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- (54) **Title:** COMMON RAIL PUMP HOUSING THROUGH HIGH PRESSURE DIE CASTING PROCESS

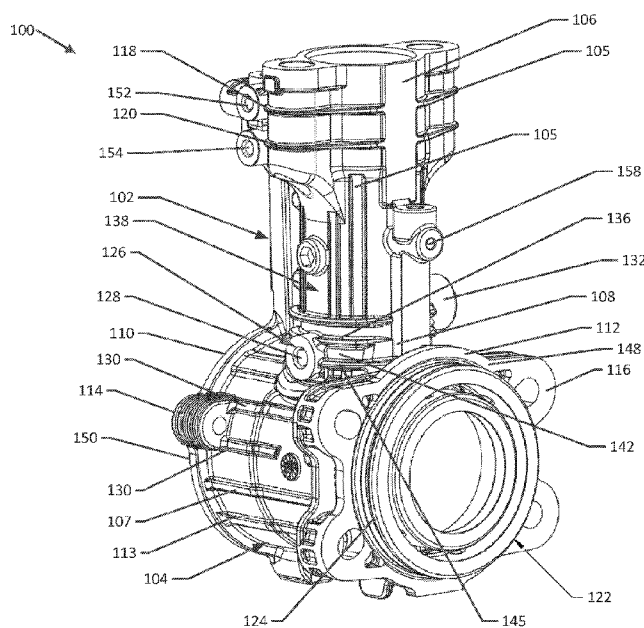


FIG. 1

- (57) **Abstract:** A fuel pump housing is provided comprising a first portion including a distal end and a proximal end, a second portion disposed adjacent the proximal end of the first portion, a first side wall including a mounting bore disposed at a first location defined by the proximal end and the second portion. The fuel pump housing further includes a second side wall including a fluid inlet port disposed at a second location defined by the proximal end and the second portion. The first location and the second location each include at least one ribbed member. The at least one ribbed member at the first location and the at least one ribbed member at the second member each provide load stress mitigation for the fuel pump housing and wherein the fuel pump housing is formed by a high pressure die casting process.



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COMMON RAIL PUMP HOUSING THROUGH HIGH PRESSURE DIE CASTING PROCESS

FIELD OF THE DISCLOSURE

[0001] The present disclosure generally relates to a fuel pump housing for an internal combustion engine. More specifically, this disclosure relates to a common rail single-cylinder fuel pump housing manufactured through a high pressure die casting process.

BACKGROUND OF THE DISCLOSURE

[0002] Fuel pumps typically include a pump housing and pumping elements that comprise a pumping plunger reciprocating within a bore enclosed by the pump housing. Hence, the pumping elements are disposed within the pump housing and facilitate the pumping of pressurized fuel received by the pump toward a high pressure fuel rail for use by engine components upstream of the fuel pump. A variety of manufacturing process exists for producing high pressure fuel pump housings that have the structural integrity sufficient to withstand the substantial internal fuel pressures and load stresses experienced by the fuel pump housing during pumping operations.

[0003] However, these processes do not provide an efficient and cost effective method of producing a large volume of high pressure fuel pump housings. For example, fuel pump housing production using a general gravity die casting process typically requires at least 20 minutes to produce a single durable high pressure pump housing. Moreover, even after the fuel pump housing is produced using the general gravity die casting process, several machining operations are required to ensure the pump housing complies with certain design specifications. As such, a need exists for a fuel pump housing design capable of being manufactured through a high pressure die casting process. The fuel pump housing design should have the requisite structural strength to withstand the above-mentioned elevated internal pressures and load stresses. Additionally, the fuel pump housing design should provide improved time-efficiencies, improved production costs, and require minimal machining operations after completion of the high pressure die-casting process.

SUMMARY OF THE DISCLOSURE

[0004] In one embodiment of the present disclosure, a fuel pump housing is provided comprising a first portion including a plurality of protrusions that form at least one first ribbed member; and a second portion disposed adjacent the first portion, the second portion including a plurality of protrusions that form at least one second ribbed member; wherein the ribbed members provide load stress mitigation for the fuel pump housing; and wherein the fuel pump housing is formed by a high pressure die casting process. In one aspect of this embodiment, the ribbed members cause the fuel pump housing to maintain structural integrity when subjected to at least one of a load stress imparted by engine vibration or a load stress imparted by operation of the fuel pump. In another aspect the fuel pump housing includes a housing wall thickness between 4 millimeters thick and 5 millimeters thick. In yet another aspect the first portion includes a distal end and a proximal end and the second portion is disposed adjacent the proximal end of the first portion. In a variant of this aspect the fuel pump housing further includes a mounting location defined by the proximal end and the second portion, the mounting location including at least one ribbed member that contacts a section of the mounting location.

[0005] In another embodiment of the present disclosure, a fuel pump housing is provided comprising, a first portion including a distal end and a proximal end; a second portion disposed adjacent the proximal end of the first portion; a first side wall including a mounting bore disposed at a first location defined by the proximal end and the second portion; and a second side wall including a fluid inlet port disposed at a second location defined by the proximal end and the second portion; wherein the first location and the second location each include at least one ribbed member; wherein the at least one ribbed member at the first location and the at least one ribbed member at the second member each provide load stress mitigation for the fuel pump housing; and wherein the fuel pump housing is formed by a high pressure die casting process. In one aspect of this embodiment, the at least one ribbed members cause the fuel pump housing to maintain structural integrity when subjected to at least one of a load stress imparted by engine vibration or a load stress imparted by operation of the fuel pump.

[0006] In another aspect the first portion includes a first ribbed member disposed adjacent the distal end and a second ribbed member disposed adjacent the first ribbed member. In yet another aspect the second portion includes a first end and a second end, the first end being

the rear section of the fuel pump housing and the second end being the front section of the fuel pump housing. In a variant of this aspect the second portion includes at least one ribbed member that extends from the first end toward the second end. In another variant of this aspect the second portion includes at least one flange disposed at the second end and at least one triangular ribbed member that contacts the second portion and the at least one flange. In yet another variant of this aspect the second portion includes a coupling member disposed adjacent the second end, the coupling member including an annular groove structured to receive a sealing component. In yet another variant of this aspect the second portion includes at least one flange disposed at the first end and at least one ribbed member that extends from the flange along the second portion toward the second end. In another aspect the fuel pump housing includes a housing wall thickness between 4 millimeters thick and 5 millimeters thick.

[0007] In yet another embodiment of the present disclosure a method of forming a fuel pump housing is provided comprising forming a first portion of a fuel pump housing using a high pressure die casting process, the first portion including a distal end and a proximal end; forming a second portion of the fuel pump housing using the high pressure die casting process, the second portion disposed adjacent the proximal end of the first portion; forming a first side wall of the fuel pump housing using the high pressure die casting process; forming a second side wall of the fuel pump housing using the high pressure die casting process; forming at least one ribbed member using the high pressure die casting process wherein the at least one ribbed member is disposed on the first side wall substantially intermediate the first portion and the second portion; and wherein the at least one ribbed member provides load stress mitigation for the fuel pump housing. In one aspect of this embodiment, the ribbed members cause the fuel pump housing to maintain structural integrity when subjected to at least one of a load stress imparted by engine vibration or a load stress imparted by operation of the fuel pump.

[0008] In another aspect the method further includes, forming a mounting bore using the high pressure die casting process, the mounting bore being formed on the first side wall and is disposed at a first location defined by the proximal end and the second portion. In a variant of this aspect the method further includes forming a fluid inlet port using the high pressure die casting process, the fluid inlet port being formed on the second side wall and is disposed at a second location defined by the proximal end and the second portion. In a variant of this variant the method further includes forming, at the first location and at the second location, at least one

ribbed member using the high pressure die casting process, wherein the at least one ribbed member at the first location and the at least one ribbed member at the second location each provide load stress mitigation for the fuel pump housing. In a variant of this variant the first location is on the first sidewall and is disposed substantially intermediate the first portion and the second portion and wherein the second location is on the second sidewall and is disposed substantially intermediate the first portion and the second portion. In another aspect the method further includes, forming a first ribbed member and a second ribbed member using the high pressure die casting process, wherein the first ribbed member is disposed adjacent the distal end and the second ribbed member is disposed adjacent the first ribbed member.

[0009] In yet another aspect the second portion includes a first end and a second end and the method further includes forming at least one ribbed member using the high pressure die casting process, wherein the at least one ribbed member extends from the first end toward the second end. In yet another aspect the method further includes, forming at least one flange and at least one ribbed member using the high pressure die casting process, wherein the at least one flange is disposed at the first end and the at least one ribbed member extends from the flange along the second portion toward the second end. In a variant of this aspect the method further includes, forming at least one flange and at least one triangular ribbed member using the high pressure die casting process, wherein the at least one flange is disposed at the second end and the at least one triangular ribbed member contacts the second portion and the at least one flange. In yet another aspect, the fuel pump housing is formed by the high pressure die casting process and includes a housing wall thickness between 4 millimeters thick and 5 millimeters thick.

BRIEF DESCRIPTION OF THE DRAWINGS

[00010] The above-mentioned and other features of this disclosure and the manner of obtaining them will become more apparent and the disclosure itself will be better understood by reference to the following description of embodiments of the present disclosure taken in conjunction with the accompanying drawings, wherein:

[00011] FIG. 1 shows a first perspective view of a fuel pump housing manufactured using a high pressure die casting process according to an embodiment of the present disclosure.

[00012] FIG. 2 shows a second perspective view of a fuel pump housing manufactured using a high pressure die casting process according to an embodiment of the present disclosure.

[00013] FIG. 3A and 3B show side views of the fuel pump housing of FIG. 1 and FIG. 2 according to an embodiment of the present disclosure.

[00014] FIG. 4A and 4B show front and rear views respectively of the fuel pump housing of FIG. 1 and FIG. 2 according to an embodiment of the present disclosure.

[00015] FIG. 5 shows a method of forming the fuel pump housing of FIG. 1- 4A/B using a high pressure die casting process.

DETAILED DESCRIPTION OF EMBODIMENTS

[00016] The embodiments disclosed herein are not intended to be exhaustive or to limit the disclosure to the precise forms disclosed in the following detailed description. Rather, the embodiments were chosen and described so that others skilled in the art may utilize their teachings.

[00017] FIG. 1 and FIG. 2 show first and second views of an exemplary fuel pump (“FP”) housing 100 manufactured using a high pressure die casting process according to an embodiment of the present disclosure. For purposes of clarity, the same reference number will be used in the various figures depicting housing 100 to identify elements that are same between the figures. As used herein, the phrase at least one of A, B, or C should be construed to mean a logical (A or B or C), using a non-exclusive logical OR. Moreover, it should be understood that steps within one or more methods disclosed herein may be executed in a different order without altering the principles of the present disclosure. As used herein and as generally known in the art, High Pressure Die Casting (“HPDC”) is a metal casting process that is one of a variety of processes characterized by forcing molten metal under high pressure into a mold cavity. The mold cavity may be created using two hardened tool steel dies which have been machined into shape and work similarly to an injection mold during the process. In one embodiment, when producing housing 100 by way of the HPDC process, the hardened tool steel dies may have a shape that is substantially similar to the illustrative embodiments of housing 100 depicted in FIGs. 1-4.

[00018] The HPDC process may be selected for manufacturing fuel pump housings based on a variety of reasons. For example, when attempting to produce fuel pump housings in large

volumes at a low cost per housing, utilizing the HPDC production process will yield noticeable cost savings per individual pumping unit. Some production cost savings are achieved based on reduced cycle times. In one example, utilizing the HPDC process to produce fuel pump housings such as housing 100 can be accomplished in just three minutes whereas alternative casting processes such as Gravity Die Casting (“GDC”) will generally take upwards of 20 minutes to produce a single housing 100. Additionally, because many design features of an exemplary housing can be achieved in the casting itself, use of the HPDC process results in fewer required machining operations after the completion of the casting process. Moreover, use of the HPDC will result in a housing 100 that has improved surface finish over that of the GDC process. As described in more detail below, use of the HPDC process further provides for a housing 100 that has reduced wall thickness which results in a total weight of the housing that is reduced in certain embodiments by approximately 35% when compared to a housing produced by the GDC process. A reduction in wall thickness and total weight may correspond to reduced total material cost.

[00019] In one example, it is generally known that use of the HPDC process to produce high pressure fuel pump housings comprise requirements for uniform overall wall thickness which includes a thickness of approximately 4 millimeters (“mm”) to 5 mm. With this relatively small wall thickness it may be desirable to have a fuel pump housing design that includes unique ribbing patterns to ensure there is a free flow of forming material to ensure solidification problems are properly mitigated. Common rail fuel pump housings produced from the GDC process have a relatively large wall thickness in the range of 8 mm to 12 mm. Accordingly, use of the HPDC process to produce high pressure fuel pump housings such as housing 100 may use a unique ribbing pattern and modified wall thickness to ensure housing 100 would successfully pass structural analysis and be able to successfully withstand the high stresses applied during pumping operations and when subjected to high engine vibration loads. Hence, the present disclosure provides a fuel pump housing 100 that combines reduced wall thickness and unique ribbing patterns that cooperate to meet or exceed desired casting structural stability requirements.

[00020] FP housing 100 generally includes an upper/first housing portion 102 and a lower/second housing portion 104. As shown in the illustrative embodiment of FIG. 1, second portion 104 is disposed adjacent first portion 102. In one embodiment, first portion 102 includes a plurality of protrusions 105 that form at least one first ribbed member and second portion 104

also includes a plurality of protrusions 107 that form at least one second ribbed member 130. In various embodiments of the present disclosure, FP housing 100 is formed by a high pressure die casting HPDC process and the disclosed ribbed members provide load stress mitigation for housing 100 when the HPDC process is utilized to produce one or more housings 100. Additionally, in various embodiments, FP housing 100 includes a plurality of ribbed members disposed at various locations on the housing. In these embodiments, the ribbed members cause housing 100 to maintain structural integrity when housing 100 is subjected to at least one of a load stress imparted by engine vibration or a load stress imparted by operation of the fuel pump.

[00021] As is known in the art, cam driven high pressure fuel pumps have become a common solution for generating high pressure fuel in common rails utilized in direct injection internal combustion engines. As discussed above, fuel pumps typically include pumping elements that comprise a pumping plunger reciprocating within a bore. These fuel pumps are typically driven by a tappet mounted adjacent to a cam for cyclically pushing on the actuated end of the pumping plunger. The pumping plunger's reciprocating motion is typically accomplished with a mechanism that moves the plunger with a rotating cam. For typical pumping operations, the overall reciprocating mass of the pump system as well as the high internal fluid pressures can cause substantial stress on the fuel pump housing in which these systems and fluids are located. Additionally, fuel pump housings such as housing 100 may be subjected to substantial operational stresses which are imparted by recurring movement of the tappet during pumping operations. In one example, housing 100 may experience substantial operational stress in first location 142 of first side wall 138 and second location 144 of second sidewall 140 which are described in more detail herein below.

[00022] In one embodiment, FP housing 100 includes a housing wall thickness that is between 4 millimeters (“mm”) thick and 5mm thick. First portion 102 includes a distal end 106 and a proximal end 108 and second portion 104 is disposed adjacent proximal end 108 of first portion 102. In one embodiment, housing 100 further includes a mounting location 126 defined by proximal end 108 and second portion 104. Mounting location 126 may include a central bore 128 structured to receive a tappet guide pin (not shown) and at least one ribbed member 136 that contacts a section of mounting location 126. In one embodiment, FP housing 100 includes a first side wall 138 including a first location 142 defined by proximal end 108 and second portion 104. In this embodiment, mounting location 126 and mounting bore 128 may be disposed at first

location 142. Likewise, housing 100 includes a second side wall 140 including a second location 144 defined by proximal end 108 and second portion 104. In this embodiment, second side wall 140 may include a fluid inlet 132 disposed at second location 144 wherein fluid inlet 132 includes a central bore 134. In this embodiment, second location 144 may include at least one ribbed member 146 that contacts a section of fluid inlet port 132. In one embodiment, first portion 102 of housing 100 further includes a fluid drain back cavity 158 structured to provide a fluid outlet function whereby fluid received within housing 100 by way of fluid inlet 132 is drained back to the fluid source. In one embodiment, first location 142 and second location 144 each include at least one ribbed member 145 that provides load stress mitigation for housing 100.

[00023] In one embodiment, first portion 102 includes a first ribbed member 118 disposed adjacent distal end 106 and a second ribbed member 120 disposed adjacent first ribbed member 118. In this embodiment, housing 100 may also include a first threaded boss 152 and a second threaded boss 154 wherein each threaded boss provides a means for coupling housing 100 to a support bracket (not shown) of an exemplary internal combustion engine (not shown). Second portion 104 of housing 100 generally includes a first end 110 and a second end 112, wherein first end 110 corresponds to a rear section 150 of housing 100 and second end 112 corresponds to a front section 148 of housing 100. Second portion 104 may further include at least one ribbed member 113 that extends from first end 110 toward second end 112. In one embodiment, ribbed member 113 may be described as a contoured ribbed member and second portion 104 may include two or more contoured ribbed members. In one embodiment, housing 100 may include stepped bore 155 and at least one threaded hole 156 disposed generally adjacent stepped bore 155. In one aspect of this embodiment, housing 100 may include two or more threaded holes 156 and stepped bore 155 cooperates with threaded holes 156 to couple housing 100 to an exemplary fuel control valve. In one embodiment, housing 100 includes a fuel inlet port 160 structured to receive pressurized fuel that is pumped to the common rail by the pumping elements disposed within housing 100. In this embodiment, fuel inlet port 160 provides a flow path that feeds fuel to an exemplary control valve which further feeds fuel to the pumping elements disposed within housing 100.

[00024] In one embodiment, second portion 104 includes at least one flange 116 disposed adjacent second end 112 and at least one triangular ribbed member 117 that contacts second portion 104 and flange 116. Triangular ribbed member 117 generally supports flange 116 to

second portion 104. In one embodiment, second portion 104 may include three flanges that are disposed at second end 112 wherein the three flanges function as mounting bosses that facilitate coupling housing 100 to an exemplary internal combustion engine or to a component of an engine system that is disposed intermediate housing 100 and the exemplary engine. In one embodiment, second portion 104 of housing 100 includes a coupling member 122 disposed adjacent second end 112 wherein coupling member 122 includes an annular groove 124 structured to receive a sealing component. Exemplary sealing components include an O-ring seal that fits securely within annular groove 124 and provides a sealing function when coupling member 122 facilitates coupling housing 100 to, for example, an engine gear housing of an internal combustion engine. In one embodiment, second portion 104 further includes at least one flange 114 disposed at first end 110 and at least one ribbed member 130 that extends from flange 114 along second portion 104 toward second end 112.

[00025] FIG. 3A and 3B show side views of the fuel pump housing of FIG. 1 and FIG. 2 according to an embodiment of the present disclosure. Likewise, FIG. 4A and 4B show front and rear views respectively of the fuel pump housing of FIG. 1 and FIG. 2 according to an embodiment of the present disclosure. The illustrative embodiments shown in FIG. 3A, 3B, 4A, and 4B provide additional visual perspectives that depict the above described features. These additional views of housing 100 will aid one of ordinary skill in the art of fuel pump housing design and production to produce housing 100 by way of the above-mentioned HPDC process.

[00026] FIG. 5 depicts a method 500 of forming fuel pump housing 100 of FIGs. 1- 4 using the above mentioned HPDC process. As such, a description of method 500 will reference elements and features of fuel pump housing 100 described above. Method 500 begins a block 502 in which the method includes forming first portion 102 of housing 100 using a high pressure die casting process, wherein first portion 102 includes distal end 106 and proximal end 108. Method 500 further includes block 504 including forming second portion 104 of housing 100 using the high pressure die casting process, the second portion 104 being disposed adjacent proximal end 108 of first portion 102. Method 500 further includes block 506 including forming first side wall 138 of housing 100 using the high pressure die casting process. At block 508 method 500 includes forming second side wall 140 of housing 100 using the high pressure die casting process. Method 500 also includes block 510 in which the method includes forming at least one ribbed member 136 using the high pressure die casting process wherein ribbed member

136 is disposed on first side wall 138 substantially intermediate first portion 102 and second portion 104. At block 512 method 500 includes that ribbed member 136 formed by the high pressure die casting process provides load stress mitigation for fuel pump housing 100. In one embodiment of the present disclosure, all features and elements of fuel pump housing 100 which are disclosed in the illustrative embodiments of FIGs. 1-4 may be formed using the above-mentioned high pressure die casting process.

[00027] In the foregoing specification, specific embodiments of the present disclosure have been described. However, one of ordinary skill in the art will appreciate that various modifications and changes can be made without departing from the scope of the disclosure as set forth in the claims below. Accordingly, the specification and figures are to be regarded in an illustrative rather than a restrictive sense. The benefits, advantages, solutions to problems, and any element(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as critical, required, or essential features or elements of any or all the claims. The invention is defined solely by the appended claims including any amendments made during the pendency of this application and all equivalents of those claims as issued.

CLAIMS

1. A fuel pump housing comprising:
 - a first portion including a plurality of protrusions that form at least one first ribbed member; and
 - a second portion disposed adjacent the first portion, the second portion including a plurality of protrusions that form at least one second ribbed member;
 - wherein the ribbed members provide load stress mitigation for the fuel pump housing; and
 - wherein the fuel pump housing is formed by a high pressure die casting process.
2. The fuel pump housing of claim 1, wherein the ribbed members cause the fuel pump housing to maintain structural integrity when subjected to at least one of a load stress imparted by engine vibration or a load stress imparted by operation of the fuel pump.
3. The fuel pump housing of claim 1, wherein the fuel pump housing includes a housing wall thickness between 4 millimeters thick and 5 millimeters thick.
4. The fuel pump housing of claim 1, wherein the first portion includes a distal end and a proximal end and the second portion is disposed adjacent the proximal end of the first portion.
5. The fuel pump housing of claim 4, further including a mounting location defined by the proximal end and the second portion, the mounting location including at least one ribbed member that contacts a section of the mounting location.
6. A fuel pump housing comprising:
 - a first portion including a distal end and a proximal end;
 - a second portion disposed adjacent the proximal end of the first portion;
 - a first side wall including a mounting bore disposed at a first location defined by the proximal end and the second portion; and
 - a second side wall including a fluid inlet port disposed at a second location defined by the proximal end and the second portion;

wherein the first location and the second location each include at least one ribbed member;

wherein the at least one ribbed member at the first location and the at least one ribbed member at the second member each provide load stress mitigation for the fuel pump housing; and

wherein the fuel pump housing is formed by a high pressure die casting process.

7. The fuel pump housing of claim 6, wherein the at least one ribbed members cause the fuel pump housing to maintain structural integrity when subjected to at least one of a load stress imparted by engine vibration or a load stress imparted by operation of the fuel pump.

8. The fuel pump housing of claim 6, wherein the first portion includes a first ribbed member disposed adjacent the distal end and a second ribbed member disposed adjacent the first ribbed member.

9. The fuel pump housing of claim 6, wherein the second portion includes a first end and a second end, the first end being the rear section of the fuel pump housing and the second end being the front section of the fuel pump housing.

10. The fuel pump housing of claim 9, wherein the second portion includes at least one ribbed member that extends from the first end toward the second end.

11. The fuel pump housing of claim 9, wherein the second portion includes at least one flange disposed at the second end and at least one triangular ribbed member that contacts the second portion and the at least one flange.

12. The fuel pump housing of claim 9, wherein the second portion includes a coupling member disposed adjacent the second end, the coupling member including an annular groove structured to receive a sealing component.

13. The fuel pump housing of claim 9, wherein the second portion includes at least one flange disposed at the first end and at least one ribbed member that extends from the flange along the second portion toward the second end.

14. The fuel pump housing of claim 6, wherein the fuel pump housing includes a housing wall thickness between 4 millimeters thick and 5 millimeters thick.
15. A method of forming a fuel pump housing comprising:
forming a first portion of a fuel pump housing using a high pressure die casting process, the first portion including a distal end and a proximal end;
forming a second portion of the fuel pump housing using the high pressure die casting process, the second portion disposed adjacent the proximal end of the first portion;
forming a first side wall of the fuel pump housing using the high pressure die casting process;
forming a second side wall of the fuel pump housing using the high pressure die casting process;
forming at least one ribbed member using the high pressure die casting process wherein the at least one ribbed member is disposed on the first side wall substantially intermediate the first portion and the second portion; and
wherein the at least one ribbed member provides load stress mitigation for the fuel pump housing.
16. The method of claim 15, wherein the ribbed members cause the fuel pump housing to maintain structural integrity when subjected to at least one of a load stress imparted by engine vibration or a load stress imparted by operation of the fuel pump.
17. The method of claim 16, further including, forming a mounting bore using the high pressure die casting process, the mounting bore being formed on the first side wall and is disposed at a first location defined by the proximal end and the second portion.
18. The method of claim 17, further including, forming a fluid inlet port using the high pressure die casting process, the fluid inlet port being formed on the second side wall and is disposed at a second location defined by the proximal end and the second portion.

19. The method of claim 18, further including, forming, at the first location and at the second location, at least one ribbed member using the high pressure die casting process, wherein the at least one ribbed member at the first location and the at least one ribbed member at the second location each provide load stress mitigation for the fuel pump housing.
20. The method of claim 19, wherein the first location is on the first sidewall and is disposed substantially intermediate the first portion and the second portion and wherein the second location is on the second sidewall and is disposed substantially intermediate the first portion and the second portion.
21. The method of claim 15, further including, forming a first ribbed member and a second ribbed member using the high pressure die casting process, wherein the first ribbed member is disposed adjacent the distal end and the second ribbed member is disposed adjacent the first ribbed member.
22. The method of claim 15, wherein the second portion includes a first end and a second end and the method further includes forming at least one ribbed member using the high pressure die casting process, wherein the at least one ribbed member extends from the first end toward the second end.
23. The method of claim 22, further including, forming at least one flange and at least one ribbed member using the high pressure die casting process, wherein the at least one flange is disposed at the first end and the at least one ribbed member extends from the flange along the second portion toward the second end.
24. The method of claim 22, further including, forming at least one flange and at least one triangular ribbed member using the high pressure die casting process, wherein the at least one flange is disposed at the second end and the at least one triangular ribbed member contacts the second portion and the at least one flange.
25. The method of claim 15, wherein the fuel pump housing is formed by the high pressure die casting process and includes a housing wall thickness between 4 millimeters thick and 5 millimeters thick.

AMENDED CLAIMS
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1. A fuel pump housing comprising:

a first portion including a plurality of protrusions that form at least one first ribbed member, wherein the first portion includes a distal end and a proximal end;

a second portion disposed adjacent the proximal end of the first portion, the second portion including a plurality of protrusions that form at least one second ribbed member;

a mounting location defined by the proximal end and the second portion, the mounting location including a central bore;

wherein the ribbed members provide load stress mitigation for the fuel pump housing;
and

wherein the fuel pump housing is formed by a high pressure die casting process.

2. The fuel pump housing of claim 1, wherein the ribbed members cause the fuel pump housing to maintain structural integrity when subjected to at least one of a load stress imparted by engine vibration or a load stress imparted by operation of the fuel pump.

3. The fuel pump housing of claim 1, wherein the fuel pump housing includes a housing wall thickness between 4 millimeters thick and 5 millimeters thick.

4. (Cancelled)

5. (Cancelled)

6. A fuel pump housing comprising:

a first portion including a distal end and a proximal end;

a second portion disposed adjacent the proximal end of the first portion;

a first side wall including a mounting bore disposed at a first location defined by the proximal end and the second portion; and

a second side wall including a fluid inlet port disposed at a second location defined by the proximal end and the second portion, wherein the first side wall is opposite the second side wall;

wherein the first location and the second location each include at least one ribbed member;

wherein the at least one ribbed member at the first location and the at least one ribbed member at the second member each provide load stress mitigation for the fuel pump housing; and

wherein the fuel pump housing is formed by a high pressure die casting process.

7. The fuel pump housing of claim 6, wherein the at least one ribbed members cause the fuel pump housing to maintain structural integrity when subjected to at least one of a load stress imparted by engine vibration or a load stress imparted by operation of the fuel pump.

8. The fuel pump housing of claim 6, wherein the first portion includes a first ribbed member disposed adjacent the distal end and a second ribbed member disposed adjacent the first ribbed member.

9. The fuel pump housing of claim 6, wherein the second portion includes a first end and a second end, the first end being the rear section of the fuel pump housing and the second end being the front section of the fuel pump housing.

10. The fuel pump housing of claim 9, wherein the second portion includes at least one ribbed member that extends from the first end toward the second end.

11. The fuel pump housing of claim 9, wherein the second portion includes at least one flange disposed at the second end and at least one triangular ribbed member that contacts the second portion and the at least one flange.

12. The fuel pump housing of claim 9, wherein the second portion includes a coupling member disposed adjacent the second end, the coupling member including an annular groove structured to receive a sealing component.

13. The fuel pump housing of claim 9, wherein the second portion includes at least one flange disposed at the first end and at least one ribbed member that extends from the flange along the second portion toward the second end.

14. The fuel pump housing of claim 6, wherein the fuel pump housing includes a housing wall thickness between 4 millimeters thick and 5 millimeters thick.

15. A method of forming a fuel pump housing comprising:

forming a first portion of a fuel pump housing using a high pressure die casting process, the first portion including a distal end and a proximal end;

forming a second portion of the fuel pump housing using the high pressure die casting process, the second portion disposed adjacent the proximal end of the first portion;

forming a first side wall of the fuel pump housing using the high pressure die casting process;

forming a second side wall of the fuel pump housing using the high pressure die casting process, wherein the second side wall is positioned opposite of the first side wall;

forming at least one ribbed member using the high pressure die casting process wherein the at least one ribbed member is disposed on the first side wall substantially intermediate the first portion and the second portion;

wherein the at least one ribbed member provides load stress mitigation for the fuel pump housing; and

forming a mounting bore using the high pressure die casting process, the mounting bore being formed on the first side wall and is disposed at a first location on the first sidewall, the first location defined by the proximal end and the second portion and is disposed substantially intermediate the first portion and the second portion, wherein the mounting bore is structured to receive a tappet guide pin and at least one ribbed member that contacts a section of a mounting location defined by the proximal end and the second portion.

16. The method of claim 15, wherein the ribbed members cause the fuel pump housing to maintain structural integrity when subjected to at least one of a load stress imparted by engine vibration or a load stress imparted by operation of the fuel pump.

17. (Cancelled)

18. The method of claim 15, further including, forming a fluid inlet port using the high pressure die casting process, the fluid inlet port being formed on the second side wall and is disposed at a second location defined by the proximal end and the second portion.

19. The method of claim 15, further including, forming, at the first location and at the second location, at least one ribbed member using the high pressure die casting process, wherein the at least one ribbed member at the first location and the at least one ribbed member at the second location each provide load stress mitigation for the fuel pump housing.

20. The method of claim 19, wherein the second location is on the second sidewall and is disposed substantially intermediate the first portion and the second portion.

21. The method of claim 15, further including, forming a first ribbed member and a second ribbed member using the high pressure die casting process, wherein the first ribbed member is disposed adjacent the distal end and the second ribbed member is disposed adjacent the first ribbed member.

22. The method of claim 15, wherein the second portion includes a first end and a second end and the method further includes forming at least one ribbed member using the high pressure die casting process, wherein the at least one ribbed member extends from the first end toward the second end.

23. The method of claim 22, further including, forming at least one flange and at least one ribbed member using the high pressure die casting process, wherein the at least one flange is disposed at the first end and the at least one ribbed member extends from the flange along the second portion toward the second end.

24. The method of claim 22, further including, forming at least one flange and at least one triangular ribbed member using the high pressure die casting process, wherein the at least one flange is disposed at the second end and the at least one triangular ribbed member contacts the second portion and the at least one flange.

25. The method of claim 15, wherein the fuel pump housing is formed by the high pressure die casting process and includes a housing wall thickness between 4 millimeters thick and 5 millimeters thick.
26. The fuel pump housing of claim 1, wherein the central bore is structured to receive a tappet guide pin and at least one ribbed member that contacts a section of the mounting location.

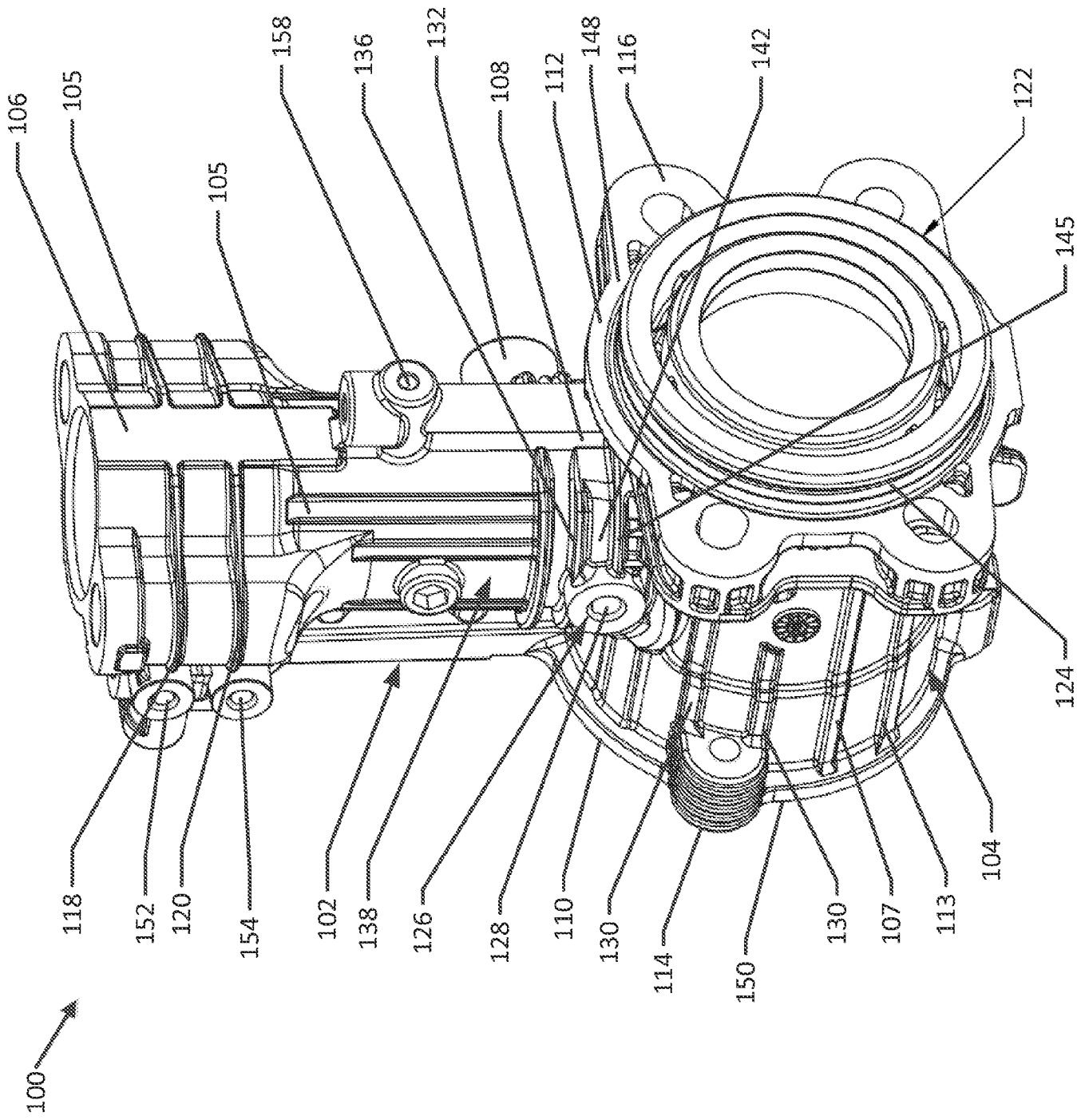


FIG. 1

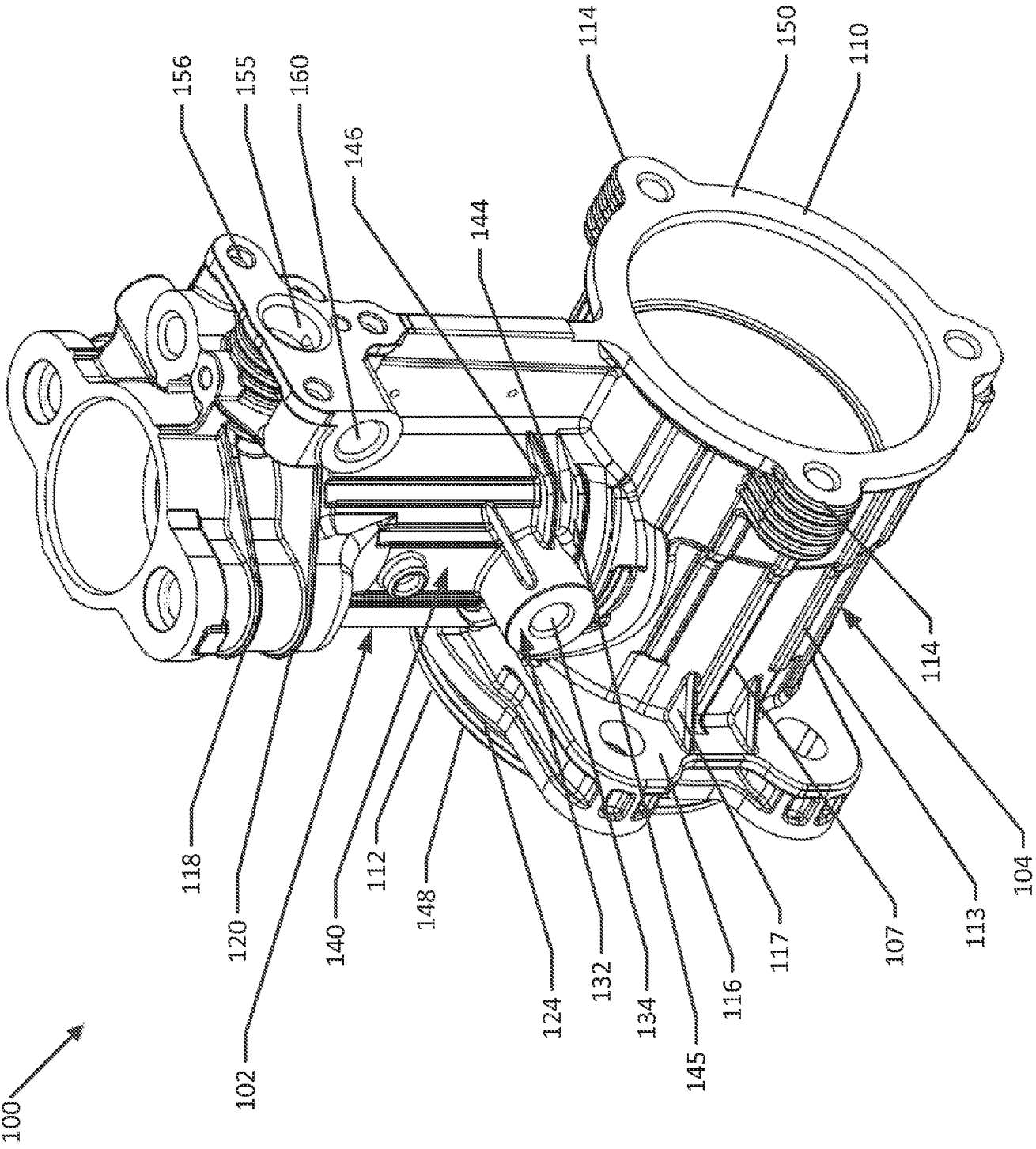


FIG. 2

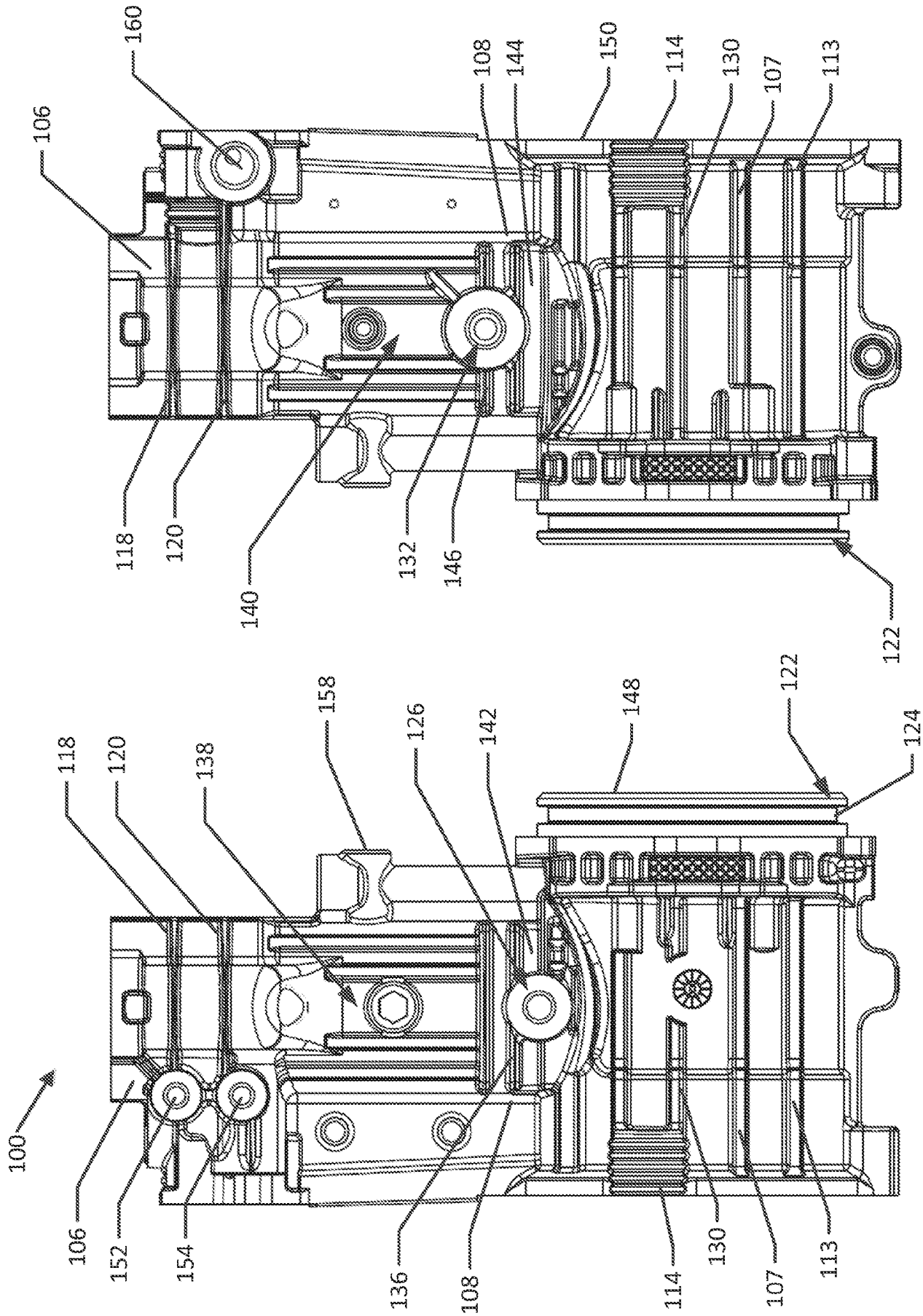


FIG. 3B

FIG. 3A

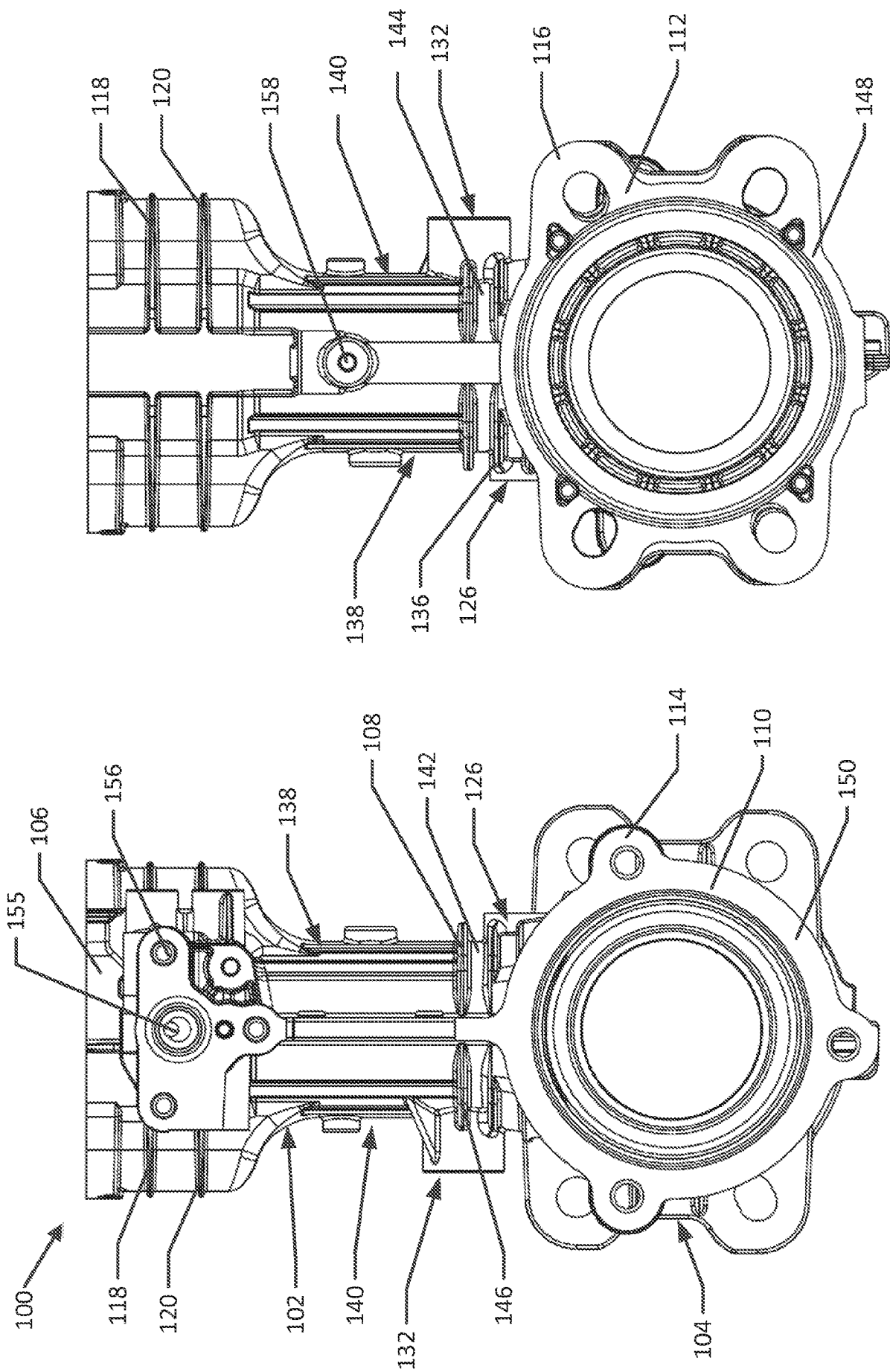


FIG. 4B

FIG. 4A

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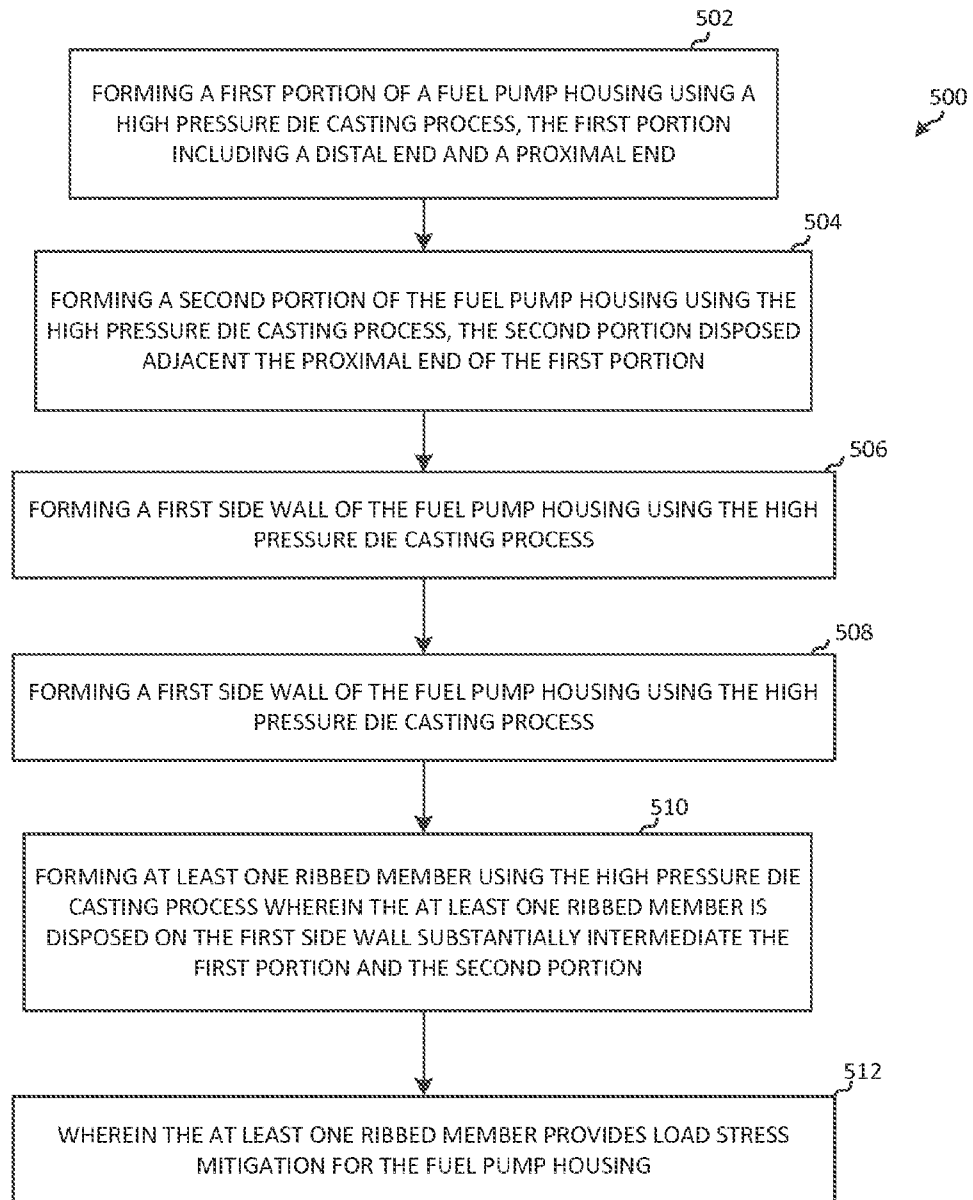


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US15/47833

A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - F02M 37/04; B22D 17/00 (2015.01) CPC - F02M 37/04; B22D 17/00 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) IPC(8) Classification(s): F02M 37/04, 59/02, 59/12, 59/16, 59/44; B22D 17/00 (2015.01) CPC Classification(s): F02M 37/04, 59/02, 59/12, 59/16, 59/44; B22D 17/00; USPC Classification(s): 418/15 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) PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC Data); Google; Google Scholar; ProQuest; IP.com; keywords: fuel pump, pump, die cast, stress, vibrate, din, rib, protrusion, high pressure		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/0037719 A1 (SUNAGA H et al.) February 26, 2004; figures 1, 3; paragraphs [0009], [0045], [0088]	1-5
X --- Y	US 2011/0052428 A1 (TARANCIOGLU MF) March 3, 2011; figure 1; paragraphs [0021], [0025], [0032]-[0034]	1-10, 12-23, 25 --- 6-25
Y	CN 203704748 U (GUIZHOU YONGHONG AVIAT MACHINERY CO LTD) 2014.07.09; figure 1; abstract	11, 24
Y	US 3,891,059 A (JONES C) June 24, 1975; figures 3, 4, 6; column 4, lines 5-10, 30-35	6-25
A	US 2004/0141858 A1 (GRANT BS) July 22, 2004; entire document	1-25
A	US 2009/0038580 A1 (HAMILTON I) February 12, 2009; entire document	1-25
A	US 5,372,475 A (KATO T et al.) December 13, 1994; entire document	1-25
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
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Date of the actual completion of the international search 28 October 2015 (28.10.2015)		Date of mailing of the international search report 14 DEC 2015
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300		Authorized officer Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774