



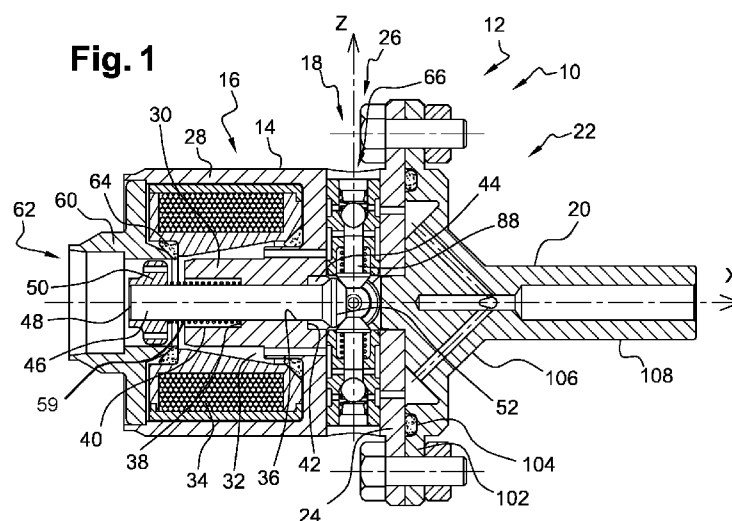
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(54) **Title:** SELECTIVE CATALYTIC REDUCTION DOSING PUMP

(57) **Abstract:** A Selective Catalytic Reduction system Dosing Pump (12) for delivering a reagent comprising a pumping part (18) having a body (14, 20) provided with a pumping element (66) having a bore (72) extending along a pumping axis (Z) within which is arranged a piston member (88), the volume of the bore beyond the piston (88) defining a dosing chamber where open an inlet and an outlet controlled by a valve. The piston (88) reciprocally moves along said pumping axis (Z) between a downward position wherein the inlet is open letting the reagent fill the chamber and, a upward position wherein the inlet is closed and the valve open to let the reagent flow off the chamber. The pump (12) further comprises a piloted actuator (16) having a plunger (46) arranged to co-operate with the piston (88). The plunger (46) reciprocally moves along a plunger axis (X) angled relative to the piston axis (Z).

Selective Catalytic Reduction dosing pump

5 TECHNICAL FIELD

The present invention relates to a new Selective Catalytic Reduction dosing pump.

BACKGROUND OF THE INVENTION

10 Selective Catalytic Reduction (SCR) system is standard equipment in most recent cars. A dosing pump delivers a reagent in the exhaust pipe to chemically react with the gases within an SCR catalyst and eliminate NO_x by up to 95%. From EP1878920 is known an in-line dosing pump comprising an electromagnetic actuator that actuates a pumping element. Different model of
15 vehicles demand different volume of reagent so, several pumps have to be designed and manufactured. Considering this variety along with the lack of space available in a vehicle for such equipment it becomes important to have a compact pump that can be adapted to a plurality of needs.

20 SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a dosing pump of a Selective Catalytic Reduction system. The dosing pump delivers a reagent comprises a pumping part having a body, provided with a pumping element having a bore extending along a pumping axis within which is arranged a
25 piston member. The volume of the bore beyond the piston defines a dosing chamber where open an inlet and an outlet controlled by a valve, the piston reciprocally moves along said pumping axis between a downward position wherein the inlet is open letting the reagent fill the chamber and, a upward position wherein the inlet is closed and the valve open to let the reagent flow off
30 the chamber. The pump further comprises a piloted actuator having a plunger arranged to cooperate with the piston.

Advantageously, the plunger reciprocally moves along a plunger axis angled relative to the piston axis. More precisely, the plunger reciprocally moves along the plunger axis between a backward position wherein the piston is in the

downward position, and an frontward position wherein the piston is at the upward position.

The pump further comprises a first elastic member permanently soliciting the plunger toward the backward position and, a second elastic member
5 permanently soliciting the piston toward the downward position.

More precisely, the plunger axis and the pumping axis intersect at a right angle.

Furthermore, the plunger and the piston have complementary shaped cooperating extremities, arranged so a displacement of the plunger along the
10 plunger axis generates a displacement of the piston along the piston axis.

The complementary shaped cooperating extremities, of the plunger and the piston are inclined surfaces that can be conical surfaces.

Furthermore, the pump may comprise a plurality of pumping element radially arranged relative to the plunger axis, the plunger cooperating with all the
15 pistons.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is now described by way of example with reference to the accompanying figures.

20 - Figure 1 is an axial section of a dosing pump as per the invention set in a first position.

- Figure 2 is similar to figure 1 but set in a second position.

- Figure 3 is a detail of figure 1.

- Figure 4 is a transversal section of the pump of figure 1.

25

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following description, similar elements will be designated with the same reference numbers.

The following description will use a tri-orthogonal direct coordinate
30 system (X, Y, Z) as shown on figure 1, where X is the longitudinal or plunger axis, Y the transversal axis and Z the vertical or pumping axis. For clarity and concision purposes and to ease the description and the understanding and, without any intention to limit the scope of the invention, especially in regards of the

numerous possibilities of installation of the system in a vehicle, words such as “right, left, top, bottom, upward, downward” will be utilized and an orientation “backward - frontward” will also serve the description in naming backward the left of figure 1 and frontward the right of the figure.

5 Selective Catalytic Reduction (SCR) system 10 delivers reagent R in the exhaust pipe to chemically react with the exhaust gases within a SCR catalyst and eliminate NOx by up to 95% from pipe emissions. The SCR system 10 comprises a piloted dosing pump 12 which embodiment is now described in reference to the figures.

10 From left to right of figure 1 the dosing pump 12 comprises arranged in a backward body 14 a piloted actuator 16 extending along the longitudinal axis X and a pumping part 18 centrally arranged and extending along the vertical axis Z and, in a frontward body 20 a delivering part 22 represented on the right.

 The backward body 14 comprises, described from the right to the left of
15 figure 1, a large radial disc-flange 24 from which backwardly (toward the left of the figure) extends a cylindrical portion 26 receiving the pumping part 18 that will be described afterward. From said cylindrical portion 26 extend an outer tubular cylindrical wall 28 and an inner tubular cylindrical wall 30. Both cylindrical walls are longitudinally coaxial X and define in between them a large recess 32 in
20 which is arranged the coil 34 of the actuator 16. The inner cylinder 30 is provided with an axial bore 36 which backward extremity 38 opens in a backward recess 40 and which frontward extremity 42 opens in a frontward recess 44. In the bore 36 is slidably arranged a plunger 46 shaft axially extending throughout the bore 36. On the back end 48 (left end) of the plunger 46 is fixed a magnetic armature 50
25 that has a disc-shape radially extending from the plunger 46. The outer diameter of the magnetic armature 50 is the same as the outer diameter or the inner cylindrical wall 30. The front end 52 (right end) of the plunger 46 is fixed an endpiece 54 having a conical shape. The endpiece 54 may integrally be formed with the plunger as well as it may be made separate and assembled afterward. On
30 the figures the endpiece is shown with two symmetric conical faces, a backward face 56 which radius radially expends and a frontward face 58 which radius diminishes in a pointy tip. In a first embodiment the frontward conical face is the only functional face of the endpiece 54.

In an alternative embodiment both conical faces, 56, 58, are made functional by increasing the longitudinal travel of the plunger 46. This permits a first pump event during the forward stroke of the plunger 46 and a second pump event during the return stroke, so two pump events while a single actuation event.

5 A longitudinal coil spring 59 arranged surrounding the plunger 46 is compressed between the bottom of the backward recess 40 and the magnetic armature 50 in which is arranged a spring seat. The spring 59 permanently solicits the plunger 46 toward the back, the left of figure 1. A disc-shape back plug 60, also called outer pole piece 60, is centrally holed 62 and is arranged and fixed in
10 abutment against the outer cylindrical wall 28. The central hole 62 is just a little larger than the disc-shape magnetic armature 50 so the plunger 46 may reciprocally slide in the bore 36 without contacting the back plug 60.

 The flow path of the reagent R will be described afterward but, as the reagent R goes near the coil 34, two O-ring seals 64, visualized on figure 1,
15 prevent any liquid intrusion into the coil 34 and prevent mixing of reagent R and coolant pumped within outer housing, not shown.

 The pumping part 18 is now described and best detailed on the magnified view of figure 3. It is arranged in the cylindrical portion 26 of the backward body 14 and it comprises several pumping elements 66, the
20 embodiment of figure 4 showing four identical pumping elements 66 but, as being identical just one will be described here after, the element 66 above in figure 1.

 The pumping element 66 comprises a cylindrical hole 68 radially extending along the vertical axis Z and, in the hole 68 is arranged a fixed sleeve 70. The sleeve 70 is provided with an axial Z bore 72 that upwardly opens in a
25 cylindrical upper chamber 74 of larger diameter than the bore 72, the intersection area forming a valve seat 76. The upper chamber 74 is itself closed by a plug 78 and, in the upper chamber 74 is arranged a check valve 80 normally closed comprising a spring 82 soliciting a ball 84 against the valve seat 76. The bore 72 downwardly opens in a cylindrical recess 86 and, in the bore 72 is slidably
30 adjusted a cylindrical piston 88 that upward head 90 is flat and downward foot 92 radially extends in a shoulder 94 followed by a pointy conical end 96. Another coil spring 98 arranged around the piston 88 is compressed in the recess 86 between the sleeve 70 and the shoulder 94 so permanently soliciting downwardly

the piston 88. The free volume of the bore 72 that is between the piston's head 90 and the ball 84 forms a dosing chamber 100.

In a preferred embodiment, the piston axis (Z) and the plunger axis (X) intersect at right angle. In alternative embodiments, the axis may not intersect and
5 then may be angled at another angle than 90° .

The delivering part 22 is now described in reference to figure 1 taken from left to right. The frontward body 20 comprises a disc flange wall 102 radially extending from the longitudinal axis X. Said flange 102 is bolted in surface contact against the large disc-flange 24 of the backward body 14. Another O-ring
10 seal 104 is arranged between the flanges 24, 102, to ensure perfect sealing. From the flange 102 frontwardly extends a conical portion 106 ending into a cylindrical portion 108.

The flow path of the reagent R is now described in reference to figure 1, from left to right of the figure.

15 The reagent R enters the dosing pump 12 via the central hole 62 provided in the outer pole piece 60. The reagent R then flows around the magnetic armature 50, on which the spring 59 seats, and via through holes operated in the magnetic armature 50 to get between the inner cylindrical wall 30 and the coil 34. As said before, thanks to the seals 64, the reagent R does not wet the coil 34 or
20 mix with surrounding coolant in contact with outer walls 28. At the bottom of the large recess 32 the reagent flows through a hole 110 longitudinally X extending through the wall and opening in the cylindrical radial hole 68 of the pumping part 18. In this area the sleeve 70 is provided on its external surface with a first undercut creating a first annular space 112 that is in fluid communication with the
25 dosing chamber 100 via inlet channels 114. Said inlet channels 114 extend through the sleeve 70. As can be observed in the figures, the inlet channel 114 opens in the dosing chamber 100 just above the piston's head 90. From the dosing chamber 100, the reagent R can flow in the upper chamber 74 only when the check valve 80 opens. From the upper chamber 74, the reagent R can exit through
30 outlet channels 116 that radially extend through the sleeve 70 and open in a second undercut provided in the external surface of the sleeve 70 and forming a second annular space 118 surrounding the sleeve 70. As visible on figure 1, the first undercut 112 and the second undercut 118 are separated and delimited by

three outer surface section that are in circumferential contact with the cylindrical hole 68 so, the reagent R flowing in the first annular space 112 has no other choice than going into the inlet channel 114. From the second annular space 118, the reagent R flows out via through holes 120 longitudinally X extending through the large disc flange 24. In the disc-flange wall 102 of the frontward body 20, the reagent R gets into a gallery 122 from which departs a connecting channel 124 centrally extending and focusing toward the longitudinal axis X. As visible on the figure 1 and 2, said connecting channel 124 is formed in the conical portion 106 of the frontward body 20 and it merges into a main delivery channel 126 that longitudinally X extends in the middle of the cylindrical portion 108 of the frontward body 20 from which the reagent R exits the dosing pump 12.

As said above the description is limited to one pumping element 66, which in figure 1, is set on the top. The description of the other elements 66 would just vary in the axis orientation of each one, the transposition being immediate, the description was not repeated.

The function of the dosing pump 12 is now described in reference to figures 1, 2 and 3.

In figure 1 the coil 34 is not energized and the plunger 46, pushed by the spring 59, is in a backward position PB. The piston 88, pushed by the vertical spring 98, is in a downward position PD. The frontward conical face 58 of the plunger 46 is in contact against the conical end 96 of the piston 88. As mentioned above, the piston 88 being in the downward position PD, the inlet channel 114 is open and the reagent R fills the dosing chamber 100.

In figure 2 the coil 34 is energized, the magnetic armature 50 is axially X attracted with a force superior to the force of the longitudinal spring 59 and the plunger 46 is longitudinally moved in a forward position PF. In doing so the frontward conical face 58 of the plunger 46 upwardly pushes the conical end 96 of the piston 88 that moves into an upward position PU. Similarly, the vertical spring 98 is further compressed. In moving up the piston's head 90 closes the inlet channel 114 and the reagent R trapped in the dosing chamber 100 is pressurized and it pushes up the ball 84 obliging the check valve 80 to open. The pressurized reagent R can flow around the ball 84 and find its way through the outlet channel 116 through to the delivery channel 126.

As can be observed and understood, the volume of the dosing chamber 100 is fixed. As soon as the piston 88 moves up, the inlet channel closes. Therefore the volume of reagent R delivered is exactly the volume contained in the dosing chamber 100.

- 5 Also, the upward movement of the piston is linked to the cone-cone contact. Other slopped or spherical shape may provide a similar transmission of force between the plunger and the piston.

- The conical profile at plunger tip can be adapted to allow two pump events per axial plunger stroke 46, as described earlier in the alternative
10 embodiment, offering a further variation to achieve higher dosed output for given electrical frequency input.

- The preceding description focused on one pumping element 66. As visible on figure 4 the embodiment comprises four pumping element 66 arranged every 90°. A major advantage of this dosing pump 12 is that within the same fixed
15 volume delimited by the backward and frontward bodies 14, 20, different numbers of pumping elements 66 can be arranged. For instance dosing pump 12 may have a single pumping element 66. Another embodiment may have two elements 66, or three, or four as presented on figure 4. More than four is also possible depending on the quantity of reagent R needed.

CLAIMS

1. Selective Catalytic Reduction system Dosing Pump (12) for delivering a reagent (R) comprising a pumping part (18) having a body (14, 20) provided with
5 a pumping element (66) having a bore (72) extending along a pumping axis (Z) within which is arranged a piston member (88), the volume of the bore (72) beyond the piston (88) defining a dosing chamber (100) where open an inlet (114) and an outlet (116) controlled by a valve (80), the piston (88) reciprocally moving along said pumping axis (Z) between a downward position (PD) wherein the inlet
10 (114) is open letting the reagent (R) fill the chamber (100) and, a upward position (PU) wherein the inlet (114) is closed and the valve (80) open to let the reagent (R) flow off the chamber (100), the pump (12) further comprising a piloted actuator (16) having a plunger (46) arranged to cooperate with the piston (88), characterized in that
15 the plunger (46) reciprocally moves along a plunger axis (X) angled relative to the piston axis (Z).
2. Dosing pump (12) as set in the preceding claim wherein the plunger (46) reciprocally moves along the plunger axis (X) between a backward position (PB)
20 wherein the piston (88) is in the downward position (PD), and an frontward position (PF) wherein the piston (88) is at the upward position (PU).
3. Dosing pump (12) as set in claim 2 further comprising a first elastic member (59) permanently soliciting the plunger (46) toward the backward
25 position (PB) and, a second elastic member (98) permanently soliciting the piston (88) toward the downward position (PD).
4. Dosing pump (12) as set in the preceding claim wherein the plunger axis (X) and the pumping axis (Z) intersect at a right angle.
30
5. Dosing pump (12) as set in any of the preceding claims wherein the plunger (46) and the piston (88) have complementary shaped cooperating extremities (58, 96) arranged so a displacement of the plunger (46) along the

plunger axis (X) generates a displacement of the piston (88) along the piston axis (Z).

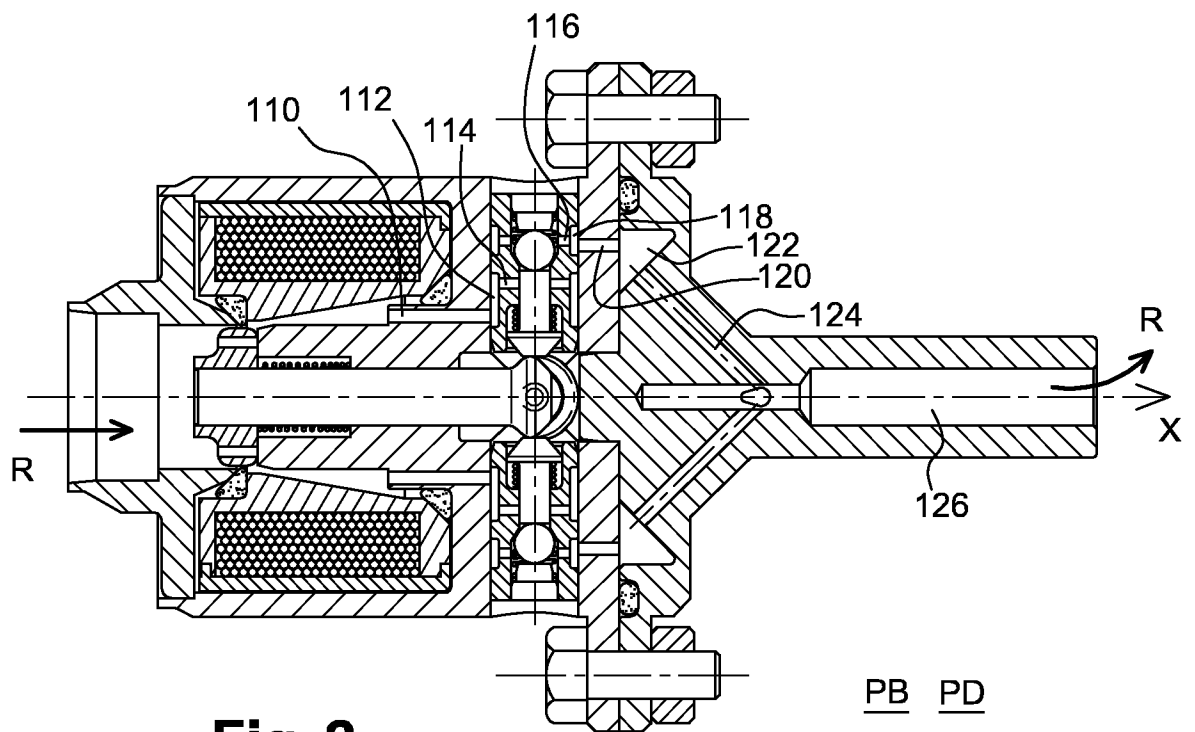
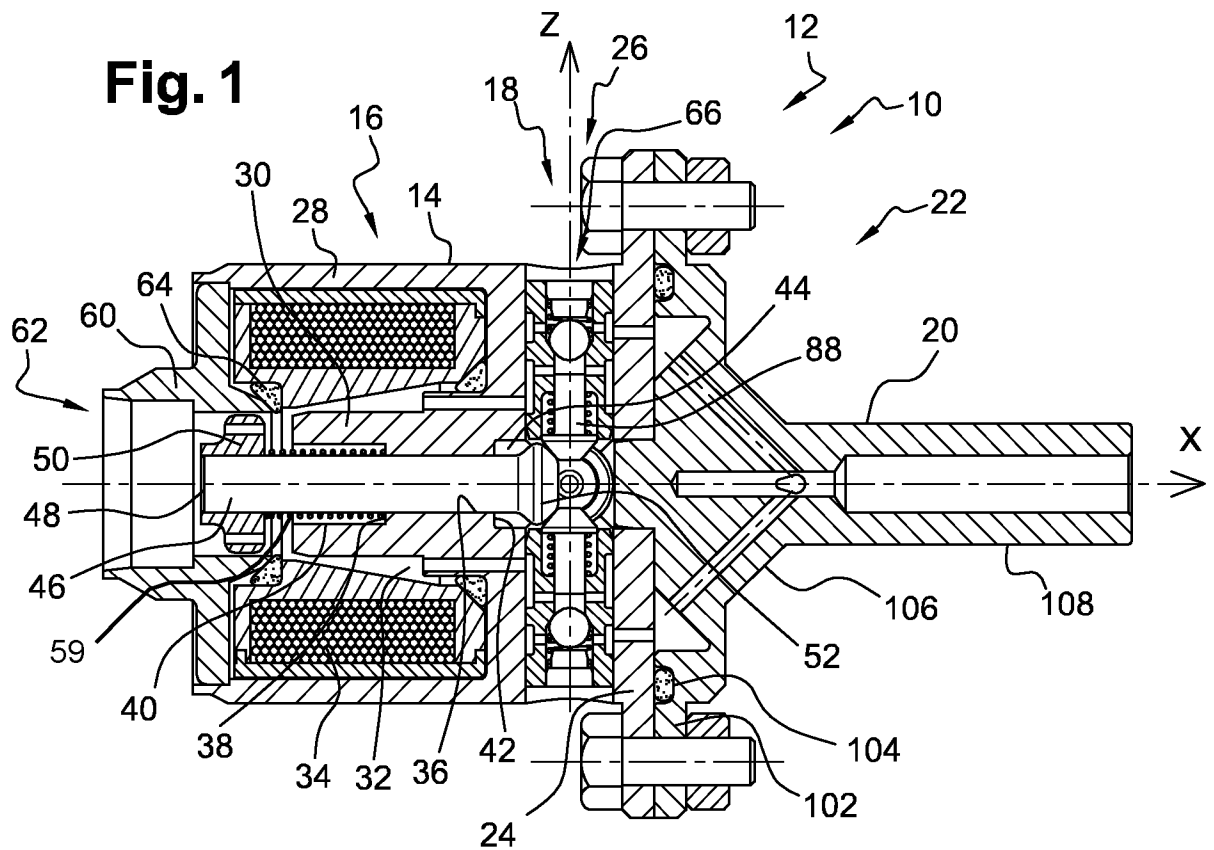
6. Dosing pump (12) as set in claim 5 wherein the complementary shaped
5 cooperating extremities (58, 96) of the plunger (46) and the piston (88) are inclined surfaces.

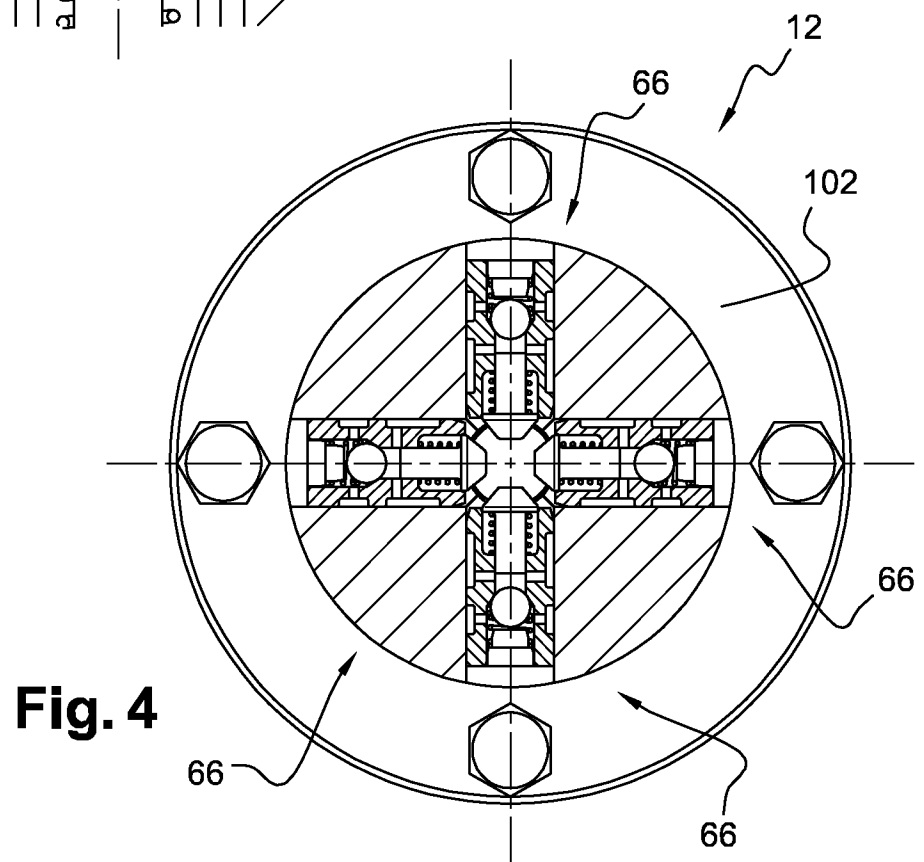
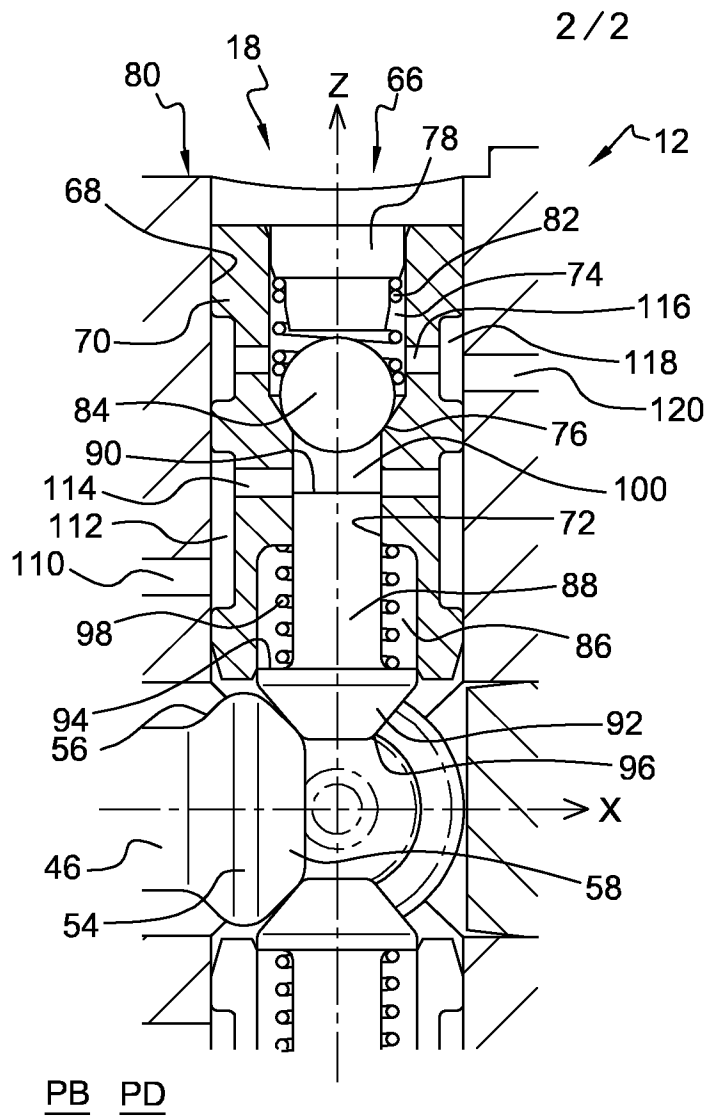
7. Dosing pump (12) as set in any of the claims 5 or 6 wherein the
cooperating extremities (58, 96) of the plunger (46) and of the piston (88) are
10 conical surfaces.

8. Dosing pump (12) as set in any of the preceding claims comprising a plurality of pumping element (66) radially arranged relative to the plunger axis (X), the plunger (46) cooperating with all the pistons (88).

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
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ADD. F01N3/20

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)
F01N F04B

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 2010 039920 A1 (BOSCH GMBH ROBERT [DE]) 1 March 2012 (2012-03-01)	1-5
A	paragraph [0026] - paragraph [0030]; figures 1, 2	6-8
A	----- EP 1 878 920 A1 (DELPHI TECH INC [US] DELPHI TECH HOLDING SARL [LU]) 16 January 2008 (2008-01-16) abstract; figure 2	1
A	----- DE 10 2006 000831 A1 (SIEMENS AG [DE]) 12 July 2007 (2007-07-12) paragraphs [0007], [0018], [0019] -----	1,8



Further documents are listed in the continuation of Box C.



See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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