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(54) **ELECTRICAL CONNECTOR**

(57) The invention relates to an electrical connector 1 comprising a first connecting part 100 and a second connecting part 200, 300, 400 adapted to mechanically couple together in a first predetermined relative position, wherein a decoupling is prevented by locking and positioning ensuring means. A decoupling of the first connecting part 100 and a second connecting part 200, 300, 400 is rendered possible when the first connecting part 100 and a second connecting part 200, 300, 400 are arranged in a second predetermined relative position.

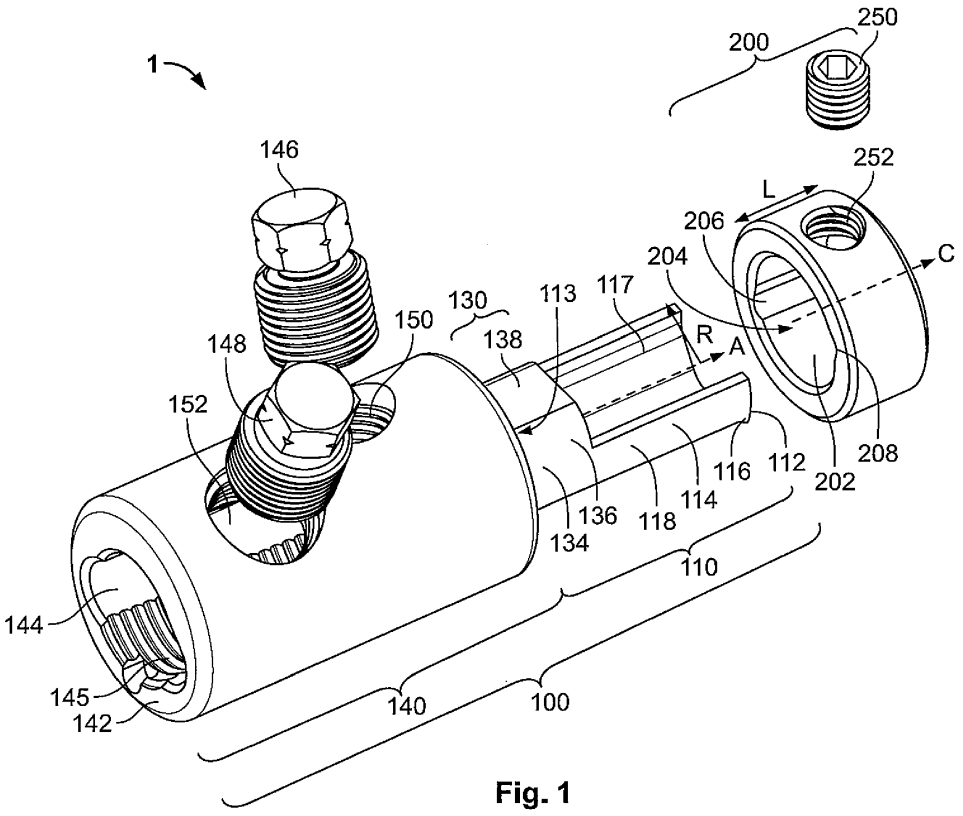

Fig. 1

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Description

[0001] The present invention relates to electrical connectors for connecting a first conductor to a second conductor.

[0002] Such connectors are widely used for joining two conductors in low voltage, medium voltage and high voltage devices.

[0003] One type of mechanical connectors comprises two connecting parts on opposing sides of the connector. An end of a first conductor, e.g. a cable, to be connected is inserted in one connecting part and fixed in place by one or more fastening bolts, e.g. shear bolts, that are tightened through threaded holes provided in the first connecting part. The second conductor, e.g. a metal pin or round, is received and fixed by the second connecting part to provide an electrical coupling between the two conductors. The second connecting part typically comprises a moveable ring to be able to correctly position the ring with respect to the metal pin to be connected and furthermore provided with a screw adapted to clamp the second conductor to the connector.

[0004] However, for the known mechanical connector, due to the fact that the ring is moveable with respect to the rest of the connector, the ring might get lost prior to use.

[0005] Hence, it is an object of the present invention to provide an electrical connector for connecting a first conductor with a second conductor that overcomes the above-mentioned drawback of the art, and therefore reduces the risk of losing the ring.

[0006] The above-mentioned problem is solved by the electrical connector according to claim 1. It relates to an electrical connector for connecting a first conductor with a second conductor, comprising a first connecting part and a second connecting part adapted to slip over at least a first portion of the first connecting part; and wherein the first and second connecting parts each comprise a means configured to prevent a decoupling of the second connecting part from the first connecting part when the first and the second connecting part are in a first predetermined relative position to each other; and to allow a decoupling when the first and second connecting part are in a second predetermined relative position to each other. In this context relative position may also relate to a plurality of positions that satisfy the condition of preventing decoupling or allowing decoupling.

[0007] Whereas in the prior art, a decoupling was possible for any relative position between the first and the second connecting part, the decoupling between the parts according to the invention is limited to one predetermined relative position by the means provided in the first and second connecting part thereby reducing the risk of an unwanted decoupling.

[0008] According to an embodiment of the invention, the first portion of the first connecting part of the connector can comprise towards its extremity a hollow right cylinder portion that is opened along its axis; wherein the cylinder can comprise towards its terminal end at least one protruding portion extending from the outer wall of the cylinder in the radial direction. The open cylinder portion is adapted to receive conductors of various shapes and diameters, e.g. wires, cables, rods or pins. The protruding portion on the terminal end provides a blocking means that will prevent the second connecting part from being decoupled when the first and the second connecting part are in the second predetermined relative position.

[0009] According to an embodiment of the invention, the cross section of the cylinder may essentially be V-shaped towards the inside of the cylinder. As a result, the geometry of the cylinder is adapted to receive different sizes of conductors, which are positioned along the length of the V-shaped cylinder interior sidewalls and can effectively blocked against the interior sidewalls.. According to an embodiment of the invention, the second connecting part may comprise an essentially circular ring shaped through-hole mating the outer radius of the cylinder and comprising at least one groove in its inner surface extending along the axis. The at least one groove will allow coupling and wanted decoupling when the first and the second connecting parts are in the second predetermined relative position. Thus, the second connecting part can pass the blocking means and thereby be mounted on the first connecting part.

[0010] According to an embodiment of the invention, in the second predetermined position, the at least one groove can be aligned with the protrusion and/or extremities of the cylinder; and wherein in the first predetermined position, the at least one groove can be misaligned with the protrusion and/or extremities of the cylinder. As a consequence, the assembly of the second connecting part with the first connecting part is rendered possible in the configuration of the second predetermined position; whereas the misalignment of the groove with the cylinder protrusion and/or with the extremities of the cylinder, i.e. in the first predetermined position, allows avoiding a decoupling of the first and the second connecting parts.

[0011] According to an embodiment of the invention, the opening angle of the hollow and open right cylinder may be 180° or less. Limiting the opening angle to 180° or less keeps the axis of the hollow right cylinder aligned with the axis of the circular ring shaped through-hole of the second connecting part in the first predetermined relative position which reduces the risk of an unwanted decoupling.

[0012] According to an embodiment of the invention, the second connecting part can further comprise a positioning ensuring means for keeping the first and second connecting parts in the first predetermined position. This positioning ensuring means forces the two connecting parts to remain in the first predetermined position relative to each other and thus cannot be decoupled involuntarily.

[0013] According to an embodiment of the invention, the positioning ensuring means can comprise a screw positioned in a threaded through-hole extending essentially in the radial direction of the ring shaped wall of the

second connecting part and ensuring the first predetermined position when the screw extends by a predetermined length into the inner volume of the ring shaped through-hole. The screw is a simple realization of the positioning ensuring means to ensure that the first and second connecting part remain in the first predetermined relative position. With the same screw it is also possible to fix a conductor once the conductor is introduced into the V-shaped cylinder of the first connecting part and at the same

[0014] According to an embodiment of the invention, the screw axis and the opposing leg of the V-shaped cylinder form an angle that shall be smaller than 90° when the first and the second connecting parts are in the first predetermined relative position. Limiting the angle to less than 90° in the first predetermined relative position allows pushing a conductor placed in the V-shaped cylinder towards the bottom of the cylinder and enables a clamping contact between the conductor and the connector.

[0015] According to an embodiment of the invention, the first portion of the first connecting part can comprise a second right cylindrical portion at its second terminal end portion aligned with the hollow right cylindrical portion; and wherein the second cylindrical portion can have an outer surface mating the inner surface of the second connecting part over an angular range of more than 180° and can further comprise a flat portion, in particular for receiving the screw of the positioning ensuring means. When the connector is not in use, e.g. for shipment or storage, the second connecting part can be securely fixed to the first connecting part, thereby reducing the risk of losing the second connecting part.

[0016] According to an embodiment of the invention, the screw can be deformed inside the ring such that the portion of the screw inside the ring is larger than the threaded through-hole. As a result, the deformed screw is no longer unscrewable. Thus, the screw and the ring can no longer be lost.

[0017] According to an embodiment of the invention, the ring of the second connecting part can further comprise a second through-hole diametrically opposed to the threaded through-hole. Hence, a means, such as a tool, for deforming the portion of the screw inside the ring can be easily introduced inside the second connecting part through this second hole.

[0018] Additional features and advantages of the present invention will be described with reference to the drawings. In the description, reference is made to the accompanying figures that are meant to illustrate preferred embodiments of the invention. It is understood that such embodiments do not represent the full scope of the invention.

Figure 1 illustrates a schematic view of elements forming an electrical connector according to the present invention;

Figure 2 illustrates a cross-section of the connector of the present invention in the configuration of the second predetermined relative position;

Figures 3a and 3b illustrate the connector of the present invention in the configuration of the first predetermined relative position;

Figure 4 illustrates the connector of the present invention during transport;

Figure 5a and 5b illustrate the connector of the present invention in a coupled state together with a conductor;

Figure 6 illustrates the second connecting part of the present invention according to a second embodiment; and

Figure 7 illustrates the second connecting part of the present invention according to a third embodiment.

[0019] Figure 1 shows a perspective view of the various elements forming a connector 1. The connector 1 comprises a first connecting part 100 and a second connecting part 200 that are configured to be mechanically coupled together. According to the invention, the second connection part 200 can slip over the first connecting part 100.

[0020] The first connecting part 100 comprises a first portion 110 provided towards its extremity 112 with a hollow right, in particular, circular cylinder portion 114 that is opened along its axis A.

[0021] The cylinder 114 comprises towards its extremity 112 one protruding portion 116, or protrusion 116, extending from the outer wall 118 of the cylinder 114 outwardly in the radial direction R. In alternative realisations the cylinder 114 can also comprise more than one protruding portion 116.

[0022] The first portion 110 of the first connecting part 100 further comprises a second area 130 provided with a second right cylindrical portion 134 at its second terminal end portion 113, adjacent the first cylindrical portion 114 and extending along the same axis A.

[0023] The second cylindrical portion 134 has a right circular portion 136 with the same radius as the first cylindrical portion 114 and extends over a larger angular range than the first cylindrical portion 114. The second cylindrical portion 134 further comprises a flat portion 138.

[0024] The first connecting part 100 further comprises a second portion 140 at the opposing end 142 of the first connecting part 100. The second portion 140 is provided with an opening 144 for receiving the extremity of an electrical conductor, e.g. a cable or a wire (not shown). The electrical conductor can be fixed in the opening 144 by means of one or more bolts 146, 148, e.g. shear bolts, that can be tightened in threaded though-holes 150, 152 provided on an upper side of the second portion 140 of

the first connecting part 100. In order to improve the fixation of the electrical cable to the second portion 140, the inner side of the opening 144 may be provided with a structured surface 145 against which the electrical conductor can be pressed when the bolts 146, 148 are tightened.

[0025] The second connecting part 200 comprises a ring shaped through-hole 204 with an inner surface 202 mating the outer radius of the circular portions of the cylinders 114,134. The inner surface 202 furthermore comprises two grooves 206, 208 extending along the axis C of the through-hole 204 and over the entire length L of the second connecting part 200.The second connecting part 200 further comprises a screw 250 positioned in a threaded through-hole 252 extending in the radial direction of the ring shaped through-hole 204.

[0026] In figure 2, a cross-section of the first 100 and the second 200 connecting parts of the connector 1. is Elements with the same reference numeral already used in Figure 1 will not be described in detail again but reference is made to their description above.

[0027] The first connecting part 100 and the second connecting part 200 are in a relative position to each other in which the second connecting part 200 can be mount onto or removed from the first connecting part 100. This relative position is called the second predetermined relative position according to the claims.

[0028] Figure 2 also illustrates, that the opening angle α of the hollow right cylinder 114 is less than 180°, as shown in the figure 1. Figure 2 further illustrates that the cylinder 114 has an essentially V-shaped cross section on the inner side with legs 122 and 124. The geometry of the cylinder 114 is adapted to receive different sizes of conductor pins or rods (not shown).

[0029] The second connecting part 200 can be mount on the hollow cylinder 114 by misaligning the axis A of the open cylinder 114 and the axis C of the ring shaped through-hole 204. In this relative position, the circular shapes of the first connecting part 100 and the second connecting part 200 are not concentric.

[0030] The misalignment of the first connecting part 100 and the second connecting part 200 is rendered possible when the ring shaped through-hole 204 is positioned such that the axis D of its threaded through-hole 252 - and the screw 250 - is facing the protrusion's 116 of the cylinder 114. In this relative position, the extremities 122a, 124a of the legs 122, 124 of the V-shaped cylinder 114 can enter the grooves 206, 208 of the second connecting part 200.

[0031] As a result, in the relative position between the first connecting part 100 and the second connecting part, also referred to as the second predetermined relative position, the second connecting part 200 can be moved over the protrusion 116 and then can slip over the first connecting part 100 along a direction parallel to the axis A and C.

[0032] Figures 3a and 3b illustrate the first connecting part 100 and the second connecting part 200 of the connector 1 in a further relative position, called the first predetermined relative position in the claims, corresponding to a mounted stage in which a decoupling of the two is prevented. Elements with the same reference numeral already used in Figure 1 or 2 will not be described in detail again but reference is made to their description above.

[0033] Figure 3a, is a three dimensional view of the connector 1 with the second connecting part 200 slip over the first portion 110 of the first connecting part 100. Figure 3.b illustrates a cross-section of the first connecting part 100 and the second connecting part 200 in the same relative position.

[0034] As can be seen in figures 3a and 3b, once the second connecting part 200 has been passed over the protrusion 116 on the outer wall 118 of the cylinder 114, the second connecting part has been rotated by 180° around its axis C.

[0035] In this relative position, the axis A of the first connecting part 100 and the axis C of the second connection part 200 are aligned. As a result, the grooves 206, 208 are misaligned with the extremities 122a, 124a of the legs 122 and 124 of cylinder 114. In this relative position, the removal of the ring shaped through-hole 204 is prevented as it abuts against the protrusion 116.

[0036] In this relative position, the screw 250 serves as a positioning ensuring means once it is screwed into the threaded through-hole 252 so that its front side 254 enters into the ring shaped through-hole 204. It is therefore no longer possible to align the grooves 206, 208 with the extremities of the legs 122a and 124a.

[0037] Now, the second connecting part 200 can be rotated around axis C with respect to the cylinder (illustrated by the double arrow 256) in an angular range β that is limited by the contact of the front of the screw 254 with one of the leg extremities 122a and 124a. In this entire angular range, the axis C and A of the ring shaped through-hole 204 and the cylinder 114 remain aligned so that over this range β a decoupling is no longer possible. According to the invention this range corresponds to the possible first relative positions of the first and second connecting parts 100 and 200 to each other.

[0038] In this embodiment it is the interplay between the protrusion 116, the grooves 206 and 208 and the fact that the opening angle α is 180° or less that prevents the misalignment of the axis A and C.

[0039] The figure 4 depicts the connector 1 in a configuration that can be used when the connector is not used, e.g. during shipment or storage. Elements with the same reference numeral already used in any one of figures 1 to 3 will not be described in detail again but reference is made to their description above.

[0040] As the right circular portion 136 of the second cylindrical portion 134 has the same radius as the outer surface 118 of the cylinder 114, the ring shaped through-hole 204 can be moved onto the second cylindrical portion 134 (see figure 1).

[0041] Once moved over the second cylindrical portion

136, the screw 250 of the ring shaped through-hole 204 is tightened such that its front end 254 comes on a rest on top of the flat portion 138, as can be seen in Figure 3b.

[0042] The screw 250 is then tightened and maintains the ring shaped through-hole 204 over the second right cylindrical portion 134 and does not move. Thus, the second connecting part 200 is in a fixed position with respect to the first connecting part 100.

[0043] In the figures 5a and 5b, the connector 1 is represented together with a mounted conductor 2. Elements with the same reference numeral already used in any one of figures 1 to 4 will not be described in detail again but reference is made to their description above.

[0044] A conductor 2 has been inserted into the first portion 110 of the first connecting part 100. The conductor 2 represented in figure 5a and 5b is for example a cylindrical rod or pin, typically made of copper or other suitable metallic materials. The connector 1 can be used with different conductors as long as the conductor diameter d2 fits into the open space 260 between the inner surface 202 of the ring shaped through-hole 204 and the inner surface 117 of the first cylinder 114.

[0045] Starting from the position as illustrated in figure 4, the screw 250 has been unscrewed to be able to move the ring shaped through-hole 204 over the cylinder 114 receiving the conductor 2. In order to securely fix the conductor 2 within the connector 1, the screw 250 is tightened again such that the screw 250 extends into the inner volume 260 of the ring shaped through-hole 204 and presses against the conductor 2.

[0046] As illustrated in the cross sectional view of figure 5b, the screw 250 presses the conductor 2 against the inner wall 117 of the first connecting part 100, more precisely against the inner wall 117 of leg 124 of the V-shaped inner surface.

[0047] For the purpose of improving the coupling between the connector 1 and the conductor 2, the angle γ between the direction of the pressing force which is along the screw axis D and the opposing leg 124 of the V-shaped inner wall 117 of the cylinder 114 is smaller than 90° when the first 100 and the second 200 connecting parts are in the first predetermined relative position. This condition can be satisfied by taking into account the opening angle α of the cylinder 114, the diameter 258 of the screw 250 and the slope δ of the leg 124. With the angle γ being less than 90° it is ensured the force along D pushes the conductor 2 towards the bottom 126 of the V-shaped inner surface 117.

[0048] Furthermore, the flat portion 138 is positioned such that there is always a distance d1 between the flat portion 138 and the conductor 2, independent of the diameter d2 of the conductor 2. Thus, it is not needed to unscrew the screw out of inner volume 260 of the ring shaped through-hole 204. Thus for any conductor 2 the screw 250 will remain with its front portion 254 inside the ring shaped through-hole 204, so that the first predetermined relative position between the first connecting part 100 and the second connecting part 200 remains ensured and the second connecting part 200 cannot be removed from the first connecting part 100.

[0049] The figure 6 represents a ring shaped through-hole 304 of a second connecting part 300 according to a second embodiment of the present invention. The only difference between the second embodiment and the first embodiment is the fact the ring shaped through-hole 304 only comprises one groove 306 instead of two or three. The remaining features are like in the first embodiment illustrated in figures 1 to 5.

[0050] The groove 306 is positioned at the same side as the through-hole 252 with the screw 250. According to other embodiments, the groove could also be moved away by about +/- 90°.

[0051] In a relative position between the first connecting part 100 and the second connecting part 300 of the second embodiment where the groove 306 is aligned with the protrusion 116 of the cylinder 114 of the first connecting part 200 the second connecting part can be moved over the protrusion and slip over the cylinder 114 to get it mount. This corresponds to the second relative position according to the claims.

[0052] Once passed the protrusion 116, the ring shaped through-hole 304 can be turned by a predetermined angle so that the protrusion 116 gets misaligned. In this position, the first relative position, a decoupling can be prevented.

[0053] The first relative position can then be secured by turning the screw 250 until it is inside the inner volume 260 of the ring shaped through-hole 304.

[0054] Unlike in the first embodiment, the axis C of the ring shaped through-hole 304 remains aligned with the axis A of the cylinder 114.

[0055] The figure 7 represents a ring shaped through-hole 404 of a second connecting part 400 according to a third embodiment of the present invention. The only difference of the third embodiment with respect to the second connecting part 200 of the first embodiment is the presence of a second through-hole 452 which is diametrically opposite to the threaded through-hole 252.

[0056] The through-hole 452 permits the insertion of a deformation tool adapted to deform the front of the screw 254 that is positioned inside the ring shaped through-hole 404 such that the front portion 254 of the screw 250 inside the ring 404 is larger than the diameter 262 of the threaded through-hole 252.

[0057] Hence, the deformed screw 250 can no longer be removed and remains with its end portion 254 inside the ring shaped through-hole 404. In this embodiment, the screw 250 and the ring can no longer be lost.

[0058] Modifications to embodiments of the invention described in the foregoing are possible without departing from the scope of the invention as defined by the accompanying claims. Expressions such as "including", "comprising", "incorporating", "consisting of", "have", "is" used to describe and claim the present invention are intended to be construed in a non-exclusive manner, namely allowing for items, components or elements not explicitly

described also to be present. Reference to the singular is also to be construed to relate to the plural.

Reference numeral list

[0059]

A, C, D: axis
L: length of the second connecting part
d1: distance between flat portion and conductor
d2: diameter of conductor
1: connector
2: conductor
100: first connecting part
110: first portion of the first connecting part
112: extremity of the first portion
113: opposite extremity of the first portion
114: cylinder portion
116: protruding portion, protrusion
117: interior sidewall
118: outer wall
119: inner wall
120: opening angle
122, 124: leg
122a, 124a: leg extremity
126: bottom of V-shape inner surface
130: second area of the first portion
134: second right cylindrical portion
136: outer surface
138: flat portion
140: second portion of the first connecting part
142: rear end of the first connecting part
144: opening
145: structured surface
146, 148: clamping bolt
150, 152: threaded through-hole
200, 300, 400: second connecting part
202: inner surface
204, 304, 404: ring shaped through-hole
206, 208, 306: groove
250: screw
252: threaded through-hole
254: front of screw
256: rotation range
258: diameter of screw
260: open space/volume
262: diameter of the through-hole 252
452: through-hole
α: opening angle
β: angular range
γ: force angle
δ: slope

Claims

1. An electrical connector (1) for connecting a first conductor (2) with a second conductor, comprising:

a first connecting part (100) and a second connecting part (200, 300, 400) which is adapted to slip over at least a first portion (110) of the first connecting part (100);

wherein the first connecting part (100) and second connecting part (200, 300, 400) each comprise a means configured to prevent a decoupling of the second connecting part (200, 300, 400) from the first connecting part (100) when the first connecting part (100) and the second connecting part (200, 300, 400) are in a first predetermined relative position to each other; and to allow a decoupling when the first connecting part (100) and second connecting part (200, 300, 400) are in a second predetermined relative position to each other.

2. The electrical connector (1) according to claim 1, wherein the first portion (110) of the first connecting part (100) comprises towards its extremity (112) a hollow right cylinder portion (114) that is opened along its axis (A);
wherein the cylinder (114) comprises towards its terminal end at least one protruding portion (116) extending from the outer wall (118) of the cylinder (114) in the radial direction (R).

3. The electrical connector (1) according to claim 2, wherein the cross section of the cylinder (114) is essentially V-shaped towards the inside (126) of the cylinder (114).

4. The electrical connector (1) according to claim 2 or 3, wherein the second connecting part (200, 300, 400) comprises an essentially circular ring shaped through-hole (204, 304, 404) mating the outer radius of the cylinder (114) and comprises at least one groove (206, 208, 306) in its inner surface (202) extending along the axis (C) of the ring shaped through-hole (204, 304, 404).

5. The electrical connector (1) according to one of claims 1 to 4, wherein in the second predetermined position, the at least one groove (206, 208, 306) is aligned with the protrusion (116) and/or extremities (122a, 124a) of the cylinder (114); and
wherein in the first predetermined position, the at least one groove (206, 208, 306) is misaligned with the protrusion (116) and/or extremities (122a, 124a) of the cylinder (114).

6. The electrical connector (1) according to claim 4 or 5, wherein the opening angle (α) of the hollow and open right cylinder (114) is 180° or less.

7. The electrical connector (1) according to one of claims 1 to 6, wherein the second connecting part (200, 300, 400) is further comprising a positioning

ensuring means for keeping the first (100) and the second (200, 300, 400) connecting parts in the first predetermined position.

8. The electrical connector (1) according to one of claims 1 to 7, wherein the positioning ensuring means comprises a screw (250) positioned in a threaded through-hole (252) extending essentially in the radial direction (D) of the ring shaped through-hole (204, 304, 404) inner surface (202) of the second connecting part (200, 300, 400) and ensuring the first predetermined position when the screw (250) extends by a predetermined length into the inner volume (260) of the ring shaped through-hole (204, 304, 404).

9. The electrical connector (1) according to one of claims 1 to 8, wherein the screw (250) axis and the opposing leg (122, 124) of the V-shaped cylinder (114) form an angle (γ) that is smaller than 90° when the first (100) and the second (200, 300, 400) connecting parts are in the first predetermined relative position.

10. The electrical connector (1) according to one of claims 1 to 9, wherein the first portion (110) of the first connecting part (100) comprises a second right cylindrical portion (134) at its second terminal end portion (113) aligned with the hollow right cylindrical portion (114); and
wherein the second cylindrical portion (134) has an outer surface (136) mating the inner surface (202) of the second connecting part (200, 300, 400) over an angular range of more than 180° and further comprising a flat portion (138), in particular for receiving the screw (250) of the positioning ensuring means.

11. The electrical connector (1) according to claim 7 or 8, wherein the screw (250) is deformed inside the ring shaped through-hole (204, 304, 404) such that the portion (254) of the screw (250) inside the ring shaped through-hole (204, 304, 404) is larger than the diameter (258, 262) of the threaded through-hole (252).

12. The electrical connector (1) according to claim 11, wherein the ring shaped through-hole (204, 304, 404) of the second connecting part (200, 300, 400) is further comprising a second through-hole (452) diametrically at the opposite of the threaded through-hole (252).

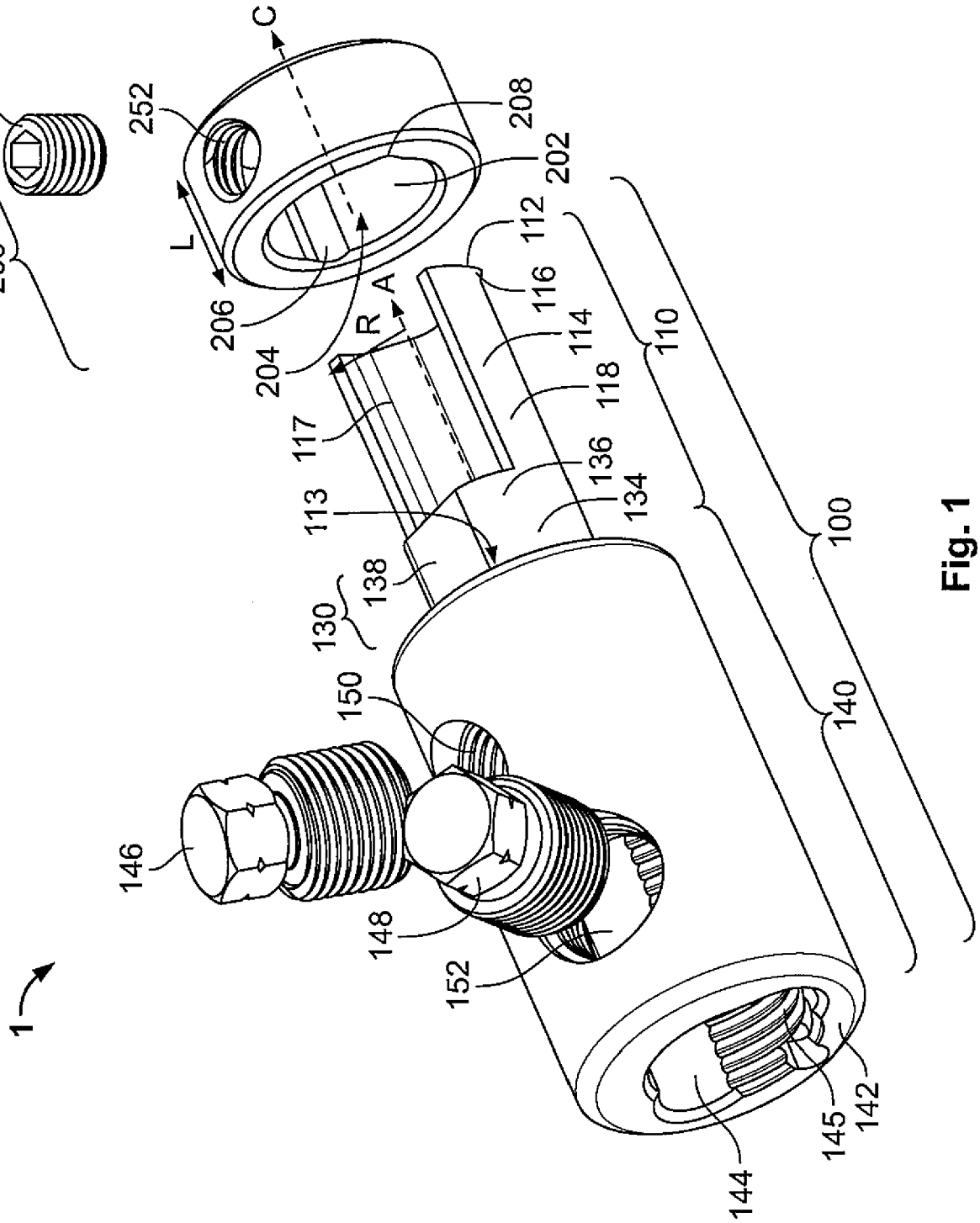
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Fig. 1

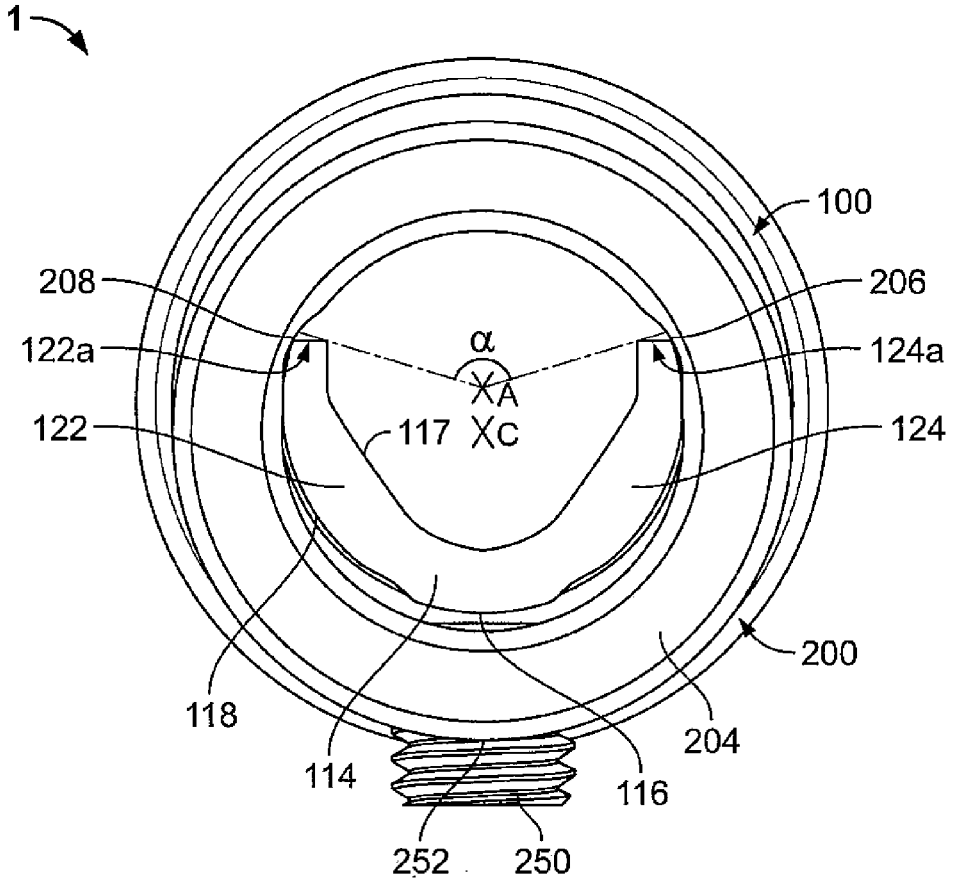
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Fig. 2

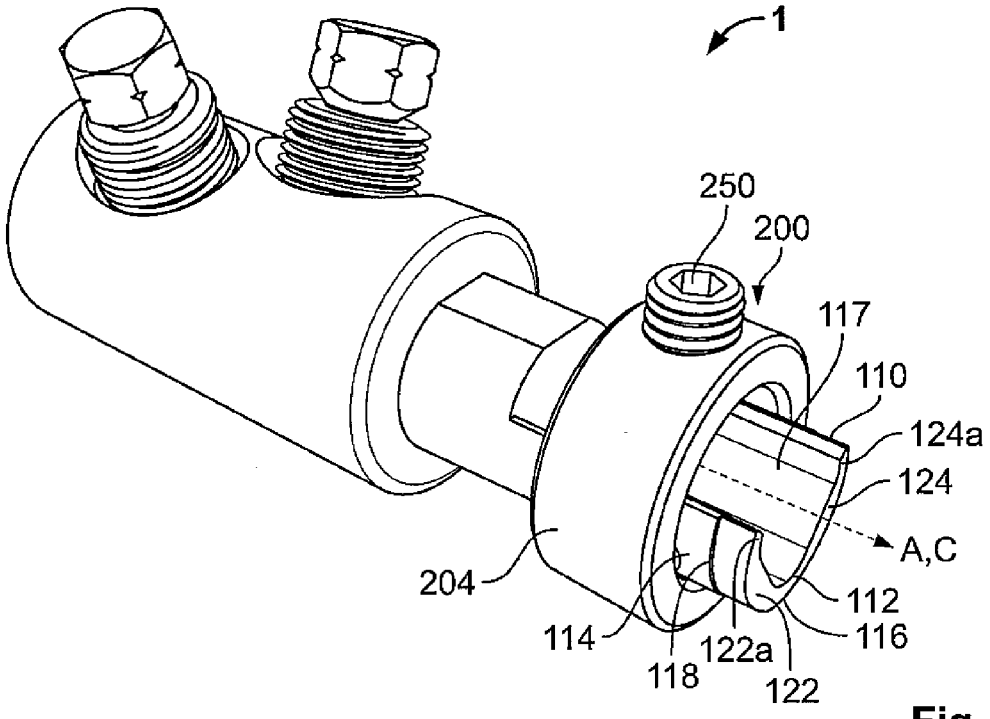
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Fig. 3a

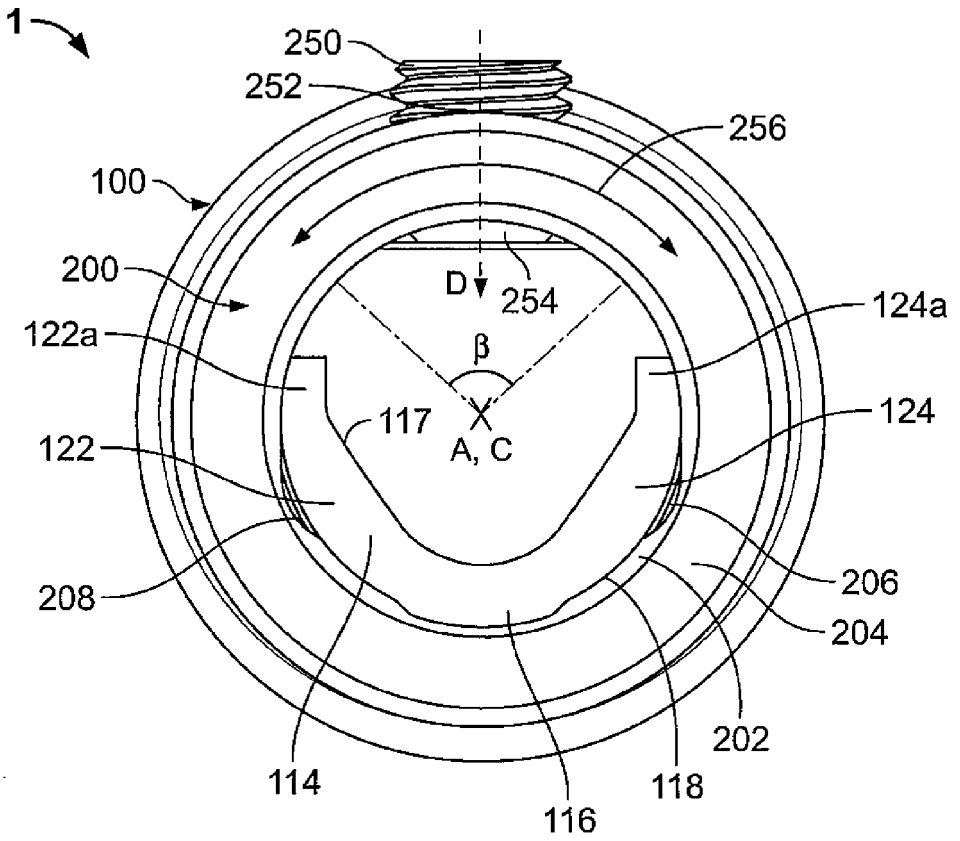
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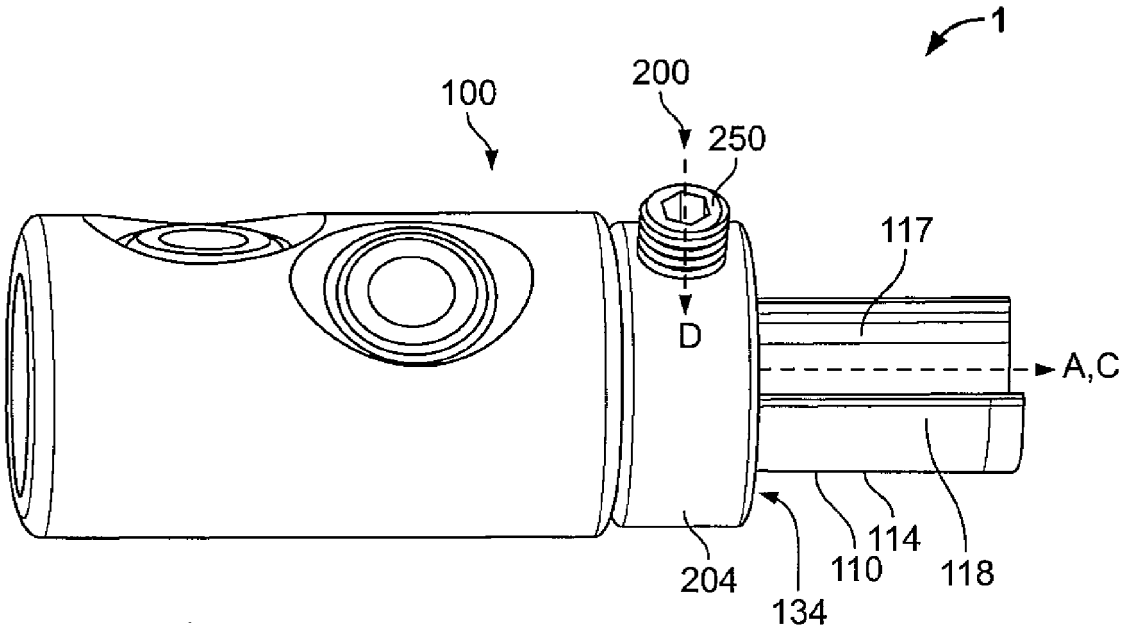
Fig. 3b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110
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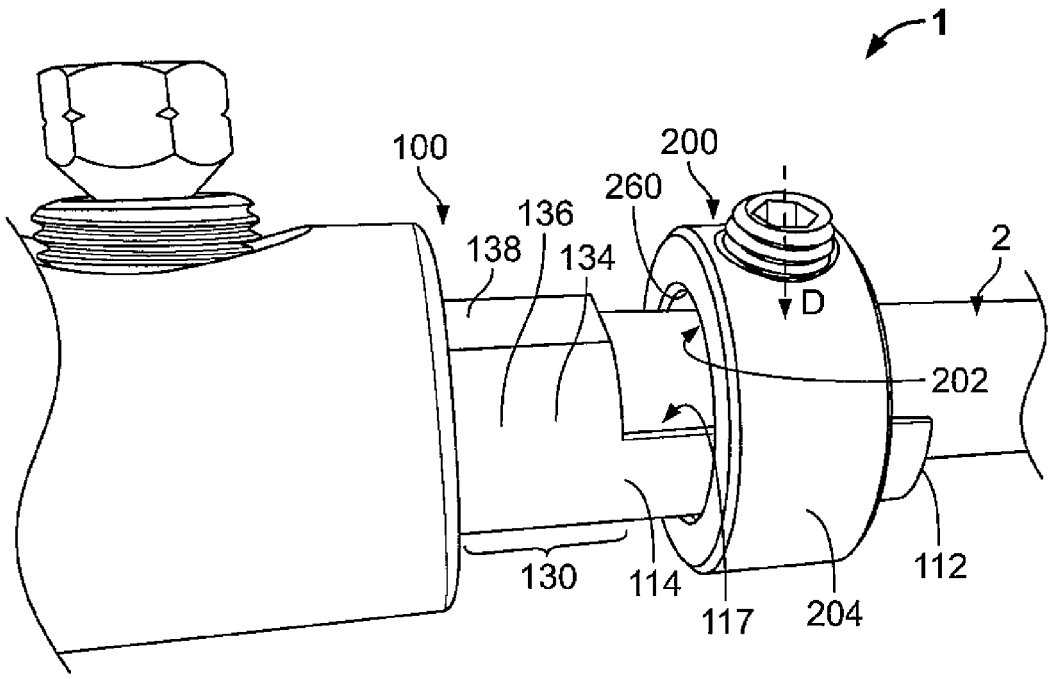
118

Fig. 4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100
200
260
136
138
134
2
D
202
130
114
117
204
112

Fig. 5a

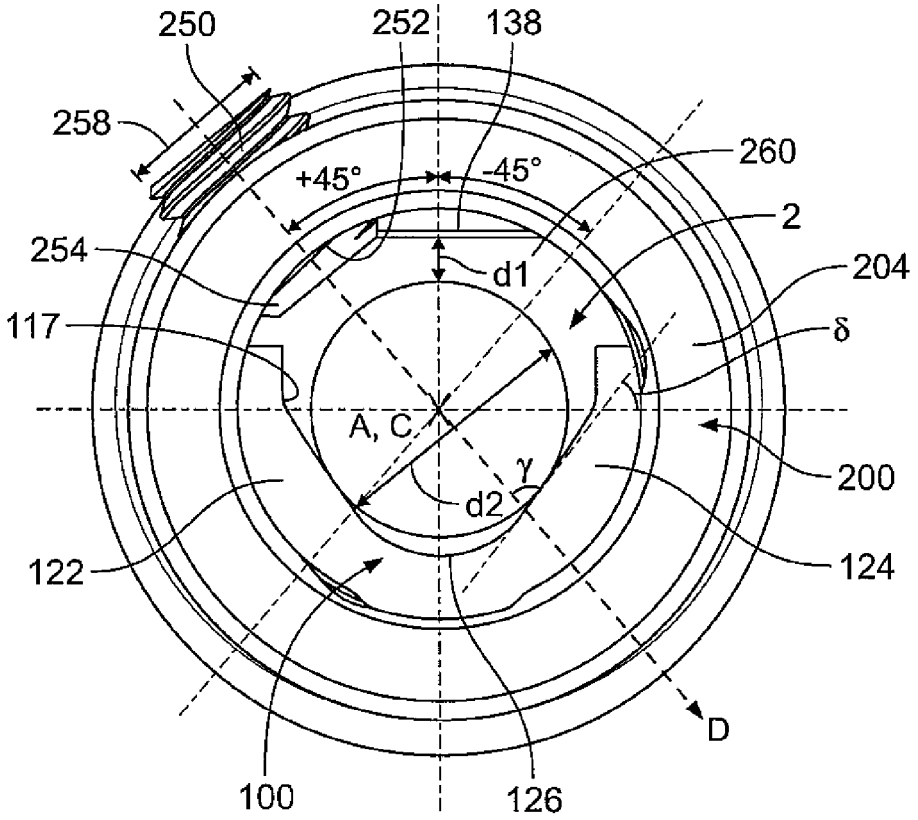
250
252
138
258
260
+45°
-45°
2
254
d1
204
117
δ
A, C
γ
200
d2
122
124
D
100
126

Fig. 5b

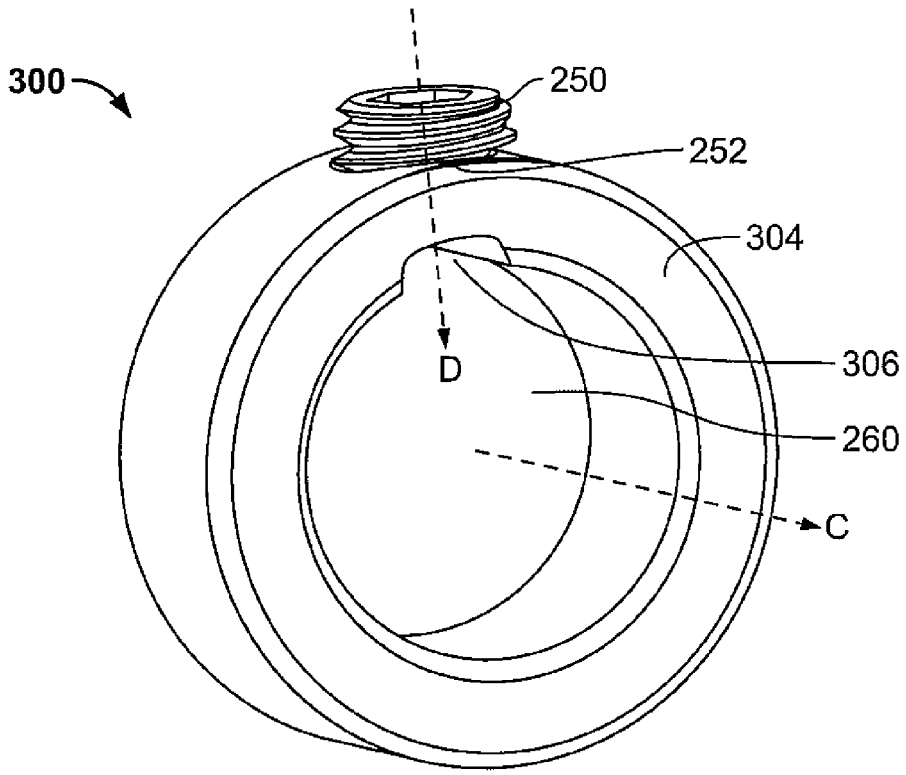

Fig. 6

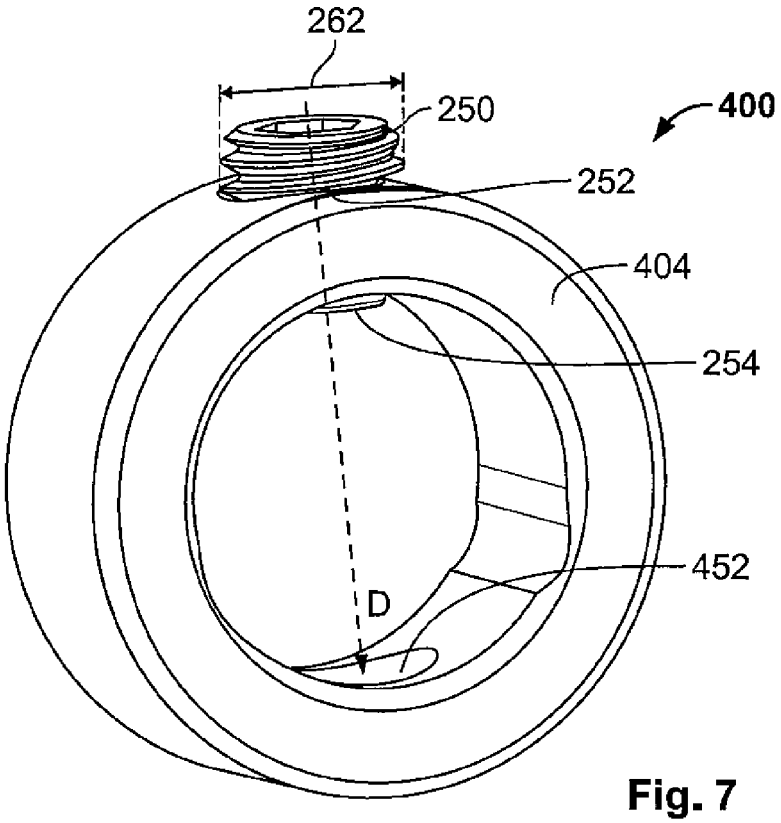

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 17 30 6193

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Place of search	Date of completion of the search	Examiner
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