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(54) FUEL PUMP

(57) A drive arrangement for a plunger operated fuel pump including said arrangement including a pump plunger adapted to reciprocate along a first axis, and being driven by a rotating cam in contact with one end of said plunger, and where said cam and said contact end of said plunger are located in a cambox housing, characterised wherein said housing includes a bore, within which is located a compensating plunger arrangement, one end of which is adapted to contact said cam, such that the cam provides reciprocating movement to said compensating plunger.

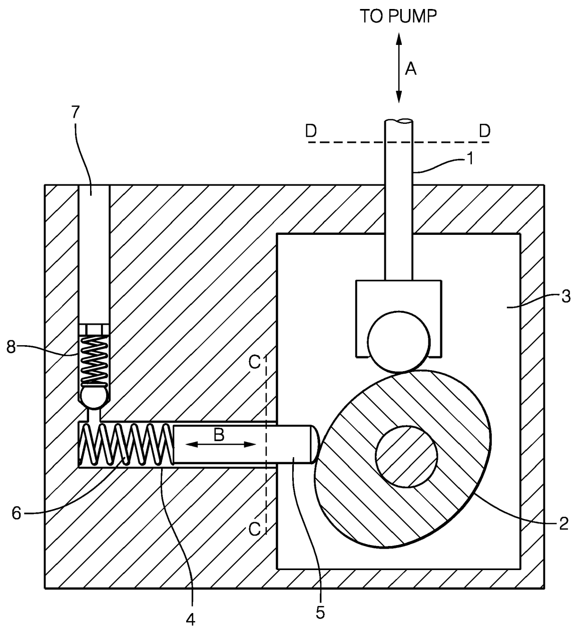

FIG. 2

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Description

Field of the Invention

[0001] This disclosure relates to fuel pumps and has particular application to plunger type pumps.

Background to the Invention

[0002] Typically high pressure pumps for fuel systems such as Diesel fuel pumps provide high pressure fuel supply for fuel injectors. These pumps typically comprise a pumping plunger adapted to pressurise a pumping chamber. The plunger is typically driven by a cam arrangement. One end of the plunger rides upon a cam within a cambox, the latter usually being filled with fluid such as the fuel and is pressurised.

[0003] It is known that the reciprocating motion of the plunger into, and out of, the cambox area of a piston pump can lead to undesirable issues in the supply and return lines. Conventional pressure regulators respond to pressure so suffer the effects of inertia and lag the pressure which has to be compensated.

[0004] In the phase of reciprocating motion of the plunger into the cambox, a pressure spike is caused because the volume of the cambox for fluid (fuel) is effectively reduced by the additional volume of the plunger itself in the cambox due; in other words the effective cambox volume changes: this leads to pressure fluctuations in the cambox.

[0005] An object of the invention is to reduce or eliminate the aforementioned problems.

Statement of the Invention

[0006] In one aspect is provided, a drive arrangement for a plunger operated fuel pump including said arrangement including a pump plunger adapted to reciprocate along a first axis, and being driven by a rotating cam in contact with one end of said plunger, and where said cam and said contact end of said plunger are located in a cambox housing, characterised wherein said housing includes a bore, within which is located a compensating plunger arrangement, one end of which is adapted to contact said cam, such that the cam provides reciprocating movement to said compensating plunger.

[0007] The arrangement may be arranged such that the pump plunger is adapted to reciprocate out of phase with the compensating plunger.

[0008] The said contact end of said pump plunger may be in contact with the cam at a point which is out of phase to the point on the cam where the contact end of the compensating plunger contacts the cam.

[0009] The said end of said pump plunger may contact the cam at a point which is opposite in phase to the point on the cam where the contact end of the compensating plunger contacts the cam.

[0010] Said compensating plunger may be adapted to reciprocate along said bore along a second axis which is substantially perpendicular to said first axis

[0011] The drive arrangement may be adapted such that when the contact end of the pump plunger is in contact with a point on the periphery of the cam closest to the axis of cam rotation, the contact end of the compensating plunger is in contact with a point on the cam which is furthest form the axis of cam rotation.

[0012] The cross sectional area or diameter of the shaft/stem of the pumping plunger may be substantially equal to that of the cross-sectional area of the compensating plunger.

[0013] The compensating plunger is urged in a direction such that its contact end is held in contact with the cam by spring means.

[0014] Said bore may be fluidly connected to the pump back-leak.

[0015] In an embodiment, the pump plunger is adapted to reciprocate out of phase with the compensating plunger. This means that the compensating plunger is arranged (e.g. such as the point of contact of the contact end of the compensating plunger is arranged relative to the point of contact of the pump plunger) such that as the pump plunger moves into the cam box, the compensating plunger moves out of the cambox.

[0016] The term pump or compensating plunger may be construed as to includes any tappet or rider which e. g. contacts the cam. In other word the term "plunger" may be construed as a plunger arrangement including a plunger with any associated tappet or rider.

Brief Description of Drawings

[0017] The invention will now be described by way of example and with reference to the following figures of which:

Figure 1 shows a schematic representation of a prior art drive portion for a plunger type pump;
Figure 2 shows one example of the invention;
Figure 3 shows plots of cambox pressure for a prior art design and a design according to one example of the invention.

Detailed Description of Invention

[0018] Figure 1 shows a schematic representation of a portion of a high pressure pump which utilises a plunger 1 to pressurise fuel in a chamber (not shown). The plunger is driven by a motordriven cam 2; the cam is located on a driveshaft. One end of the end of the plunger in contact with the cam, and the cam itself is located in a cam box 3, which typically contains fuel. As the plunger moves in a reciprocating fashion indicated by arrows A, the length of the plunger portion that is located inside the cam box varies thus effectively changing the volume of the cambox causing pressure fluctuation is the cam box.

[0019] Figure 2 shows a simple embodiment according to one aspect. A bore 4 is provided in the cam box wall, in the example this is perpendicular to the axis of the plunger. Located within the bore and extending outside the bore is a compensating plunger 5, which may be urged towards the cambox volume by spring means 6, such that it is in contact with, and driven by, the cam. The point of contact of one end of the compensating plunger on the cam is at a location on the cam which is out of phase with the point of contact of pump plunder (or rider thereof) with the cam. This is to say when the pump plunger moves away i.e. out of the cambox the compensating plunger moves in a direction into the cambox, and vice versa. The term "out of phase" may be considered as such.

[0020] In the example of figure 2, with the design of cam shown, there is an angle (phase difference) of 90 degrees between the point of contact on the cam of the compensating plunger 5 and the pump plunger end. In this way, with the cam design shown, when the pump plunger is most extended in the cam box at the end of its reciprocating motion (i.e. at its lowest point) the compensating plunger 5 is pushed by the cam to its furthest position away from the cambox. The compensation plunger reciprocates out of phase with the pump plunger in the direction of arrow B. In this way if the compensating plunger has the same cross sectional area (in the plane C) as the pump plunger portion (stem) across plane D, the effective volume of the cam box will remain constant.

[0021] Ina refined embodiment, the bore in the cambox wall accommodating the compensating plunger is fluidly connected with the backleak via backleak channel 7 to allow any leakage from the cambox via the plunger to return.

[0022] In a further refined embodiment the bore preferably includes a non-return valve 8 located in the back leak channel. The chamber provided by the bore at other end of the compensating plunger can be connected to the return line 7 (back-leak) as mentioned and/or isolated by the use of a non-return valve so that the chamber operates in a partial vacuum. This minimizes any pressure fluctuations on the return circuit.

[0023] The salient end of the compensating plunger can be kept in contact with the cam by resilient means (spring) as shown, or other means such as by direct mechanical means.

[0024] Figure 3 shows a plot of cambox pressure against cam displacement for a prior art design 10 and a design one according to one example of the invention 11; the figure thus shows un-compensated and compensated plots. As can be seen there is an improvement in designs according to aspects of the invention by reduction of cambox pressure peaks.

Claims

1. A drive arrangement for a plunger operated fuel pump including a pump plunger adapted to reciprocate along a first axis, and being driven by a rotating cam in contact with one end of said plunger, and where said cam and said contact end of said plunger are located in a cambox housing, characterised wherein said housing includes a bore, within which is located a compensating plunger, one end of which is adapted to contact said cam, such that the cam provides reciprocating movement to said compensating plunger, such that in any cam position the effective volume of the cam box is substantially constant.

2. A drive arrangement as claimed in claim 1 arranged such that the pump plunger is adapted to reciprocate out of phase with the compensating plunger.

3. A drive arrangement as claimed in claims 1 or 2 wherein the said contact end of said pump plunger is in contact with the cam at a point which is out of phase to the point on the cam where the contact end of the compensating plunger contacts the cam.

4. A drive arrangement as claimed in claim 3 wherein the said end of said pump plunger contacts the cam at a point which is opposite in phase to the point on the cam where the contact end of the compensating plunger contacts the cam.

5. A drive arrangement as claimed in claim 1 to 4 wherein said compensating plunger is adapted to reciprocate along said bore along a second axis which is substantially perpendicular to said first axis

6. A drive arrangement as claimed in claims 1 to 5 adapted such that when the contact end of the pump plunger is in contact with a point on the periphery of the cam closest to the axis of cam rotation, the contact end of the compensating plunger is in contact with a point on the cam which is furthest form the axis of cam rotation.

7. A drive arrangement as claimed in claims 1 to 6 wherein the cross sectional area or diameter of the shaft/stem of the pumping plunger is substantially equal to that of the cross-sectional area of the compensating plunger.

8. A drive arrangement as claimed in claims 1 to 7 where the compensating plunger is urged in a direction such that its contact end is held in contact with the cam by spring means.

9. A drive arrangement as claimed in claims 1 to 8 wherein said bore is fluidly connected to the pump back-leak.

10. A drive arrangement as claimed in claims 1 to 9 wherein said bore includes a non- return valve.

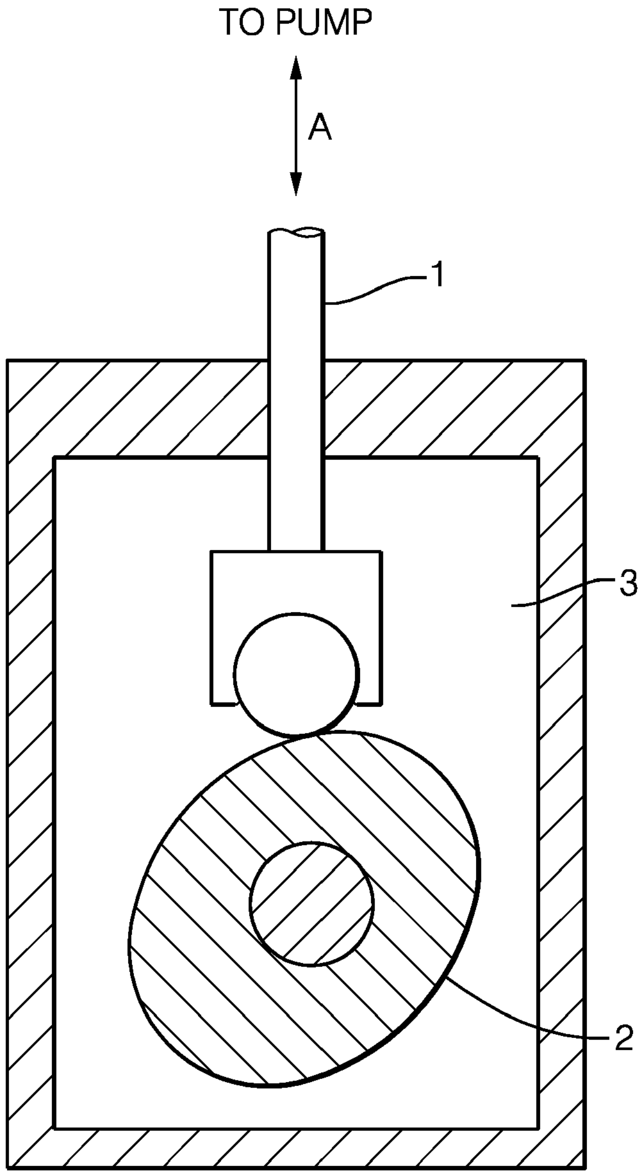

FIG. 1

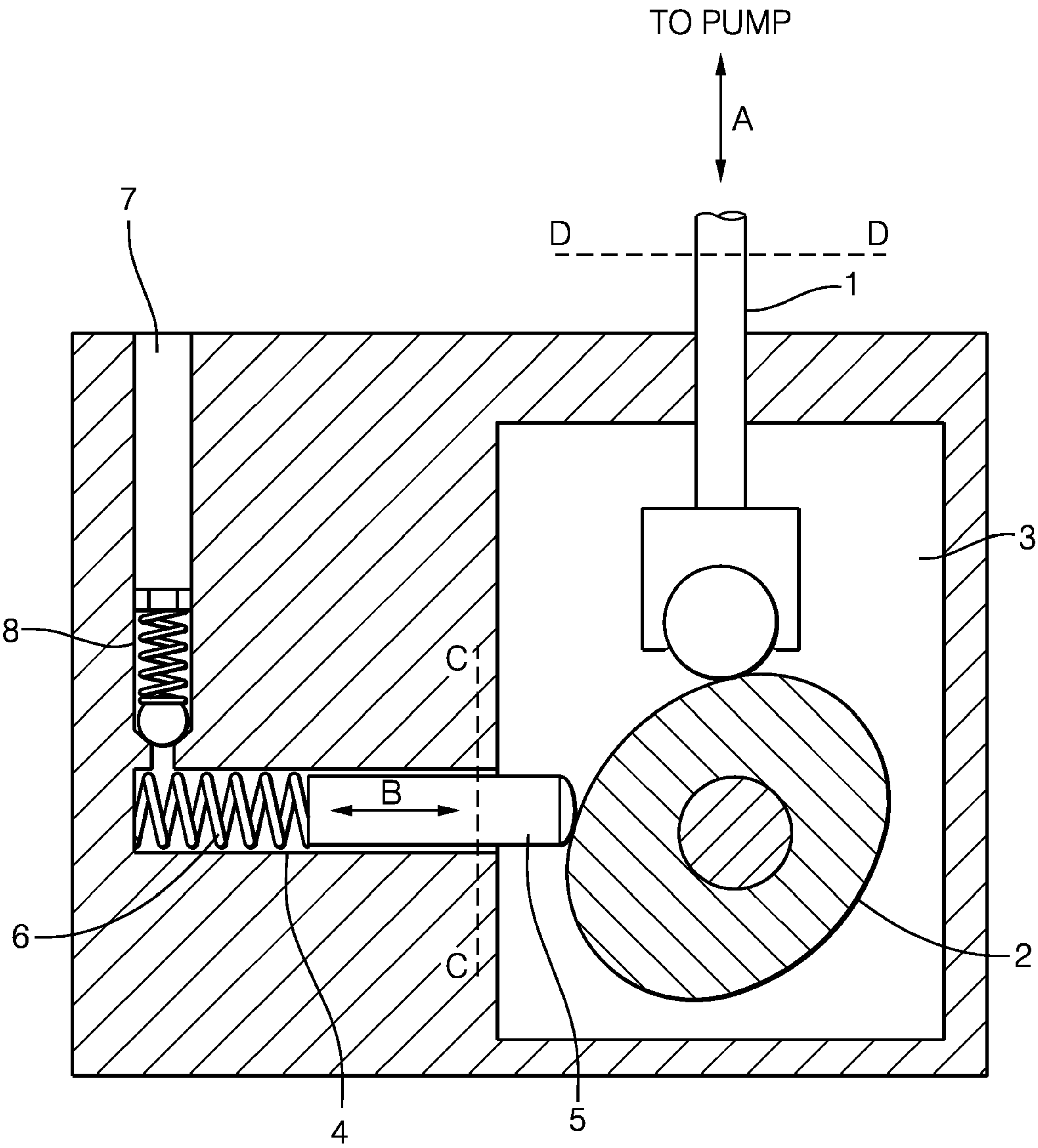

FIG. 2

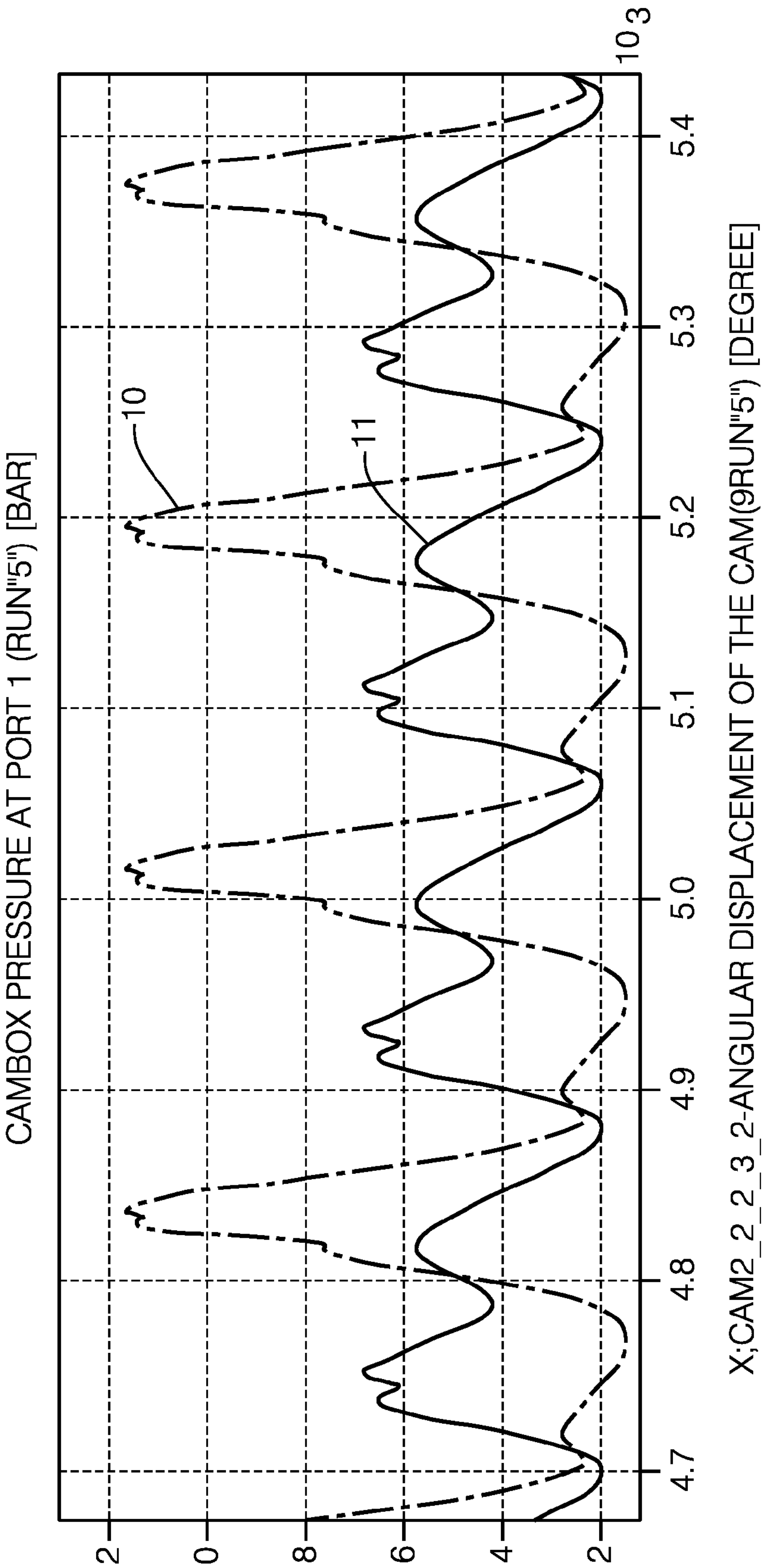
CAMBOX PRESSURE AT PORT 1 (RUN"5") [BAR]
[BAR]
12
10
8
6
4
2
10
11
4.7
4.8
4.9
5.0
5.1
5.2
5.3
5.4
10 3
X;CAM2_2_2_3_2-ANGULAR DISPLACEMENT OF THE CAM(9RUN"5") [DEGREE]

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 16 19 8727

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	US 2010/170480 A1 (MAIER EBERHARD [DE] ET AL) 8 July 2010 (2010-07-08) * abstract; figure 1 * * paragraph [0004] - paragraph [0006] * * paragraph [0007] * * paragraph [0031] - paragraph [0032] * * paragraph [0035] * * paragraph [0033] * * paragraph [0025] * * paragraph [0024] * -----	1-8	INV. F02M59/10 F04B9/04 F04B39/00 ADD. F02M55/04
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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	12 April 2017	Barunovic, Robert

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82