

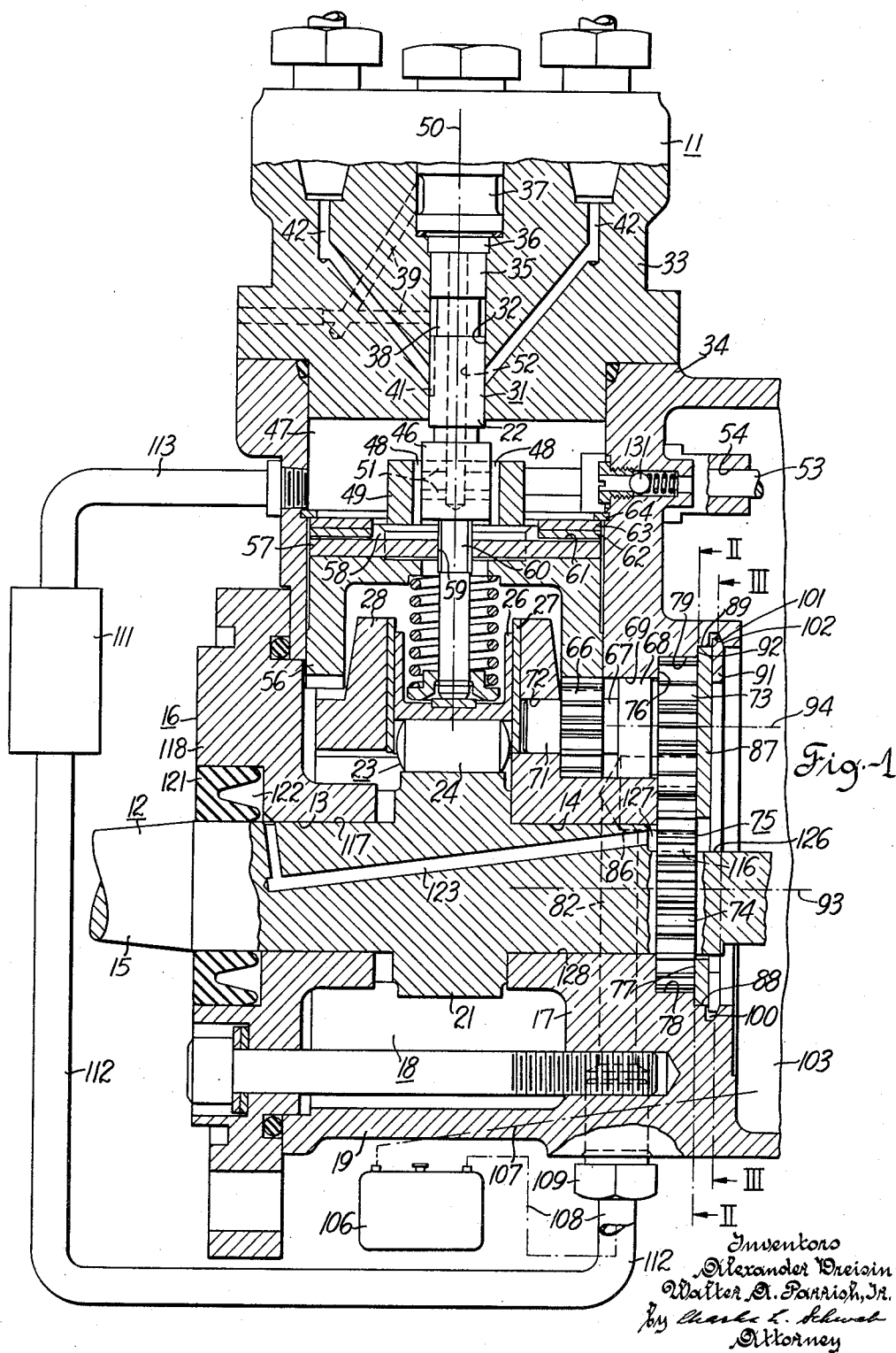
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FUEL SUPPLYING MECHANISM

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2 Sheets-Sheet 1



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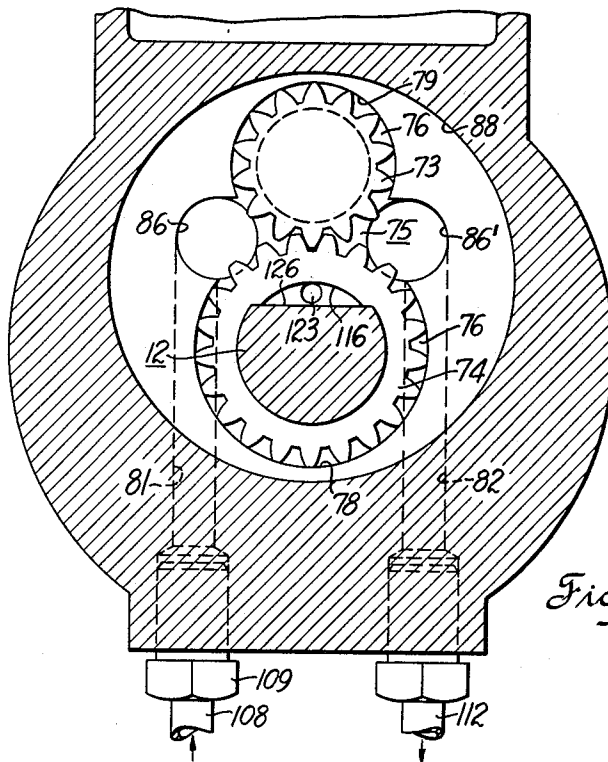


Fig. 2

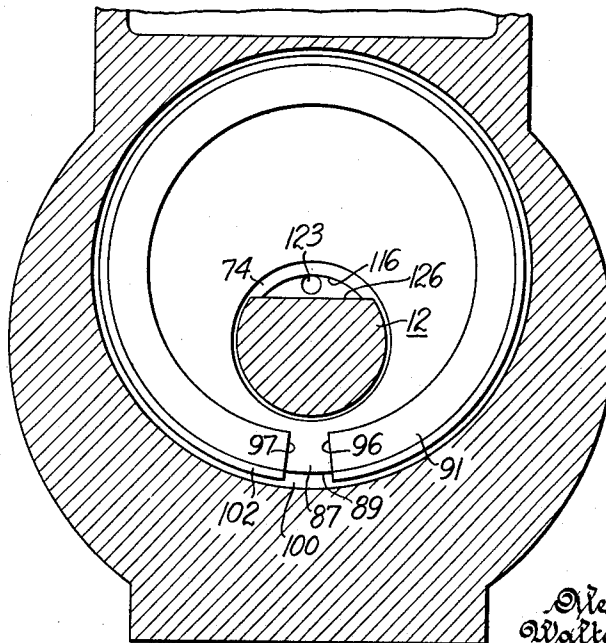


Fig. 3

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FUEL SUPPLYING MECHANISM

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This invention relates to fuel supply mechanism of the type employed to supply fuel to compression ignition engines, and more particularly relates to the provision of a stepped diameter plunger and an improved lubrication system for a distributor type fuel injection pump.

In fuel injection pumps of the type utilizing a reciprocating and rotating plunger to pump and distribute fuel to a plurality of engine cylinders, it has been the practice to lubricate the drive mechanism employed to rotate and reciprocate the plunger by a lubrication system completely independent of the fuel being pumped. Such a prior art pump is illustrated in U.S. Patent 2,980,092, issued to Alexander Dreisin and Louis G. Kaplan on a fuel injection pump on April 18, 1961. In such prior art constructions the plunger pumping and distributing bore and the bore in the dividing wall between the fuel supply chamber and the drive compartment were of the same diameter. The fuel inlet portion of the plunger, disposed within a fuel supply chamber, was of the same diameter as the portions of the plunger in the pumping and distributing bore and in the dividing wall bore.

The present invention improves upon the efficiency of this prior art pump by providing a stepped diameter plunger wherein the fuel inlet portion of the plunger is of greater diameter than the pumping and distributing portion. By increasing the diameter of the inlet portion of the pump plunger, fuel supplied to the injectors is more accurately controlled. An increased diameter portion on the pump plunger created a problem in manufacturing, inasmuch as two different pairs of cylindrical surfaces were required to be held to extremely close concentricity tolerances to insure proper fit between the plunger pumping portion and its bore and between the inlet portion and the bore in which it fits in the wall separating the fuel supply compartment and drive compartment.

The present invention eliminates the fluid tight fit heretofore required between the plunger and the wall separating the fuel supply chamber from the drive compartment. The present invention also permits use of inexpensive journal bearings in place of expensive antifriction bearings and the use of an inexpensive low pressure seal at the front bearing rather than a more expensive seal for a higher pressure. Further, this invention reduces manufacturing costs and parts requirements in that the same size control sleeve may be used on pump plungers with different diameters at their pumping portions. The present invention also avoids excessive wear of the precision pump components which would otherwise result should wear particles from the drive compartment be allowed to flow into the supply chamber.

It is an object of this invention to provide an improved fuel injection pump wherein fuel delivery is more accurately controlled.

It is a further object of this invention to provide a fuel injection pump wherein fuel delivery is more accurately controlled by providing an enlarged diameter inlet portion of the plunger.

It is a further object of this invention to provide a distributor type injection pump of the type having a pumping

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and distributing plunger in which a fuel supply chamber and a drive compartment are filled with fuel.

It is a further object of this invention to provide a fuel injection pump of the type having a pumping and distributing plunger wherein all the moving parts thereof are lubricated by the fuel being pumped.

It is a further object of this invention to provide a fuel injection pump which is fuel lubricated and wherein the flow of the fuel is so directed that wear particles from the drive compartment do not pass to the fuel supply chamber.

It is a further object of this invention to provide a distributor type fuel injection pump which is less expensive to manufacture and better in performance than prior distributor type fuel injection pumps.

It is a further object of this invention to provide an improved lubrication system for a fuel injection pump of the distributor type wherein the camshaft is mounted on cylindrical bearing surfaces rather than antifriction bearings and a low pressure seal is used at the front camshaft bearing.

It is a further object of this invention to provide an improved fuel injection pump of the distributor type wherein the control sleeve for the inlet portion of the plunger may be used on various pump plungers having different diameters at their pumping and distributing portion.

These and other objects of this invention will be apparent upon reading the following description in conjunction with the drawings in which:

FIG. 1 is a section view of a fuel injection pump in which the present invention is incorporated;

FIG. 2 is a section view taken along the line II—II of FIG. 1;

FIG. 3 is a section view taken along the line III—III of FIG. 1.

Referring to FIG. 1, the distributor type fuel injection pump 11 is part of a fuel supply system for a compression ignition engine. A drive shaft 12 is adapted at its front end 15 to be connected to an engine, not shown, is journaled in cylindrical surface type bearings 13, 14 formed in opposite side walls 16, 17, respectively, of the drive compartment 18 of the pump housing 19. The drive shaft 12 includes a cam portion 21 which includes a plurality of cams which reciprocate a pump plunger 22 as the shaft 12 is rotated. Reciprocation of the plunger 22 is effected through thrust transmitting means 23 interposed between the cam portion 21 and the plunger. The thrust transmitting means 23 includes a roller 24 and a barrel 26 reciprocally mounted in a sleeve 27, the latter being press fit into an inwardly disposed portion 28 of the housing 19. The plunger 22 has a pumping and distributing portion 31 which reciprocally and rotatably fits in fluid tight engagement with a plunger bore 32 in the head portion 33 of the housing 19. The head portion 33 is rigidly secured to the lower portion 34 of the housing 19 by a plurality of cap screws, not shown. A pumping chamber 36 is disposed at the upper end of the bore 32 and when the fuel is pressurized to a high injection pressure on the upward stroke of the pumping part 35 of the pumping and distributing portion 31, a delivery valve 37 permits the fluid to pass to the distributing part 38 of the pumping and distributing portion 31 of the plunger 22 through delivery passage 39. As the plunger 22 rotates, fuel is delivered through an axially extending groove 41 in the periphery of the distributing part 38 of the plunger 22 to the injector supply passages 42.

A cylindrical fuel inlet portion 46 is coaxially formed in relation to the pumping and distributing portion 31 of the plunger 22. The fuel inlet portion 46 is disposed within a fuel supply chamber 47 and fluid is permitted to flow to the pumping chamber 36 from the fuel supply chamber 47 when inlet ports in the form of grooves 48 of the control sleeve 49 register with inlet ports 51 in the fuel inlet portion of the plunger. Rotation and reciprocation of the sleeve 49 controls beginning and ending of injection. The inlet ports 51 are connected with the pumping chamber 36 by an interior passage 52 formed in plunger 22 on the axis 50 thereof. The sleeve is rotatably and reciprocably positioned relative to the housing 19 by a control rod 53 which is reciprocably and rotatably mounted in a bore 54 in wall 17.

The plunger 22 is rotated by a gear train connected to the drive shaft 12 which includes a gear 56 nonrotatably connected to a drive plate 57 through a pair of ears 58 on gear 56. The plate 57 has a central opening 59 for slidably receiving a torque transmitting portion 60 of plunger 22. Opening 59 and portion 60 are so formed as to cause the plunger 22 to rotate with the plate 57. Sufficient clearance is provided between the sides of plate 57 and gear 56 to provide free flow of fuel between the supply chamber 47 and the drive compartment 18. Thus in effect, the supply chamber 47 and drive compartment 18 are a single receptacle for fuel. A bearing surface 61 on the gear 56 is in thrust transmitting relation to a thrust washer 62 which rotates with gear 56 and bears against thrust plate 63 held in place by a snap ring 64. The gear train for rotating the plunger 22 also includes a gear 66 formed on a countershaft 67 in meshing relation with gear 56 and a gear 73 which meshes with a gear 74 coaxial with and nonrotatively secured to the drive shaft 12. The countershaft 67 includes a cylindrical journal portion 68 between gears 66 and 73 which rotates in a bearing surface 69 of wall 17 and a journal surface 71 in bearing engagement with a second bearing surface 72 in portion 28 of the housing 19. The journal portion 68 of the countershaft 67 is of at least as large a diameter as the outside diameter of gear 66, thereby permitting the gear 66 to pass through the opening presenting bearing surface 69.

Referring to FIGS. 1, 2 and 3, gears 73, 74 are disposed between a pair of axially facing surfaces 76, 77 and semi-cylindrical surfaces 78, 79 formed in the wall 17. An inlet passage 81 and an outlet passage 82 are formed in the wall 17 of the housing. The fuel inlet passage 81 and the fuel outlet passage 82 communicate with the gears 73, 74 at transversely opposite sides, respectively, of the meshing teeth on the gears 73, 74. The bores 86, 86' at the end of the passages 81, 82, respectively, form inlet and outlet chambers in the wall 17 at transversely opposite sides of the teeth of the gears 73, 74 which are in mesh. Thus the gears 73, 74 and surfaces 76, 77, 78, 79 constitute the essentials of a gear type pump 75. The surface 77 in axially confronting relation to the gears 73, 74 is formed on an annular plate 87 and is axially shiftably supported in the wall 17 of the housing by a cylindrical surface 88. The outside circumference 89 of the plate 87 is slightly smaller in diameter than the diameter of the cylindrical surface 88. A resiliently deformable retainer 91 constitutes biasing means for urging the plate 87 against the gears 73, 74 and against a flat surface 92 formed in the wall 17 at right angles to the axis 93 of the drive shaft 12 and the axis 94 of the countershaft 67. The retainer 91 is a snap ring having circumferentially facing ends 96, 97 defining a gap.

Conically shaped camming surfaces 101, 102 are formed on the housing 19 and retainer 91 in complementary and axially facing relation to one another. Camming surface 101 is formed on one axial side of an annular recess 100. When the pressure in the pump exceeds a predetermined value, the plate 87 will move to the right forcing the retainer 91 to contract through the

camming action of the camming surfaces 101, 102. Such axial movement will permit the fuel to escape to the governor compartment 103. Fuel in the governor compartment 103 is at approximately atmospheric pressure and is permitted to return to the fuel tank 106 through a conduit 107 schematically illustrated. Actually conduit 107 may be so positioned that the governor compartment is maintained full of fuel to insure lubrication of parts therein. Fuel is drawn from tank 106 by a conduit 108 which is connected by a suitable fitting 109 to inlet passage 81. The outlet passage 82 is connected to a full flow filter 111 by a conduit 112. Fluid flowing from filter 111 passes to the supply chamber 47 through a conduit 113.

Wear particles of the drive compartment 18 are prevented from passing to the fuel supply compartment 47. The fuel flowing from the supply chamber 47 to the drive compartment 18 is directed to the governor compartment by way of bearings 13, 14. Fuel lubricating journal type bearing 13 and mating bearing surface 117 on shaft 12 flows axially to the left to a cavity 122 defined by a low pressure seal 121, shaft 12 and cap 118 which forms a part of wall 16. The cavity 122 is connected to the governor compartment 103 through a passage 123 formed in the shaft 12 and a recess 116 in gear 74. A flat 126 is formed on the shaft 12 to drivingly connect the gear 74 and this flat extends axially to the left, as viewed in FIG. 1, sufficiently to provide a small connecting chamber 127 at the end of passage 123. Fuel also flows from the drive compartment to the governor compartment between bearing surfaces 14 and journal type surface 128. Thus the journal type bearings act as restricted flow passage means for conveying fuel from the drive compartment to the exterior thereof.

A pressure regulating valve 131 is provided in the wall 17 intermediate the fuel supply chamber 47 and the governor compartment 103. The governor compartment 103, the fuel tank 106 and fuel supply passage 81 are at a low pressure and may be considered the low pressure zone of the fuel system. The outlet passage 82, conduit 112, filter 111, conduit 113 and fuel supply chamber 47 are at an intermediate pressure as regulated by the valve 131 and these portions of the fuel supplying mechanism may be thought of as being an intermediate pressure zone. The pressure chamber 36, nozzle supply passages 42, passage 39 are cyclically at a high pressure and may be considered a high pressure zone. When the fuel filter 111 becomes clogged, pressure in conduit 112 and chamber 86' goes up and then the plate 87, retainer 91 and camming surfaces 101 and 102 function as a relief valve for the pump. The stepped diameter plunger 22 and lubrication system are intimately related improvements inasmuch as the concept of providing an enlarged inlet portion 46 would require eccentricity tolerances so critical that the cost would be excessive if the plunger were required to have a fluid tight fit with a dividing wall maintaining fluid separation between the supply chamber and drive compartment. The practical and novel lubrication system, herein described, made the stepped diameter plunger commercially feasible by eliminating the dividing wall between the supply chamber and drive compartments. By connecting the front axial end of the front bearing 13 with the governor chamber, the seal 121 is subjected to little more than atmospheric pressure and therefore an inexpensive low pressure seal, such as the radial contact seal illustrated, may be used in place of a more expensive high pressure seal such as a face type seal. As is evident from the drawings and the foregoing description, the plunger 22 is guided laterally only by the bore 32.

The pressure differential across cylindrical surface bearings 13, 14 insure sufficient lubrication to permit journal type bearings to be effectively employed. For instance, if there was no pressure difference across bearing 13 an antifriction bearing, such as a roller or ball bearing,

might be required. By routing the fuel flowing across bearings 13, 14 to the governor compartment, flow is away from the fuel supply compartment and therefore wear particles created in the drive compartment 18 will not be carried to the supply chamber 47. Also the lubrication of the injection pump is self-contained and does not require additional conduits and the like.

Another advantage of this invention is the interchangeability of control sleeves between pumps of different capacities. The sleeve may be standard for pump plungers which have the same enlarged diameter inlet portion but which do not have the same size pumping and distributing portion. Thus the same control sleeve can be used on pumps for different size engines with the same number of cylinders. Using the same internal diameter control sleeve permits one size of broach to be used in manufacturing the sleeves for a family of injection pumps.

Although a single embodiment of this invention has been illustrated and described, it is intended that modifications and other embodiments are within the scope of this invention as defined by the appended claims.

What is claimed is:

1. In a fuel injection pump of the type having a housing with walls defining a drive compartment and a bore with a pumping chamber at one end thereof, a drive shaft rotatably mounted in axially spaced walls of said drive compartment and a cam portion on said shaft disposed in said drive compartment intermediate said walls, the combination comprising: a fuel supply chamber within said housing in free flow fluid communication with said drive compartment whereby fuel lubricates pump parts disposed within said supply chamber and drive compartment, a plunger having a cylindrical pumping and distributing portion reciprocably and rotatably disposed in said bore for pumping and distributing fuel, a cylindrical fuel inlet portion on said plunger and disposed within said fuel supply chamber, the diameter of said inlet portion being greater than said pumping and distributing portion, a control sleeve surrounding said inlet portion, inlet ports in said sleeve and inlet portion, respectively, an inlet passage in said plunger connecting said pumping chamber in free fuel flow communication with an inlet port in said inlet portion, thrust transmitting means intermediate said cam portion and plunger for reciprocating the latter upon rotation of said shaft, and means driven by said shaft for rotating said plunger to distribute pumped fuel and cyclically bring said inlet ports in said inlet portion and sleeve into registration with one another.

2. The structure set forth in claim 1 and further comprising a governor compartment in said housing with a wall thereof common to one of said axially spaced walls, a pair of bearings for said shaft in said axially spaced walls, a fluid seal between the other of said walls and said shaft on the axial side of said bearing in said other wall remote from said drive compartment, and a passage interconnecting the axial end of said bearing in said other wall remote from said drive compartment with said governor compartment.

3. The structure set forth in claim 2 wherein said passage is in said drive shaft.

4. In a fuel supply system having high, intermediate and low pressure zones and a fuel injection pump of the type having a housing with walls defining a drive compartment, a drive shaft rotatably mounted in axially spaced walls of said housing at opposite sides of said drive compartment and a cam portion on said shaft disposed in said drive compartment intermediate said walls, the combination comprising: a fuel supply chamber within said housing in fluid communication with said drive compartment whereby fuel lubricates pump parts disposed within said supply chamber and drive compartment, said supply chamber being in said intermediate pressure zone, a bore extending in one direction from said supply chamber and having a pumping chamber at its outer end, said

pumping chamber being in said high pressure zone, a plunger having a cylindrical pumping and distributing portion reciprocably and rotatably disposed in said bore for pumping and distributing fuel and a cylindrical fuel inlet portion disposed within said fuel supply chamber, a control sleeve surrounding said inlet portion, inlet ports in said sleeve and inlet portion, respectively, an inlet passage in said plunger connecting said pumping chamber in free fuel flow communication with said inlet port in said inlet portion, thrust transmitting means intermediate said cam portion and plunger for reciprocating the latter upon rotation of said shaft, means driven by said shaft for rotating said plunger to distribute pumped fuel and to cyclically bring said inlet ports in said inlet portion and sleeve into registration with one another, a bearing in each of said walls in supporting relation to said shaft, a fluid seal between said shaft and one of said walls on the axial side of one of said bearings remote from said drive compartment, said seal, said one wall and said shaft defining an annular cavity for receiving fuel passing axially along said one bearing away from said drive compartment, and passage means for conveying fuel from said cavity to said low pressure zone of said fuel supply system.

5. The structure set forth in claim 4 wherein said passage means includes a passage in said shaft extending to a point of said housing remote from said drive compartment and supply chamber.

6. The structure set forth in claim 5 and further comprising a governor compartment in said housing on the side of said other wall remote from said drive compartment and wherein said point is within said governor compartment.

7. In a fuel injection pump of the type having a housing with walls defining a drive compartment, a drive shaft rotatably mounted in said walls at opposite sides of said drive compartment and a cam portion on said shaft disposed in said drive compartment intermediate said walls, the combination comprising: a fuel supply chamber within said housing, a bore extending in one direction from said supply chamber and having a pumping chamber at its outer end, a plunger having a cylindrical pumping and distributing portion reciprocably and rotatably disposed in said bore for pumping and distributing fuel and a cylindrical fuel inlet portion disposed within said fuel supply chamber, said fuel inlet portion being of greater diameter than said pumping and distributing portion and said plunger being laterally guided only by said bore, a control sleeve surrounding said inlet portion, inlet ports in said sleeve and inlet portion, respectively, and an inlet passage in said plunger connecting said pumping chamber in free fuel flow communication with said inlet port in said inlet portion, thrust transmitting means intermediate said cam portion and plunger for reciprocating the latter upon rotation of said shaft, means driven by said shaft for rotating said plunger to distribute pumped fuel and to cyclically bring said inlet ports in said inlet portion and sleeve into registration with one another, means permitting fluid flow from said fuel supply chamber to said drive compartment whereby said cam portion of said shaft is lubricated by said fuel, and restricted flow passage means conveying fuel from said drive compartment to the exterior thereof during operation of said pump.

8. A fuel injection pump assembly comprising: a housing, a bore in said housing with a pumping chamber at one end thereof, walls in said housing defining a first pressure zone including a supply chamber and a second pressure zone including a governor compartment, said second zone being maintained at a lower pressure than said first zone, a pump plunger having a cylindrical pumping and distributing portion reciprocably and rotatably mounted in said bore and having a cylindrical fuel inlet portion disposed within said supply chamber, said fuel inlet portion being of greater diameter than said pumping and distributing portion, means in said first pressure zone for rotating and reciprocating said plunger includ-

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ing a drive shaft extending through and supported by a cylindrical bearing surface in one of said walls, a seal between said shaft and said one wall at the axially outer end of said bearing surface, fluid passage means for conveying fuel from the axially outer end of said bearing surface to said governor compartment thereby establishing a pressure differential across said bearing surface causing fuel to flow axially therealong to lubricate said bearing surface and flush wear particles to said governor compartment, said passage means including an axially extending passage in said shaft.

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