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(54) **Downhole tool provided with inserts and method for removing the inserts of a downhole tool**

(57) This invention relates to a downhole tool (100) package including a downhole tool comprising at least one pocket (106) for insertion of an insert (109) for reaming, cutting or stabilizing, each pocket being accessible from the external surface (104) of the tool body (101) and being associated with a channel (105) extending from said external surface (104) to the bottom of the pocket (106) and forming an opening (111) at the bottom of the pocket (106). The tool package preferably also compris-

es a pushing object (112) which can be introduced into said channel (105) and means for pushing this object (112) via the opening (111) against an insert (109) inserted in said pocket (106). The invention also relates to a method for removing an insert (109) from a pocket (106) in this tool, including the step of applying a removing force onto the insert (109) through the channel (105) and through the opening (111).

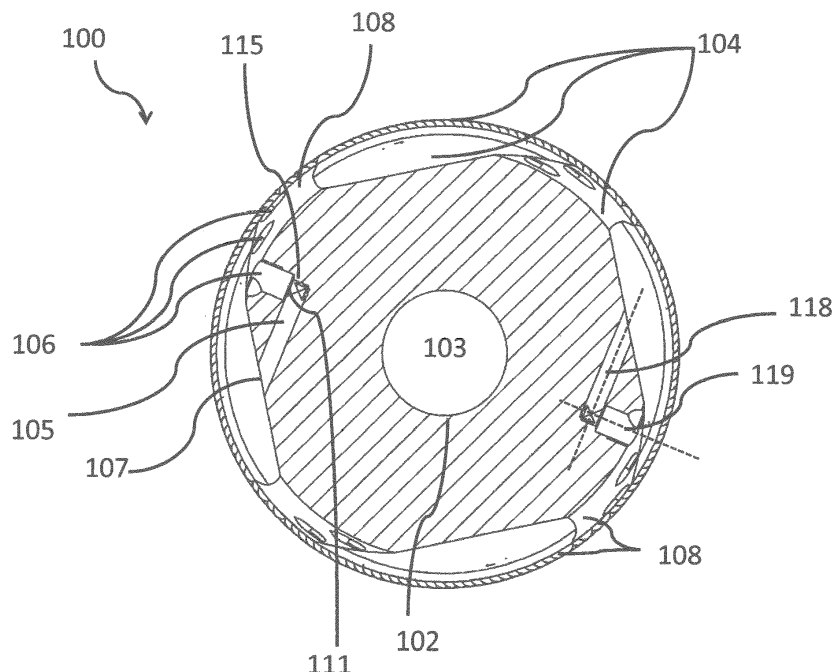


Fig. 3a

Description

[0001] The present invention relates to a downhole tool package including a downhole tool comprising a tool body with a central bore, an external surface and at least one pocket which is accessible from said external surface, said pocket being provided for insertion of an insert for reaming, cutting or stabilizing.

[0002] This invention in particular relates to a downhole tool package of which the downhole tool comprises inserts for reaming, cutting or stabilizing, such as polycrystalline diamond cutters and/or tungsten carbide inserts and/or matrix diamond impregnated inserts. The inserts are provided in respective pockets in the tool body in such a manner that they are kept in place during operation in a wellbore. For example, the inserts may be inserted by interference fit.

[0003] This invention also relates to a method for removing the inserts of a downhole tool according to this invention.

[0004] Varieties of downhole tools for reaming, cutting or stabilizing purpose are available for operation in a wellbore. These downhole tools are generally provided with cutting inserts or reaming inserts, having generally a cylindrical shape and provided with a hard material. The inserts are permanently fixed to the downhole tool by brazing or welding or are removably fixed by interference fit.

[0005] During operation in a wellbore, downhole tools and their inserts are subject to very hard constraints and high temperature conditions. Downhole tools are prone to wear and have to be periodically sent to maintenance for redressing. Downhole tools having their inserts secured to the tool body by interference fit are more easily redressed than downhole tools with welded or brazed inserts.

[0006] One of the known methods for redressing downhole tools provided with inserts secured to the tool body by interference fit comprises the removal of the inserts by welding a stud to its tip and then applying pulling shocks to the insert until it is removed. Such a process is difficult and time consuming.

[0007] It is an object of this invention to provide a downhole tool package which allow an easier and less time consuming process for removing the inserts, so that the time needed for maintenance of the tools can be reduced. It is another object of this invention to allow maintenance of the tools on site.

[0008] This object has been achieved by providing a downhole tool package including a downhole tool with a tool body having a central bore, an external surface, and at least one pocket which is accessible from said external surface, said pocket being provided for insertion of an insert for reaming, cutting or stabilizing, in which, according to this invention, said tool body further comprises at least one channel separated from said bore, extending from the external surface of the tool body to the bottom of a pocket, and forming an opening at the bottom of this

pocket.

[0009] In this downhole tool, the bottom of an insert inserted in a pocket is accessible through the channel and the opening. This makes it possible to apply a force on the bottom of the insert, in order to remove it from the pocket. This is much easier and less time consuming than the known methods.

[0010] Preferably, an insert for reaming, cutting or stabilizing is inserted by interference fit into at least one pocket of the downhole tool, and the channel associated with this pocket is provided for introducing a pushing object into said channel in order to exert a removing force onto the insert via said opening in order to overcome the interference fit.

[0011] In a preferred embodiment, the downhole tool package according to this invention also comprises pushing means for removing an insert from a pocket in the tool body, said pushing means comprising at least one pushing object provided to be introduced in a channel associated with said pocket and to be placed in a working position in which it can be pushed against the insert via the opening, in order to exert a removing force onto the insert.

[0012] An external force can be applied directly on the pushing object or indirectly, through other pushing means. When the force is applied directly on the pushing object, the pushing object can have an elongated shape so that it can be placed in a position in which one end is in a position in the channel in which it can be pushed against the insert, while the other end is extending out of the pocket or is at least easily accessible from the outside of the pocket for applying an external force onto it.

[0013] An external force can also be applied on other pushing means which are brought into contact with the pushing object. The force is then transmitted to the pushing object, which can have a compact shape.

[0014] Preferably, the dimensions of the pushing object are such that it can be pushed through the opening in the bottom of said pocket.

[0015] In a further preferred embodiment the pushing object has a contact side and a pushing side opposite to said contact side, that in a first working position of the pushing object, the pushing side is contacting a wall of the channel and the contact side is facing the insert, and that said pushing side is shaped so as to form a free space between the wall of the channel and at least an upper portion of the pushing side when the pushing object is in said first working position in the channel.

[0016] In a particular embodiment the pushing object has a pushing side comprising a convex surface, in particular a spherical surface. Preferably, the pushing object is ball shaped.

[0017] It is also preferred that the pushing means further comprise at least one elongated pusher provided to be introduced into said channel in order to move the pushing object against the insert and having an end portion which is so configured that, when the end portion contacts the pushing object, a further displacement of the pusher

in the longitudinal direction causes a displacement of the pushing object in a direction forming an angle (α) with said longitudinal direction.

[0018] In a very advantageous embodiment, at least one elongated pusher comprises a tapered end portion having a first lateral side comprising a first surface extending in the longitudinal direction of the pusher and, at the opposite side thereof, a second lateral side comprising a second surface which is inclined with respect to said longitudinal direction, and said pusher is configured such that

- the pusher can be placed in an initial pushing position in which the end part is introduced between the wall of the channel and the pushing object, the first surface being in contact with the wall of the channel and the inclined second surface being in contact with the pushing object, and
- that the pusher is moveable from said initial pushing position to a deeper position in the channel, so that the inclined second surface is pushed against the pushing object, in order to move it from a first working position towards the pocket, so that the insert is moved by the pushing object.

[0019] Preferably, the inclined surface forms an angle with the longitudinal axis of the first pusher, comprised between 10° and 60°, preferably between 20° and 45°, more preferably 30°.

[0020] A preferred embodiment of the downhole tool package according to this invention comprises pushing means which comprise at least two different elongated pushers of which the respective end parts have a different width at the level of the lower edge of the inclined second surface, such that each of said different pushers is adapted to move the pushing object from a different working position in the channel towards the pocket.

[0021] The pushing means may also comprise at least one elongated pusher having a bottom surface which is substantially perpendicular to its longitudinal axis.

[0022] In this downhole tool, it is preferred that the longitudinal axis of the pocket and the longitudinal axis of the channel associated therewith form an angle comprised between 70° and 110°.

[0023] In an advantageous embodiment, the external surface of the downhole tool body comprises at least one raised portion and said pocket has an entry in the surface of said raised portion. Preferably, the raised portion has the shape of a blade extending longitudinally, helically or spirally along the tool body.

[0024] In a particular embodiment the channel in the tool body comprises means for connecting said channel to an exterior fluid duct, such as a hydraulic fluid duct. In this downhole tool, a fluid can be brought in the channel so that it reaches the insert through the opening, and a fluid pressure can be applied in the fluid so as to exert said removing force on the insert. Preferably a hydraulic

pressure is applied on the insert.

[0025] In a most preferred embodiment of the invention, said insert is a polycrystalline diamond cutter or a tungsten carbide insert or a matrix diamond impregnated insert.

[0026] The object of this invention also has been achieved by providing a method for removing an insert from a pocket in a downhole tool of a downhole tool package according to any one of the preceding claims, the method comprising the step of applying a removing force on the insert through a channel extending to the bottom of said pocket and through the opening at the bottom of this pocket.

[0027] A preferred method according to this invention comprises the steps of placing a pushing object in a working position in the channel, and pushing said pushing object against the insert via the opening, in order to exert a removing force onto the insert.

[0028] The removing force can be obtained by applying an external force directly on the pushing object or indirectly, through other pushing means. When the force is applied directly on the pushing object, the pushing object can have an elongated shape so that it can be placed in a position in which one end is in a position in the channel in which it contacts the insert, while the other end is extending out of the pocket or is at least easily accessible from the outside of the pocket for applying an external force onto it.

[0029] An external force can also be applied on other pushing means which are brought into contact with the pushing object. This force is then transmitted by the other pushing means to the pushing object. The pushing object can have a compact shape, such as a ball shape.

[0030] In a very advantageous method in which the external force is applied indirectly to the pushing object,

- an elongated pusher is introduced into said channel, said pusher having an end portion which is so configured that, when the pusher contacts the pushing object, a further displacement of the pusher in the longitudinal direction causes a displacement of the pushing object in a direction forming an angle (α) with said longitudinal direction,
- the pusher is brought in a position in which the end portion is in contact with the pushing object and that the pusher is moved to a deeper position in the channel, so that the pushing object is moved towards the pocket, from a first working position to a second working position, so that the insert is moved by the pushing object.

[0031] Preferably, a first and a second elongated pusher are used in this method, whereas each elongated pusher comprises a tapered end portion having a first lateral side comprising a first surface extending in the longitudinal direction of the pusher and, at the opposite side thereof, a second lateral side comprising a second surface which is inclined with respect to said longitudinal

direction, the first and second pushers comprising respective end portions having different widths at the level of the lower edge of the inclined second surface, said width of the second pusher being greater than said width of the first pusher, and the method also includes the steps of

- introducing the first elongated pusher in the channel into an initial pushing position in which its end portion is introduced between the wall of the channel and the pushing object, the first surface being in contact with the wall of the channel and the inclined second surface being in contact with the pushing object which is in a first working position,
- moving said first pusher from said initial pushing position to a deeper position in the channel, so that the inclined second surface is pushed against the pushing object, and moves it towards the pocket, from a first working position to a second working position,
- introducing the second elongated pusher into an initial pushing position in which its end portion is introduced between the wall of the channel and the pushing object, the first surface being in contact with the wall of the channel and the inclined second surface being in contact with the pushing object, which is in said second working position, and
- moving said second pusher from said initial pushing position to a deeper position in the channel, so that the inclined second surface is pushed against the pushing object, and moves it towards the pocket, from said second working position, to a third working position.

[0032] Although In the preceding paragraph the movement of the elongated pushers is defined as if it were performed in two steps - introducing a pusher in an initial pushing position and then pushing it to a deeper position - , it is emphasized that this definition must be interpreted as also including a continuous movement during which both steps are performed without any interruption.

[0033] In a further preferred method, a first and a second pushing object are used, and the method comprises the steps of

- placing the first pushing object in a working position in the channel,
- pushing the first pushing object from the first working position to a second working position in order to move the insert,
- placing the second pushing object in the channel,
- pushing the second pushing object against the first pushing object in order to move the first pushing object from its second working position to a third working position, so that the insert is moved further towards the access opening of the pocket.

[0034] In a particular method according to this invention, the method includes introducing a fluid into the chan-

nel so that the fluid reaches the insert through the opening, and applying a fluid pressure in the fluid so as to exert said removing force on the insert. Preferably, a hydraulic pressure is applied on the insert.

[0035] 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 1a represents an elevated view of an embodiment of a downhole tool of a downhole tool package according to the present invention.

Figure 1b represents an elevated view of an embodiment of a downhole tool of the figure 1a further comprising inserts.

Figure 2a represents a side view of the embodiment of the downhole tool of figure 1a.

Figure 2b represents a side view of the embodiment of the downhole tool of figure 1b.

Figure 3a represents a schematic cross sectional view of the downhole tool along line A-A of figure 2a.

Figure 3b represents a schematic cross sectional view of the downhole tool along line A-A of figure 2b.

Figure 4 represents a schematic cross sectional view of the downhole tool along line A-A of figure 2b in a step of a method for removing the inserts from the downhole tool.

Figure 5a represents a schematic enlarged view of a zone of the downhole tool comprising a pocket connected to a channel and wherein the pocket comprises an insert.

Figure 5b represents a schematic view of the zone of figure 5a in a first step of a method for removing the insert.

Figure 5c represents a schematic view of the zone of figure 5a in a second step of a method for removing the insert.

Figure 5d represents a schematic view of the zone of figure 5a in a third step of a method for removing the insert.

Figure 5e represents a schematic view of the zone of figure 5a in a fourth step of a method for removing

the insert.

Figure 5f represents a schematic view of the zone of figure 5a in a fifth step of a method for removing the insert.

Figure 5g represents a schematic view of the zone of figure 5a in a sixth step of a method for removing the insert.

Figure 5h represents a schematic view of the zone of figure 5a in a seventh step of a method for removing the insert.

Figure 5i represents a schematic view of the zone of figure 5a in an eighth step of a method for removing the insert.

Figure 5j represents a schematic view of the zone of figure 5a in a ninth step of a method for removing the insert.

[0036] In a particular embodiment of the downhole tool package according to the present invention, the package comprises a downhole reamer tool (100) having a tool body (101) in which a central bore (103) is formed. The tool body has an external surface (104) comprising a plurality of raised portions (108) in which pockets (106) are provided. Each pocket (106) is accessible from the external surface (104) through an access opening (107) so that an insert (109) for reaming can be inserted in each pocket.

[0037] Each pocket (106) is associated with a channel (105) in the tool body (101). This channel is extending from the external surface (104) to the bottom of the pocket (106). The channel (105) and the pocket (106) are in communication through an opening (111).

[0038] The raised portions (108) have the form of blades extending helically along the tool body (101) such that the projection of all the blades in a transversal plan of the downhole tool covers the whole circumference of the tool as presented in figure 3a. Alternatively, the raised portions (108) have the form of blades extending longitudinally or spirally along the tool body (101).

[0039] The raised portions (108) are separated from each other by lowermost surfaces (122), and are preferably distributed at equal distance from each other around the tool body (101). Figures 1a, 1b, 2a, 2b, 3a, 3b, show a downhole tool according to an embodiment of the present invention comprising four raised portions (108), but the number of raised portions is not a limitation of the present invention.

[0040] Figures 1a and 2a present a non-limitative embodiment of raised portions (108) comprising:

- a first zone Z1 extending along a first section of the tool body (101) and comprising a plurality of inserts, preferably dome shaped inserts or truncated dome

shaped inserts, preferably made of tungsten carbide and;

- two tapered zones Z2 each comprising at least one pocket (106) sized for receiving an insert which is preferably adapted to cut the formation such as a polycrystalline diamond cutter insert, an impregnated diamond insert or a tungsten carbide insert.

[0041] Figure 3a shows the pockets (106) formed into the raised portion (108) of the downhole tool, and the channels (105) separated from the central bore (103) and extending from the access opening (107) in the external surface (104) of the tool body to the bottom extremity (115) which is located below the pocket (106) and in communication with the pocket (106) through an opening (111).

[0042] Each pocket (106) is arranged so that it is accessible from the outermost surface (121) of the raised portion (108) while the access opening (107) of the channel (105) is located in a surface area which is closer to the central bore (103) than said outermost surface (121).

[0043] The channel (105) has a longitudinal axis (118) and the pocket (106) has a longitudinal axis (119), the angle between both axes being about 90°. In other configurations of the downhole tool, the angle between the channel axis (118) and the pocket axis (119) may be different, and may, for example, be any angle between 70° and 110°.

[0044] In figures 1b, 2b and 3b, the downhole tool (100) is shown when it comprises inserts (109) which are pressed into the pockets (106) by interference fit. The insert (109) is a polycrystalline diamond stud inserted into the pocket (106) by interference fit.

[0045] One of the many advantages of the channels (105) being provided in the downhole tool (100) is that the channel allows air evacuation while pressing the inserts (109) into the associated pocket by interference fit. To that end, the channel access opening (107) at the external surface (104) of the tool body (101) is not closed. Pressures differential in the tool are thereby avoided.

[0046] Each channel (105) is configured such that a pushing object (112) can be introduced into the channel (105) in order to apply a removing force on the base (110) of the insert (109) provided in the associated pocket (106). In the embodiment shown in figure 4, the pushing object (112) is ball shaped.

[0047] This ball shaped pushing object (112) has dimensions adapted to pass through the opening (111) in the bottom of the associated pocket (106), a contact side (124) and a pushing side (125) opposite to said contact side.

[0048] Figures 5a to 5j show an enlarged view of a channel (105) and an associated pocket (106) comprising an insert (109). In figure 5b, a first pushing object (112) is inserted into the channel (105) such that it reaches the bottom (115) of the channel (105) and faces the base (110) of the insert 109.

[0049] In particular, this ball shaped pushing object (112) is placed on the bottom (115) of the channel (105), in a first working position in which its pushing side (125) is contacting a wall (126) of the channel (105) and its contact side (124) is facing the insert (109). In this position, a free space is formed between an upper portion of the ball shaped pushing side (125) and the wall (126) of the channel (105).

[0050] The downhole tool package also comprises (see figures 4 and 5a-5j) a number of different elongated pushers (113a)-(113d) having a longitudinal axis (123a)-(123d) which is provided to be introduced into a channel (105) in order to push the ball shaped pushing object (112) against the insert (109) in order to move this insert (109) out of the pocket (106). To this end, a first type of pusher (113a)-(113c) has a tapered end portion (120a)-(120c) having a first lateral side comprising a first surface (127a)-(127c) extending in the longitudinal direction of the pusher and, at the opposite side thereof, a second lateral side comprising a second surface (114a)-(114c) which is inclined with respect to said longitudinal direction. A second type of elongated pusher (113d), has a bottom surface (120d) which is substantially perpendicular to its longitudinal axis (123d).

[0051] Each pusher (113a)-(113c) of the first type is configured such that when the end portion contacts the ball shaped pushing object (112), a further displacement of the pusher (113) in the longitudinal direction causes a displacement of the pushing object (112) towards the insert (109).

[0052] A first pusher (113a) has a bottom extremity formed by the longitudinal surface (127a) and the inclined surface (114a) running towards each other according to an acute angle and meeting each other in a common bottom edge. The width (W1) of the pusher at the level of the lower edge of the inclined surface is zero or close to zero. The inclined surface (114a) forms an angle (α) with the longitudinal axis (123a) of the first pusher (113a), comprised between 10° and 60°, preferably between 20° and 45°, more preferably 30°.

[0053] In a first step (see figure 5b) of a preferred method for removing an insert (109) from a pocket (106), this first pusher (113a) is first placed in an initial pushing position in which the end part (120a) is introduced between the wall (126) of the channel (105) and the pushing object (112). The longitudinal surface (127a) is then in contact with the wall (126) of the channel (105) while the inclined surface (114a) is in contact with the pushing object (112). The pusher (113a) is moved from this initial pushing position to a deeper position (see figure 5c) in the channel (105), so that the inclined surface (114a) is pushed against the ball shaped pushing object (112), and moves it from its first working position towards the pocket (106) to a second working position. Normally, said deeper position is reached when the bottom edge of the first pusher contacts the bottom of the channel (105), but the movement of the first pusher could be stopped before the bottom is reached. In this way the contact side (124) of the

pushing object (112) is pushed against the base (111) of the insert (109), the interference fit of the insert (109) is overcome and the insert (109) is moved towards the external surface (104) of the tool body (101).

[0054] The pushing means also comprise a second elongated pusher (113b) which differs from the first one (113a) in that the end portion comprises a truncated bottom extremity. The end part (120b) of the second pusher (113b) has a particular width (W2) at the level of the lower edge of the inclined second surface (114b), which is greater than the corresponding width (W1) of the end part (120a) of the first pusher (113a) (the width (W1) being zero or close to zero).

[0055] In a second step of the method the first pusher (113a) is removed from the channel (105), and said second pusher (113b) is introduced in the channel (105). The end part (120b) of the second pusher (113b) is introduced between the wall (126) of the channel (105) and the pushing side (125) of the pushing object (112) which is in the second working position (see figure 5d). The second pusher (113b) is adapted to move the pushing object (112) further towards the pocket (106) from the second working position to a third working position (see figure 5e).

[0056] During this second step, the longitudinal surface (127b) of the second pusher (113b) is in contact with the wall (126) of the channel (105) while the inclined surface (114b) is in contact with the pushing object (112). The pusher (113b) is moved from this initial pushing position to a deeper position (see figure 5e) in the channel (105), so that the inclined surface (114b) is pushed against the pushing side (125) of the ball shaped pushing object (112), and moves it from its second working position towards the pocket (106) to a third working position. Normally, said deeper position is reached when the bottom edge of the second pusher contacts the bottom of the channel (105), as shown in figure 5e, but the movement of the second pusher could be stopped before the bottom is reached. In this way the contact side (124) of the pushing object (112) is pushed against the base (111) of the insert (109), and the insert (109) is moved further towards the external surface (104) of the tool body (101).

[0057] The pushing means also comprise a third elongated pusher (113c). This third pusher (113c) comprises a truncated bottom extremity. The third pusher (113c) differs from the second pusher (113b) in that the end portion has a width (W3) at the level of the lower edge of the inclined second surface (114c), which is greater than the corresponding width (W2) of the end part (120b) of the second pusher (113b).

[0058] In a third step, the second pusher (113b) is removed from the channel (105) and the third pusher (113c) is introduced in the channel (105). The end part (120c) of the third pusher (113c) is introduced between the wall (126) of the channel (105) and the pushing side (125) of the pushing object (112) which is in the third working position (see figure 5f). The third pusher (113c) is adapted to move the pushing object (112) further towards the

pocket (106) from the third working position to a fourth working position (see figure 5g).

[0059] During this third step, the longitudinal surface (127c) of the third pusher (113c) is in contact with the wall (126) of the channel (105) while the inclined surface (114c) is in contact with the pushing object (112). The pusher (113c) is moved from this initial pushing position to a deeper position (see figure 5g) in the channel (105), so that the inclined surface (114b) is pushed against the pushing side (125) of the ball shaped pushing object (112), and moves it from its third working position towards the pocket (106) to a fourth working position. Normally, said deeper position is reached when the bottom edge of the third pusher (113c) contacts the bottom of the channel (105) but the movement of the third pusher could be stopped before the bottom is reached. In this way the contact side (124) of the pushing object (112) is pushed against the base (111) of the insert (109), and the insert (109) is moved further towards the external surface (104) of the tool body (101).

[0060] The pushing means also comprise a second ball shaped pushing object (116) as shown in figure 5h. The diameter of the second pushing object (116) preferably is smaller than or equal to the diameter of the first ball shaped pushing object (112).

[0061] When the first pushing object (112) has been moved to a working position in which the distance between the pushing side (125) and the opposite channel wall (126) is at least equal to the radius of the channel (105), the second ball shaped pushing object (116) is inserted in the channel (105), and a fourth pusher (113d) having a bottom surface (120d) which is substantially perpendicular to its longitudinal axis (123d), is introduced in the channel (105). This fourth pusher (113d) is a pusher of the second type.

[0062] A force is then applied on the fourth pusher (113d) in order to move it to a deeper position in the channel (105), and this force is transferred via the second (116) and the first pushing object (112) to the insert (109), as shown in figure 5h. The second ball shaped pushing object (116) is moved until it reaches the bottom of the channel (105), and meanwhile the first ball shaped pushing object (112) is pushed through the opening (111) into the pocket (106), as shown in figure 5i.

[0063] In this way, the inserts (109) of the downhole tool (100) can be removed from the pockets (106), and the downhole tool can be redressed in a relatively easy way, by applying a removing force on the insert (109) through the channel (105) extending to the bottom of the associated pocket (106) and through the opening (111) at the bottom of this pocket (106).

[0064] The first pushing object (112) is ball shaped and has a Young module high enough to support a hammer force, preferably a Young module superior to 100GPa.

[0065] In a preferred method, a hammer (117) is used for hammering the pushers (113a)-(113d) as shown for the first pusher (113a) in figure 4. The inclined surface (114a) of the first pusher (113a) forms an angle (α) of

about 30° with the longitudinal axis (123a). Hammering the first pusher (113a) results in a displacement of the ball (112) along a first distance (x) until the bottom edge of the end portion (120a) of the first pusher (113a) reaches the bottom (115) of the channel (105), as presented in figure 5c.

[0066] The second pusher (113b) has an end portion (120b) with an inclined surface (114b) forming an angle (β) which is equal or smaller than the angle (α) of the inclined surface of the first pusher (113a).

[0067] Hammering the second elongated object (113b) results in a displacement of the ball (112) along an additional distance (x1) until the bottom extremity of the end portion (120b) reaches the bottom (115) of the channel (105), as presented in figure 5e.

[0068] The third pusher (113c) has an end portion (120c) with an inclined surface (114c) forming an angle (γ) which is equal or smaller than the angle (α) of the inclined surface of the first pusher (113a), or equal or smaller than the angle (β) of the inclined surface (114b) of the second pusher (113b).

[0069] Hammering the third pusher (113c) results in a displacement of the ball (112) along an additional distance (x2) until the bottom edge of the end portion (120a) of the first pusher (113a) reaches the bottom (115) of the channel (105), as presented in figure 5g.

[0070] When the ball (112) has been moved to a working position in which the distance between the pushing side (125) and the opposite channel wall (126) is at least equal to the radius of the channel (105), a second ball (116) is inserted in the channel (105), and a fourth elongated pusher (113d), having a bottom surface (120d) which is substantially perpendicular to its longitudinal axis (123d), is introduced in the channel (105).

[0071] Alternatively, the second ball (116) is inserted when the first ball (112) has moved along a distance superior to half of the diameter of the channel (105).

[0072] The fourth pusher (113d) comprises an end portion (120d) comprising a chamfered surface substantially perpendicular to the longitudinal axis (123d). Hammering the fourth pusher (113d) pushes the second ball (116) against the first ball, resulting in an additional displacement (x3) of the first ball (112) and the insert (109), as presented in figure 5i.

[0073] Once the second ball (116) reaches the bottom (115) of the channel (105), as shown in figure 5i, the fourth pusher (113d) is removed and the first pusher (113a) is reintroduced in the channel (105) as shown in figure 5j. The same operations of introducing, hammering, and removing the appropriate pushers (113a)-(113d) are then repeated until the insert (109) gets out of the pocket (106).

[0074] This method of removing inserts strongly decreases the time of redressing the downhole tools when the inserts (109) have to be replaced.

[0075] The ball (112) can be replaced by any other object provided that this other object has:

o dimensions adapted to pass through the opening (111) connecting the channel (105) to the pocket (106);
 o a contact side (124) facing the base of the insert (110) when it is introduced into the channel (105) and;
 o a pushing side (125) opposite to said contact side (124) and shaped such that a space is available between the wall (126) of the channel (105) and an upper portion of the pushing side (125) when it is introduced into the channel (105).

[0076] In an alternative method for removing an insert (109) from a downhole tool (100) according to the present invention, the removing force is applied on the base (110) of the insert (109), by introducing a fluid into the channel (105) so that the fluid reaches the insert (109) through the opening (111), and by applying a fluid pressure in the fluid.

[0077] The method includes the provision of connecting means on the tool body (101) so that the access opening (107) of the channel (105) can be connected to a fluid duct. This involves for example providing means for connecting a hydraulic terminal, such as a threaded connector. The method comprises applying a hydraulic pressure which is sufficient to overcome the interference fit of the insert (109) and sufficient to remove the insert (109) from the pocket (106).

[0078] In this alternative method, the insert (109) must perfectly fit into the pocket (106) such that no leaks appear while applying the hydraulic pressure. More preferably, the thread provided in the connector must be a national pipe tapered thread providing a tight fluid connection with the hydraulic terminal.

[0079] The present invention has been described for a downhole tool package wherein the downhole tool is a reamer tool. However, other embodiments of the downhole tool package according to the present invention may be possible and may include as a downhole tool other alternative tools than the downhole reamer tool presented herein above. The downhole tool may be a drill bit in which the inserts to be provided into the pockets are cutting elements. In another alternative, the downhole tool may be a roller reamer tool in which the inserts to be provided into the pockets are cartridges comprising reaming rollers.

Claims

1. A downhole tool (100) package including a downhole tool comprising a tool body (101) with a central bore (103), an external surface (104), and at least one pocket (106) which is accessible from said external surface (104), said pocket (106) being provided for insertion of an insert (109) for reaming, cutting or stabilizing, **characterized in that** said tool body (101) further comprises at least one channel (105)

separated from said bore (103), extending from the external surface (104) of the tool body (101) to the bottom of a pocket (106), and forming an opening (111) at the bottom of the pocket (106).

2. A downhole tool (100) package according to claim 1 **characterized in that** an insert (109) for reaming, cutting or stabilizing is inserted by interference fit into at least one pocket (106) of the downhole tool, and that the channel (105) associated with this pocket (106) is provided for introducing a pushing object (112) into said channel (105) in order to exert a removing force onto the insert (109) via said opening (111) in order to overcome the interference fit.
3. A downhole tool package according to claims 1 or 2 **characterized in that** it also comprises pushing means for removing an insert (109) from a pocket (106) in the tool body (100), said pushing means comprising at least one pushing object (112) provided to be introduced in a channel (105) associated with said pocket (106) and to be placed in a working position in which it can be pushed against the insert (109) via the opening (111), in order to exert a removing force onto the insert (109).
4. A downhole tool package according to claim 3 **characterized in that** the dimensions of the pushing object (112) are such that it can be pushed through the opening (111) in the bottom of said pocket (106).
5. A downhole tool package according to claim 3 or 4 **characterized in that** the pushing object (112) has a contact side (124) and a pushing side (125) opposite to said contact side, that in a first working position of the pushing object (112), the pushing side (125) is contacting a wall (126) of the channel (105) and the contact side (124) is facing the insert (109), and that said pushing side (125) is shaped so as to form a free space between the wall (126) of the channel (105) and at least an upper portion of the pushing side (125) when the pushing object (112) is in said first working position in the channel (105).
6. A downhole tool package according to claim 9 **characterized in that** the pushing side (125) comprises a convex surface, in particular a spherical surface.
7. A downhole tool package according to claim 9 or 10 **characterized in that** the pushing object (112) is ball shaped.
8. A downhole tool package according to any one of claims 3 to 7 **characterized in that** said pushing means further comprise at least one elongated pusher (113a)-(113d) provided to be introduced into said channel (105) in order to move the pushing object against the insert (109) and having an end portion

which is so configured that, when the end portion contacts the pushing object, a further displacement of the pusher in the longitudinal direction causes a displacement of the pushing object (112) in a direction forming an angle (α) with said longitudinal direction.

9. A downhole tool package according to claim 8 **characterized in that** at least one elongated pusher (113a)-(113c) comprises a tapered end portion (120a)-(120c) having a first lateral side comprising a first surface (127a)-(127c) extending in the longitudinal direction of the pusher and, at the opposite side thereof, a second lateral side comprising a second surface (114a)-(114c) which is inclined with respect to said longitudinal direction, and that said pusher (113a)-(113c) is configured such that

- the pusher (113a)-(113c) can be placed in an initial pushing position in which the end part (120a) is introduced between the wall (126) of the channel (105) and the pushing object (112), the first surface (127a)-(127c) being in contact with the wall (126) of the channel (126) and the inclined second surface (114a)-(114c) being in contact with the pushing object (112), and
- that the pusher (113a)-(113c) is moveable from said initial pushing position to a deeper position in the channel (105), so that the inclined second surface is pushed against the pushing object (112), in order to move it from a first working position towards the pocket (106), so that the insert (109) is moved by the pushing object (112).

10. A downhole tool package according to claim 9 **characterized in that** said pushing means comprises at least two different elongated pushers (113a), (113b), (113c) of which the respective end parts (120a), (120b), (120c) have a different width (W1), (W2), (W3) at the level of the lower edge of the inclined second surface (114a), (114b), (114c) such that each of said different pushers (113a)-(113c) is adapted to move the pushing object (112) from a different working position in the channel (105) towards the pocket (106).
11. A downhole tool package according to claims 9 or 10 **characterized in that** said pushing means comprise at least one elongated pusher (113d) having a bottom surface (120d) which is substantially perpendicular to its longitudinal axis (123d).
12. A downhole tool package according to any one of the preceding claims **characterized in that** in the downhole tool (100), the longitudinal axis (119) of said pocket (106) and the longitudinal axis (118) of the channel (105) associated therewith form an an-

gle comprised between 70° and 110°.

13. A downhole tool package according to any one of the preceding claims **characterized in that** the external surface of the downhole tool body (100) comprises at least one raised portion (108) and that said pocket (106) has an entry in the surface of said raised portion.
14. A downhole tool package according to claim 13 **characterized in that** said raised portion (108) has the shape of a blade extending longitudinally, helically or spirally along the tool body (101).
15. A downhole tool package according to any one of the preceding claims **characterized in that** the channel (105) in the tool body comprises means for connecting said channel (105) to an exterior fluid duct, such as a hydraulic fluid duct.
16. A downhole tool package according to any one of the preceding claims **characterized in that** said insert (109) is a polycrystalline diamond cutter or a tungsten carbide insert or a matrix diamond impregnated insert.
17. A method for removing an insert (109) from a pocket (106) in a downhole tool (100) of a downhole tool package according to any one of the preceding claims, **characterized in that** the method comprises the step of applying a removing force on the insert (109) through a channel (105) extending to the bottom of said pocket (106) and through the opening (111) at the bottom of this pocket (106).
18. A method according to claim 17 **characterized in that** the method comprises the steps of placing a pushing object (112) in a working position in the channel (105), and pushing said pushing object against the insert (109) via the opening (111), in order to exert a removing force onto the insert (109).
19. A method according to claim 18 **characterized in that** an elongated pusher (113a)-(113d) is introduced into said channel (105), said pusher having an end portion which is so configured that, when the pusher contacts the pushing object, a further displacement of the pusher in the longitudinal direction causes a displacement of the pushing object in a direction forming an angle (α) with said longitudinal direction, that the pusher is brought in a position in which the end portion is in contact with the pushing object (112) and that the pusher (113a)-(113d) is moved to a deeper position in the channel (105), so that the pushing object (112) is moved towards the pocket (106), from a first working position to a second working position, so that the insert (109) is moved by the pushing object (112).

20. A method according to claim 19 **characterized in that** a first (113a) and a second elongated pusher (113b) are used, that each elongated pusher (113a), (113b) comprises a tapered end portion (120a)-(120c) having a first lateral side comprising a first surface (127a)-(127c) extending in the longitudinal direction of the pusher and, at the opposite side thereof, a second lateral side comprising a second surface (114a)-(114d) which is inclined with respect to said longitudinal direction, that the first and second pushers comprise respective end portions having different widths (W1), (W2) at the level of the lower edge of the inclined second surface (114a), said width (X2) of the second pusher (113b) being greater than said width (X1) of the first pusher (113a), and that the method includes the steps of

- introducing the first elongated pusher (113a) in the channel (105) into an initial pushing position in which its end portion (120a) is introduced between the wall (126) of the channel (105) and the pushing object (112), the first surface (127a) being in contact with the wall (126) of the channel (105) and the inclined second surface (114a) being in contact with the pushing object (112) which is in a first working position,
- moving said first pusher (113a) from said initial pushing position to a deeper position in the channel (105), so that the inclined second surface (114a) is pushed against the pushing object (112), and moves it towards the pocket (106), from a first working position to a second working position,
- introducing the second elongated pusher (113b) into an initial pushing position in which its end portion (120b) is introduced between the wall (126) of the channel (105) and the pushing object (112), the first surface (127b) being in contact with the wall (126) of the channel (126) and the inclined second surface (114b) being in contact with the pushing object (112), which is in said second working position, and
- moving said second pusher (113b) from said initial pushing position to a deeper position in the channel (105), so that the inclined second surface (114b) is pushed against the pushing object (112), and moves it towards the pocket, from said second working position (106), to a third working position.

21. A method according to any one of claims 18 to 20, **characterized in that** a first and a second pushing object are used, and that the method comprises the steps of

- placing the first pushing object (112) in a working position in the channel (105),
- pushing the first pushing object (112) from the

first working position to a second working position in order to move the insert (109),

- placing the second pushing object (112) in the channel (105),
- pushing the second pushing (112) against the first pushing object (112) in order to move the first pushing object from its second working position to a third working position, so that the insert (109) is moved further towards the access opening of the pocket (106).

22. A method according to claim 17 **characterized in that** the method comprises the steps of

- introducing a fluid into the channel (105) so that the fluid reaches the insert (109) through the opening (111), and
- applying a fluid pressure in the fluid so as to exert said removing force on the insert (109).

23. A method according to claim 22 **characterized in that** a hydraulic pressure is applied on the insert (109).

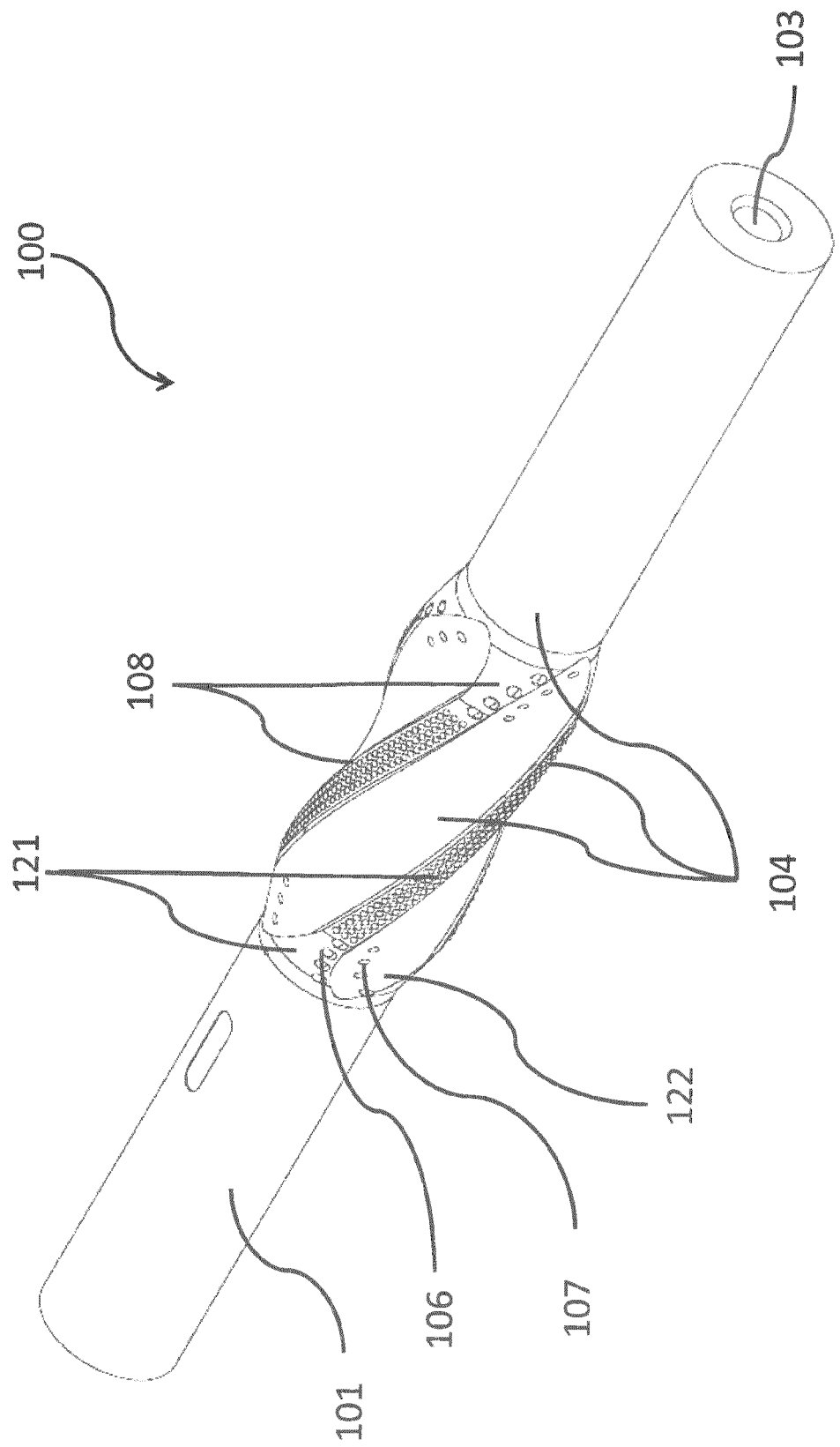


Fig. 1a

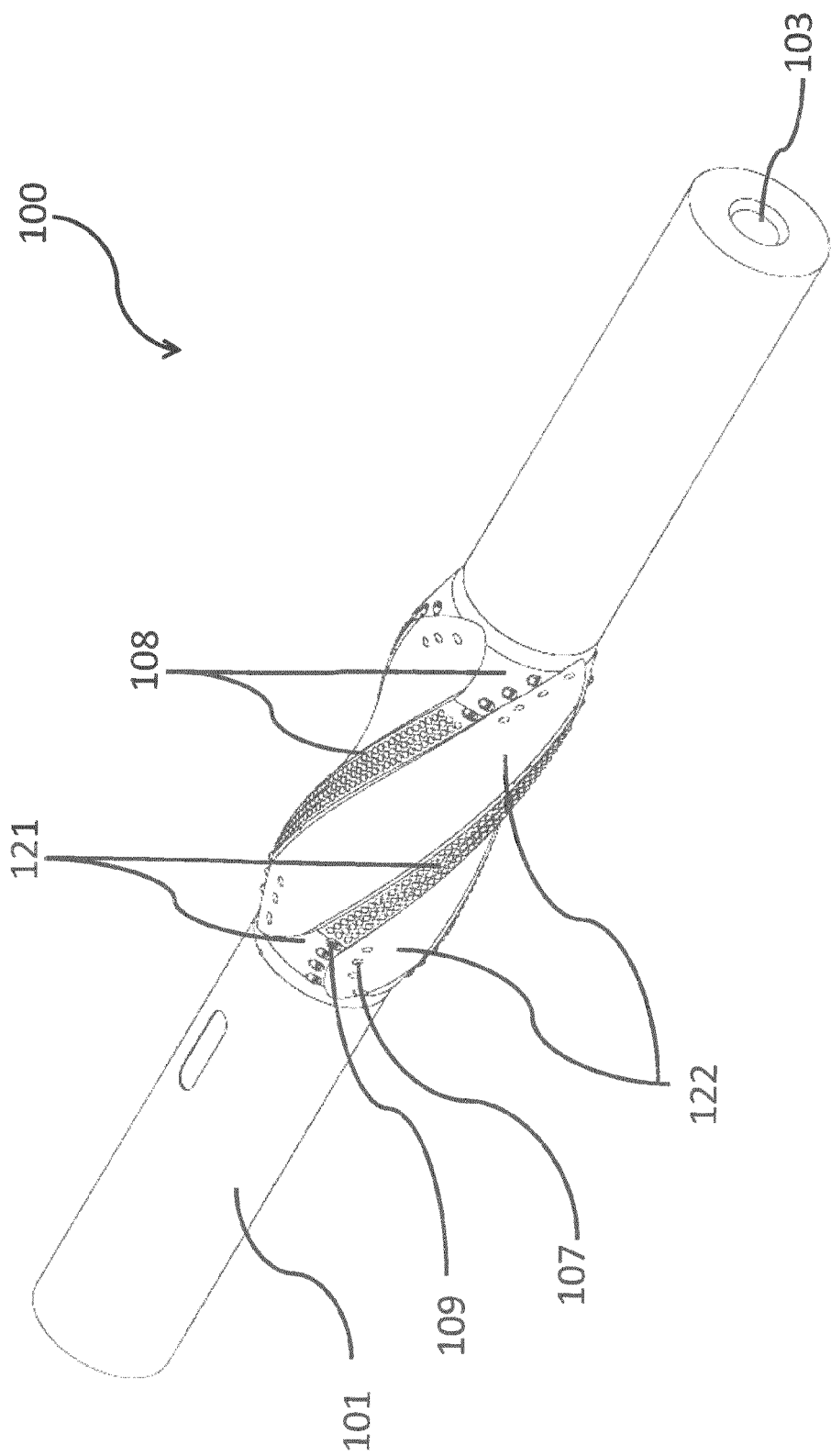


Fig. 1b

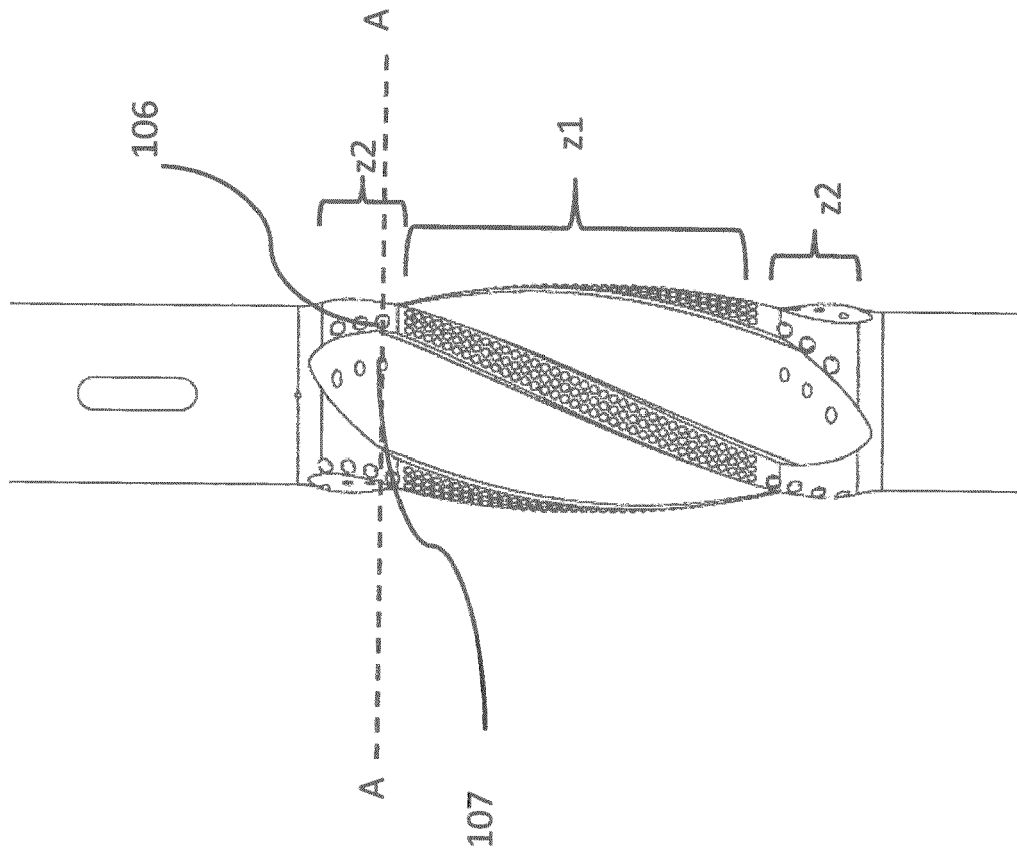
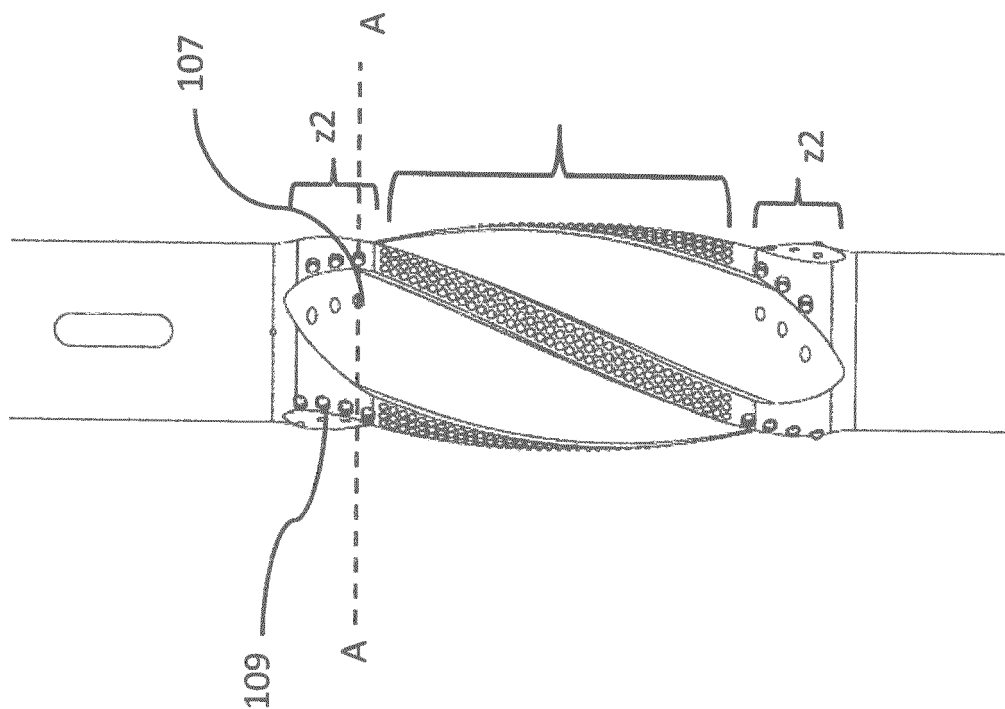


Fig. 2a



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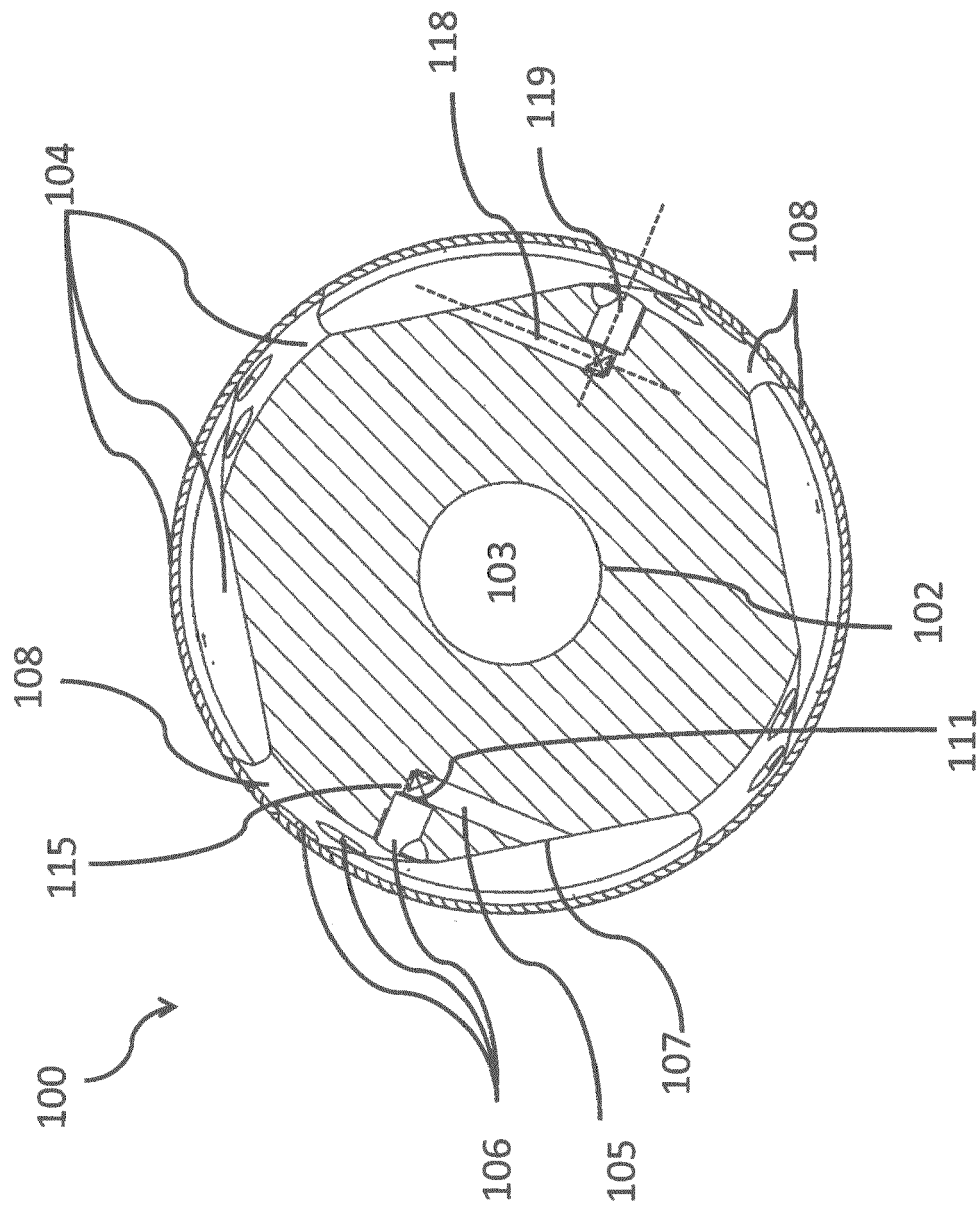


Fig. 3a

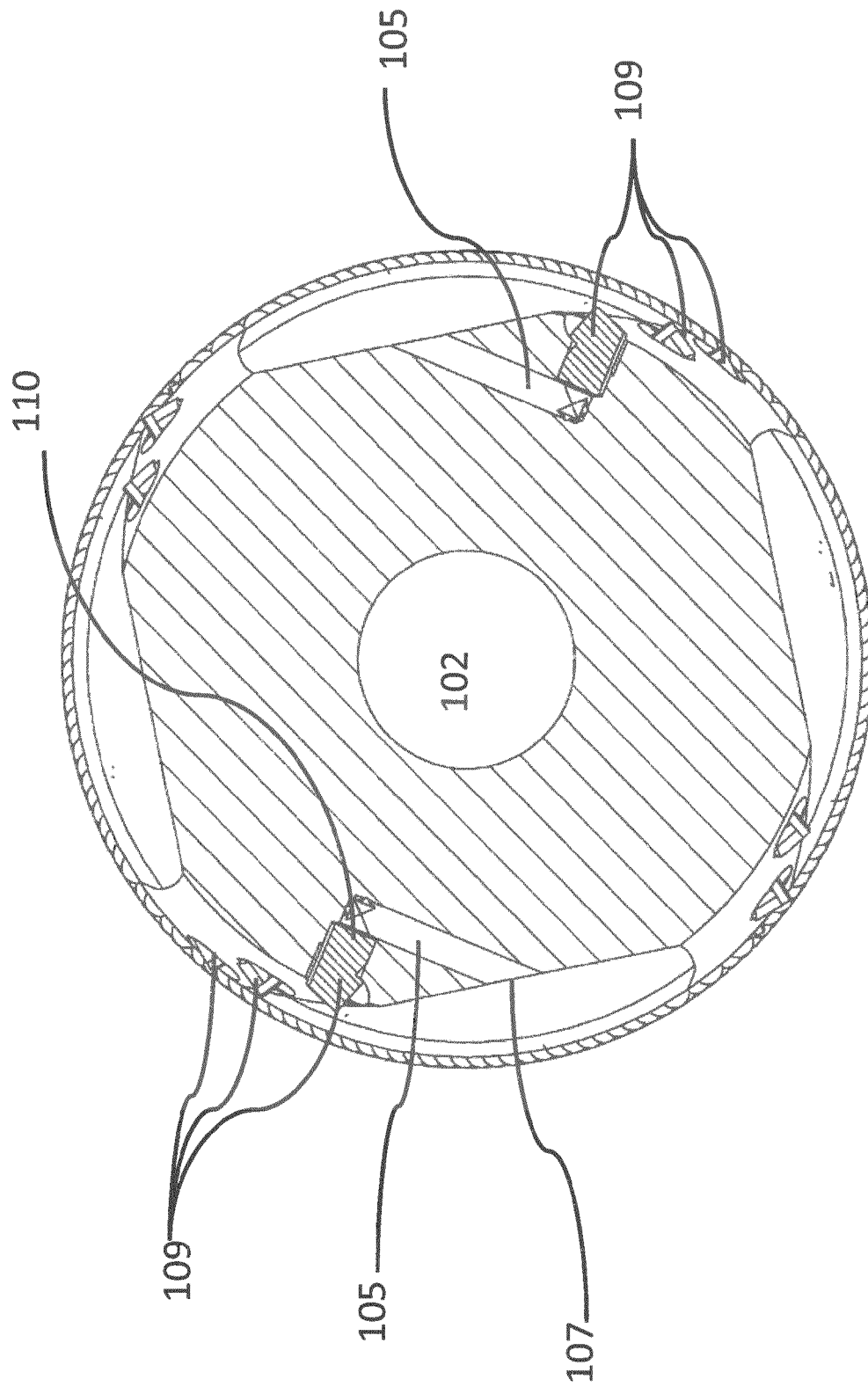


Fig. 3b

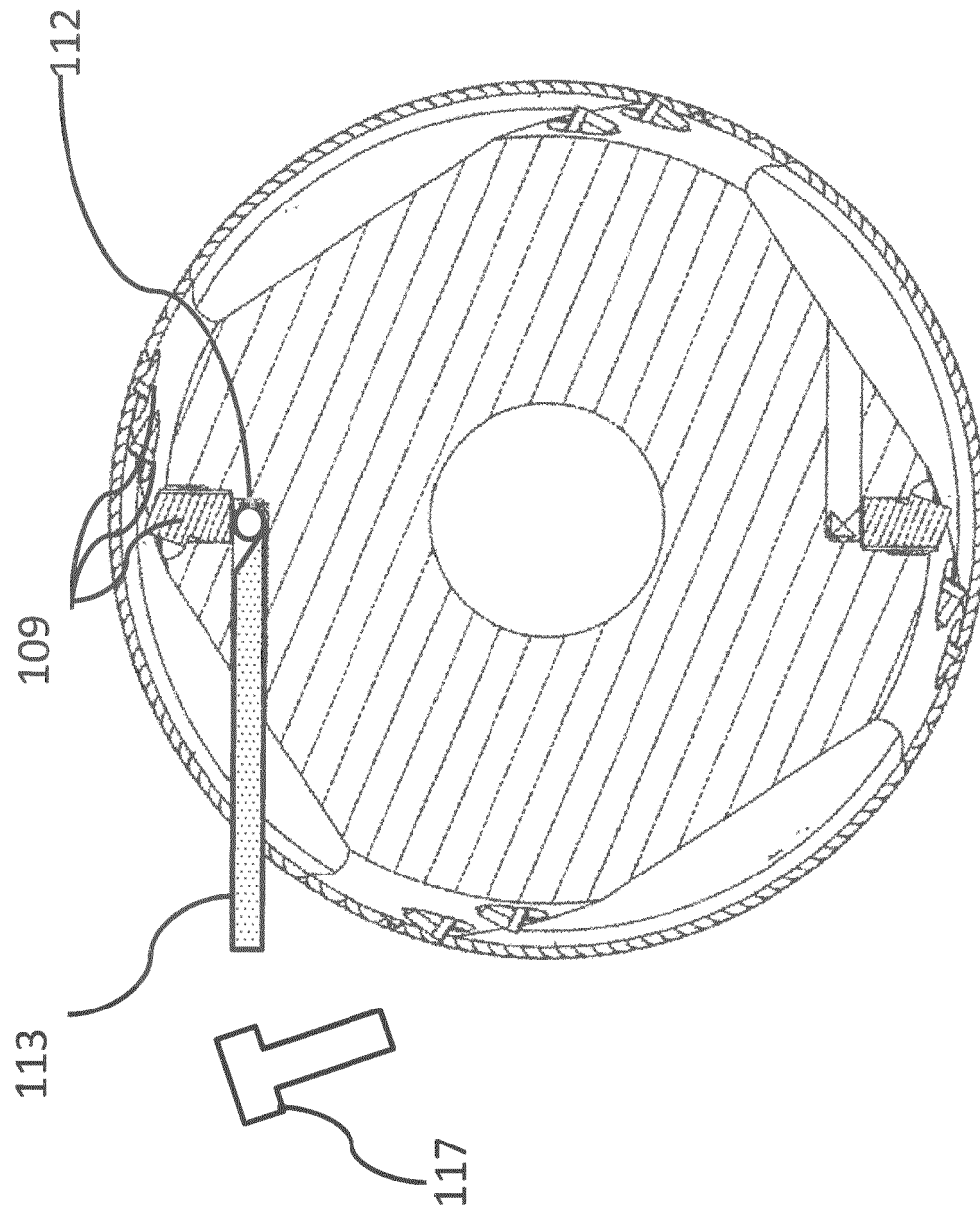


Fig. 4

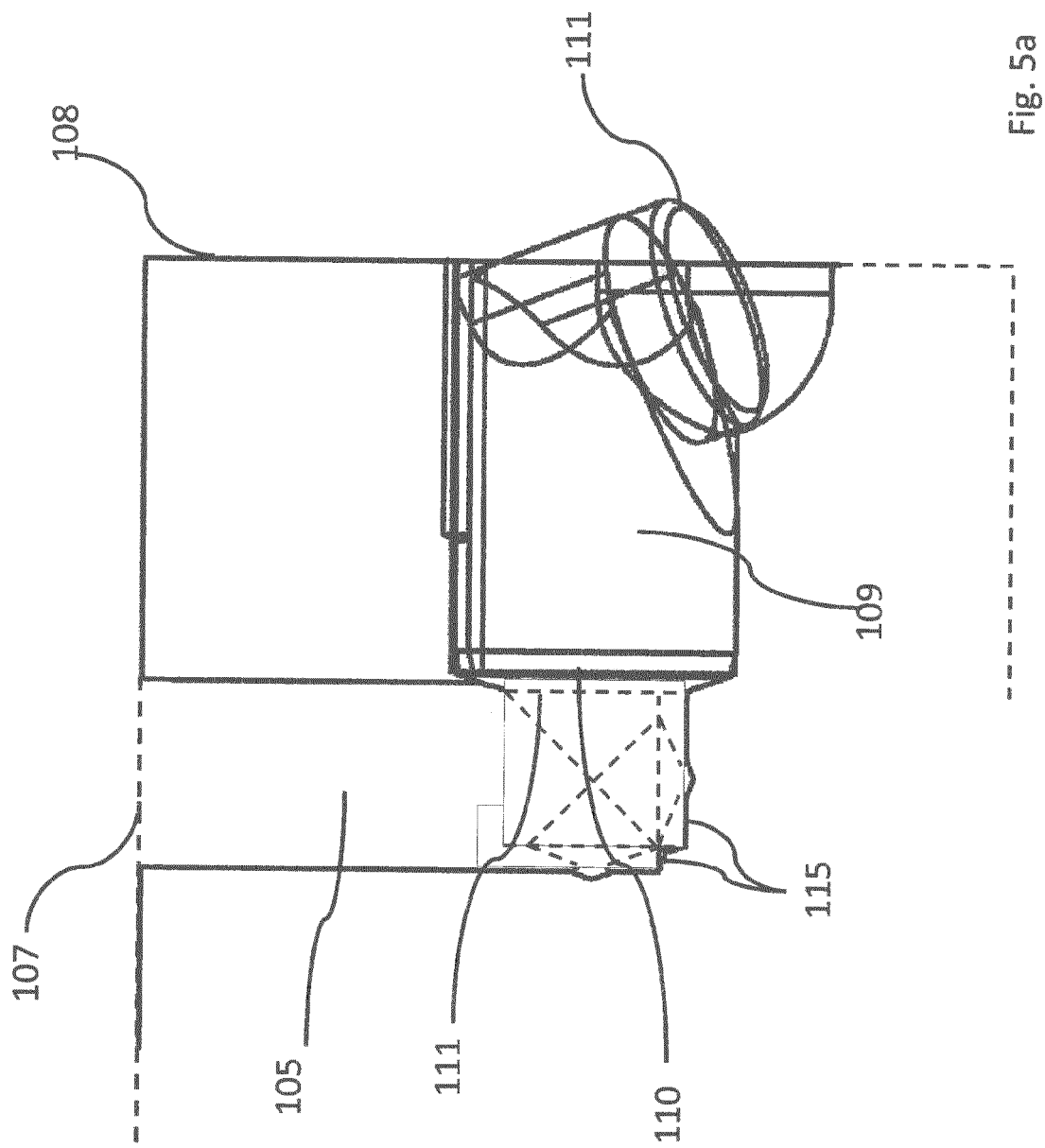


Fig. 5a

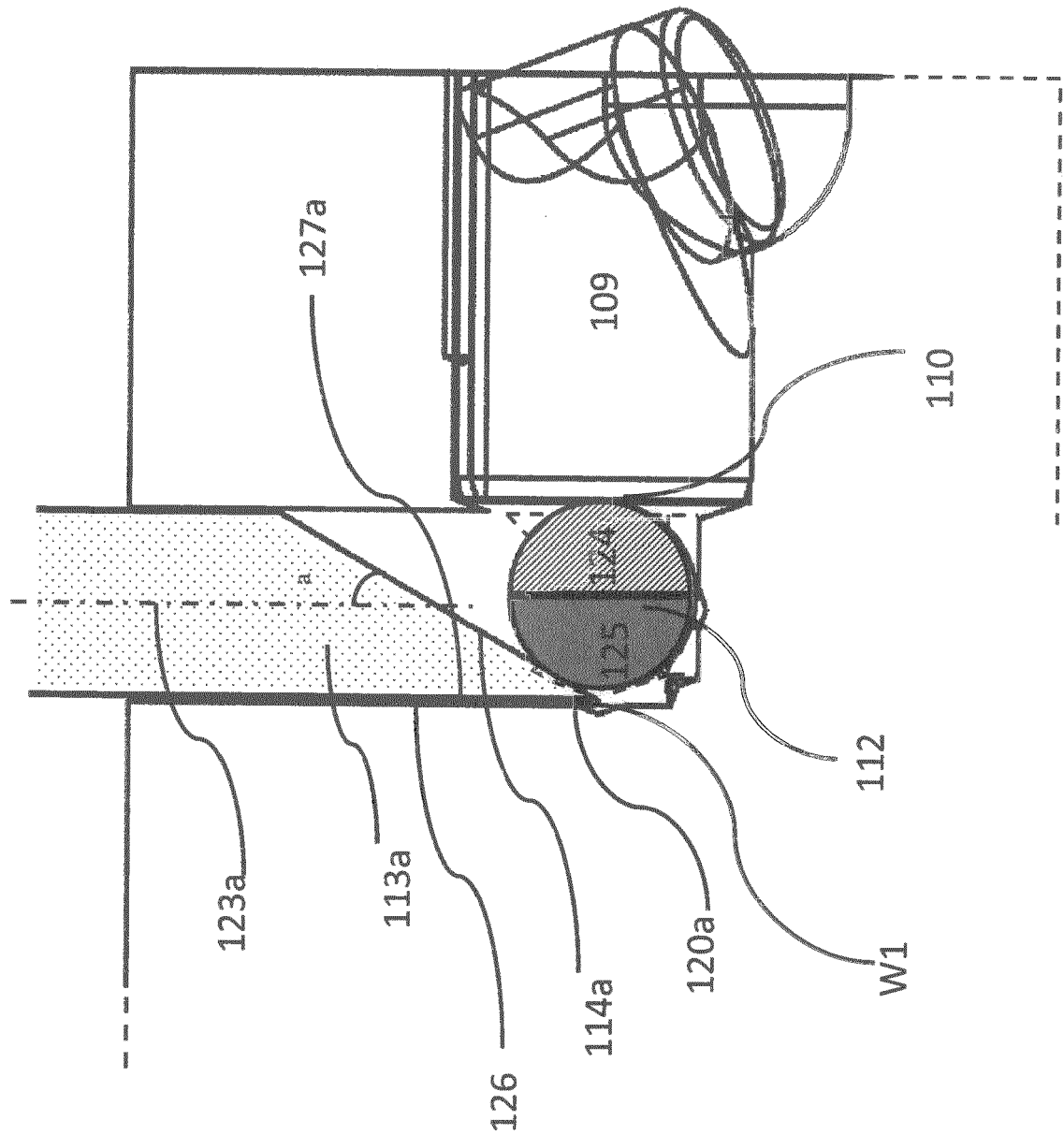


Fig. 5b

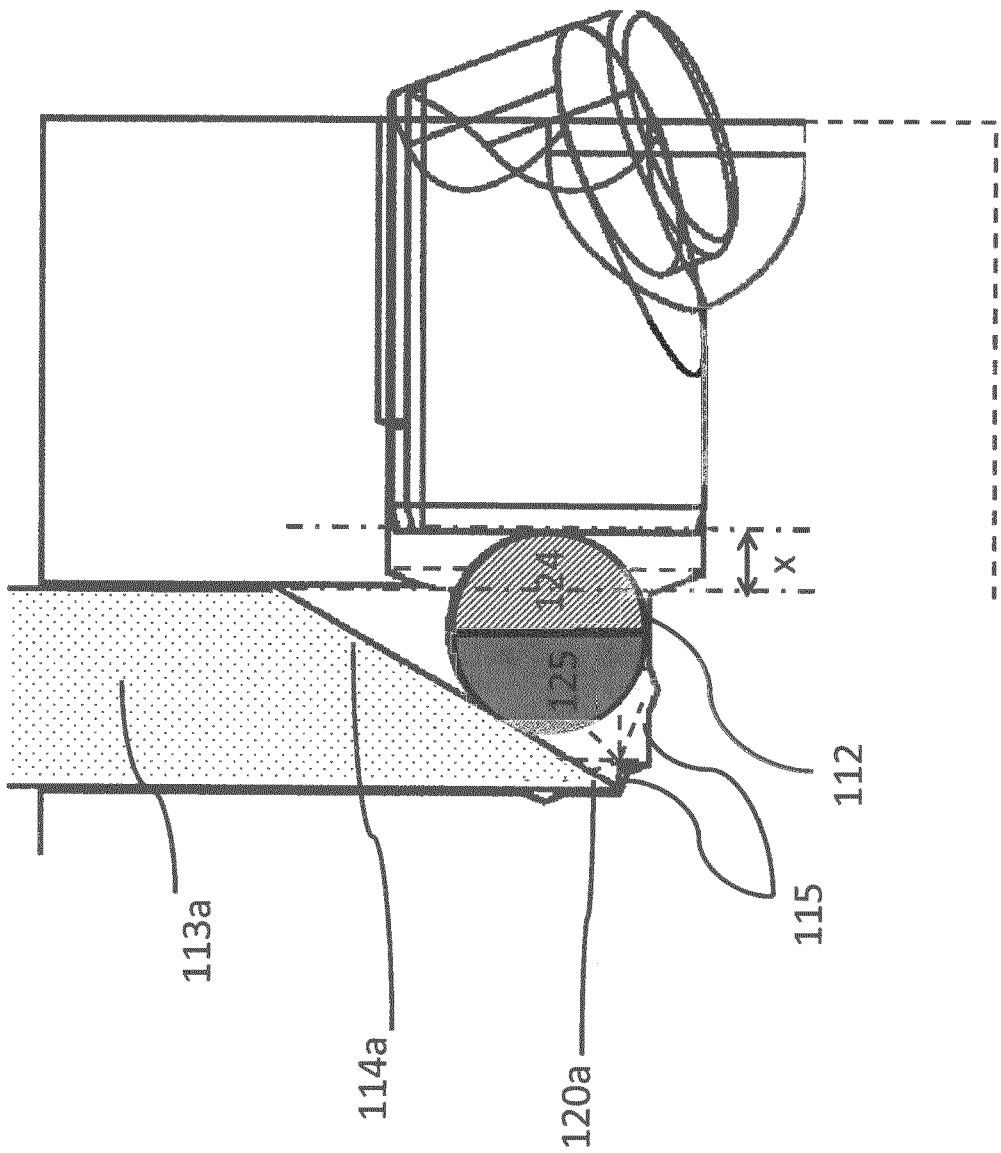
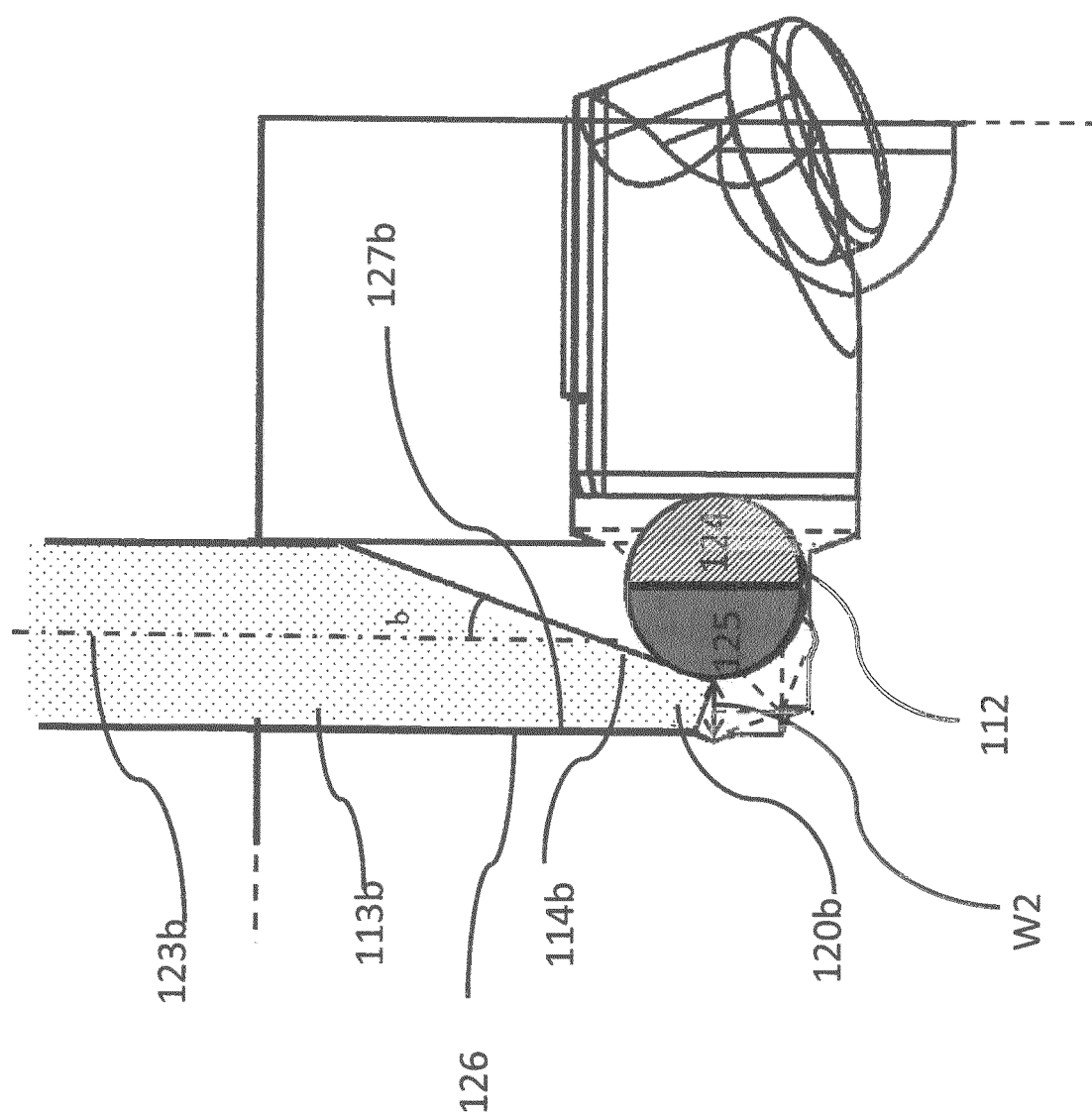


Fig. 5c



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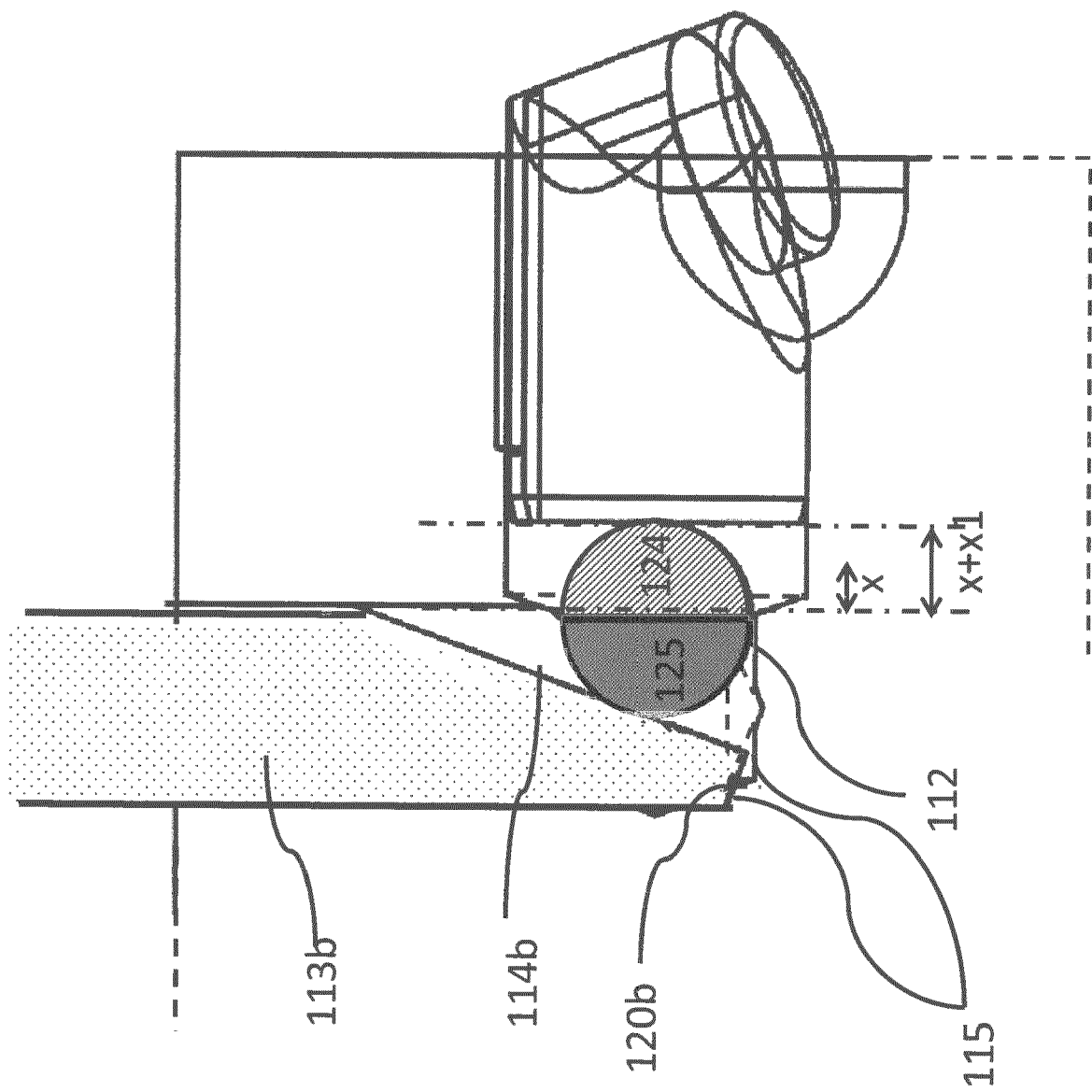
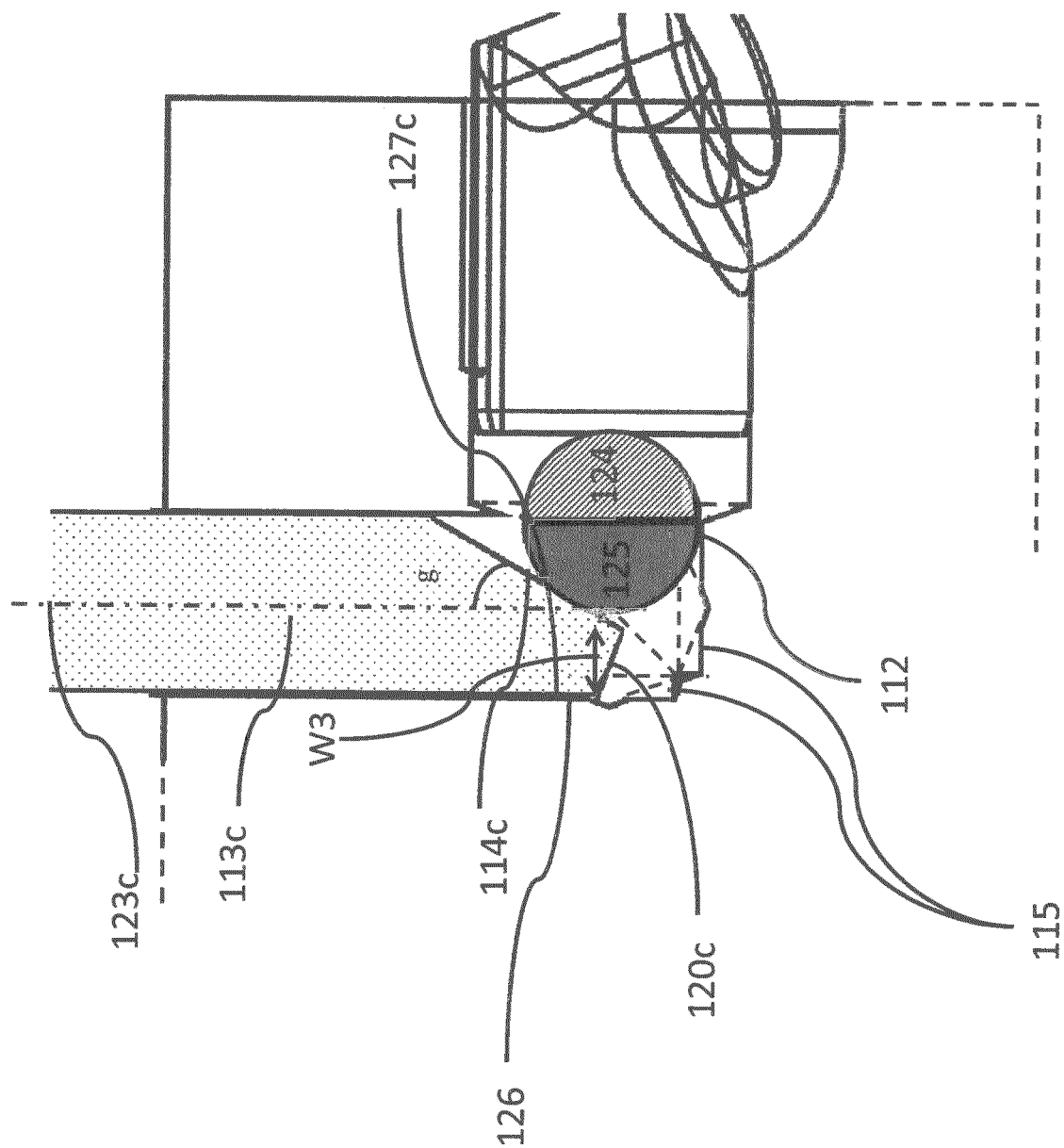
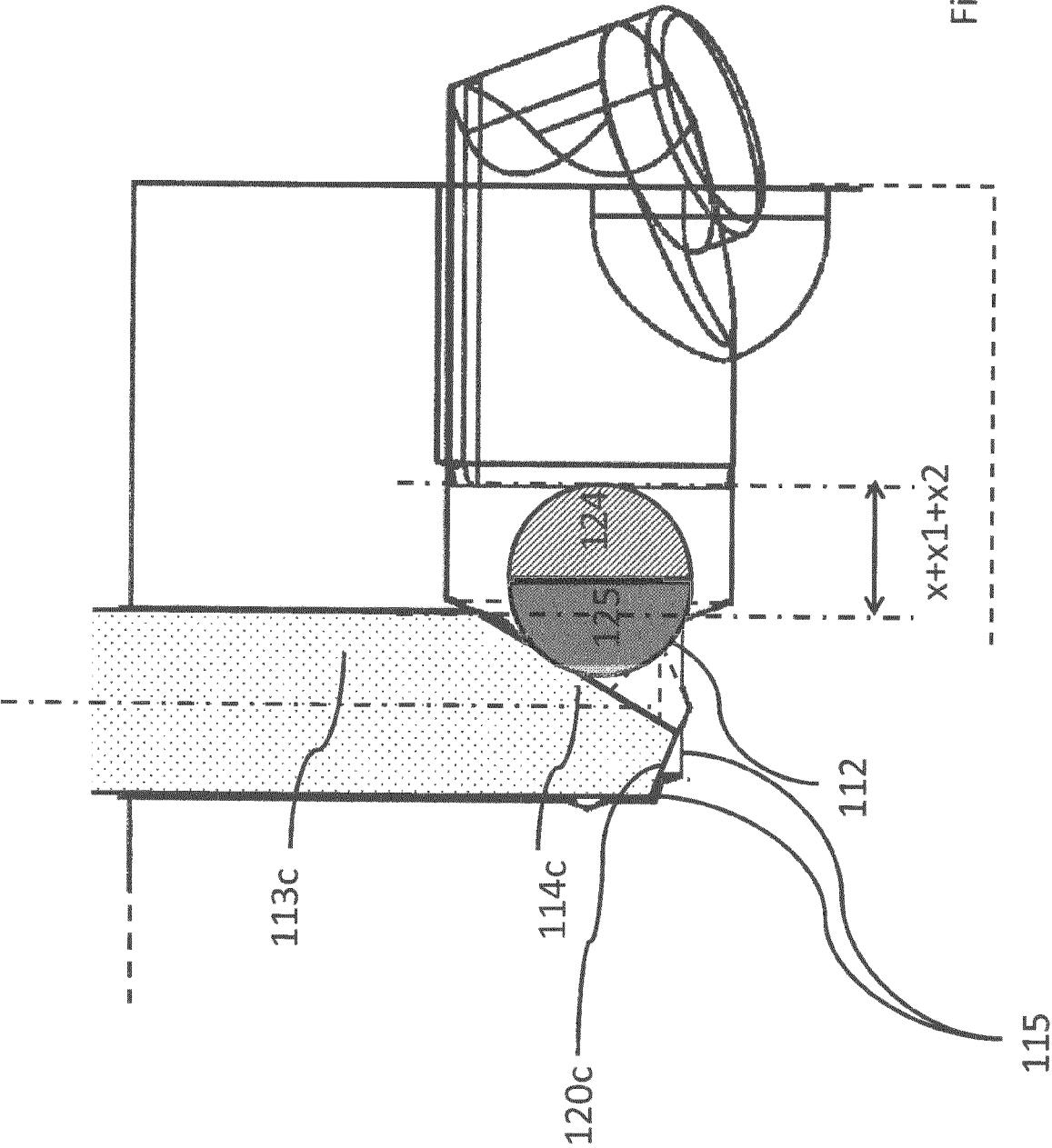
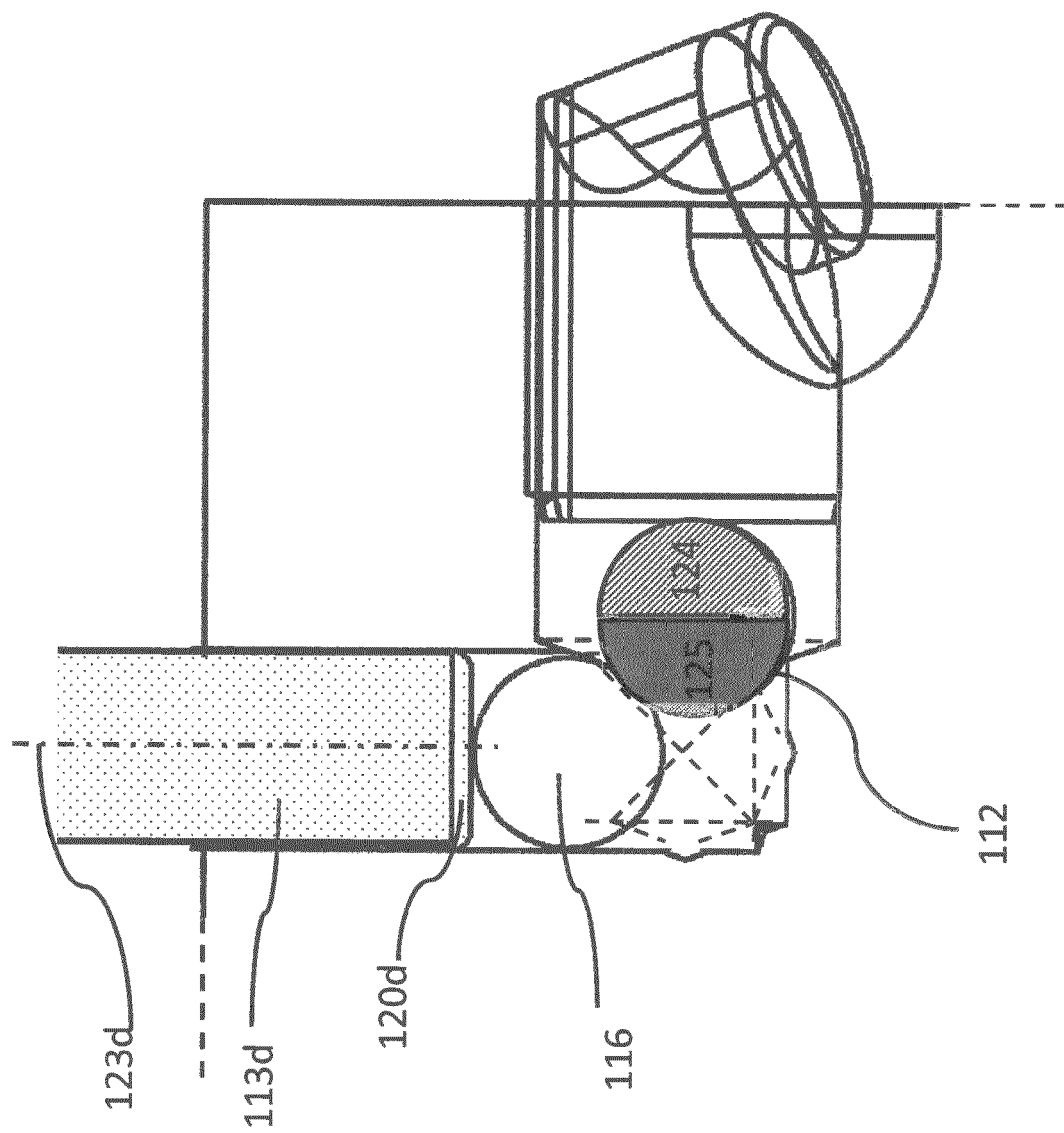


Fig. 5e



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60
75





5500

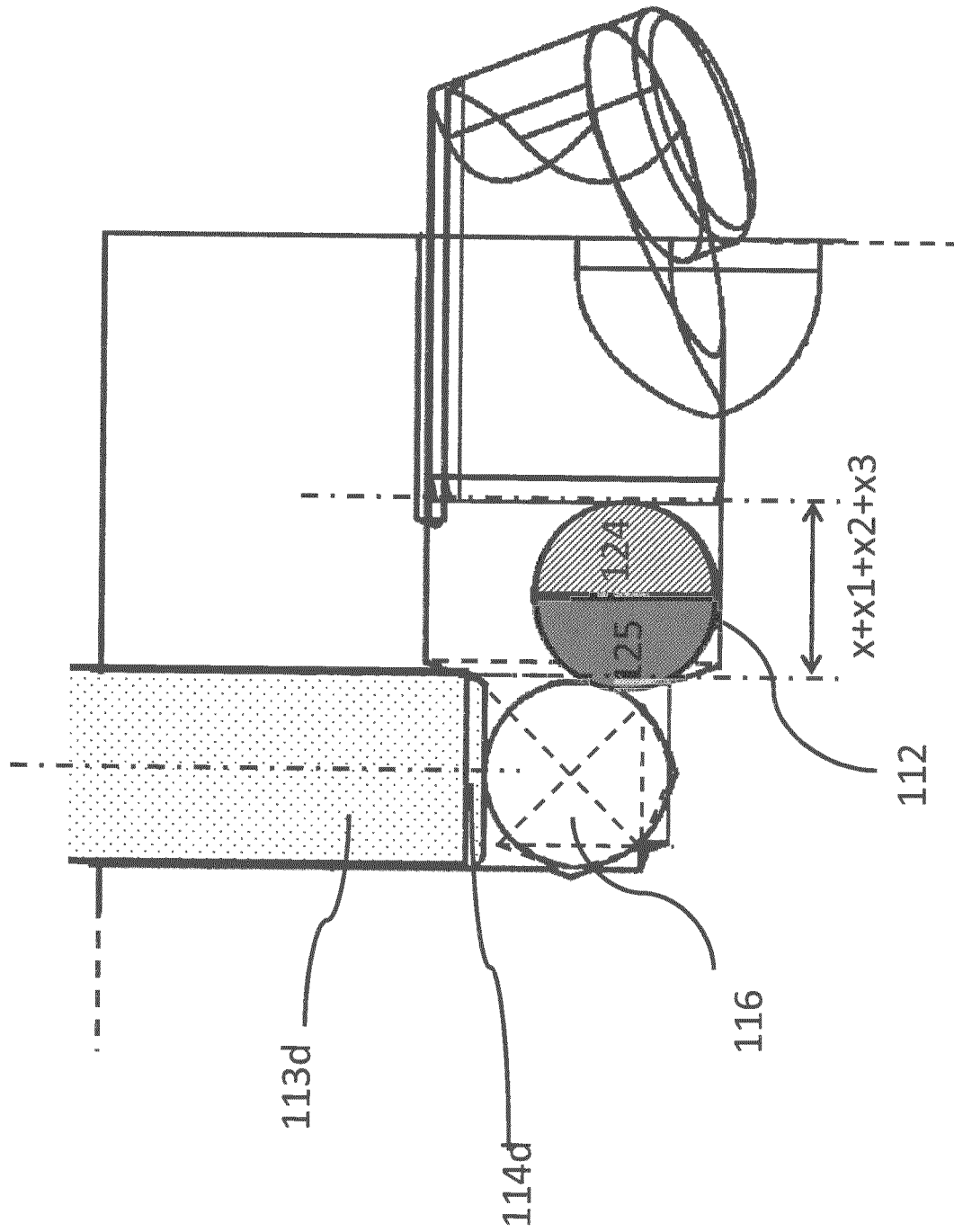
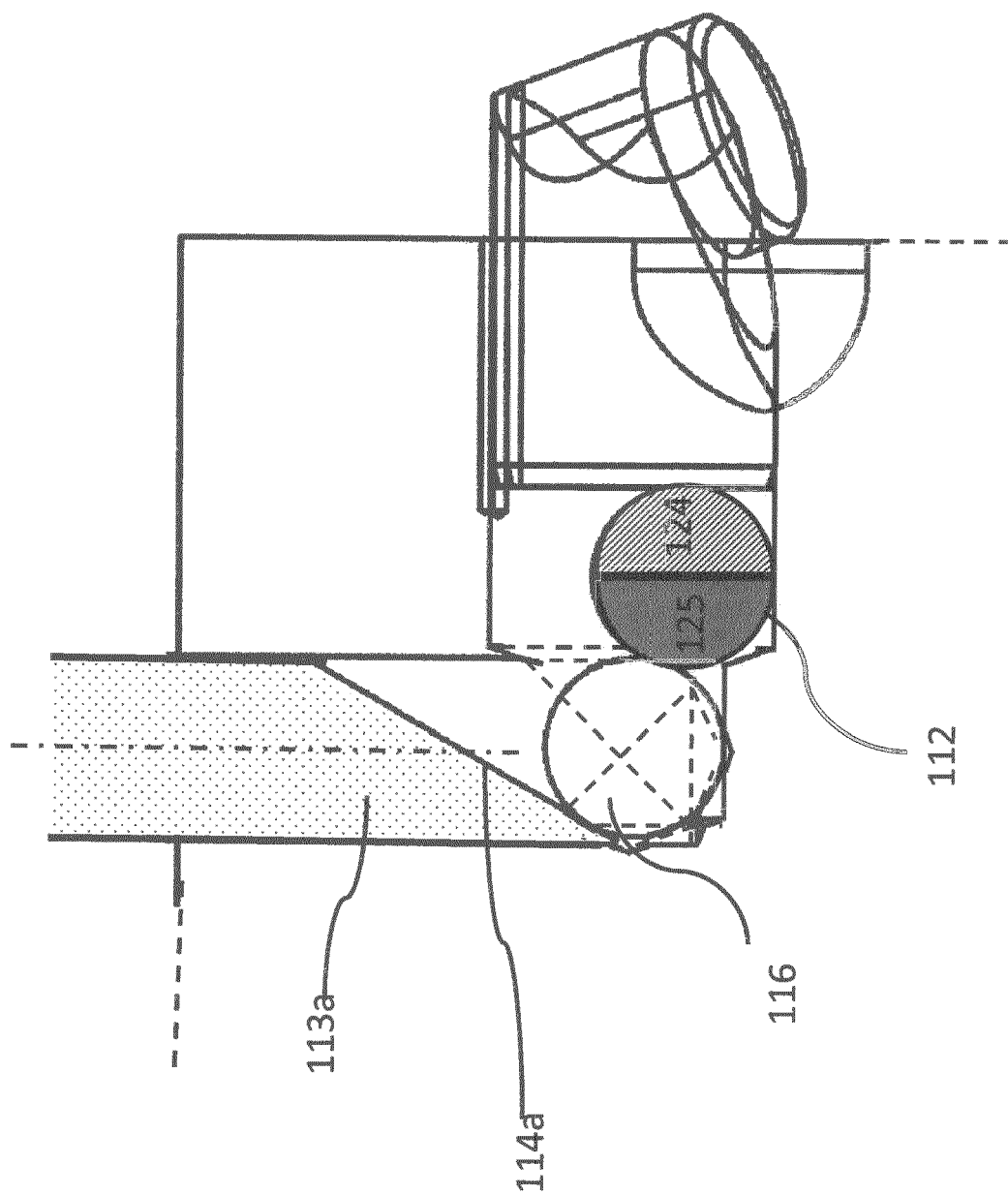


Fig. 5i



505



EUROPEAN SEARCH REPORT

Application Number
EP 14 17 5284

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 7 533 738 B1 (HALL DAVID R [US] ET AL) 19 May 2009 (2009-05-19) * figures 1,2,8,9 * * column 1, lines 5-9 * * column 2, lines 44-62 * * column 3, lines 58-60 * * column 4, lines 33-56 * -----	1-3,8, 12-18, 22,23	INV. E21B10/633 E21B17/10
X	US 4 606 108 A (DAVIS KENNETH [US]) 19 August 1986 (1986-08-19) * figures 6,7,9-12 * * column 3, line 17 - column 4, line 4 * * column 4, lines 17-35 * -----	1-9, 11-14, 16-19,21 10,20	
A			
			TECHNICAL FIELDS SEARCHED (IPC)
			E21B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 9 December 2014	Examiner Maukonen, Kalle
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 14 17 5284

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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09-12-2014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 7533738	B1	19-05-2009	NONE

US 4606108	A	19-08-1986	GB 2183690 A 10-06-1987
		US 4606108 A	19-08-1986

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82