(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 339 166 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
29.06.2011 Bulletin 2011/26

(51) Int Cl.:
F02M 59/44 *(2006.01)*

(21) Application number: **09015969.0**

(22) Date of filing: **23.12.2009**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
AL BA RS

(71) Applicant: **Caterpillar Motoren GmbH & Co. KG**
24159 Kiel (DE)

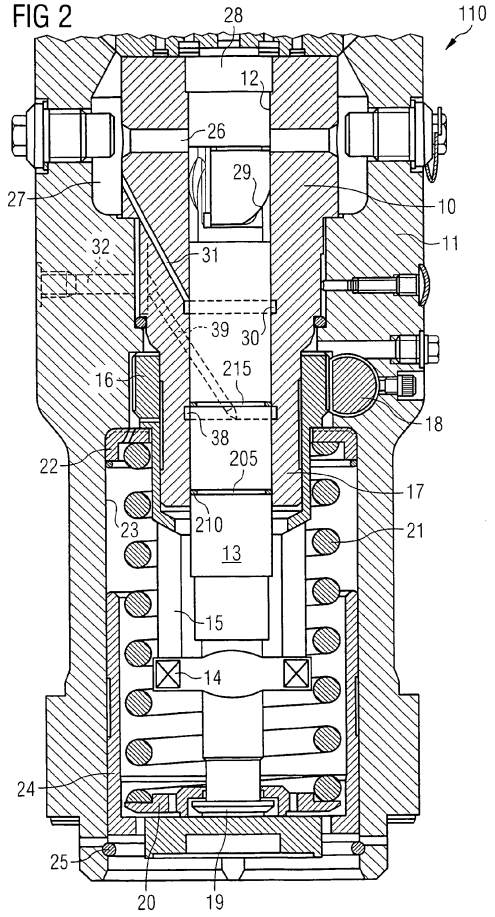
(72) Inventors:
- **Nagel, Jürgen**
  24214 Gettorf (DE)
- **Jacobs, Holger**
  24159 Kiel
  (DE)
- **Abraham, Volker**
  24159 Kiel
  (DE)
- **Banck, Andreas**
  24159 Kiel
  (DE)

(74) Representative: **Kramer - Barske - Schmidtchen**
European Patent Attorneys
Landsberger Strasse 300
80687 München (DE)

(54) Purging method and system with scraper or wiper ring for preventing formation of deposits inside fuel pump

(57) The present disclosure refers to a fuel injection system (100) configured to supply fuel as, e.g., heavy fuel oil to injection nozzles (105) of a large internal combustion engine (5). The system may comprise a fuel injection pump (110) configured to measure fuel as, e.g., heavy fuel oil into correct amounts for injection, building up a high pressure, and delivering it to at least one injection nozzle (110) of the large internal combustion engine (5) at the proper time. The fuel injection pump (110) may include a pump barrel (10) extending along a longitudinal direction and having a barrel wall (12), and a plunger (13) configured to reciprocate within the pump barrel (10) and guided by the barrel wall (12). At least one scraper ring (210; 220) may be attached to one of the plunger (13) and the barrel inner wall (12) and configured to slide along the other of the plunger (13) and the barrel inner wall (12).

FIG 2



EP 2 339 166 A1

Description

Technical Field

[0001] The present disclosure generally refers to a fuel injection system for supplying fuel as, e.g., heavy fuel oil to injection nozzles of a large internal combustion engine. Furthermore, the present disclosure refers to a fuel injection pump, as well as to a method for purging a fuel injection pump configured to pump fuel as, e.g., heavy fuel oil, of a large internal combustion engine.

[0002] In addition, the present disclosure refers to a high-pressure fuel pump for supplying fuel as, e.g., heavy fuel oil to a common rail of a fuel injection system, and to a method for purging a fuel pump configured to pump fuel as, e.g., heavy fuel oil, of a large internal combustion engine.

Background

[0003] Generally, the term "large internal combustion engine" may refer to internal combustion engines which may be used as main or auxiliary engines of ships/vessels such as cruiser liners, cargo ships, container ships, and tankers, or in power plants for production of heat and/or electricity. In particular, large internal combustion engines may be configured to bum at least one fuel selected from the group consisting of Diesel, Marine Diesel Oil (MDO), and heavy fuel oil (HFO).

[0004] The terms "fuel injection pump" and "high-pressure fuel pump" as used herein may be replaced against each other. In other words: the presented characteristics of a fuel injection pump according to the present disclosure may also be provided in a high-pressure fuel pump which may be used to supply fuel like heavy fuel oil or the like at high pressure to a common rail.

[0005] Heavy fuel oil may contain "asphaltenes". Asphaltenes may be defined as molecular substances that are found in crude oil, along with resins, aromatic hydrocarbon, and alcane (i.e, saturated hydrocarbons). Asphaltenes may consist primarily of carbon, hydrogen, nitrogen, oxygen, and sulfur, as well as great amounts of vanadium and nickel. Heavy oils may contain much higher proportions of asphaltenes than of medium API graphic oil or light crude oils. For example, ISO 8217 Fuel Standard may describe various parameters of "heavy fuel oil", also referred to as "marine distillate fuels" or "marine residual fuels".

[0006] In addition, fuels like Diesel or MDO may contain contaminations like e.g. heavy fuel oil and/or other components as, e.g., zinc etc. These contaminations may generate deposits within the pump. In case of zinc, layers of zinc sulfate may develop.

[0007] Fuel injection pumps for supplying fuel as, e.g., heavy fuel oil to injection nozzles of large internal combustion engines are basically known. These pumps are configured to measure fuel as, e.g., heavy fuel oil into correct amounts of oil injection, building up a high pressure, and delivering it to the injection nozzles of the large internal combustion engines at the proper time. Such a fuel injection pump may include a pump housing, a pump barrel being arranged in the pump housing, the pump barrel extending along a longitudinal direction and having a barrel inner wall. A plunger may be configured to reciprocate within the pump barrel and guided by the barrel inner wall. A first groove may be formed in the barrel inner wall at a first position with respect to the longitudinal direction and covered by the plunger.

[0008] A fuel injection pump of the type described above is, e.g., known from GB 2 260 374 A. In this document, it is mentioned that it is known to provide in the wall of a bore a groove which is connected to a supply of lubricant under pressure, the groove being disposed intermediate a port or ports and the end of the bore from which the plunger extends. Since the plunger is reciprocating lubricant is picked up from the groove to provide lubrication of the working clearance between the plunger and the wall of the bore. Some lubricant were to flow out of the working clearance and will lubricate the working surfaces. However, fuel due to the high fuel pressure which is developed in the pumping chamber of the pump, will also flow along the working clearance and will mix with the lubricant in the groove and will flow onto the working surfaces. If the fuel is a light fuel such as is used in Diesel engines for vehicles, escape of fuel is not serious so far. As the lubrication of the various surfaces is concerned although desirable that the escape of fuel should be as small as possible since it deletes the engine lubricating oil. To this end it is known to provide a further groove intermediate the port or ports and the first mentioned groove, and to connect the further groove to the low pressure fuel source so that the maturity of the fuel is collected and returned to the source.

[0009] It is further mentioned that, if the fuel is a heavy fuel, for example of the type which requires to be heated before it is supplied to the pump (e.g. HFO), the leakage of fuel as described presents a number of problems. Firstly, the fuel will tend to accumulate in the grooves and the lubricating action as described would be impaired. Secondly, since the heavy fuel has blocked the intended flow of lubricant, the lubricant will due to the heat, tend to form a locker. Thirdly, the fuel oil in the event that the engine is stopped will tend to solidify making it difficult if not impossible for the means which controls the setting of the sleeve to function.

[0010] In the above-identified GB 2 260 374 A it is disclosed to provide a circumferential groove in the wall of the bore intermediate said port or ports and the end of the bore from which the plunger extends. A first passage is formed in the pump barrel and which in use, is connected to the source of lubricant under pressure and a second passage in the pump barrel is connected to the groove and through which a control flow of lubricant takes place in the use of the pump. Accordingly, the deposits which may be built up at the pump barrels may be removed by pumping Diesel fuel instead of heavy fuel oil

with this fuel injection pump for the specific time period. Hence, purging cannot be conducted without stopping the normal heavy fuel oil supply.

[0011] EP 0 537 911 B1 refers to a very similar fuel injection pump. In EP 0 537 911 B1 it is mentioned that with pumps known from GB 2 260 374 A, it is a usual practice when stopping the engine to purge the pump of the heavy fuel by running it for a period of time on light fuel. This would avoid the possibility of the heavy fuel solidifying in the various passages within the pump and thereby preventing or hindering restarting of the engine without heating the pump, but with such a pump it would be necessary when changing over to the light fuel to provide the lubrication of the plunger. As a solution it is disclosed in EP 0 537 911 B1 to provide a passage which interconnects a first and second groove, and a pair of changeover valves for controlling liquid flow to and from the grooves respectively. The first one of said valves when in position connecting the associated groove to a drain and being in said one position when heavy fuel is being pumped by the pump and in its other position connecting the associated groove to a sort of lubricating oil under pressure and a second one of said valves when in one position connecting the associated groove to the drain and being in said one position when heavy fuel is being pumped by the pump and in its other position connecting the associated groove to a lubricating oil drain. The change over valves are in their said positions when light fuel is being pumped by the pump. The lubricating oil flows between the groove through the passage. Accordingly, the fuel injection pump known from EP 0 537 911 B1 may show the same problems as the fuel injection pump of GB 2 260 374 A.

[0012] Today hard coatings may often be used on pump plungers as a measure against wear and seizure of the plunger. These layers may have a very low surface roughness. Such coatings may normally not being used inside the barrel, hence layers will emerge mainly on the barrels surface, because of their higher surface roughness, which is a better bond for the deposit layers.

[0013] The present disclosure is directed, at least in part, to improving or overcoming one or more aspects of prior systems.

Summary of the Disclosure

[0014] In a first aspect of the present disclosure a fuel injection system configured to supply fuel as, e.g., heavy fuel oil to injection nozzles of a large internal combustion engine may comprising a fuel injection pump which may be configured to measure fuel as, e.g., heavy fuel oil into correct amounts for injection, building up a high pressure, and delivering it to at least one injection nozzle of the large internal combustion engine at the proper time. The fuel injection pump may include a pump barrel extending along a longitudinal direction and having a barrel wall, and a plunger configured to reciprocate within the pump barrel and guided by the barrel wall. At least one scraper or wiper ring may be attached to one of the plunger and the barrel inner wall and may be configured to slide along the other of the plunger and the barrel inner wall.

[0015] In another aspect of the present disclosure a fuel injection pump may be configured to be used in a fuel injection system of the type mentioned above. The fuel injection pump may be configured to measure fuel as, e.g., heavy fuel oil into correct amounts for injection, building up a high pressure, and delivering it to at least one injection nozzle of the large internal combustion engine at the proper time. The fuel injection pump may include a pump barrel extending along a longitudinal direction and having a barrel inner wall, and a plunger configured to reciprocate within the pump barrel and guided by the barrel inner wall. At least one scraper ring may be attached to the plunger and configured to slide along the barrel inner wall.

[0016] In another aspect of the present disclosure a fuel injection system may be configured to supply fuel as, e.g., heavy fuel oil to a common rail of a large internal combustion engine. The system may comprise a high-pressure fuel pump configured to supply fuel as, e.g., heavy fuel oil at high-pressure to a common rail. The fuel pump may include a pump barrel extending along a longitudinal direction and having a barrel wall, and a plunger configured to reciprocate within the pump barrel and guided by the barrel wall. At least one scraper ring may be attached to one of the plunger and the barrel inner wall and may be configured to slide along the other of the plunger and the barrel inner wall.

[0017] In another aspect of the present disclosure a method for purging a fuel injection pump configured to pump fuel as, e.g., heavy fuel oil, of a large internal combustion engine within, e.g., a ship or generator set, may comprise the method step of mechanically scraping or wiping off any deposits on a plunger or an barrel inner wall of the fuel injection pump during reciprocating motion of the plunger. The same method may be applicable to a fuel pump which may be configured to supply fuel as, e.g., heavy fuel oil to a common rail of a large internal combustion engine.

[0018] Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

Brief Description of the Drawings

[0019] Fig. 1 shows a schematic block diagram of an exemplary embodiment of a fuel injection system of the present disclosure;

[0020] Fig. 2 shows a schematic sectional view of a fuel injection pump which may be adapted to be used in a fuel injection system shown in Fig. 1;

[0021] Fig. 3 shows a piston and pump barrel adapted to be used in a fuel injection pump as, e.g., shown in Fig. 2;

[0022] Fig. 4 shows a further schematic longitudinal sectional view of a pump barrel of a fuel injection pump

shown in Figs. 1 to 3;

[0023] Fig. 4a shows a detail "Z1" of Fig. 4;

[0024] Fig. 5 shows an enlarged detail of a scraper ring or wiper ring mounted at a plunger of a fuel injection pump according to the present disclosure;

[0025] Fig. 6 shows another embodiment of a scraper or wiper ring mounted on a plunger of a fuel injection pump according to the present disclosure;

[0026] Fig. 7 shows another exemplary embodiment of a scraper or wiper ring mounted at a plunger of a fuel injection pump according to the present disclosure; and

[0027] Fig. 8 shows another exemplary embodiment of scraper or wiper rings mounted on a plunger of a fuel injection pump according to the present disclosure.

Detailed Description

[0028] Fig. 1 shows a schematic block diagram of an exemplary embodiment of a fuel injection system 100 configured to supply fuel as, e.g., heavy fuel oil to injection nozzles 105 of a large internal combustion engine 5. In accordance with this exemplary embodiment of fuel injection system 100 each injection nozzle 105 may be connected to an associated fuel injection pump 110 via a high-pressure fuel line 115. Alternatively, one fuel injection pump 110 may be configured to supply fuel as, e.g., heavy fuel oil to a plurality of fuel injection nozzles 110. Each fuel injection pump 110 may be connected to a fuel reservoir 120 via fuel supply lines 116.

[0029] In Fig. 1 the basic structure of a fuel injection system according to one aspect of the present disclosure is shown. An alternate structure may comprise a common rail and one single fuel pump instead of a plurality of fuel injection pumps 110. Accordingly, in this alternate structure the fuel injection nozzles 105 may connect to the common rail and the high-pressure fuel pump may supply the fuel at high-pressure to the common rail from which the high-pressure fuel is distributed to the individual injection nozzles 105.

[0030] In the following, further details of a fuel injection pump 110 are provided with reference to Figs. 2 and 3. Referring to Fig. 2, the pump may comprise a stepped pump barrel 10 which may be located within a housing 11. Formed in the barrel may be a bore in which is formed a reciprocable plunger 13. The plunger 13 may extend from the end of the barrel 10 and may be provided with a pair of lateral pegs 14 which may be located in grooves 15 respectively formed in an extension of a control sleeve 16 which is mounted for angular movement about a cylindrical portion 17 of the barrel 10. The sleeve 16 may be provided with teeth for engagement by a rack bar 18 in known manner. The plunger 13 may have a foot 19 formed at its free end, the foot 19 being engaged by a spring abutment 20 and this in turn is engaged by one end of a coiled compression spring 21 the opposite end of which may be in engagement with a flanged spring abutment 22 which may additionally serve to retain the control sleeve 16 against axial movement.

[0031] The housing 11 may define a cylindrical guide surface 23 for a cup shaped tappet 24 which in use, may be driven inwardly by the action of an engine cam either directly or indirectly through a rocker mechanism. During inward movement of the tappet 24 the base wall thereof may engage with the foot 19 of the plunger 13 to impart inward movement of the plunger 13 against the action of the spring. The spring 21 may return the plunger 13 and also the tappet when so allowed by the cam.

[0032] In known manner there may be provided in the wall of the bore a pair of ports 26 which communicate with a fuel supply gallery 27 defined between the housing and the pump barrel 10. The ports 26 may be arranged to be covered by the plunger 13 after a predetermined inward movement and thereafter fuel will be expelled from the pumping chamber 28 defined in part by the end of the plunger and the wall of the bore to an associated engine. The plunger 13 may also provided with a groove which is in communication with the pumping chamber 28, the groove having a helical control edge 29 which may uncover one of the ports 26 to the groove after a further inward movement of the plunger and when the port may be uncovered to the groove fuel may spill from the pumping chamber and may be returned to the supply gallery 27. The angular setting of the sleeve and plunger may determine the point during the inward movement of the plunger at which spill takes place and therefore the amount of fuel supplied to the associated engine.

[0033] Formed in the wall of the bore at a position intermediate the ports 26 and the end of the barrel 10 from which the plunger extends, may be a circumferential groove 30. The groove 30 may be connected to the gallery 27 so that substantially all the fuel which may leak from the pumping chamber due to the high pressure therein in use of the pump 110, will be collected in the groove 30 and returned to the fuel supply gallery 27 via passage 31.

[0034] Dependent from the kind of fuel pumped within the fuel injection pump 110 deposits, e.g. in form of layers of hardened asphaltenes and/or zinc sulphates and/or zinc sulfites and/or calcium sulphates, may develop at the outer surface of plunger 13 and/or the barrel inner wall 12, e.g. within the area between ports 26 and cylindrical portion 17.

[0035] Another groove 38 may be formed in the wall of the bore at a position below groove 30, in particular at a position which may be located more far way from edge 29 than mentioned groove 30. This groove 38 may also be connected to a fuel drain (not shown) via inlet 33, passage 32 and passage 39.

[0036] Referring to Figs. 2 and 3 a more schematic view of a similar piston 13 and barrel 10 as, e.g., to be used in a fuel injection pump 110 shown in Fig. 2, is shown. This exemplary embodiment of a modified plunger for a fuel injection pump 110 may be provided with a first groove 205 and/or a second groove 215. In at least one of these two grooves 205, 215 a scraper ring 210, 220 may be mounted. The scraper ring 210, 220 may

contact the barrel inner wall 12 of the bore with some pressure for sliding along the barrel inner wall 12 during the reciprocating movement of plunger 13. Scraper ring 210 and/or scraper ring 220 may prevent formation of deposit layers in an area where deposit layers may normally be generated on barrel inner wall 12. Scraper rings 210, 220 may apply a pressure force on barrel inner wall 12 in order to remove any deposits. One or more scraper rings 210, 220 may protrude beyond the external outer circumference of plunger 13 by approximately 0.1 to 0.1 mm, if, e.g. the diameter of plunger 13 is about 30 mm in diameter or less, and the plunger is not inserted in the barrel 10. In other words: the scraper or wiper rings may have a certain elasticity so that the rings push with an appropriate pressure against the barrel inner wall. The same may apply if one or more scraper rings are mounted in grooves formed within the barrel inner wall.

[0037] First groove 215 and associated scraper ring 220 may be located at a position which is farther away from pumping chamber 28 than first groove 30. Both, groove 215 and associated scraper 220 may be located such that scraper 220 may move between first groove 30 and second 40 during alternate motion of plunger 19.

[0038] Groove 205 and associated scraper ring 210 may be located at a position in a longitudinal direction of plunger 13 farther away from pumping chamber 28 than groove 215. In addition, groove 205 and associated scraper ring 210 may be arranged so that scraper ring 210 may move in the area between second groove 38 in barrel inner wall 12 and front end of pumping barrel 10 facing to foot 13 of plunger 13.

[0039] In this exemplary embodiment of plunger 13 and pumping barrel 10 for a fuel injection pump 110 the area of barrel inner wall 12 between the groove 30 and groove 38 and the area between groove 38 and the front end of pumping barrel 10 may be scraped off or wiped off by scraper rings 210, 220.

[0040] Fig. 4 shows another exemplary embodiment of a plunger 13 and pumping barrel 10. Only groove 215 and associated scraper ring 220 may be provided. Pumping barrel 10 of this exemplary embodiment shown in Fig. 4 may comprise a groove 230 formed at barrel inner wall 12. The groove 230 may be chamfered so that insertion of plunger 13 may be possible and simultaneously reducing or avoiding damaging of scraper ring 220.

[0041] Fig. 5 shows a schematic sectional view of ring 220 mounted in groove 215 of Fig. 4. Here, it is shown that scraper ring 220 may have an upper and lower edge having, e.g. a sharp edge. In addition, scraper ring 220 may have an internal elasticity and internal spring force so that scraper 220 may tend to extend radial outwardly, and, consequently, may tend to contact barrel inner wall 12 to its own elasticity. It might be possible that scraper ring 220 may not fit exactly in groove 215 but may fit in a longitudinal direction of piston 13. Scraper ring 220 may consist of any suitable material, in particular, of a material selected from the group consisting of metal, fiber glass, reinforced plastic, plastic, epoxy, and alloys and any mixture thereof.

[0042] A fiber glass type scraper ring is shown in part in Fig. 6. Here, fiber glass scraper ring 220' has a similar shape as scraper ring 220 of Fig. 5, but chamfered edges. Other reasonable shapes for scraping off or wiping off deposits on barrel inner wall 12 may be possible.

[0043] Another exemplary embodiment of a scraper ring 220" is shown in Fig. 7. Here, scraper ring 220" may have a shape like a O-ring. Here, scraper ring 220" may be forced within a groove 215" formed on the outer surface of piston 13 so that due to the ring's elasticity the ring's outer surface keeps contact to barrel inner wall 12.

[0044] A package of rings 220" may alternatively be used as, as shown in Fig. 8.

[0045] It is to be noted that a scraper ring 220, 220', or 220" may have a slit so that insertion of ring in the associated groove 215 may be facilitated. Alternatively, a scraper ring 220, 220', or 220" may comprise two or more ring segments to be inserted in the associated groove 215, 215', 215".

Industrial Applicability

[0046] Referring to Figs. 1-8 the basic operation of a fuel injection pump shown and how the purging method may be conducted will be explained. During pumping fuel, e.g., heavy fuel oil, with a fuel injection pump 110 fuel may leak in the gap between barrel inner wall 12 and the outer surface of plunger 13. This fuel may result in formation of deposits on plunger 13 and/or barrel inner wall 12. The reason is that heavy fuel oil (HFO) may contain calcium, phosphorous, zinc, and sulfur. Consequently, deposits or layers of calcium sulphates and/or zinc sulphates and/or zinc sulfites etc. may built up. In addition, high asphaltenes contents in heavy fuel may also produce deposits within the fuel injection pump, in particular, on a plunger outer surface or barrel inner wall 12.

[0047] In case that one or more scraper rings 210, 220 may be arranged at piston 13 or barrel inner wall 12 purging may be achieved due to scraping or wiping off of any deposits or layers which may develop at plunger 13 and/or barrel inner wall 12.

[0048] As already mentioned above an alternate fuel injection pump 110 or fuel supply pump may be provided according to the present disclosure in which purging may be achieved by means of at least one scraper ring 210, 220 mounted at plunger 13 or at barrel inner wall 12 only. In this case, deposits or layers on barrel inner wall 12 may be scraped off or wiped off by scraper ring 210 and/or 220 simultaneously with reciprocating motion of plunger 13.

[0049] The at least one scraper ring 210; 220 may be selected from the group consisting of a spring ring, a slit ring, a ring comprising at least two separate ring segments, a piston ring, and a spring washer.

[0050] Although the preferred embodiments of this invention have been described herein, improvements and modifications may be incorporated without departing

from the scope of the following claims. Examples of such modifications and improvements may be disclosed in the above description and/or in the attached claims.

Claims

1. A fuel injection system (100) configured to supply fuel as, e.g., heavy fuel oil to injection nozzles (105) of a large internal combustion engine (5), comprising:

   a fuel injection pump (110) configured to measure fuel as, e.g., heavy fuel oil into correct amounts for injection, building up a high pressure, and delivering it to at least one injection nozzle (110) of the large internal combustion engine (5) at the proper time, the fuel injection pump (110) including:

   a pump barrel (10) extending along a longitudinal direction and having a barrel inner wall (12); and
   a plunger (13) configured to reciprocate within the pump barrel (10) and guided by the barrel wall (12);

   at least one scraper ring (210; 220) attached to one of the plunger (13) and the barrel inner wall (12) and configured to slide along the other of the plunger (13) and the barrel inner wall (12).

2. The fuel injection system of claim 1, further comprising a first groove (30) formed within the barrel inner wall (12) and a second groove (38) formed within the barrel inner wall (12), the second groove (38) being located in a larger distance with respect to a pump chamber than the first groove (30),
   wherein a scraper ring (220) is located such that it slide in the area between the first groove (30) and second groove (38), and
   wherein a further scraper ring (210) is located such that it slide in the area between the second groove (38) and a barrel front side facing a plunger foot (19).

3. The fuel injection system of any one of the preceding claims, wherein the at least one scraper ring (210; 220) has a certain elasticity and is dimensioned such that the scraper ring (210; 220) contacts and pushes against the barrel inner wall (12) and the plunger (13), respectively with a certain pressure force.

4. The fuel injection system of any one of preceding claims, wherein the at least one scraper ring (210; 220) is selected from the group consisting of a spring ring, a slit ring, a ring comprising at least two separate ring segments, a piston ring, and a spring washer.

5. The fuel injection system of any one of the preceding claims, wherein the at least one scraper ring (210; 220) is configured to scrape or wipe off deposits or layers at the contacted surface (12; 13).

6. A fuel injection pump (110) configured to be used in a fuel injection system of any one of the preceding claims, the fuel injection pump (110) being configured to measure fuel as, e.g., heavy fuel oil into correct amounts for injection, building up a high pressure, and delivering it to at least one injection nozzle (110) of the large internal combustion engine (5) at the proper time, the fuel injection pump (110) including:

   a pump barrel (10) extending along a longitudinal direction and having a barrel inner wall (12);
   a plunger (13) configured to reciprocate within the pump barrel (10) and guided by the barrel inner wall (12); and
   at least one scraper ring (210; 220) attached to the plunger (13) and configured to slide along the barrel inner wall (12).

7. A method for purging a fuel injection pump (110) configured to pump fuel as, e.g., heavy fuel oil, of a large internal combustion engine (5) within, e.g., a ship or generator set, wherein the fuel injection pump (110) includes a pump barrel (10), the pump barrel (10) extending along a longitudinal direction and having a barrel inner wall (12), a plunger (13) configured to reciprocate within the pump barrel (10) and guided by the barrel inner wall (12), the method comprising:

   mechanically scraping or wiping off any deposits on the plunger (13) or the barrel inner wall (12) during reciprocating motion of the plunger (13).

8. A fuel injection system configured to supply fuel as, e.g., heavy fuel oil to a common rail of a large internal combustion engine (5), comprising:

   a high-pressure fuel pump configured to supply fuel as, e.g., heavy fuel oil at high-pressure to a common rail, the fuel pump including:

   a pump barrel (10) extending along a longitudinal direction and having a barrel wall (12);
   a plunger (13) configured to reciprocate within the pump barrel (10) and guided by the barrel wall (12);

   at least one scraper ring (210; 220) attached to one of the plunger (13) and the barrel inner wall (12) and configured to slide along the other of the plunger (13) and the barrel inner wall (12).

FIG 1

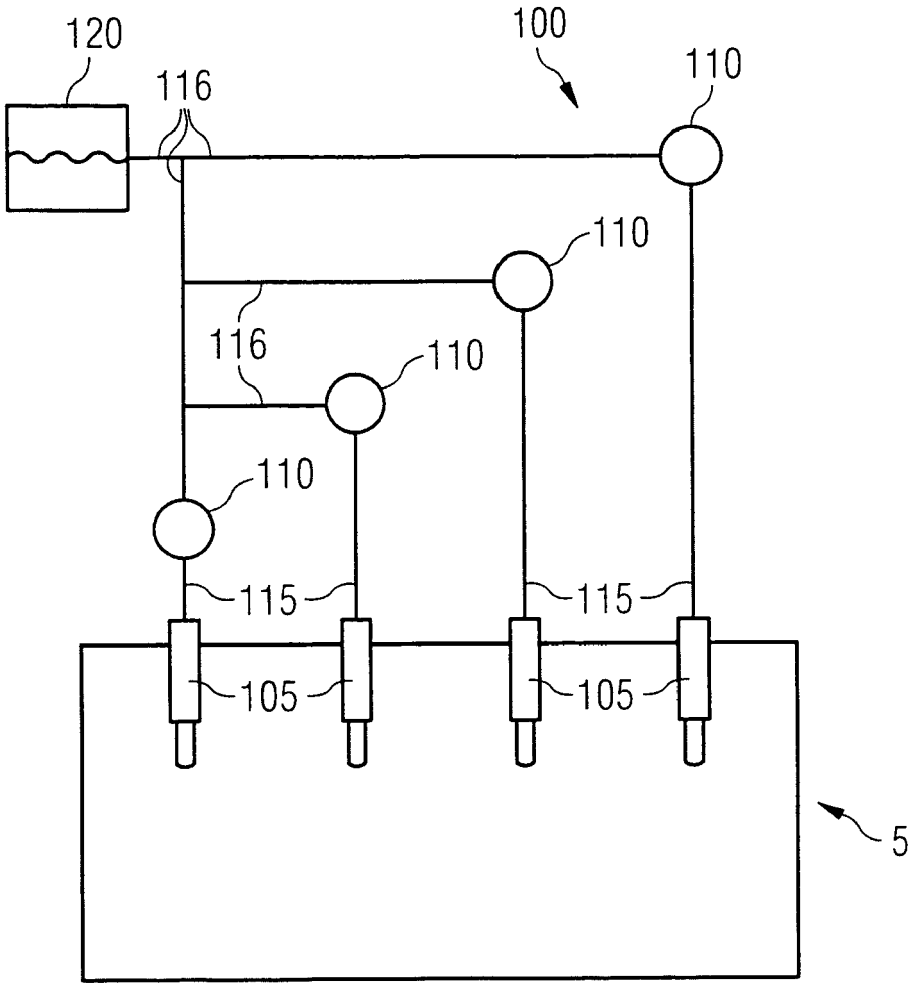


FIG 2

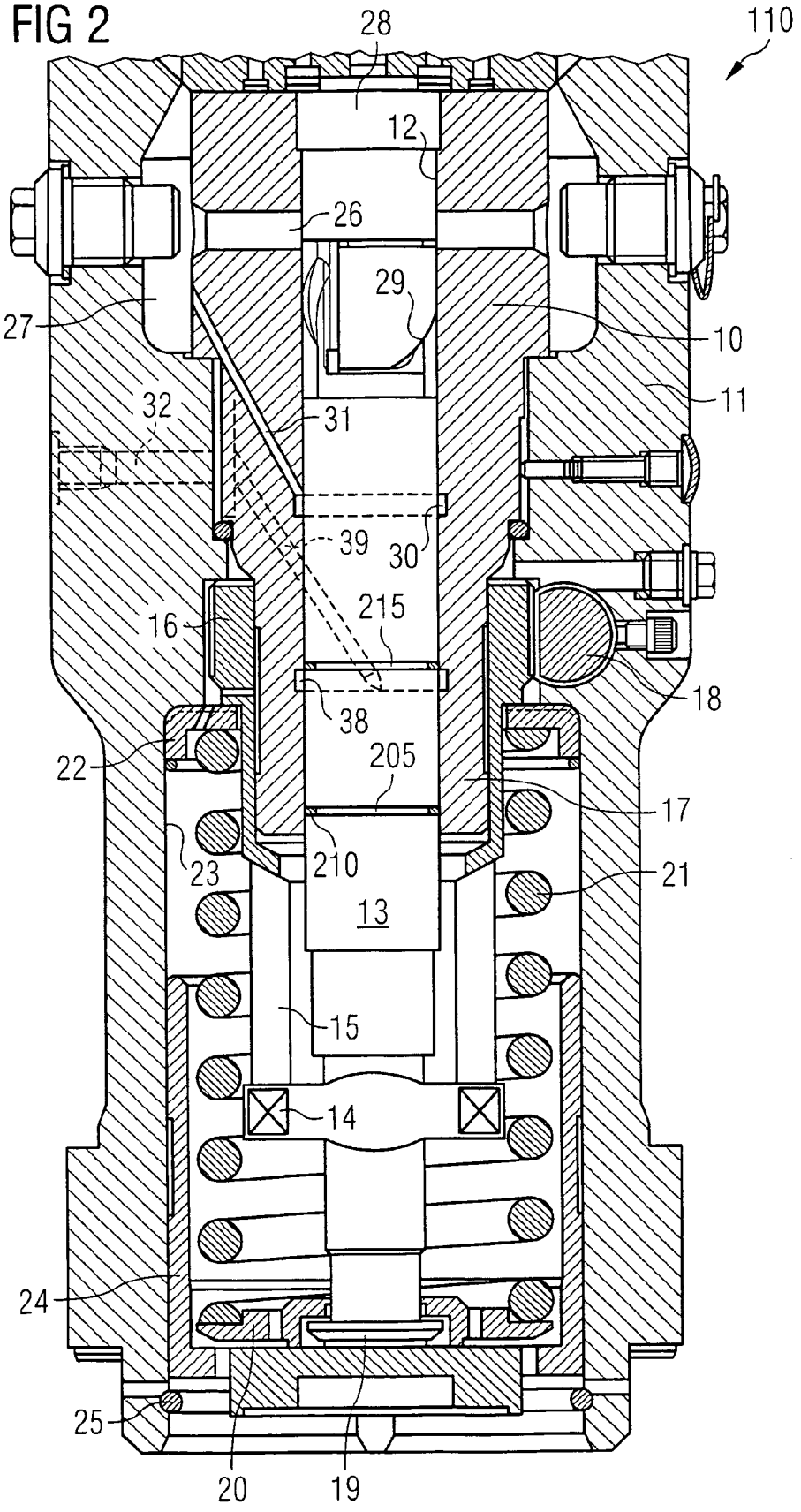

110
28
12
26
29
27
10
11
32
31
39
30
215
16
18
38
205
22
17
23
210
21
13
15
14
24
25
20
19

FIG 3

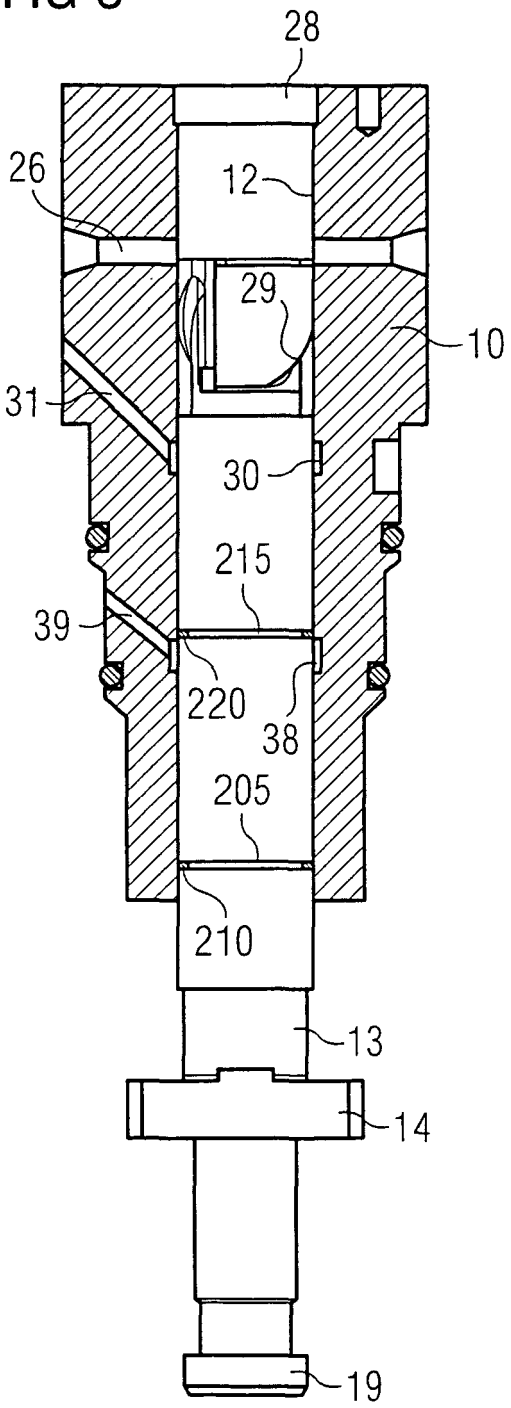


FIG 4

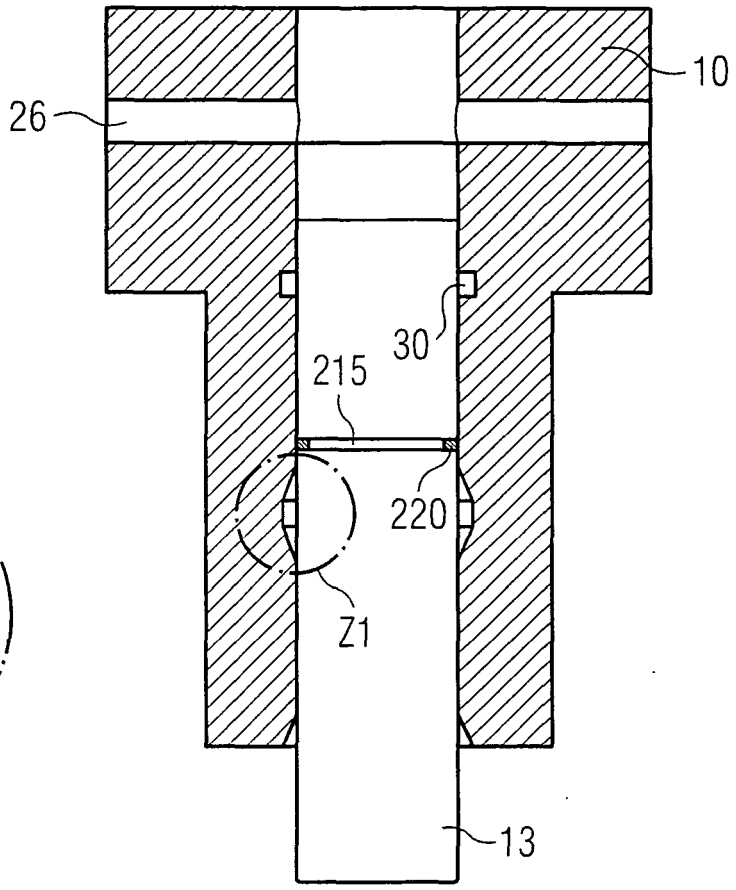


FIG 4a

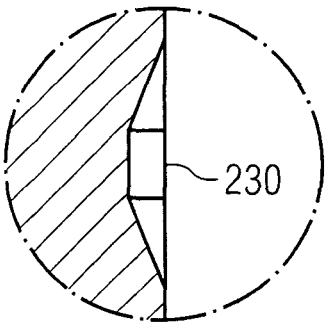


FIG 5

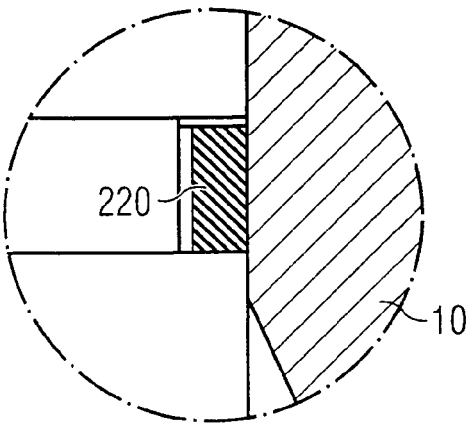


FIG 6

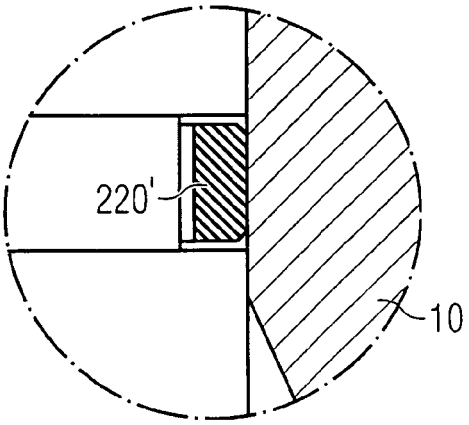


FIG 7

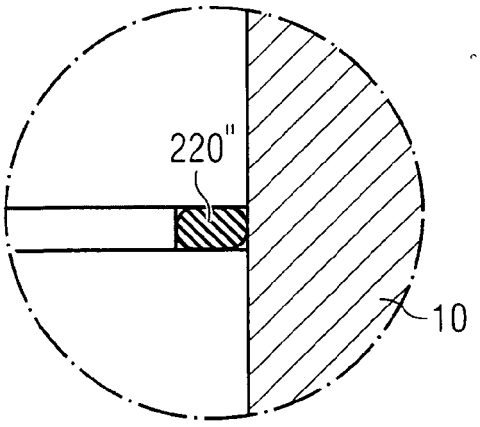
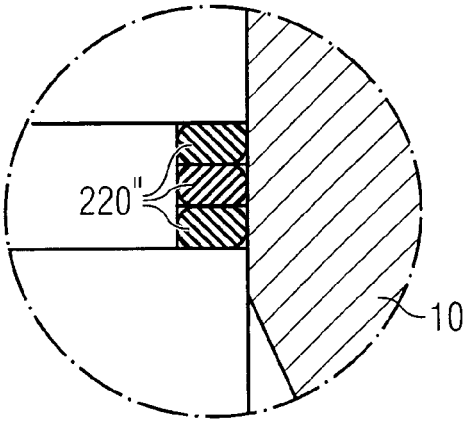


FIG 8



Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 09 01 5969

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 10 2006 059333 A1 (MAN DIESEL SE [DE]) 19 June 2008 (2008-06-19) * page 2, paragraph 0012 - page 3, paragraph 0019; figure 1 *	1-8	INV. F02M59/44
X	US 2 130 339 A (HANS DUNKELMANN) 20 September 1938 (1938-09-20) * page 1, line 37 - page 2, line 3; figure 1 *	1,3-8	
X	DE 10 2007 019909 A1 (MAN DIESEL SE [DE]) 6 November 2008 (2008-11-06) * page 3, paragraph 0018 - page 3, paragraph 0019; figure 2 *	1,3-8	
X	US 2009/114190 A1 (SHAFER SCOTT [US] ET AL) 7 May 2009 (2009-05-07) * page 3, paragraph 0020 - page 3, paragraph 0021; figures 3,4 *	1,3-8	
			TECHNICAL FIELDS SEARCHED (IPC)
			F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 May 2010	Etschmann, Georg

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 01 5969

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

07-05-2010

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102006059333 A1	19-06-2008	CN 101344057 A	14-01-2009
		JP 2008151132 A	03-07-2008
		KR 20080055649 A	19-06-2008
US 2130339 A	20-09-1938	NONE	
DE 102007019909 A1	06-11-2008	CN 101294532 A	29-10-2008
		JP 2008274934 A	13-11-2008
		KR 20080096369 A	30-10-2008
US 2009114190 A1	07-05-2009	NONE	

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- GB 2260374 A **[0008] [0010] [0011]**
- EP 0537911 B1 **[0011]**