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(71) Applicant: PERKINS ENGINES COMPANY LIMITED [GB/GB]; Eastfield, Peterborough PE1 5FQ (GB).

(72) Inventors: MUTHUKALYANI, Sathish Babu; 66 Livingstone Road, Kingssheath, Birmingham B14 6DN (GB).

BRADLEY, Joe Daniel; 37 Windsor Crescent, Northampton NN5 5AP (GB). DARLEY, James Andrew; 97 Lincoln Road, Deeping Gate, Peterborough Cambridgeshire PE6 9BB (GB). BENNETT, Robert Michael; 65 West Street, Helpston, Peterborough Cambridgeshire PE6 7DU (GB).

(74) Agent: BRP RENAUD & PARTNER MBB; Rechtsanwälte Patentanwälte Steuerberater, Königstraße 28, 70173 Stuttgart (DE).

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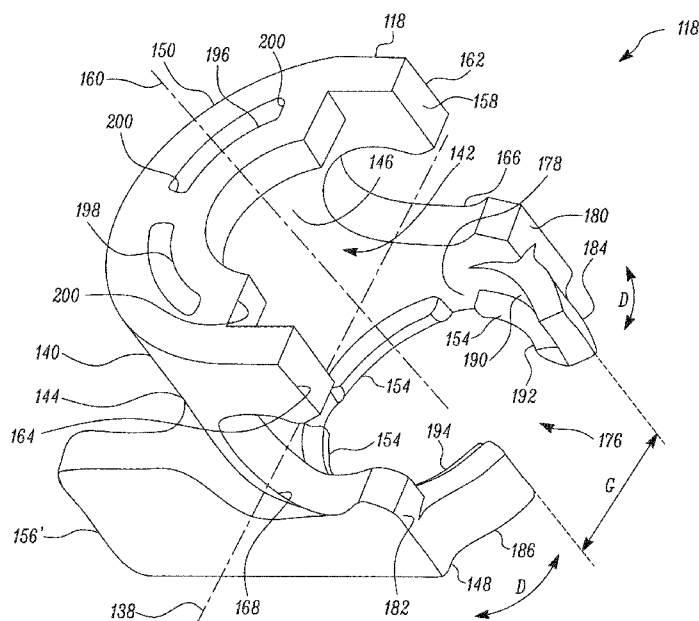


FIG. 6

(57) Abstract: A clip (118) for coupling a leak off connector (116) to a fuel injector (110) is disclosed. The clip is flexible and resilient. The clip includes a body (140) with a cavity (142) and a collar (144). The cavity is shaped so as to fit around and conform to at least a portion of the leak off connector such that the clip is retentively coupled to the leak off connector. A lip (154) is arranged on the collar and is configured to engage the fuel injector. Further, at least two tabs (156, 156') are coupled to the lip at opposing sides of the body and extend from the body. A movement of the two tabs by a force applied causes the lip to disengage from the fuel injector.

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DescriptionLEAK OFF CLIP FOR FUEL INJECTORS5 Technical Field

The present disclosure relates to the field of fuel injector assemblies for engines. More particularly, the present disclosure relates to a leak off clip that facilitates coupling of leak off connectors with fuel injectors of the fuel injector assemblies.

10 Background

Fuel injectors are applied in engine systems to deliver relatively high pressure fuel to combustion chambers of the engines systems for power generation. Fuel injectors may receive a pressurized fluid through connections, such as common rail systems. A received fuel is delivered to the combustion
15 chambers via injection nozzles arranged within the injectors. In general, a pressure-fed fuel first flows into a pressure control chamber of the fuel injector, and while a portion of fuel may be delivered for combustion, excess fuel is returned to a fuel tank via a circulation hose. A leak off connector facilitates the injectors' to be coupled to the circulation hose. It is known for fuel injector
20 assemblies to use a connector clip or a leak off clip that ensures that the leak off connector remains engaged with the fuel injectors. This is to prevent an undue disengagement of the leak off connectors from the injectors, such as because of engine vibrations, in turn preventing a leakage of fuel.

During service and repairs, connector clips may require to be
25 disassembled from the fuel injectors. One difficulty associated with conventional disassembly processes is the requirement to have additional tooling, such as pliers, tongs, etc., that are made to pull the connector clips out of engagement

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from the injectors and the connectors. Such a process is intensive of effort and time. Owing to a relatively small size of the connector clips, there also is an increased chance for the connector clips to be misplaced or lost. Such situations call for clip replacement, which adds to the burden of cost.

- 5 Patent Application EP 2101097 relates to a connecting device for a fluid transfer line. The connecting device has a deformable positioning unit mounted on a tubular female endfitting.

Summary of the Invention

- Various aspects of the present disclosure disclose a clip for
- 10 coupling a leak off connector to a fuel injector. The clip is flexible and resilient. The clip includes a body including a cavity and a collar. The cavity is shaped so as to fit around and conform to at least a portion of the leak off connector such that the clip is retentively coupled to the leak off connector. Further, a lip is arranged on the collar and is configured to engage the fuel injector. Furthermore,
- 15 at least two tabs are coupled to the lip at opposing sides of the body. The two tabs extends from the body. A movement of the at least two tabs by a force applied causes the lip to disengage from the fuel injector.

- Certain aspects of the present disclosure disclose a fuel injector assembly. The fuel injector assembly includes a fuel injector, a leak-off
- 20 connector, and a clip. The leak of connector is adapted to be coupled to the fuel injector. The clip is configured to couple the leak off connector to the fuel injector. The clip is flexible and resilient. The clip includes a body with a cavity and a collar. The cavity is adapted to fit around at least a portion of the leak off connector such that the clip is retentively coupled to the leak off connector.
- 25 Further, a lip is arranged on the collar and is configured to engage the fuel injector. Furthermore, at least two tabs are coupled to the lip at opposing sides of the body. The two tabs also extend from the body. A movement of the two tabs by a force applied causes the lip to disengage from the fuel injector.

Brief Description of the Drawings

FIG. 1 is an exemplary engine system having an engine installed with a fuel injector assembly that includes a flexible and resilient clip (or simply a clip), in accordance with the concepts of the present disclosure;

5 FIG. 2, 3, 4, and 5, are partial views of the injector assembly of FIG. 1, with the injector assembly illustrated to include a fuel injector, a leak off connector, an O-ring, and a clip, alongside depicting an exemplary assembly process of the injector assembly in sequence, in accordance with the concepts of the present disclosure;

10 FIG. 6 and 7 are detailed, enlarged views of the clip, in accordance with the concepts of the present disclosure;

 FIG. 8 is an embodiment of the clip, in accordance with the concepts of the present disclosure; and

15 FIG. 9 is a cross-sectional view of an assembled view of the injector assembly, in accordance with the concepts of the present disclosure.

Detailed Description

Referring to FIG. 1, an engine system 100 is shown. The engine system 100 includes an engine 102 and a fuel injection system 104 of the engine 102. The engine 102 may be one of the commonly applied power generation
20 units, such as an internal combustion engine (or simply an engine). The engine 102 may embody a V-type, an in-line, or a different configuration, as is conventionally known. Although not limited, the engine 102 may represent power generation units, such as a compression ignition engine powered by diesel fuel, a stratified charge compression ignition (SCCI) engine, or a homogeneous
25 charge compression ignition (HCCI) engine. In an embodiment, the engine 102 may be a gaseous engine or a dual fuel engine. Gaseous engines may use natural gas, propane gas, methane gas or any other gaseous suitable fuel for combustion and subsequent operation. The engine 102 is a multi-cylinder engine, although

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an engine with a single cylinder may also be applicable. Further, the engine 102 may be a two-stroke engine, a four-stroke engine, or a six-stroke engine.

Although the configurations disclosed, aspects of the present disclosure need not be limited to a particular engine type.

5 The engine 102 may be applicable in machines, such as general heavy machineries and conventional mobile equipment. In an example, machines may include off-highway trucks, mining trucks, skid steer loaders, wheel loaders, track type tractors, excavators, dozers, wheel loaders, etc. The present disclosure also envisions an extended application of the engine to stationary machines, such as power generation systems and other electric power generating machines. 10 Although the present disclosure contemplates employment of a multi-cylinder diesel engine, an equivalent application of the aspects of the present disclosure may be directed to other engine configuration and types as well.

 The fuel injection system 104 includes a number of fuel injector 15 assemblies 106, 106', 106'', 106''' that equal a number of cylinders of the engine 102. In so doing, one fuel injector assembly is allocated for each cylinder of the engine 102. Although four fuel injector assemblies 106, 106', 106'', 106''' are shown, aspects of the present disclosure are applicable to more or less number of fuel injector assemblies. Further, the fuel injection system 104 includes a fuel re- 20 circulation hose 108 that facilitates return of excess fuel from each of the fuel injector assemblies 106, 106', 106'', 106''' to a fuel tank (not shown). For this purpose, the fuel re-circulation hose 108 is fluidly connected to fuel injectors 110, 110', 110'', 110''' of each of the fuel injector assemblies 106, 106', 106'', 106''' that receives excess fuel and transfers the excess fuel to a fuel tank. In 25 general, the fuel re-circulation hose 108 forms a low pressure flow line and a travel path to relatively easily allow the excess fuel to return to the fuel tank. As shown, the fuel re-circulation hose 108 is intermittently arranged to the fuel injectors 110, 110', 110'', 110''', with a hose portion fluidly coupled to each fuel injector, among the fuel injectors 110, 110', 110'', 110'''.

For ease in reference and understanding, further description is directed towards the fuel injector assembly 106 alone. It will be understood that details discussed for the fuel injector assembly 106 will be applicable for each fuel injector assembly 106 of the fuel injection system 104.

5 Referring to FIGS 2, 3, 4, and 5, the fuel injector assembly 106 is shown in further detail. The fuel injector assembly 106 includes the fuel injector 110, a leak off connector 116, an O-ring 117, and a flexible and resilient leak off clip (or simply a clip 118). FIGS 2, 3, 4, and 5, also depict an exemplary sequence of assembling the clip 118 with the leak off connector 116, and the leak
10 off connector 116 with the fuel injector 110, according to an aspect of the present disclosure.

The fuel injector 110 may be configured to receive fuel from a common rail (not shown) under relatively high pressure. The fuel injector 110 may include a pressure control chamber to receive the pressure fed fuel from the
15 common rail. A portion of the received fuel may be released to control a valve body of the fuel injector 110 to perhaps alter the fuel injector's nozzle orifice (not shown). As the injection nozzle orifice is opened, fuel is dispensed or injected into the combustion chambers for combustion and subsequent power generation. During each fuel injection cycle, excess fuel may be generated within the fuel
20 injector 110. This excess fuel is recirculated back to the fuel tank. To this end, excess fuel may follow the alternate travel path (through the fuel re-circulation hose 108, FIG. 1) to return to the fuel tank. Further, the fuel injector 110 may include an electrical input portion 120 that may facilitate receipt of electrical energy to cater to various operational parameters of the fuel injector 110. The
25 fuel injector 110 includes a female end fitting 122 to which the fuel re-circulation hose 108 is fluidly connected (as will be discussed further below), assisting in the formation of a return travel path for the excess fuel. One or more grooves (or simply a groove 114) is structured on an outer surface of the female end fitting 122 to receive the clip 118, such as a lip of the clip 118 (also discussed later).

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The leak off connector 116 is a tubular member configured to be fluidly coupled to the fuel injector 110. The fluid coupling of the leak off connector 116 enables the leak off connector to receive the excess fuel from the fuel injector 110. To this end, the leak off connector 116 includes a male end fitting 124 that is received into the female end fitting 122 of the fuel injector 110. Both the female end fitting 122 and the male end fitting 124 may be tubular structured, so as to mate and comply with each other. Other known shapes and profiles are possible. A tubular stem 128 of the leak off connector 116 may extend from the male end fitting 124 towards a T-junction and diverge into two fluid lines. Such a configuration forms twin diverged end sections 130, 132 (or a first diverged end section 130 and a second diverged end section 132) of the leak off connector 116. Such a configuration imparts the leak off connector 116 with a T-shaped profile. As with the tubular stem 128, the twin diverged end sections 130, 132 are also tubular in construction. The T-junction includes a clip seat 126 around which the clip 118 may be seated during assembly of the clip 118 to the leak off connector 116. Further, the twin diverged end sections 130, 132 of the leak off connector 116 are configured to be coupled to the intermittent sections of the fuel re-circulation hose 108 that perhaps extend from and to adjacent fuel injector assemblies (such as fuel injector assembly 106', FIG. 1). The twin diverged end sections 130, 132 of the leak off connector 116 may be secured to the fuel re-circulation hose 108 via screw clamps, for example.

The male end fitting 124 includes a groove 134 in which the O-ring 117 is positioned. The O-ring 117 may be of a suitable size in relation to dimensions of the groove 134. A positioning of the male end fitting 124 within the female end fitting 122 may assume a clearance-fit engagement. During an exemplary assembly practice, as the male end fitting 124 of the leak off connector 116 is inserted and positioned into the female end fitting 122 of the fuel injector 110, the O-ring 117 is circumferentially compressed against the groove 134 and an inner wall portion of the female end fitting 122. As a result, force may be

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required to effectively assemble the male end fitting 124 into the female end fitting 122. Once assembled, the leak off connector 116 may be relatively tightly retained by the fuel injector 110, with the O-ring 117 forming an interface between the male end fitting 124 and the female end fitting 122. In so doing, the O-ring 117 may also facilitate control and mitigation of a radial play between the male end fitting 124 and the female end fitting 122. Moreover, the O-ring 117 seals the leak off connector 116 with the fuel injector 110, preventing possibilities of fuel leakage from said interface.

The clip 118 is used as an additional assembly element to secure and retentively couple the leak off connector 116 to the fuel injector 110. The clip 118 may secure the leak off connector 116 to the fuel injector 110 and minimize axial play between said components, and in turn prevent axial displacement (or disengagement) of the leak off connector 116 from the fuel injector 110. The clip 118 is applicable particularly during conditions, such as those involving excessive engine vibrations, which may cause the leak off connector 116 to be disengaged from the fuel injector 110, had the clip 118 been absent. The clip 118 is also applicable during normal working conditions, as pressure difference may persist across the interface formed by the O-ring 117 (such as low pressure within the fuel re-circulation hose 108), and which may otherwise cause the male end fitting 124 to be disengaged from the female end fitting 122. By constituting such an additional assembly element, the clip 118 also ensures that a fuel leakage between the leak off connector 116 and the fuel injector 110 is effectively prevented.

The clip 118 includes a body 140 with a cavity 142 and a collar 144. The body 140 of the clip 118 is flexible and resilient, as disclosed above. Although not limited, the clip 118 is shell shaped with a uniform thickness defined across the clip 118's structure. The cavity 142 is adapted to fit around at least a portion of the leak off connector 116 and substantially laterally position and retain the leak off connector 116 (best shown in FIGS. 4 and 5), and thereby

retentively couple the clip 118 to the leak off connector 116. In particular, the cavity 142 is shaped so as to fit around and conform to at least a portion of the leak off connector by engaging the twin diverged end sections 130, 132 of the leak off connector 116. The collar 144 includes a curved portion or a wall 146 with a first axial end 148 and a second axial end 150. The collar 144 includes a lip 154 at the first axial end 148 that is adapted to engage to the fuel injector 110 around the female end fitting 122. Further, the clip 118 is also provided with at least two tabs 156, 156' (or a first tab 156, and a second tab 156', best shown in FIG. 7) that are arranged at diametrically opposed sides of the first axial end 148. The two tabs 156, 156' are configured to disengage the lip 154 from the fuel injector 110.

Referring to FIGS 6 and 7, the clip 118 is shown, with surrounding components removed for better understanding the contours and silhouettes of the clip 118. The clip 118 includes an intermediate portion 158 defined between the first axial end 148 and the second axial end 150. The body 140 of the clip 118 defines a semi-cylindrical structure with the wall 146 or the curved portion being defined about an axis 160 of the body 140. In so doing, the body 140 defines a first curvature end 162 and a diametrically opposed, second curvature end 164. The wall 146 includes a pair of cutouts 166, 168 (or a first cutout 166 and a second cutout 168) at the intermediate portion 158. The pair of cutouts 166, 168 are also referred to as a first cutout 166 and a second cutout 168. The first cutout 166 is structured on the first curvature end 162, while the second cutout 168 is structured at the second curvature end 164. As the first curvature end 162 is diametrically opposed to the second curvature end 164, the pair of cutouts 166, 168 are also defined diametrically opposed to each other. Moreover, the pair of cutouts 166, 168 are also co-axial (along axis 138) to each other. In some embodiments, however, it may be contemplated that the pair of cutouts 166, 168 are positioned without being co-axial to each other, so as to accommodate a twin diverged end sections 130, 132 of the leak off connector 116, which are bent

about an axis 174 of the twin diverged end sections 130, 132. Further, the pair of cutouts 166, 168 may be circular in shape so as to accommodate the twin diverged end sections 130, 132 of the leak off connector 116. More particularly, the pair of cutouts 166, 168 together, along with the cavity 142, define a
5 receptacle 170 configured to support and retain the twin diverged end sections 130, 132 and the clip seat 126 of the leak off connector 116 within the cavity 142. The receptacle 170 (or the pair of cutouts 166, 168) includes a mouth 172 that has a dimension lesser than a diameter of the leak off connector 116 (or of the twin diverged end sections 130, 132). In that way, the twin diverged end sections 130,
10 132 of the leak off connector 116 may be snap fitted into the receptacle 170 so as to be retentively coupled by the clip 118. The clip 118 is therefore “captive”, supporting and retaining the leak off connector 116 within the cavity 142.

In an embodiment, the clip 118 may possess an alternate shape such as a semi-cuboidal shape with a curved cavity (such as the cavity 142)
15 defined within. The clip 118 with such a configuration may also fit around at least a portion of the female end fitting 122 of the fuel injector 110, while encompassing a portion of the leak off connector 116. Opposed sides of the semi-cuboidal shaped clip may define the pair of cutouts and which may remain similar in form and function of the cutouts 166, 168 described above.
20 Accordingly, alternate profiles for the clip 118 may be contemplated, such as those also constituting a polygonal shape, etc.

Further, the collar 144 defines an opening 176 to receive the female end fitting 122 of the fuel injector 110 at the first axial end 148. The opening 176 has an inner wall 178, and as with the wall 146, the inner wall 178 is
25 also curved to define a first curved retention end 180 and a second curved retention end 182 (or simply retention ends 180, 182) of the opening 176. In an embodiment, the inner wall 178 is contiguous to the wall 146. A diametrically opposed pair of arms (first arm 184 and second arm 186) are provided at the retention ends 180, 182 defined at the first axial end 148. The pair of arms 184,

186 extend in continuity to the inner wall 178, such as in curvature continuity, and converge to define a gap, G , therebetween. In a default state of the clip 118, the gap, G , is smaller than a diameter of the female end fitting 122. An extension of the pair of arms 184, 186 also define a contiguous inner wall surface 190 at the first axial end 148. In an embodiment, the wall 146 and the contiguous inner wall surface 190 are in continuity to each other.

The lip 154 of the clip 118 is structured on the contiguous inner wall surface 190. The lip 154 includes an array of spaced apart lip portions (also denoted as lip 154) that extend radially into the opening 176. The lip 154 is defined in manner that it is spread circumferentially over the contiguous inner wall surface 190, extending from the first arm 184, to the inner wall 178, and all the way till the second arm 186. A portion of the lip 154 extended into the first arm 184 is termed as a first lip portion 192, while a portion of the lip 154 extended into the second arm 186 is termed as a second lip portion 194. With the lip 154 being structured as spaced apart lip portions, the lip 154 avoids hampering of a flexibility of the clip 118 at the opening 176, making the diametrically opposed pair of arms 184, 186 flexible relative to the inner wall 178 (see arrows, D , FIG. 6).

The two tabs (divided into a first tab 156 and a second tab 156') are arranged at opposing sides (or diametrically opposite) of the body 140, and are also diametrically opposed to a layout of the pair of arms 184, 186. Moreover, the two tabs 156, 156' integrally extend from the body 140, and, in that way, are coupled to the lip 154 (which is also integrally formed) within the contiguous inner wall surface 190. More particularly, the first tab 156 may be coupled to the first lip portion 192, while the second tab 156' may be coupled to the second lip portion 194. A connection of the two tabs 156, 156' to the pair of arms 184, 186 may be such that a movement (direction, C , FIG. 7) of the two tabs 156, 156', attained by a force applied, causes the gap, G , (FIG. 6) to increase, allowing the lip 154 to disengage from the fuel injector 110. The two tabs 156,

156' are tangentially arranged relative to the body 140. Both the first tab 156 and the second tab 156' are compressible towards each other, so as to effect a movement of the pair of arms 184, 186, and thus the first lip portion 192 and the second lip portion 194 (arrows, *D*, FIG. 6). The two tabs 156, 156' may
5 constitute thicker or strengthened sections of the clip 118 (such as inclusive of metal sections, for example) so as to effect a flexure of the first lip portion 192 and the second lip portion 194, as a movement between the first tab 156 and the second tab 156' is initiated. In effect, as the two tabs 156, 156' move towards each other, the first lip portion 192 and the second lip portion 194 may be
10 deformed and the gap, *G*, may be expanded.

In an embodiment, each of the body 140, the lip 154, and the two tabs 156, 156' of the clip 118, are integrally formed, perhaps in the same mold. In an embodiment, the clip 118 may be made from plastic so as to be deformable, resilient and flexible.

15 Further, the collar 144 of the clip 118 includes a reinforcement structure 196 arranged between the cutouts 166, 168, and positioned at the second axial end 150 of the collar 144. The reinforcement structure 196 is inclusive of a semicircular inner ring member 198 with a curvature, substantially concentrically positioned within the collar 144. The inner ring member 198 may have a
20 thickness that match the thickness of the collar 144. Three links denoted as links 200 are extended from the inner ring member 198, and along a plane of inner ring member 198, to connect the curved portion (wall 146), thereby making the reinforcement structure 196 integral with the collar 144. The links 200 also match the thickness of the collar 144. Moreover, the links 200 may be circularly
25 arrayed, with each link 200 making right angles to a successive link 200, from a start of the curvature to an end of the curvature, as shown.

Referring to FIG. 8, a clip 118' is shown. The clip 118' is similarly referenced as the clip 118, and is also similar in form and function to the clip 118. However, the clip 118' includes tabs 204, 204' that are in

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structurally varied from the two tabs 156, 156'. In particular, the tabs 204, 204' are further extended in length from the clip 118' in comparison to the two tabs 156, 156'. The tabs 204, 204' are also wider and define a first end 206 and a second end 206' (or ends 206, 206'), respectively. The ends 206, 206' include a first compression spacer 208 and a second compression spacer 208' (collectively, compression spacers 208, 208'), respectively. The compression spacers 208, 208' are bent and directed towards each other, as shown. In an embodiment, the clip 118' may include only a single compression spacer 208. Additionally, the tabs 204, 204' include raised features, referred to as a first gripper 210 and a second gripper 210'. Although, not limited, the grippers 210, 210' are also defined at the ends 206, 206', respectively. The grippers 210, 210' are shaped in the form of bulges and are directed outwardly and oppositely to the compression spacers 208, 208', as shown.

Referring to FIG. 9, a cross sectional view of an assembly between the leak off connector 116, the fuel injector 110, and the clip 118 is shown. This assembly pertains to the position where the leak off connector 116 is retained with the fuel injector 110, and the clip 118 secures an assembly between the leak off connector 116 and the fuel injector 110. As shown, the twin diverged end sections 130, 132 of the clip 118 are seated and retained within the pair of cutouts 166, 168. The male end fitting 124 of the leak off connector 116 is inserted into the female end fitting 122 so as to draw substantially entirely the tubular stem 128 within the female end fitting 122. In this position, the lip 154 of the clip 118 is snapped into the groove 114 of the female end fitting 122.

Industrial Applicability

Referring to FIGS. 2, 3, 4, and 5, an exemplary assembly operation of the fuel injector assembly 106 is discussed in sequence. During assembling, an operator assembles the O-ring 117 to the groove 134 of the male end fitting 124 (FIGS. 2 and 3). Thereafter, the operator inserts the clip seat 126

of the leak off connector 116 into the cavity 142 of the clip 118. An associated direction of engagement of the clip 118 to the leak off connector 116 is substantially lateral to the axis 160 (direction, *A*, FIGS. 2 and 3). As the clip 118 is brought into engagement with the leak off connector 116, the twin diverged
5 end sections 130, 132 are snapped into the receptacle (or into the pair of cutouts 166, 168). In so doing, the cavity 142 is adapted to fit around at least a portion of the leak off connector 116. A seating of the clip 118 to the leak off connector 116 and an engagement of the cutouts 166, 168 to the twin diverged end sections 130, 132 facilitates the leak off connector 116 to be retentively coupled within
10 the receptacle 170. As a result, a captive assembly between the clip 118 and the leak off connector 116 is obtained (FIG. 4).

Further, the operator pushes the captive assembly of the clip 118 and the leak off connector 116 into the female end fitting 122 of the fuel injector 110. An associated direction of assembly is facilitated along the axis 160 of the clip 118 and envisioned by direction, *B* (FIG. 4). In that way, the lip 154 of the
15 opening 176 snaps into the groove 114 of the female end fitting 122, and thus, the captive assembly of the clip 118 and the leak off connector 116 is secured into the fuel injector 110 (FIG. 5). A chamfered top edge 202 (FIG. 9) of the female end fitting 122 may allow the opening 176 of the clip 118 to slide past an outer
20 periphery of the female end fitting 122 with relative ease.

During disassembly, the operator applies a force to move or compress the two tabs 156, 156' towards each other (direction, *C*, FIG. 7) to affect a movement of the first lip portion 192 and the second lip portion 194 of the lip 154. As a result, the gap, *G*, between first lip portion 192 and the second
25 lip portion 194 starts to expand. Once the gap, *G*, expands to a suitable extent, such as to tally with a diameter of the female end fitting 122, the operator moves the captive assembly of the clip 118 and the leak off connector 116 out of engagement from the fuel injector 110. An associated direction of disengagement may be envisioned as being opposite to the direction, *A* (FIG. 2).

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As an alternative assembly practice, the operator may first assemble the leak off connector 116 to the fuel injector 110 by inserting the male end fitting 124 of the tubular stem 128 into the female end fitting 122 of the fuel injector 110. Thereafter, the operator may assemble the clip 118 to the assembly
5 of the leak off connector 116 and the fuel injector 110. In detail, the operator may move or squeeze the two tabs 156, 156' of the clip 118 towards each other to expand the gap, G (FIG. 6). once the gap, G , is at least equivalent to the diameter of the female end fitting 122, the operator may bring forth the first lip portion 192 and the second lip portion 194 to encompass the female end fitting 122, around
10 the groove 114. Once such a position is attained, the operator may release the two tabs 156, 156' to allow the first lip portion 192 and the second lip portion 194 to return to the default state, thereby engaging the lip 154 with the groove 114. Simultaneously, the operator may also snap the twin diverged end sections 130, 132 into the receptacle 170 (or the cutouts 166, 168), as mentioned above.

15 As with the clip 118, the clip 118' (FIG. 8) may be similarly operated. As an additional aspect of clip 118', during disassembly of the clip 118' for example, the operator applies a force to move or compress the tabs 204, 204' towards each other. As a result, the gap, G , (FIG. 6) between first lip portion 192 and the second lip portion 194 (FIG. 6) starts to expand. Further,
20 since the compression spacers 208, 208' of the tabs 204, 204' are directed towards each other, the compression spacers 208, 208' move and abut each other and halt a further compression of the tabs 204, 204' towards each other. In that way, the tabs 204, 204' are restrained from being overly compressed. Moreover, the gap, G , is also restricted to expand to a maximum degree, and which may
25 comply with a diameter of the female end fitting 122.

As the clip 118 is captive to the leak off connector 116, however small the clip 118 may be, the chances for the clip 118 to be lost or misplaced from the leak off connector 116 is minimal. Moreover, the two tabs 156, 156' allows the operator to remove the clip 118 from the groove 114 of the female end

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fitting 122 without the need to have additional tooling. The clip 118 is also reinforced by the reinforcement structure 196 imparting robustness to the clip 118, and effectively allowing back and forth movement (squeeze) of the two tabs 156, 156' towards each other.

- 5 It should be understood that the above description is intended for illustrative purposes only and is not intended to limit the scope of the present disclosure in any way. Thus, one skilled in the art will appreciate that other aspects of the disclosure may be obtained from a study of the drawings, the disclosure, and the appended claim.

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Claims

1. A clip for coupling a leak off connector to a fuel injector,
the clip being flexible and resilient, the clip comprising:
 - 5 a body comprising a cavity and a collar, the cavity shaped so as to fit around and conform to at least a portion of the leak off connector such that the clip is retentively coupled to the leak off connector;
 - a lip arranged on the collar and configured to engage the fuel injector; and
 - 10 at least two tabs coupled to the lip at opposing sides of the body and extending from the body, wherein a movement of the at least two tabs by a force applied causes the lip to disengage from the fuel injector.
2. The clip of claim 1, wherein the movement of the at least
15 two tabs include compressing the at least two tabs towards each other.
3. The clip of claim 1 or 2, wherein the body defines a semi-cylindrical structure, with the at least two tabs being tangentially arranged relative to the body.
20
4. The clip of any preceding claim, wherein the collar includes a wall, defining a pair of cutouts, the pair of cutouts being diametrically opposed to each other and adapted to support and retain the leak off connector within the cavity.
25
5. The clip of claim 4, wherein the collar includes a reinforcement structure arranged between the pair of cutouts.

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6. The clip of claim 4 or 5, wherein the pair of cutouts defines a receptacle and a mouth, wherein the mouth of the pair of cutouts is smaller than a diameter of the leak off connector.
- 5 7. The clip of any preceding claim, wherein the collar defines an opening to receive the fuel injector, the opening having an inner wall, the collar including a diametrically opposed pair of arms that extend in continuity to the inner wall to define a contiguous inner wall surface.
- 10 8. The clip of claim 7, wherein the lip is structured on the contiguous inner wall surface as an array of spaced apart lip portions.
9. The clip of any preceding claim, wherein the body, the lip, and the at least two tabs, are integrally formed.
- 15 10. The clip of any preceding claim, wherein the least two tabs include one or more compression spacers to limit a movement of the at least two tabs towards each other.

20

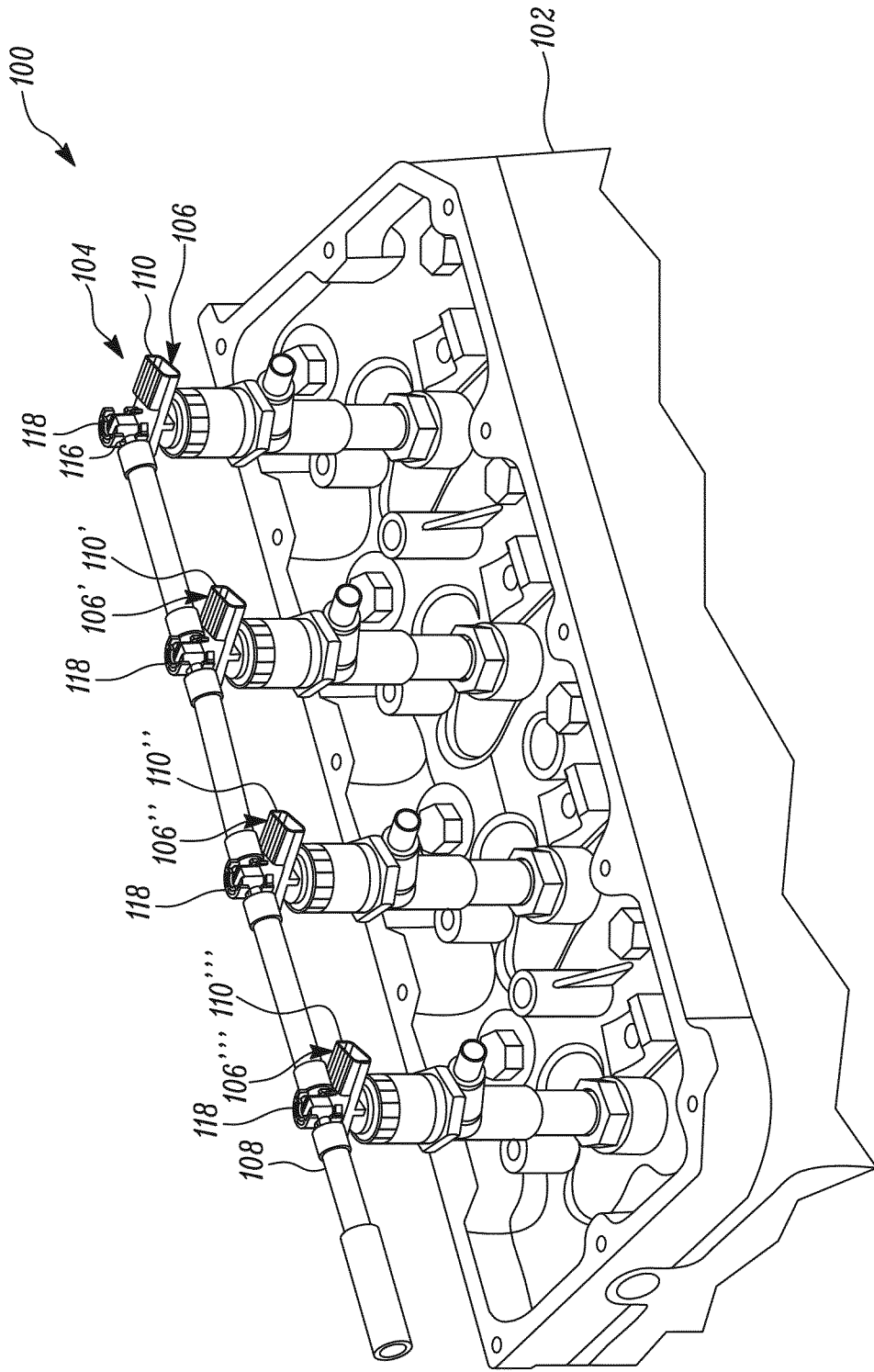


FIG. 1

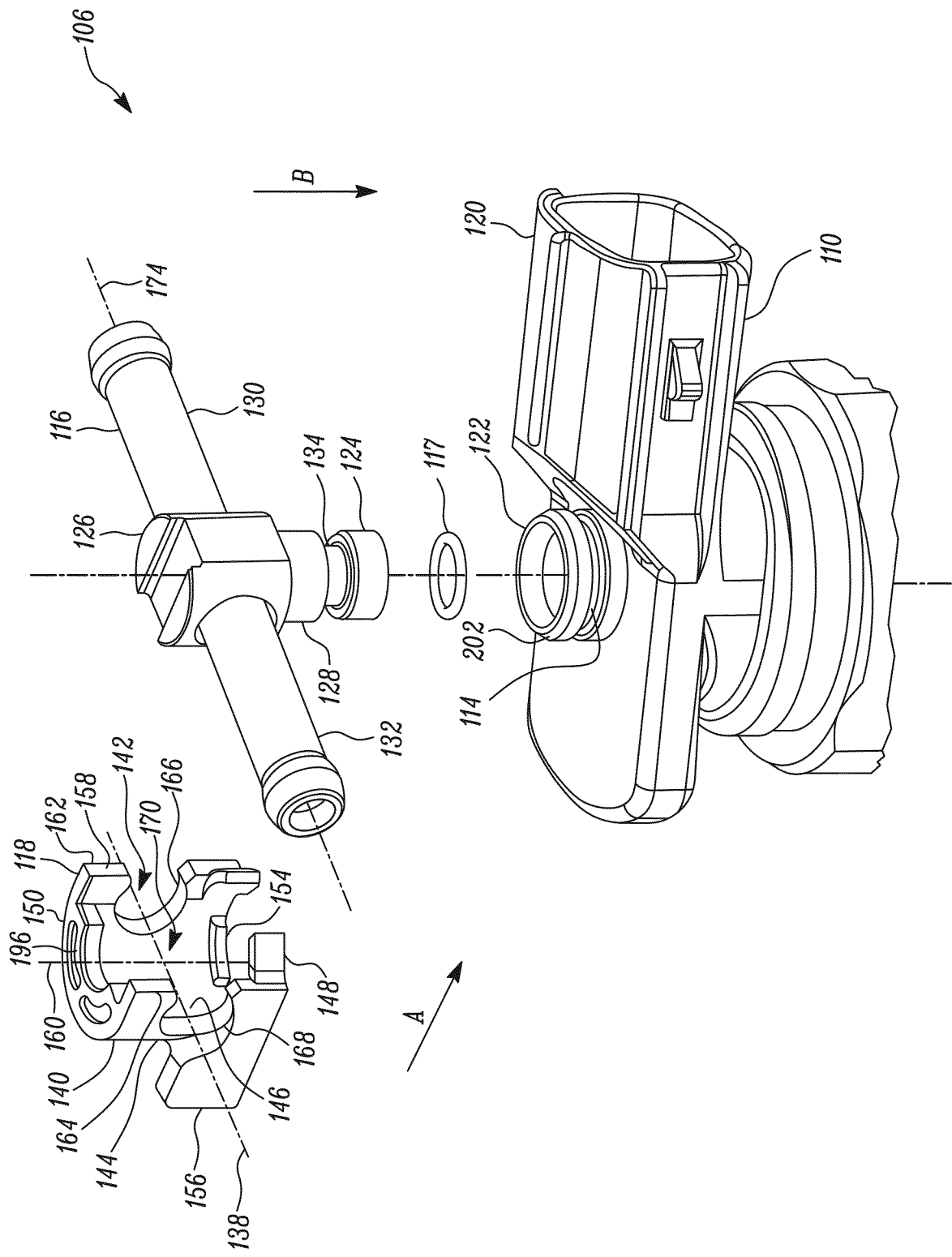


FIG. 2

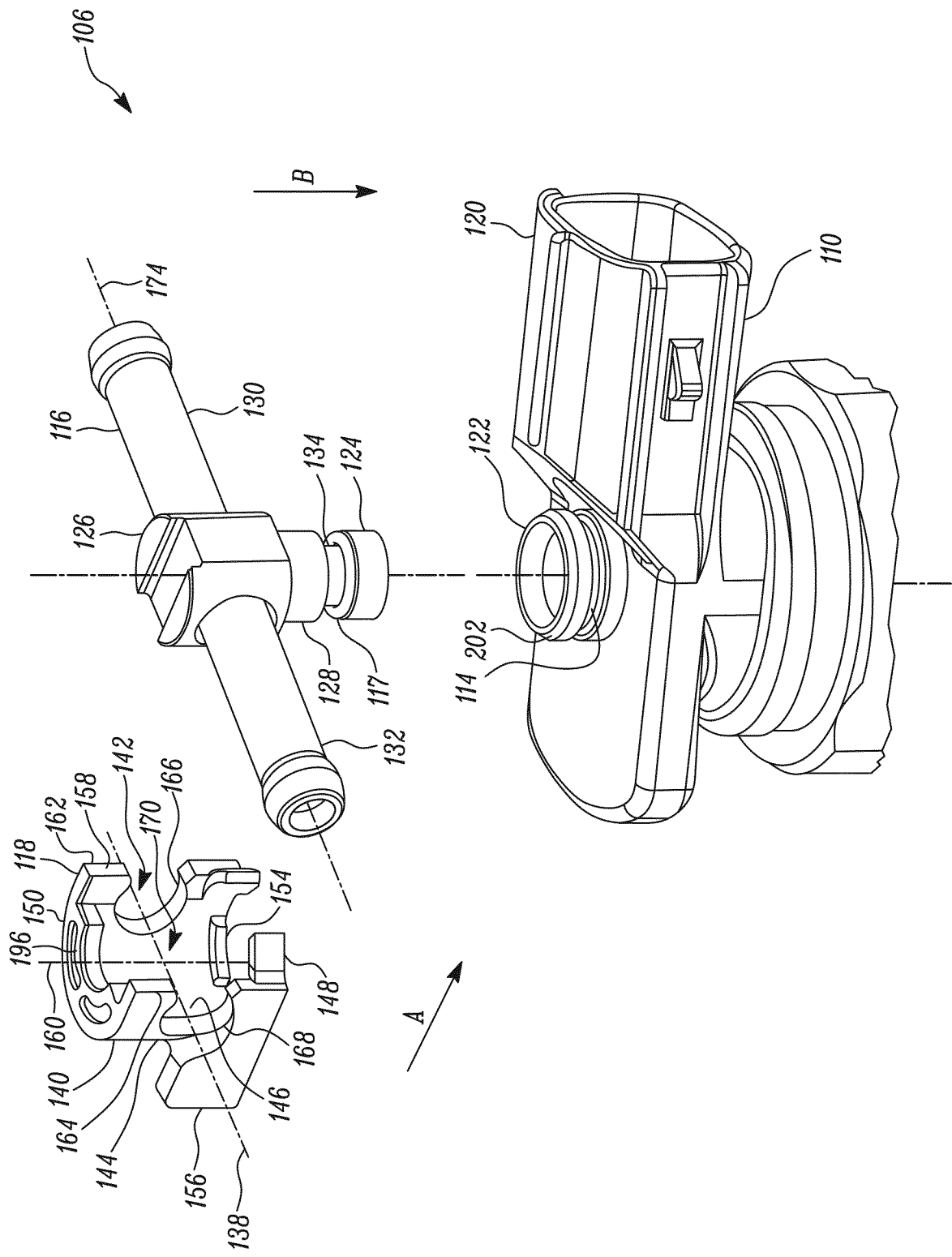


FIG. 3

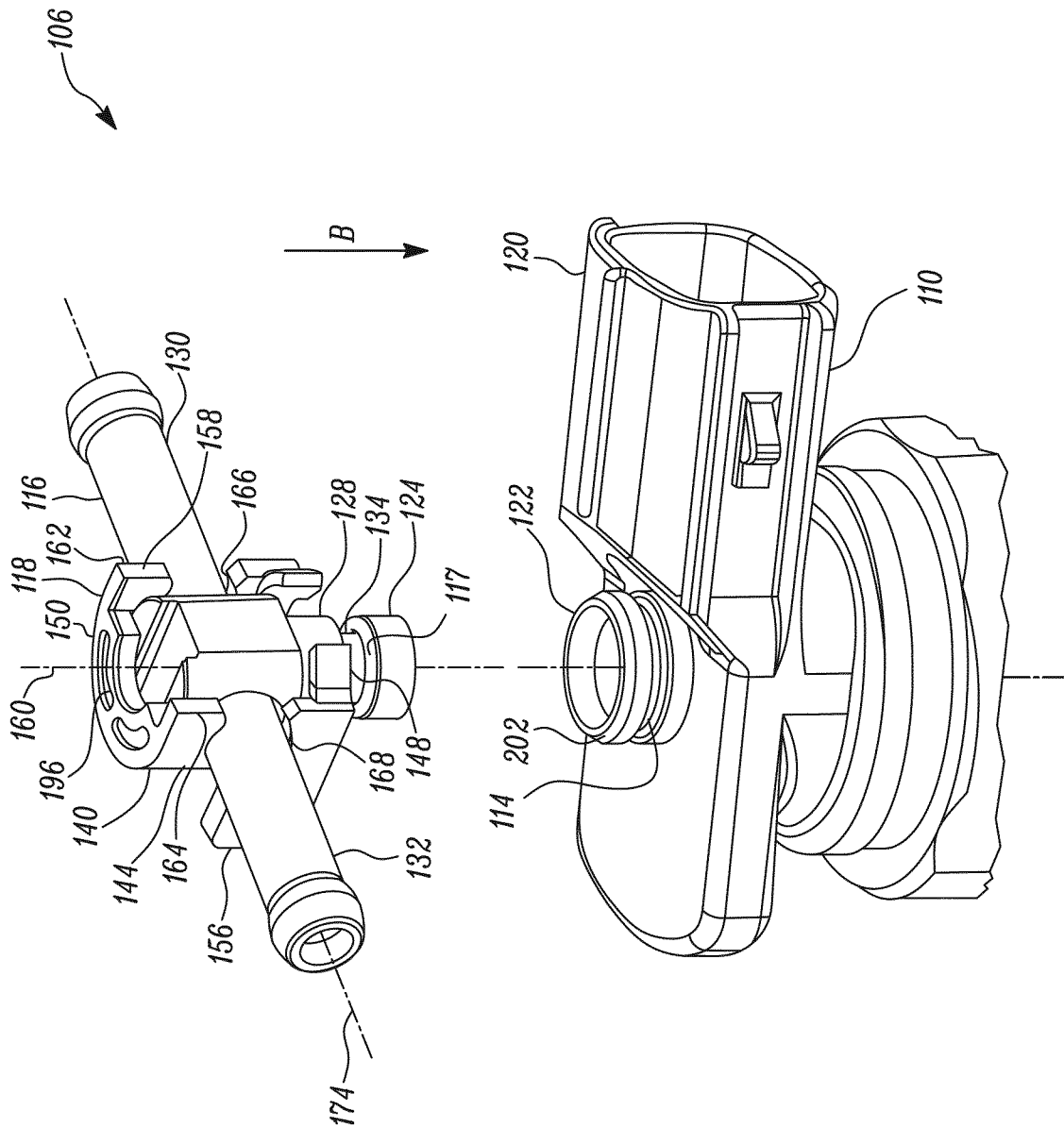


FIG. 4

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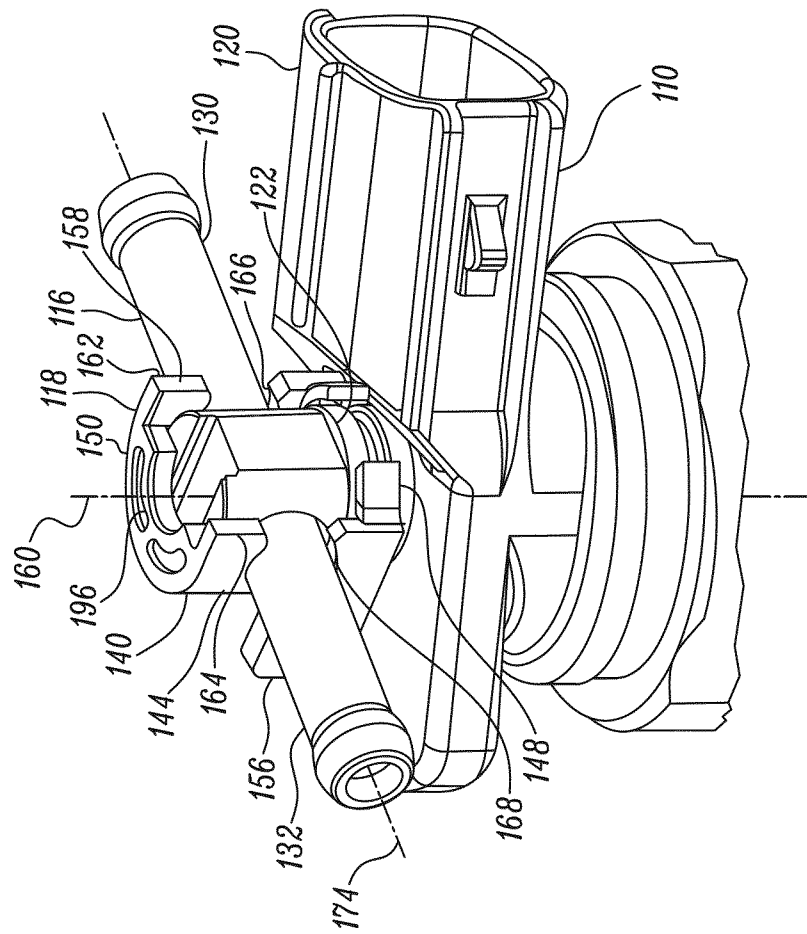


FIG. 5

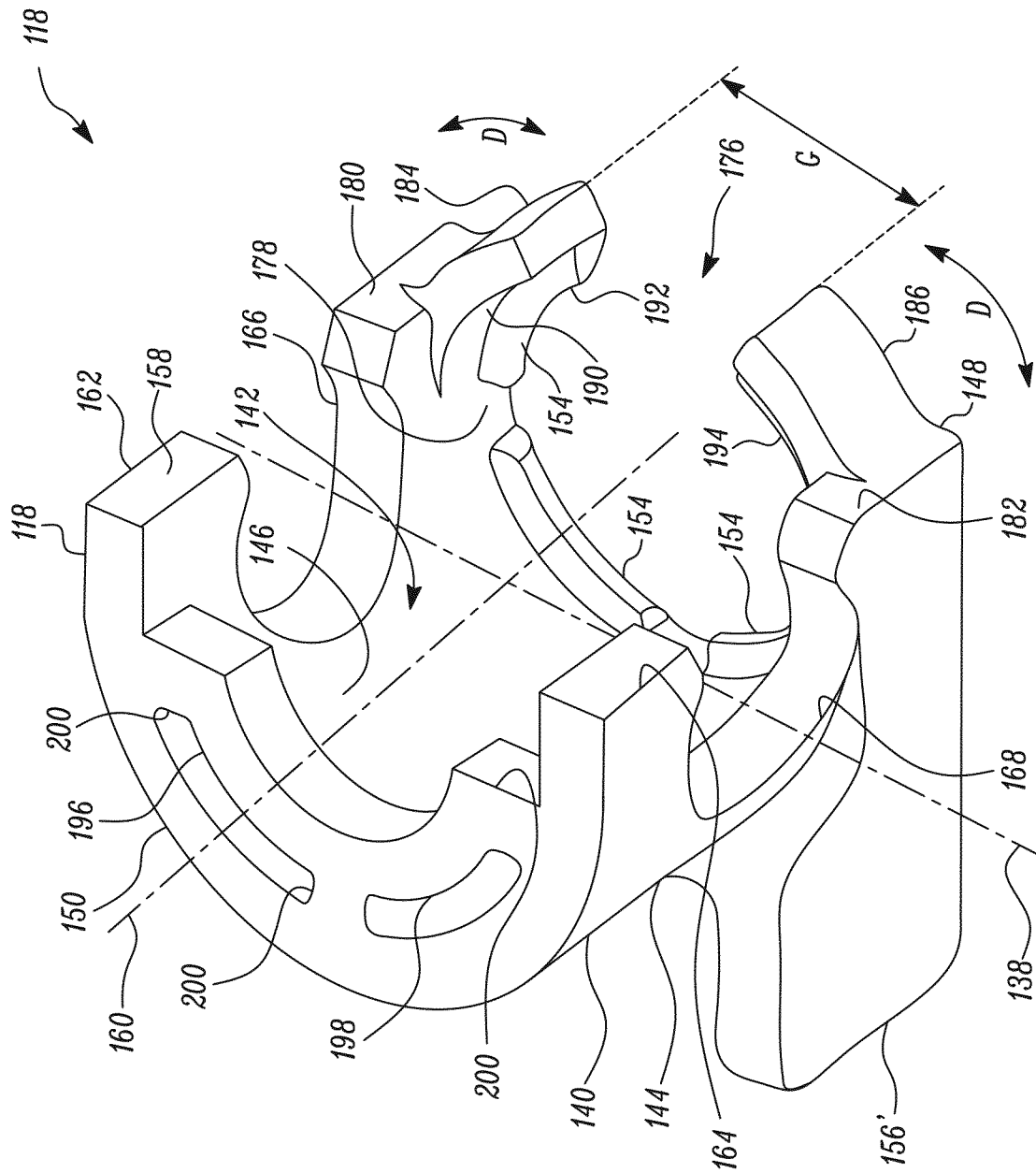


FIG. 6

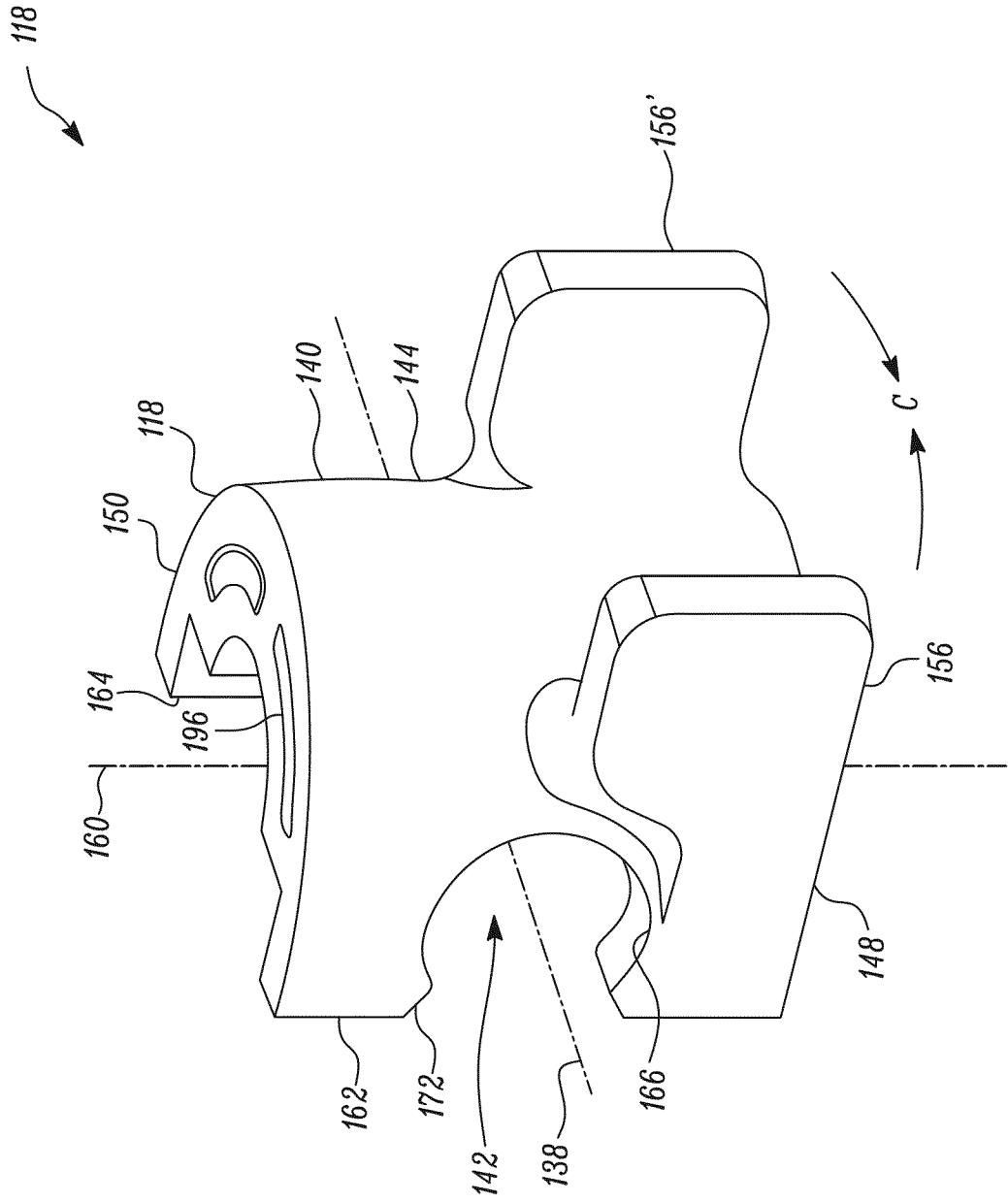


FIG. 7

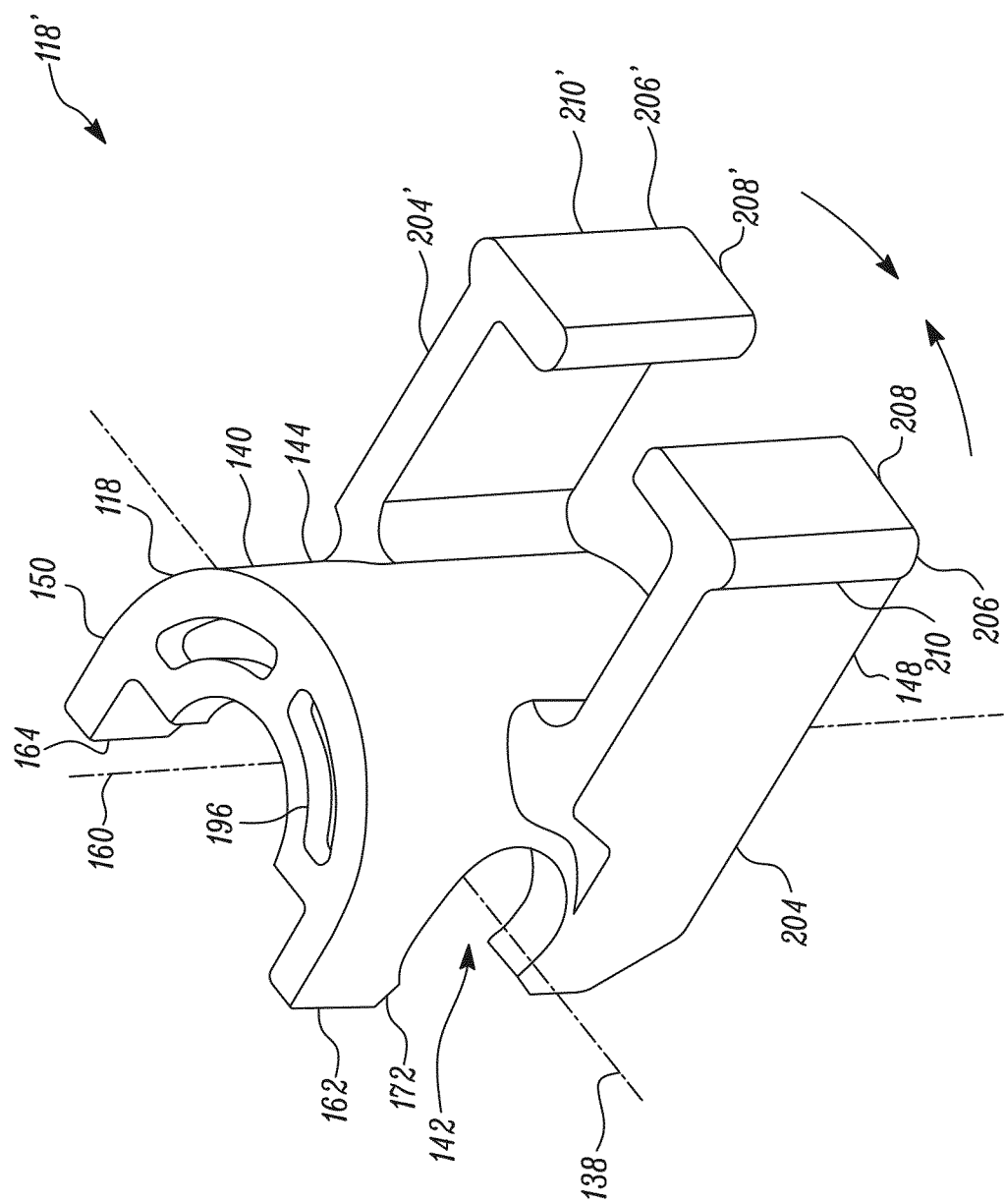


FIG. 8

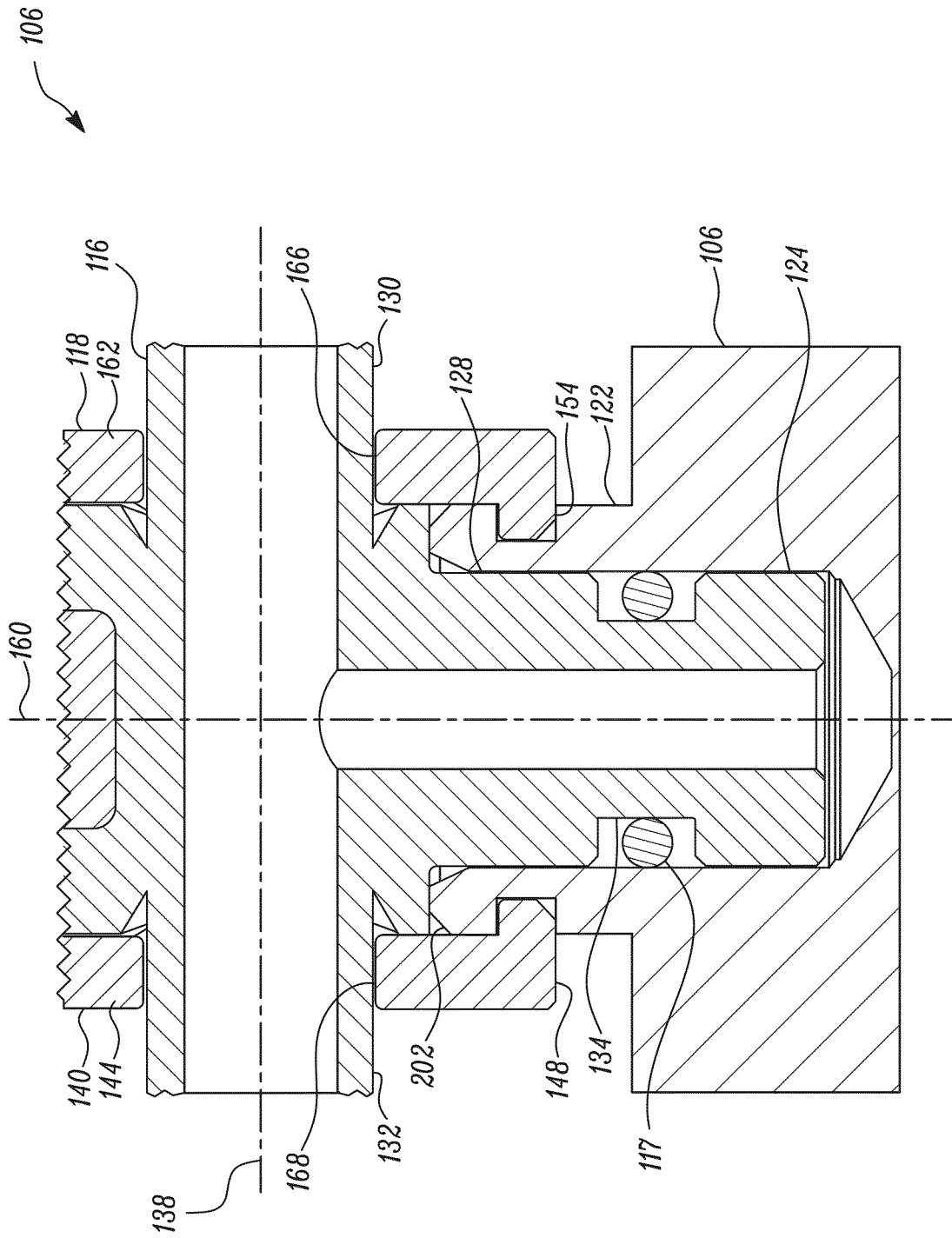


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/059077

A. CLASSIFICATION OF SUBJECT MATTER

INV. F02M55/02 F02M21/02 F02M37/00 F16L37/098 F16L37/10
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F02M F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 501 195 A (HALL BRYAN C [US]) 26 March 1996 (1996-03-26) column 3, lines 33-43; figure 5 -----	1-3,9
X	DE 195 36 441 A1 (SAAB AUTOMOBILE [SE]) 3 April 1997 (1997-04-03) the whole document -----	1,2,7-9
X	US 2004/232696 A1 (ANDRE MAXIME [IT]) 25 November 2004 (2004-11-25) the whole document -----	1-3,9,10



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search

9 June 2017

Date of mailing of the international search report

20/06/2017

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Nobre Correia, S

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/059077

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