(109) are placed in a respective hole (6),(106);(106),(107) of each cartridge (5),(105) and each cartridge is inserted into a respective pocket (4),(104). The cartridges (5),(105) are then fixed by means of the two bolts, by alternately screwing a partial length of the first bolt (8), (108) into a threaded hole (10),(110) and screwing a partial length of the second bolt (9), (109) into the other threaded hole (11),(111), or by synchronously screwing the first bolt (8),(108) and the second bolt (9),(109) into their respective threaded holes (10),(110);(11),(111).

In order to disassemble such a downhole tool assembly the two bolts (8),(108);(9),(109) are removed from the treaded holes (10),(110);(11),(111) by alternately unscrewing a partial length of the first bolt and unscrewing a partial length of the second bolt out of its threaded hole, or by synchronously unscrewing the first bolt (8),(108) and the second bolt (9),(109).

CLAIMS

1. A down-hole tool assembly comprising
   - a tool body (1),(101) comprising at least one pocket (4),(104) for insertion of a cartridge (5),(105), and
   - at least one cartridge (5),(105),

   said cartridge (5),(105) being fastened in the pocket (4),(104) in at least two different locations by respective bolts (8),(9); (108),(109) which are screwed into the tool body (1),(101), said bolts (8),(9) having a bolt shaft (8b),(9b); (108b),(109b) and a bolt head (8a),(9a); (108a),(109a), said bolt shaft extending through a hole (6),(7);(106),(107) in the cartridge (5),(105) and being screwed into a threaded hole (10),(11);(110),(111) in the tool body (1),(101), while the bolt head is in contact with a contact surface (61), (71); (161), (171) of the cartridge, **characterized in that** the cartridge comprises abutment means (62),(72);(162),(172); (14),(15);(114),(115) for constraining the movement of each bolt (8),(9);(108),(109) in its axial direction and away from the tool body (1),(101), such that each bolt (8), (9) is retained in its hole (6), (10), (7), (11); (106),(110), (107),(111) when it is at least partially loosened, and in that the dimensions of the cartridge (5),(105) relative to the dimensions of the pocket (4),(104) are such that there is a total clearance (C) between two opposite sides of the cartridge and the respective pocket walls facing said sides, such that $C \leq \sqrt{X^2 + Y^2} - X$, where C is the total pocket clearance, X is the dimension of the cartridge between said opposite sides, and Y is the depth of the pocket (4).

2. A downhole tool assembly according to claim 1, characterized in that the total clearance (C) between the two opposite sides of the cartridge and the respective pocket walls facing said sides is a clearance fit.

3. A downhole tool assembly according to claim 1 or 2, characterized in that the clearance between the pocket and the cartridge, in combination with the conception of the cartridge

provides a safety means in case of unintentional loosening of the fastening elements, wherein if one of the bolts is loosening, the bolt abuts against the abutment means and pushes the cartridge into a tilted position in the pocket so that the cartridge wedges itself inside the pocket and any further movement of the cartridge and any further unscrewing of the bolt is prevented.

4. A downhole tool assembly according to any one of the preceding claims , characterized in that two of said different locations are provided along an axis intersecting said two opposite sides of the cartridge (5),(105).

5. A down-hole tool assembly according to any one of the preceding claims characterized in that said holes (6),(7);(106),(107) in the cartridge (5),(105) comprise a first section (6a),(7a); (106a),(107a) into which the bolt head (8a),(9a); (108a),(109a) is introduced, and a second section (6b),(7b); (106b),(107b) through which the bolt shaft (8b),(9b); (108b),(109b) extends, the second section having a transverse dimension which is smaller than the transverse dimension of the first section, such that a first shoulder part (61),(71);(161),(171) is formed which constitutes said contact surface for the bolt head.

6. A down-hole tool assembly according to any one of the preceding claims characterized in that the tool body (1),(101) comprises at least one pair of threaded holes (10),(11); (110),(111) in a bottom wall of the pocket (4),(104), and in that the cartridge (5),(105) comprises respective holes (6),(7);(106),(107) at corresponding locations, so that each cartridge hole (6),(7);(106),(107) is aligned with a respective threaded hole (10),(11); (110),(111) in the tool body, and in that the cartridge (4),(104) is fixed by means of respective bolts (8),(9);(108),(109) extending through each of said aligned holes.

7. A down-hole tool assembly according to any one of the preceding claims characterized in that there is a clearance between the bolt head (8a),(9a); (108a),(109a) and said abutment

means (62),(72);(162),(172);(14),(15);(114),(115), said clearance being maximum 15% of the largest transverse dimension of the bolt head.

8. A down-hole tool assembly according to any one of the preceding claims, characterized in that the abutment means (62),(72);(162),(172);(14),(15);(114),(115) is arranged in the hole (6),(7);(106),(107) in the cartridge, such that a passage is left for reaching the bolt head (8a),(9a); (108a),(109a).

9. A down-hole tool assembly according to any one of the preceding claims characterized in that the abutment means comprise a retaining ring (14),(15);(114),(115) which is inserted in the hole.

10. A down-hole tool assembly according to any one of the preceding claims characterized in that the abutments means (62),(72);(162),(172);(14),(15);(114),(115) is permanently fixed inside the hole.

11. A down-hole tool assembly according to any one of the preceding claims characterized in that that said hole (6),(7);(106),(107) in the cartridge (5),(105) comprises
    - a first section (6a),(7a);(106a),(107a) into which the bolt head (8a),(9a); (108a),(109a) is introduced,
    - a second section (6b),(7b);(106b),(107b) through which the bolt shaft extends, the second section having a transverse dimension which is smaller than the transverse dimension of the first section, such that a first shoulder part (61),(71);(161),(171) is formed which constitutes a contact surface for the bolt head, and
    - a third section (6c),(7c);(106c),(107c), at the side facing away from the tool body, having a transverse dimension which is smaller than the transverse dimension of the first section, such that a second shoulder part (62),(72);(162),(172) is formed which constitutes said abutment means for the bolt head.

12. A down-hole tool assembly according to claim 11 characterized in that a T-shaped slot (12),(13);(112),(113) is provided in a side face of the cartridge (5),(105), said slot (12),(13);(112),(113) opening into the first (6a),(7a);(106a), (107a) and the second section (6b),(7b);(106b),(107b) of the hole, such that the bolt can be introduced in the hole through said T-shaped slot, into a position in which the bolt head is situated between the first (61),(71);(161),(171) and the second shoulder part (62),(72);(162),(172), while the bolt shaft extends through the second section of the hole.

13. A down-hole tool assembly according to any one of the preceding claims characterized in that the edges of the cartridge (5), (105) are chamfered and in that the edges of the pocket (4), (104) are rounded.

14. A down-hole tool assembly according to any one of the preceding claims characterized in that the outermost surface of the tool body (1), (101) is formed by raised portions (2), (102) in a form of blades or ribs extending longitudinally, spirally or helically along a section of the tool body, two adjacent raised portions defining a flow path (3), (103) there between, and in that the pockets (4), (104) are formed into those raised portions.

15. A down-hole tool assembly according to any one of the preceding claims characterized in that at least one cartridge (5), (105) is a roller assembly or a stabilizing pad or a reamer pad.

16. A method of assembling a down-hole tool assembly according any one of the preceding claims comprising the steps of :

- providing a tool body (1), (101) comprising at least one pocket (4), (104) for insertion of a tool cartridge (5),(105), and a pair of threaded holes (10),(11);(110),(111);
- inserting a cartridge (5),(105) into said pocket (4),(104), said cartridge having respective holes (6),(7);(106),(107) at locations corresponding to the locations of

said threaded holes (10),(11);(110),(111), and a respective first (8),(108) and second bolt (9),(109) inserted into the corresponding holes (6),(7);(106),(107) of the cartridge, said bolts having a bolt shaft (8b),(9b); (108b),(109b) and a bolt head (8a),(9a); (108a),(109a), each bolt shaft extending through a corresponding hole (6),(7);(106),(107) in the cartridge (5),(105), , the cartridge comprising abutment means (62),(72);(162),(172); (14),(15);(114),(115) for constraining the movement of each bolt (8),(9);(108),(109) in its axial direction and away from the tool body (1),(101), such that each bolt (8), (9), (108), (109) is retained in its hole (6), (10), (7), (11) when it is at least partially loosened,

said cartridge (5),(105) and said pocket (4),(104) having relative dimensions such that there is a total clearance (C) between two opposed sides (5a-5d); (105a-105d) of the cartridge (5),(105) and the pocket walls (4a-4d),(104a-104d) facing said sides, such that $C \leq \sqrt{X^2 + Y^2} - X$, where C is the total pocket clearance, X is the length of the cartridge between said opposed sides, and Y is the depth of the pocket, and

- fixing the cartridge (5),(105) in the pocket (4),(104) by means of said first and said second bolt,
  - by alternately screwing a partial length of the first bolt (8),(108) into a threaded hole (10),(110) and screwing a partial length of the second bolt (9),(109) into the other threaded hole (11),(111), or
  - by synchronously screwing the first bolt (8),(108) and the second bolt (9),(109) into their respective threaded holes (10),(110); (11),(111),

  at least until the bolt heads (8a), (9a), (108a), (109a) are in contact with a contact surface (61),(71),(161),(171) of the cartridge (5),(105).

17. A method of disassembling a downhole tool assembly according to any one of claims 1 to 15, said method comprising the step of
    - alternately unscrewing a partial length of the first bolt (8),(108) and unscrewing a partial length of the second bolt (9),(109) out of its threaded hole, or

- synchronously unscrewing the first bolt (8),(108) and the second bolt(9),(109).

18. A downhole tool assembly comprising :
    - a tool body (1),(101) comprising at least one pocket (4),(104) for insertion of a cartridge (5), (105) and ;
    - at least one cartridge (5), (105);

    said cartridge (5), (105) being fastened in the pocket (4), (104) in at least two different locations by respective bolts (8), (9); (108), (109) being screwed into said pocket (4), (104), said bolts (8),(9) having a bolt shaft (8b),(9b); (108b),(109b) and a bolt head (8a),(9a); (108a),(109a), said bolt shaft extending through a hole (6),(7);(106),(107) in the cartridge (5),(105) into a threaded hole (10),(11);(110),(111) in the tool body (1),(101), while the bolt head is in contact with a contact surface of the cartridge, characterized in that said cartridge comprises abutment means (62), (72); (162), (172); (14), (15); (114), (115) for constraining the movement of each fastening element (8), (9), (108), (109) in its axial direction and away relative to the tool body (1) (101), such that each bolt (8), (9) is retained in its hole (6), (10), (7), (11) when it is at least partially loosened, and in that the dimensions of said cartridge relative to the dimensions of said pocket are selected such that there is a clearance fit between said cartridge and said pocket, such that said cartridge (5), (105) is insertable into the pocket or removable from said pocket following a single direction, and gets blocked into the pocket when said cartridge is tilted to an angle exceeding a predetermined angle relative to said single direction.

19. Downhole tool according to claim 18 wherein said cartridge is fixed by means of two bolts and wherein, when a bolt is self-loosening, the at least partly unscrewed bolt abuts against the abutment means and pushes the cartridge into a tilted position in the pocket such that the cartridge wedges itself into the pocket and any further movement of the cartridge and any further unscrewing of the loosened bolt is prevented.

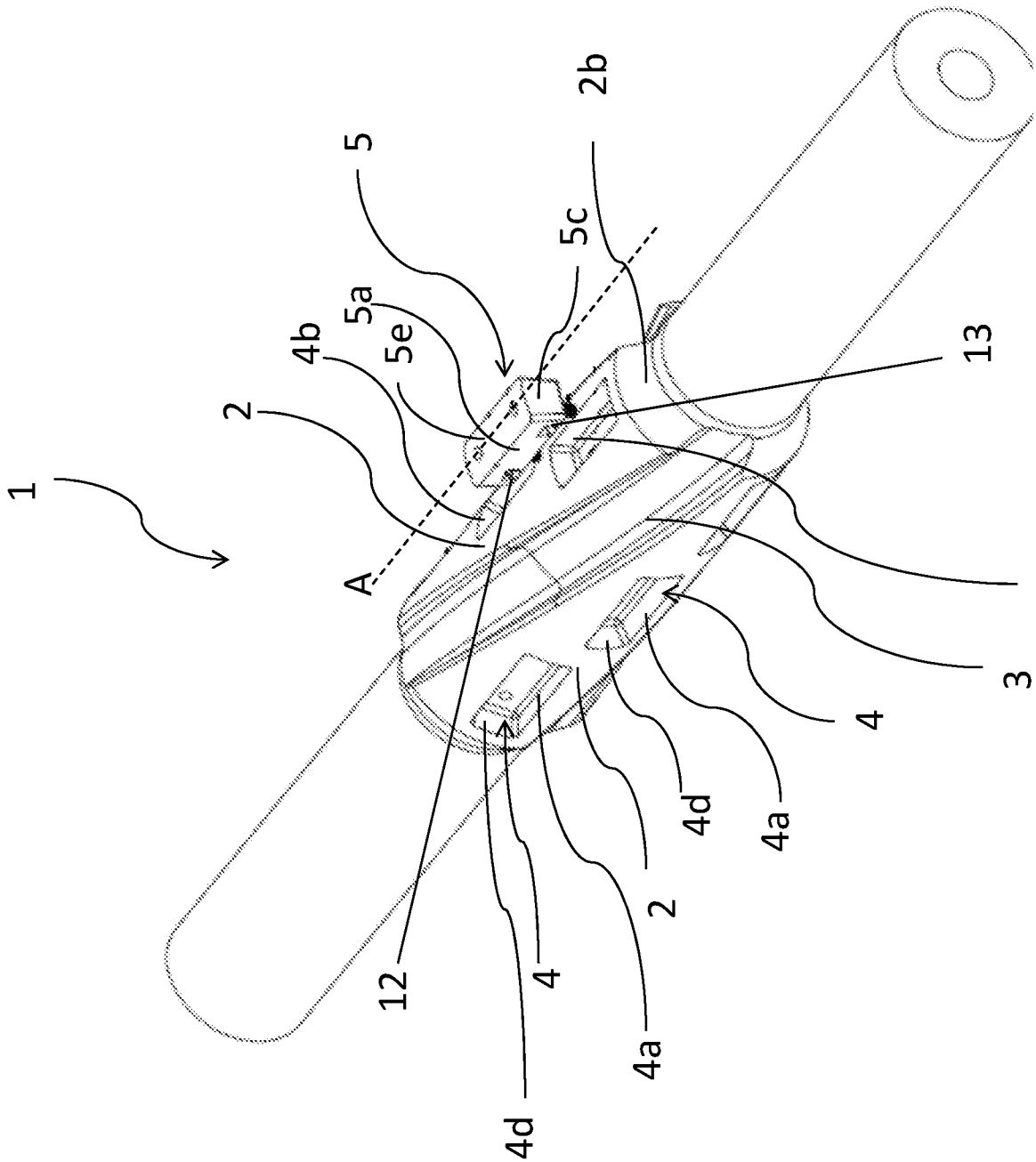

Fig. 1

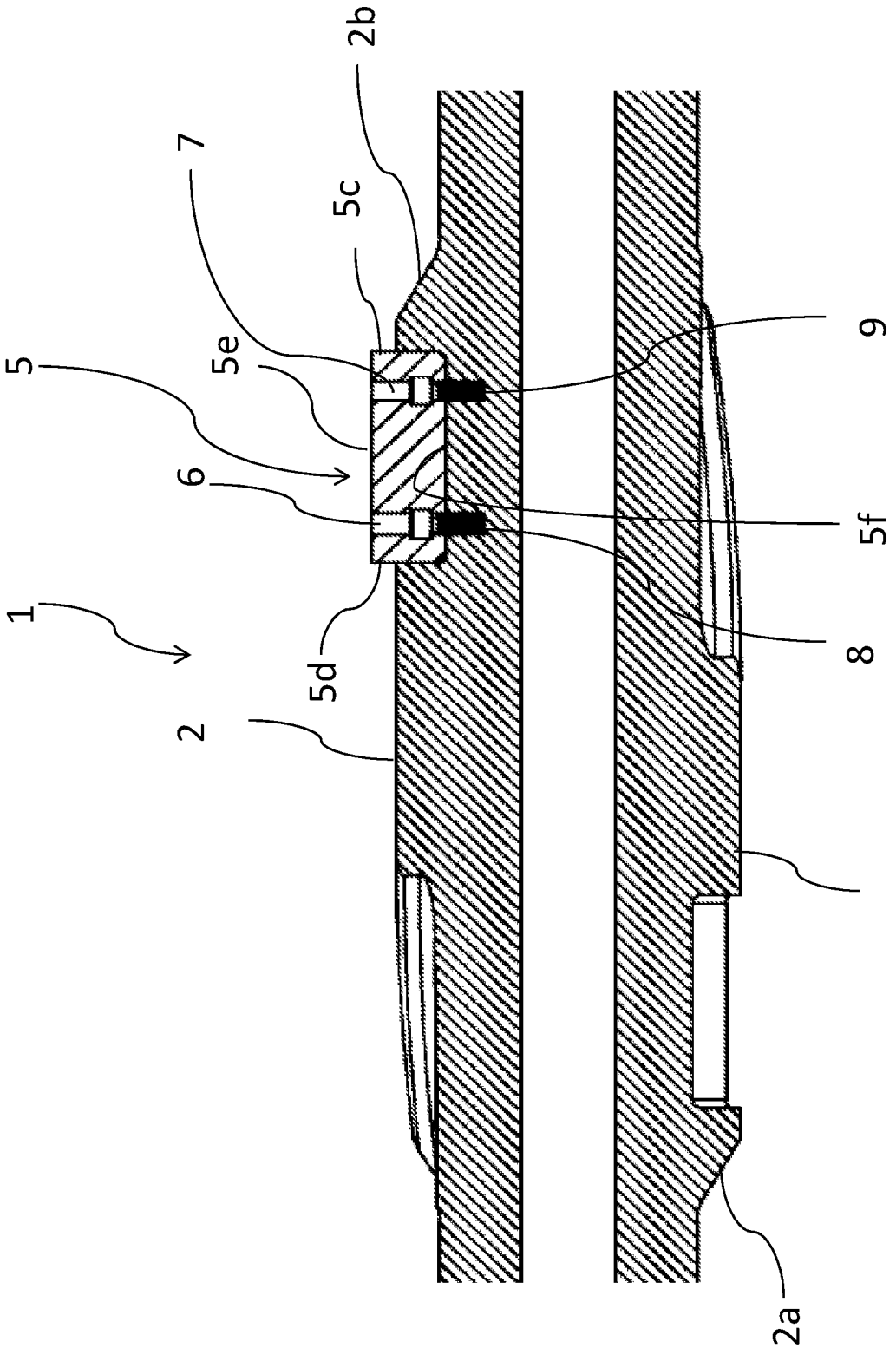

Fig. 2

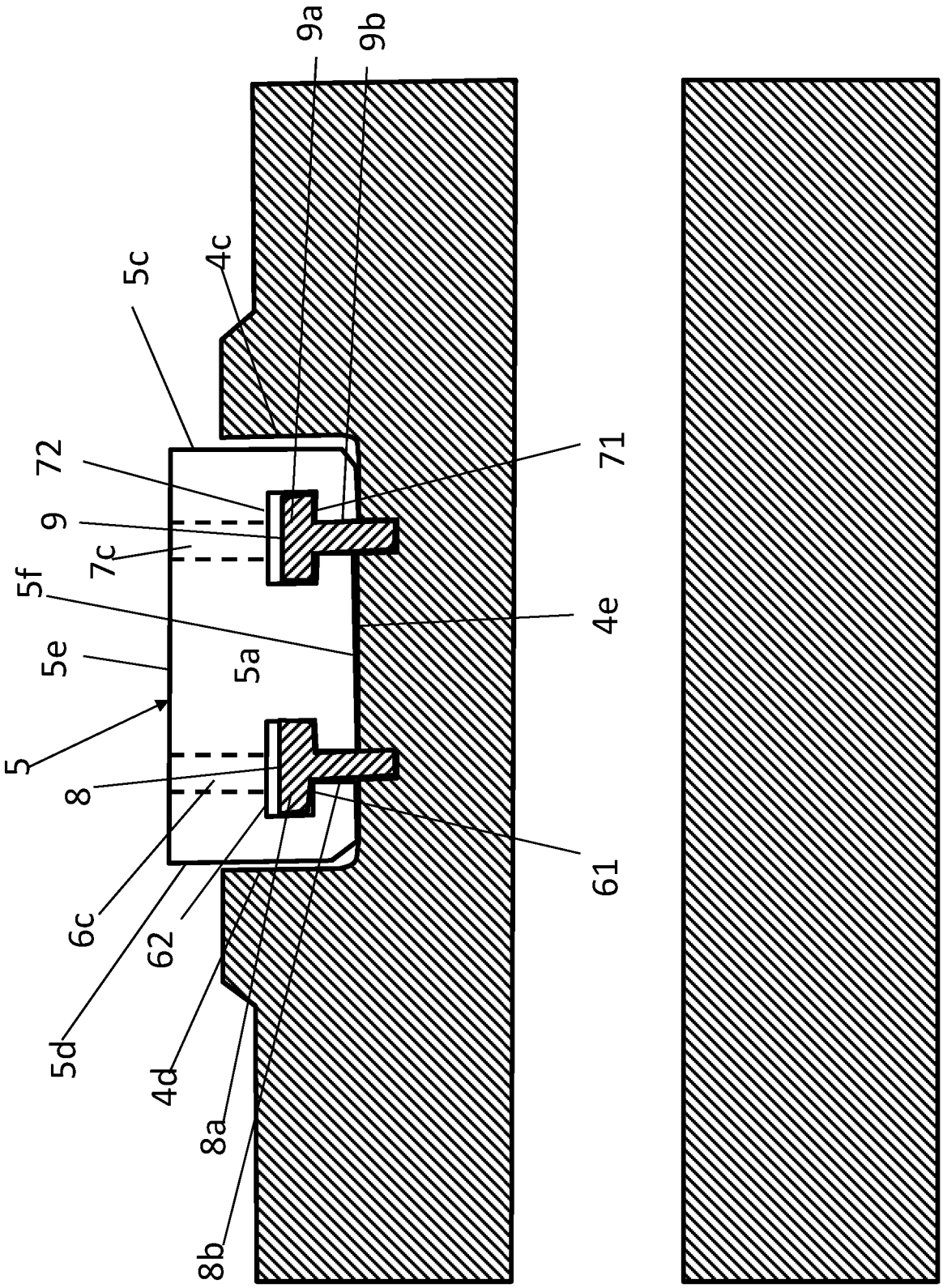

Fig. 3A

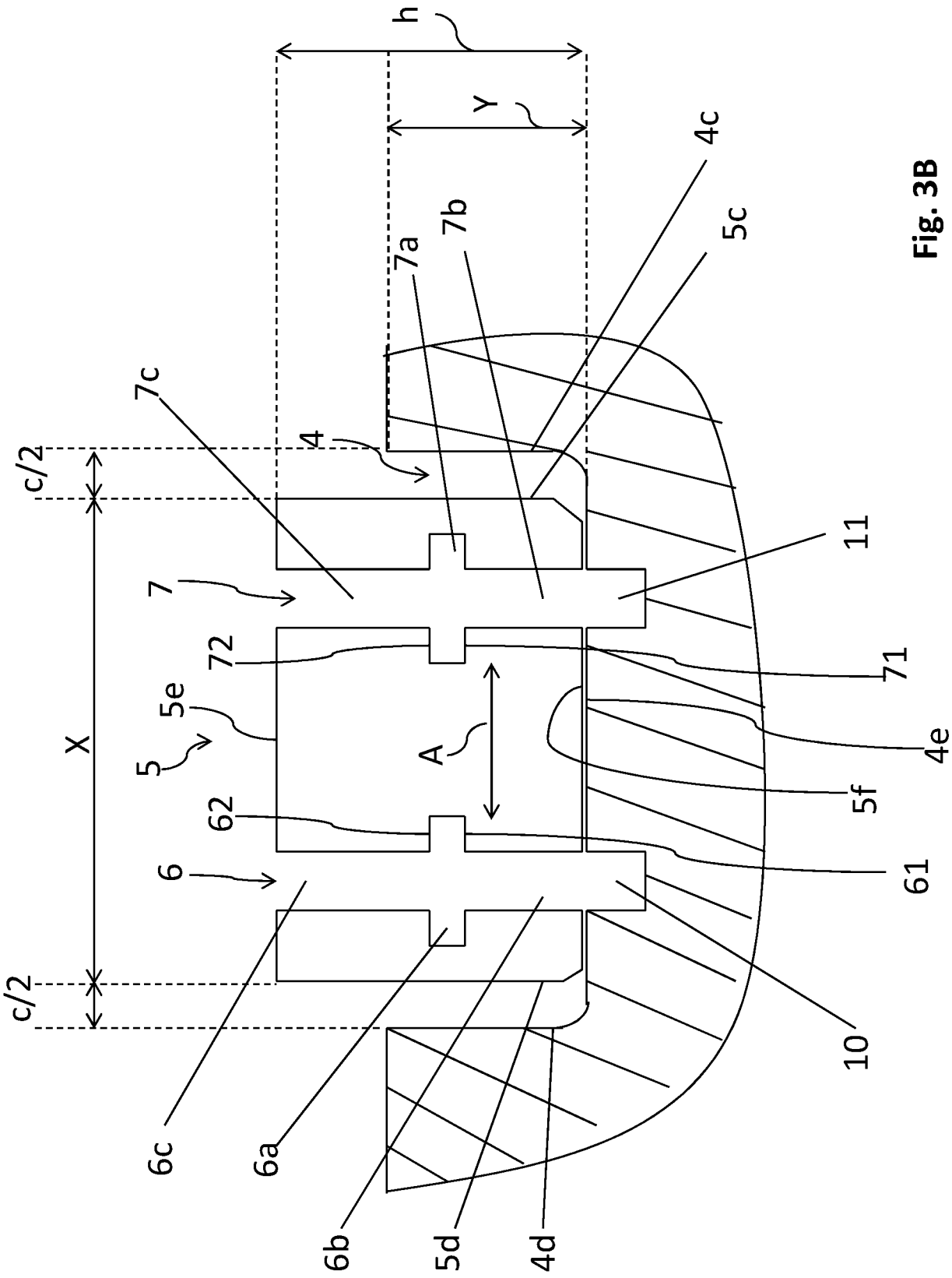
h
Y
4c
5c
7b
7a
7c
4
c/2
11
7
72
71
5e
X
5
A
4e
5f
62
6
61
c/2
10
6c
6a
6b
5d
4d

Fig. 3B

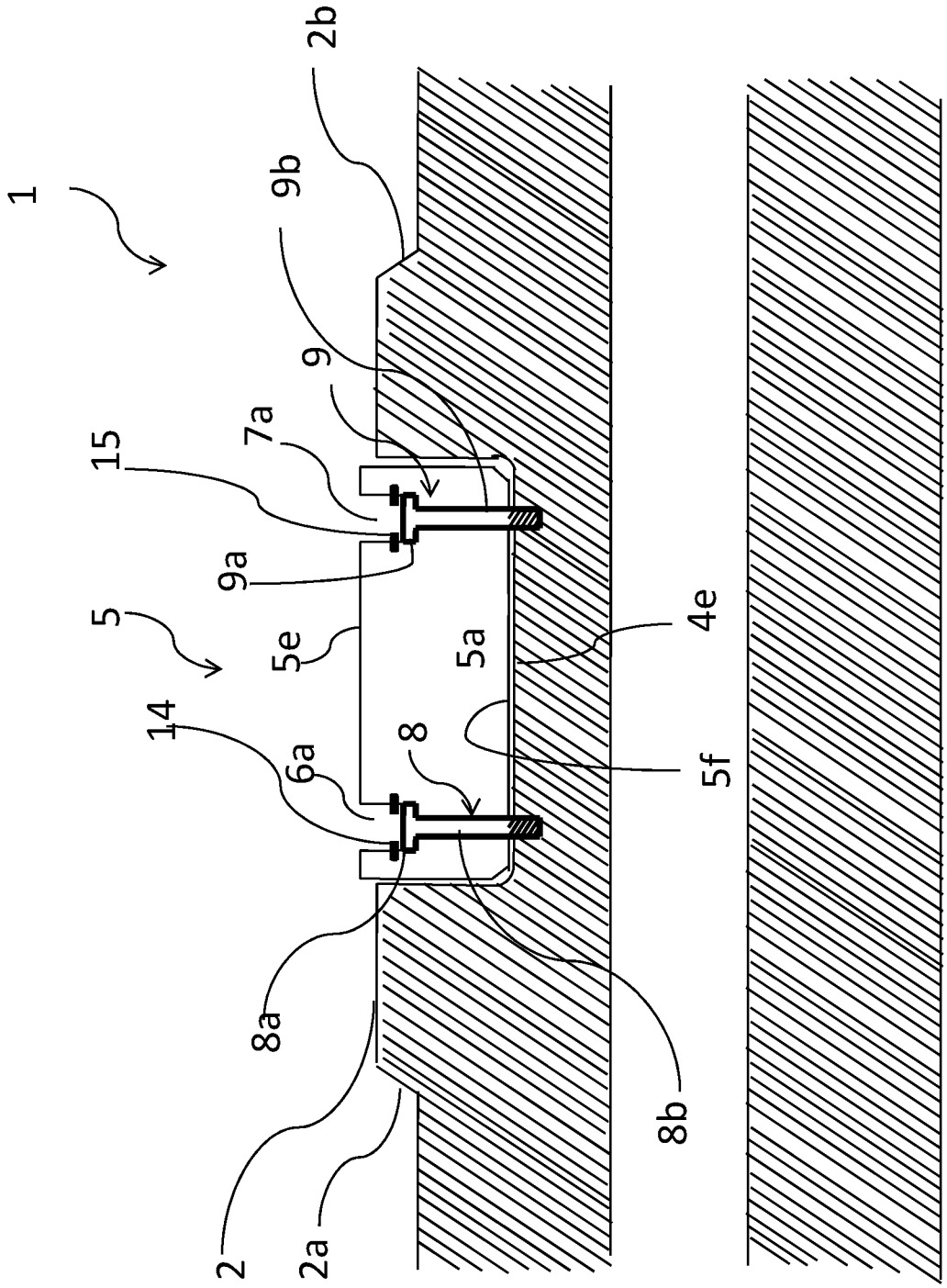

Fig. 4

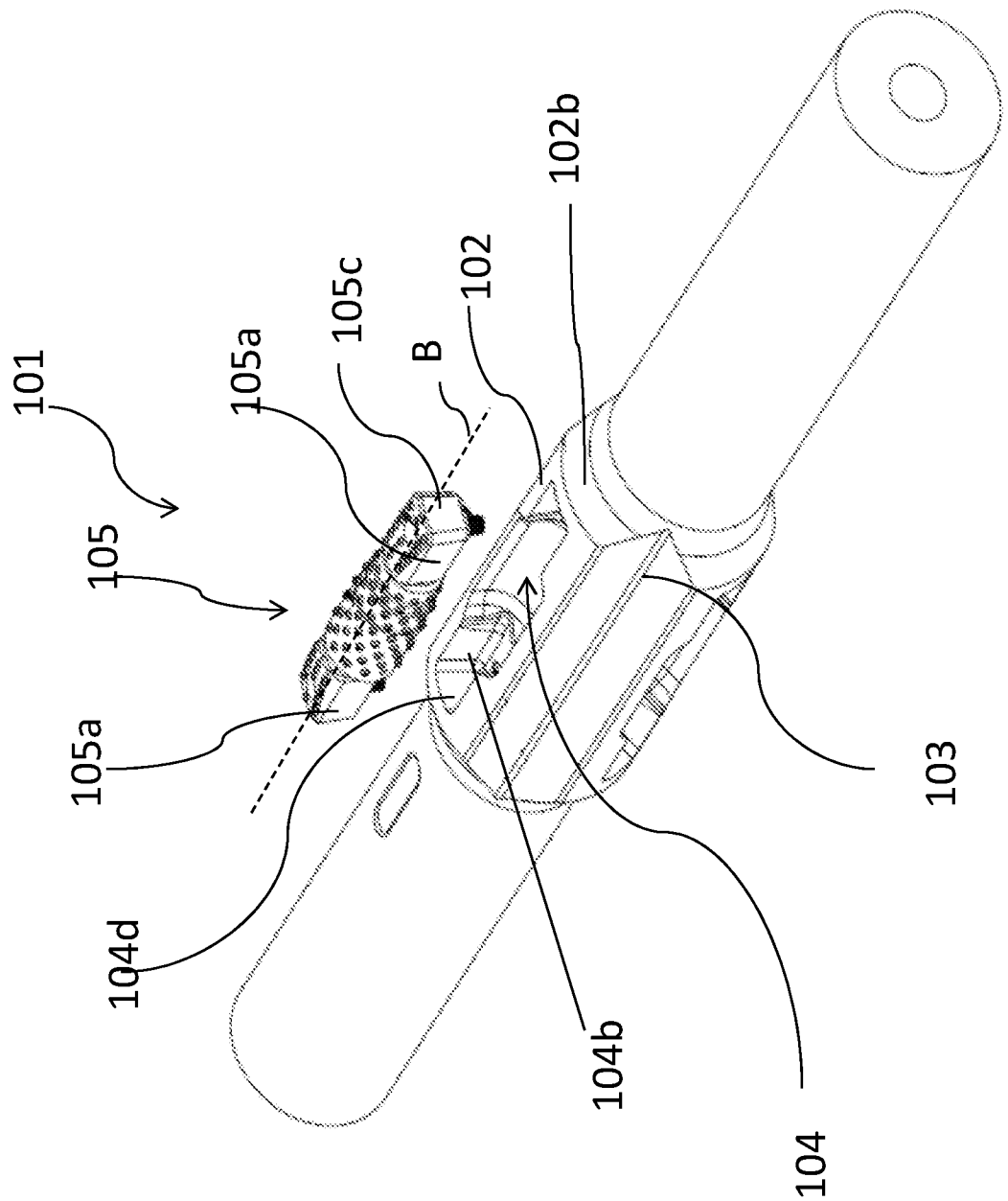

Fig. 5

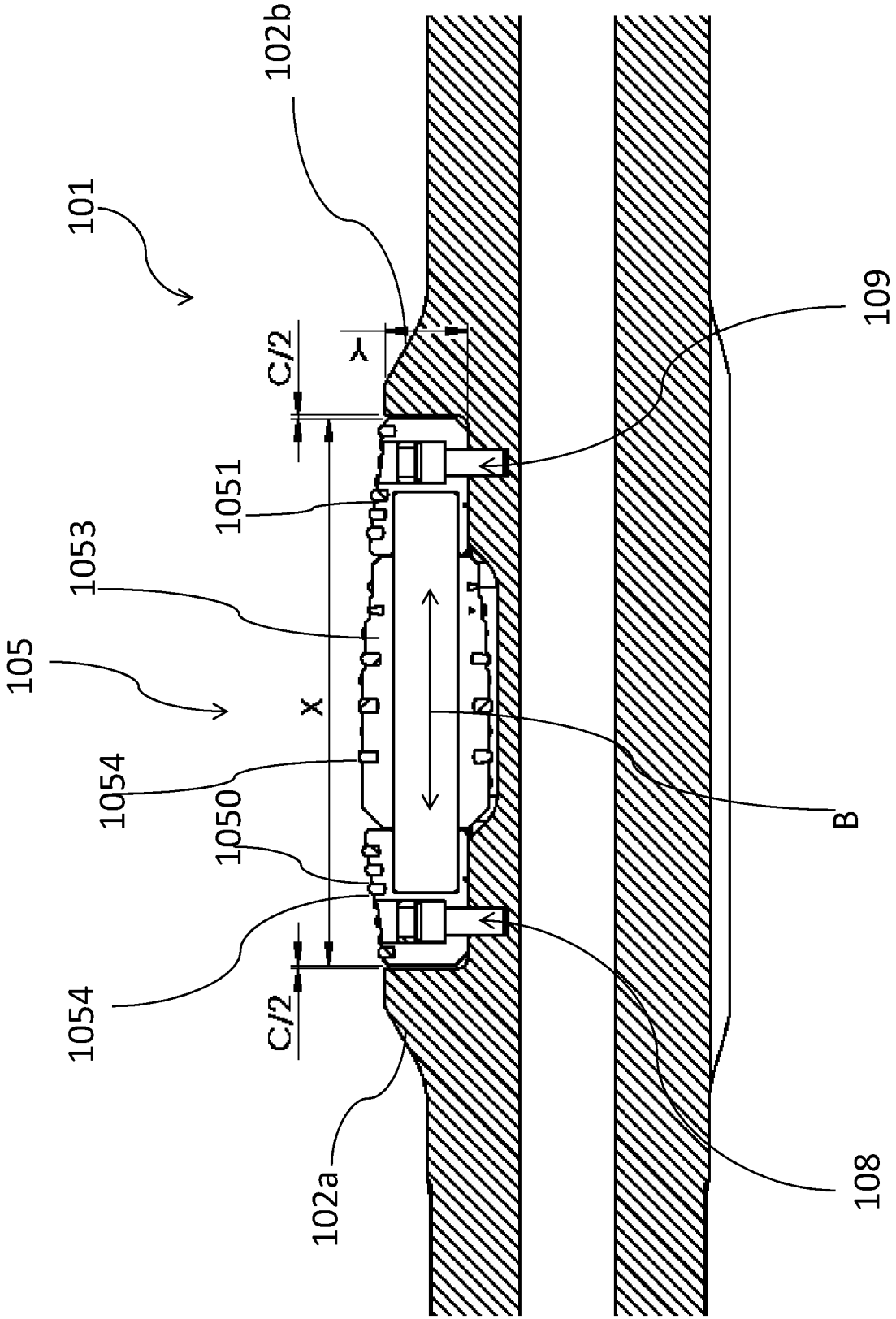

Fig. 6

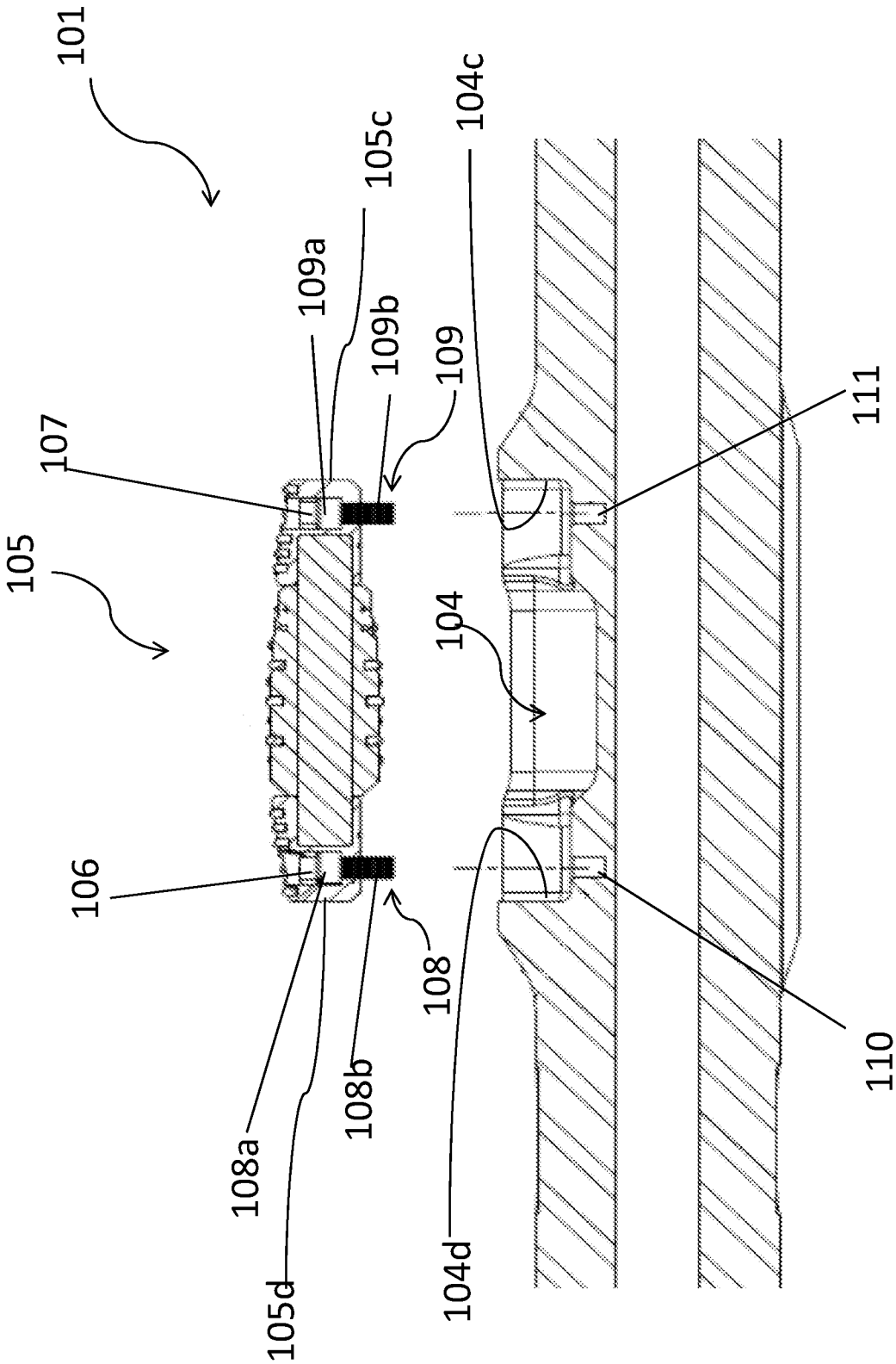
101
105c
104c
109a
109b
109
107
111
105
104
106
108
110
108a
108b
105d
104d

Fig. 7

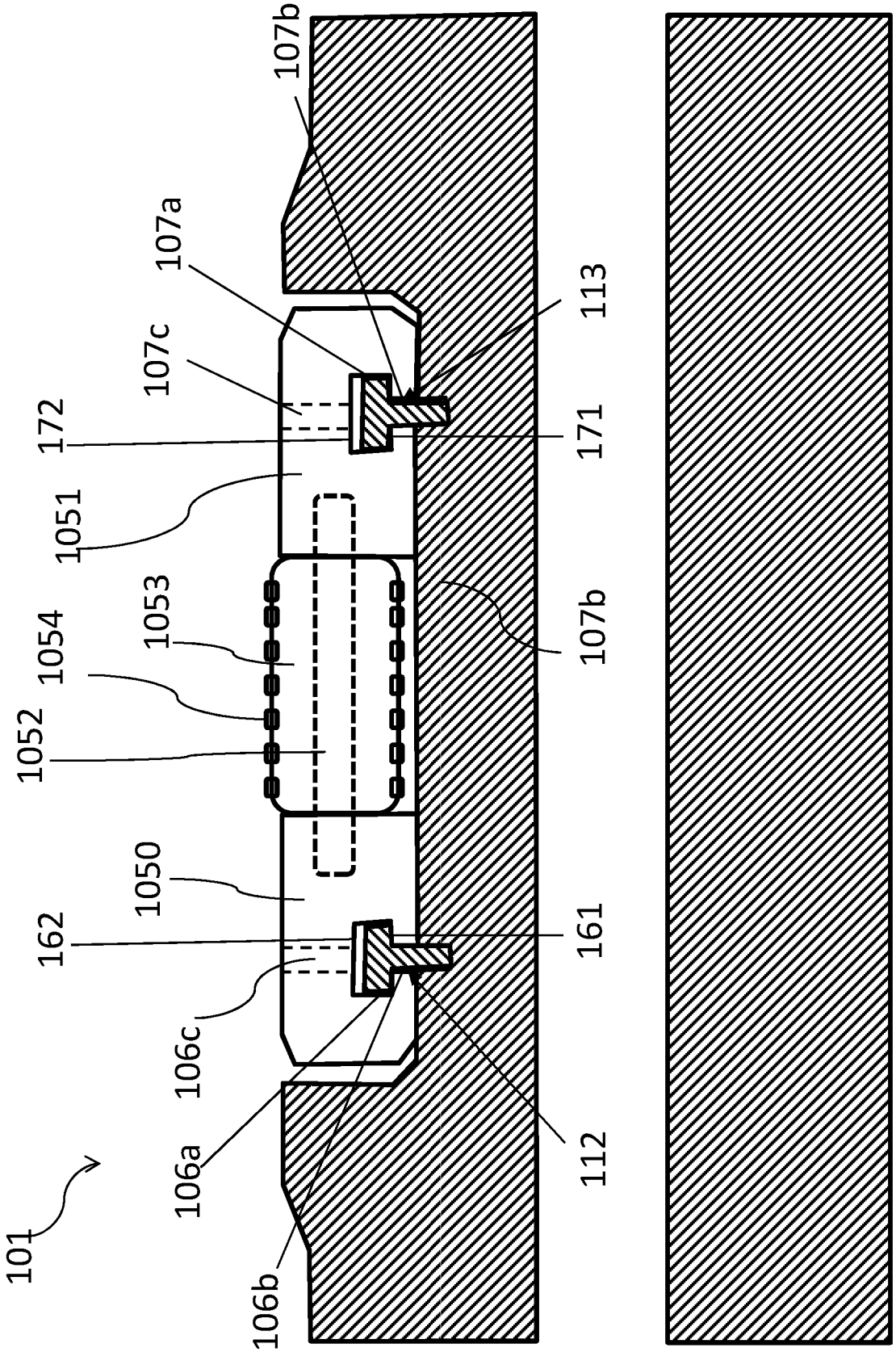
107b
107a
113
107c
172
171
1051
1053
1054
107b
1052
1050
162
161
106c
106a
112
101
106b

Fig. 8

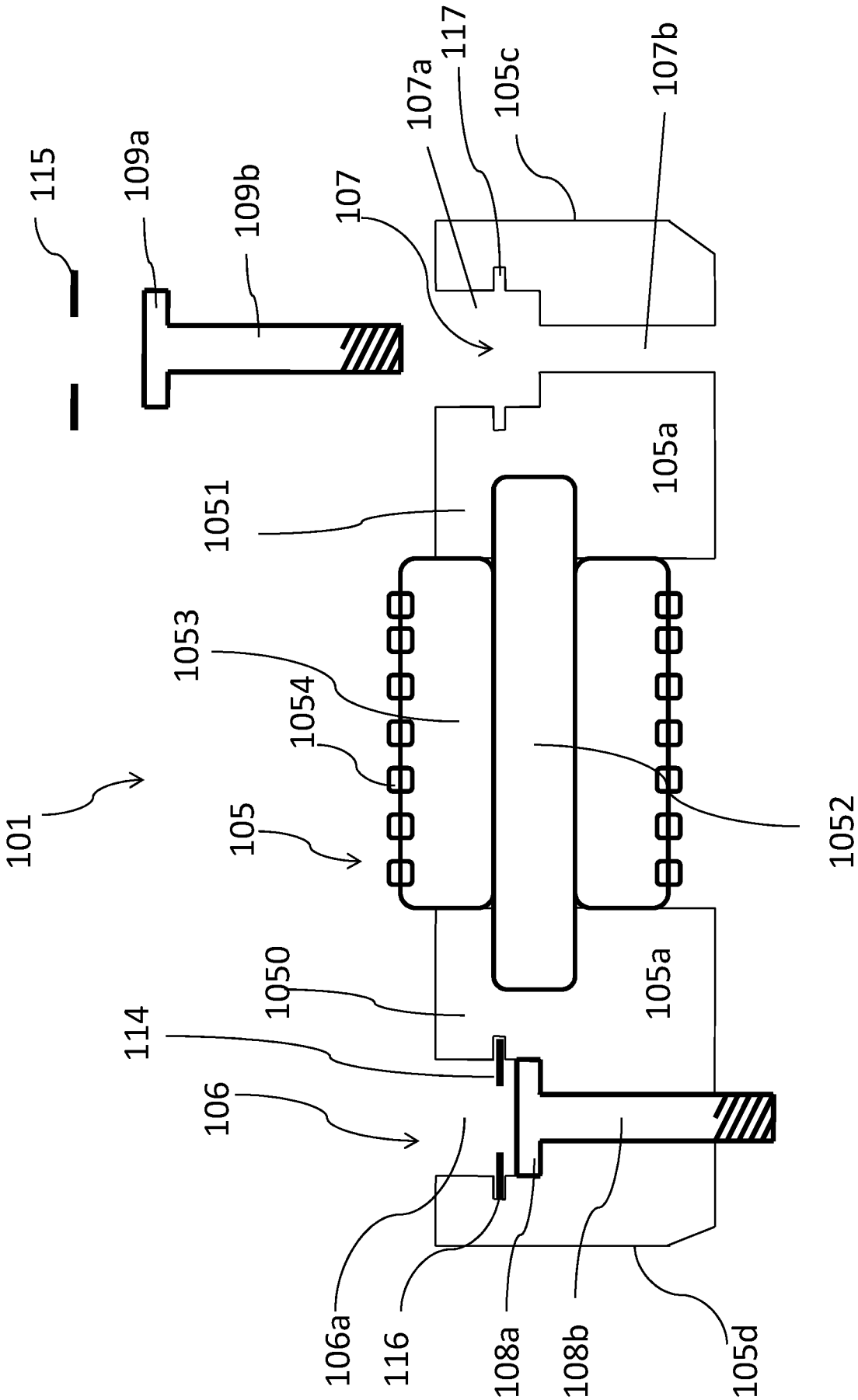
115
109a
109b
107
107a
117
105c
107b
105a
1051
1053
1054
105
101
1052
1050
114
106
106a
116
108a
108b
105d

Fig. 9