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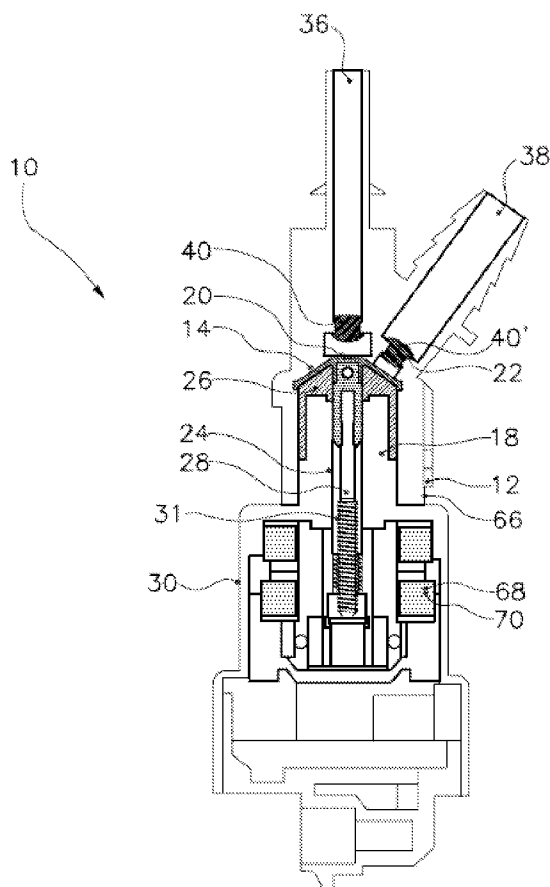
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(54) Title: METERING PUMP



(57) Abstract: Metering pump Metering pump of the mem-
brane syringe type, in particular for injecting a liquid additive
into a fuel tank, the pump comprising a hollow pump body, ar-
ranged in which are : - a membrane dividing the inside of the
pump into a metering chamber and an actuating chamber; - an
actuator in the actuating chamber; - a piston having a piston
head connected to the membrane and a rod that extends from
the piston head towards the actuator, the actuator and the rod
cooperating so as to move the piston between a rest position
and a deployed position; and - a guiding member that limits
rotational movement of the piston about its axis. The guiding
member is positioned between the piston head and the inner
side wall of the pump body.



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Metering pump

Introduction

The present invention relates to a metering pump of the membrane syringe type, in particular for injecting a precise dose of a liquid additive into a fuel tank.

Prior art

5 Despite its good environmental performance due, in particular, to its low consumption, diesel remains criticized for its releases of soot particles. In order to store the soot particles resulting from the combustion and thus prevent these particles from being emitted into the atmosphere, the particle filter has been developed. With such a filter, the particle emissions can be reduced to the limit
10 of measurability. In order to function correctly, it must be cleaned regularly. The particles stored in the particle filter may be burnt to regenerate the particle filter.

 The usual temperature of the exhaust gases is around 150°C. With the so-called "Common-Rail" technique, which allows a subsequent injection and
15 which gives rise to a post-combustion, the temperature of the exhaust gases may reach 350°C. The treatment of hydrocarbons in the oxidation catalyst gives rise to a new increase in temperature to 450°C. This temperature is still below the particle combustion temperature of around 550°C.

 To enable complete combustion of all the particles, it has been proposed to
20 inject an additive into the fuel so as to lower the combustion temperature of the particles. An additive, such as for example the product EOLYSTTM, a compound based on cerine and on iron or on iron alone developed by Rhodia, makes it possible to lower the natural combustion temperature of the particles to 450°C, namely around 100°C less than their natural combustion temperature. The
25 particle filter can thus be regenerated in only a few minutes, every 400 to 500 km.

 The additive is generally used in an organic solution stored in an additional tank placed in the vicinity of the fuel tank. In order to inject an amount of liquid additive proportional to the volume of fuel introduced during filling, an
30 additivation system with a metering pump has been developed.

 Such a metering pump is, for example, described in Patent Application WO 2005/024219 in the name of the Applicant. This pump is a variable volume

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pump of the membrane syringe type and enables accurate metering of the liquid additive. Such a pump comprises a piston that moves in a cylinder and is controlled by a high resolution linear actuator. The pump moreover comprises a metering chamber, into which the additive may be sucked through an inlet valve.

5 The additive may then be discharged from the metering chamber through an outlet valve towards the fuel tank.

To ensure the proper functioning of the particle filter regeneration, the fuel must comprise a very precise proportion of additive. It is therefore important to provide a metering pump that allows precise metering of the additive to be
10 injected. In another respect, for integration into a motor vehicle, it is important to provide a compact metering pump.

The metering pump is generally equipped with an actuator in the form of a stepper motor and a piston having a piston head and a rod comprising a threaded portion that cooperates with the stepper motor to obtain a precise movement of
15 the piston and consequently a precise metering of the liquid additive. To limit or prevent rotational movement of the piston about its axis, a guiding member is provided. Such a guiding member generally comprises a slider mounted on the actuator and that extends in the direction of the piston head. The slider engages in a slot made in the rod. To prevent a discontinuity in the threading of the rod,
20 the interaction between the slider and the rod must take place at a certain distance from the actuator. This distance entrains a larger length of the metering pump and is consequently not compatible with the objective of providing a compact metering pump.

The same type of problem may also be encountered for metering an
25 additive of the fuel detergent type in mainly petrol-type fuels. The actual composition of petrols may sometimes not correspond to the information available on the dispensing pumps. This may result in the malfunctioning of the engines, or even in their deterioration. It is therefore possible to resort to metering a detergent in the petrol so that the detergent acts on the fuel deposits
30 accumulated in a fuel system and/or in an intake system of an internal combustion engine and so that these deposits are reduced, or even eliminated. As explained above, a compact metering pump is of great advantage.

Object of the invention

The object of the present invention is to provide an improved metering
35 pump which does not have the disadvantages mentioned above.

General description of the invention claimed with its main advantages

According to the invention, a metering pump of the membrane syringe type, in particular for injecting a liquid additive into a fuel tank, comprises :

- a hollow pump body, arranged in which is a membrane dividing the inside of the pump into a metering chamber and an actuating chamber;
- an actuator in the actuating chamber;
- a piston having a piston head connected to the membrane and a rod that extends from the piston head towards the actuator, the actuator and the rod cooperating so as to move the piston between a rest position and a deployed position; and
- a guiding member that limits rotational movement of the piston about its axis.

According to a first aspect of the invention, the guiding member is positioned between the piston head and the inner side wall of the pump body. The guiding member positioned between the piston head and the side wall of the pump body allows a more compact configuration of the metering pump. This is because there is no need to extend the distance between the actuator and the piston head to accommodate a guiding member, such as a slider.

Preferably, the guiding member comprises a slider connected to the piston head, the slider cooperating with a guide in the inner side wall of the pump body. Owing to such a guiding member, the movement of the piston in the pump body is limited to a sliding movement defined by the guide. Alternatively, the inner wall of the pump body may be provided with a slider and the piston head may comprise a guide that receives the slider.

Preferably, the guide is formed by radial protuberances on the inner side wall of the pump body, the radial protuberances being arranged so as to receive the slider between two such radial protuberances. Alternatively, the guide may be formed by a groove in the inner side wall of the pump body, the groove receiving a radial protuberance formed on at least one part of the slider.

Advantageously, the guide and the slider are parallel to the axis of the piston, thus allowing a purely linear movement of the piston. Any rotational movement of the piston and consequently any torsion of the membrane are prevented.

According to another aspect of the metering pump, the metering chamber comprises an inlet port intended to be connected to an additive tank and an outlet port intended to be connected to a fuel tank, the inlet port and the outlet port each comprising a non-return valve. The non-return valve comprises a valve seat with

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a passage opening and an umbrella-type valve comprising a rod that passes through the passage opening and a stopper, the stopper comprising, in a peripheral region, a first protuberance directed towards the valve seat. The non-return valve moreover comprises a second protuberance on the valve seat
5 directed towards the stopper. The first protuberance and the second protuberance are arranged so as to form a labyrinth-type seal when the stopper rests on the valve seat. An important aspect of a metering pump is its capacity to enable precise metering of additive to be injected into the fuel tank. An additive leak at the inlet port and/or outlet port influences the metering volume and hence
10 compromises the precise metering of the additive. In particular, it should be noted that the additive tank is generally connected to the atmosphere to allow ventilation of the tank. This communication to the atmosphere also allows, however, foreign bodies, for example dust, to be deposited in the additive tank. When such a foreign body is deposited at the non-return valve, it may prevent
15 the correct closure of the valve and may thus create a leakage path for the additive. To prevent such leakage paths, the inventors propose to form the non-return valve as an umbrella valve with a first protuberance directed towards the valve seat. Moreover, the valve seat comprises a second protuberance directed towards the stopper of the umbrella valve. The arrangement of the first
20 protuberance and the second protuberance to form a labyrinth-type seal makes it possible to prevent the leakage paths. Thus, the precise metering of the additive can be maintained. Moreover, according to one particular mode, the protuberances are preferably made from elastic material.

According to another aspect of the metering pump, the actuating chamber
25 comprises a communication with the atmosphere. This communication is open at least during the operation of the actuator. This is because the additive tank generally comprises a communication with the atmosphere to allow ventilation of the additive tank. In other words : the metering chamber is generally ventilated (vented to atmospheric pressure). Hence, if the actuating chamber is
30 not also ventilated, an increase in the temperature of the actuator (for example, following an energy dissipation) will lead to an increase of the pressure in the actuating chamber. This pressure increase may cause deformation of the membrane leading to a reduction in the volume of the metering chamber. Putting the actuating chamber in communication with the atmosphere, at least during
35 operation of the actuator, makes it possible to prevent a pressure increase in the

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actuating chamber and thus makes it possible not to deform the membrane. The precise metering of the liquid additive into the fuel tank can thus be guaranteed.

According to another aspect of the metering pump, the pump moreover comprises a control unit with at least one temperature sensor for measuring the temperature of the liquid additive and a means for influencing the control of the actuator as a function of the temperature measured. The control of the temperature of the liquid additive makes it possible to determine the temperature range in which the metering pump should function. By knowing the specific problems of various temperature ranges, it is possible to consequently influence the control of the actuator. By adjusting the control of the actuator based on the temperature measured, certain operating parameters may be controlled to thus reduce or even eliminate the compromising effect of a certain temperature range. Thus, the proper operation of the metering pump may be ensured under all the operating conditions.

The metering pump preferably comprises a means for controlling the actuator so as to adjust the displacement rate of the piston; and/or to adjust the force applied by the actuator; and/or to adjust a predetermined volume of additive to be injected. It has been noted that at low temperature the viscosity of the liquid additive is increased and makes it more difficult to suck up the additive. Moreover, the increased viscosity of the additive causes an increased deformation of the membrane during the pumping cycle, which modifies the volume of the metering chamber. The inventors have realized that modification of the volume of the metering chamber may be avoided when the pumping rate is slowed down. This is because a slower suction of the very viscous liquid additive makes it possible to limit, or even eliminate, the membrane deformation effect. Moreover, the suction of the additive is facilitated. Due to the elimination of membrane deformation, the predetermined volume of the metering chamber may be maintained and accurate metering remains possible even in the presence of very viscous liquid additive caused by a low temperature.

According to the invention, it is also or alternatively possible to adjust the force applied by the actuator as a function of the temperature measured. A greater force exerted on the piston makes it possible to facilitate the suction of the additive into the metering chamber and the injection of the additive into the fuel tank. This is particularly advantageous when the metering pump functions under very low temperature conditions where the additive is very viscous. The

precise metering of the liquid additive by the metering pump can therefore be guaranteed.

According to the invention, it is also or alternatively possible to adjust the determined volume of additive as a function of the temperature to take into account deformation of the membrane and an increase in the viscosity of the additive. Thus, even in the case of deformation of the membrane, which leads to a change in the volume of the metering chamber, a desired volume may be injected into the fuel tank without having to modify the force applied by the actuator or the displacement rate of the piston. The precise metering of the liquid additive by the metering pump can therefore be guaranteed.

In order to do this, in practice it is sufficient to establish nomograms that give the volume of liquid injected as a function of the piston stroke and this being done for various temperatures (for example, every 10°C from -40°C to +80°C) and then to store the latter in the control unit of the actuator.

According to another aspect of the metering pump, the actuator is a linear actuator comprising a stepper motor which is supplied by a holding current to keep the piston in its rest position when the necessary amount of additive has been injected. This makes it possible to prevent, following vibrations, the piston from moving and from causing the unwanted injection of additive into the tank. The expression "rest position" is understood to mean that the piston is at rest against the wall of the metering chamber. The metering pump comprises a control unit with at least one temperature sensor for measuring the temperature of the actuator and a means for applying a higher holding current to this motor as a function of the temperature measured. At low temperature, the actuator force is reduced. Furthermore, in view of the increased viscosity of the liquid additive at low temperature, the force needed to displace the piston is higher. By increasing the holding current of the actuator, there is energy dissipation which results in heating of the actuator and in particular in heating of the magnets of the stepper motor. Thus, the application of a higher holding current results in restoring the actuator force. Furthermore, heating of the actuator also leads to heating of the liquid additive and therefore to a lower viscosity. Thus, the proper operation of the metering pump may be ensured even in the case of very low temperature. According to this aspect of the invention, the actuator is controlled both while operating and at rest (when it does not have to inject additive).

Preferably, the control unit comprises a means for detecting a possible step loss of the stepper motor and a means for applying a higher supply current when

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a step loss is detected. Such a step loss is generally due to the fact that the actuator force is insufficient, this insufficiency being itself generally due to the fact that the actuator is too cold. When a step loss is detected, a higher supply current is applied to heat the actuator and thus guarantee the proper operation of the metering pump.

According to another aspect of the metering pump, the latter moreover consists of a management unit comprising :

- a means for determining the volume of liquid additive to be injected into the fuel tank;
- a means for detecting an interruption of the power supply to the actuator; and
- a storage means for storing, in case of such an interruption, information on the volume injected and information on the status of an injection cycle at the time of the interruption.

The additive must be injected into the fuel tank in a very precise proportion relative to the volume of fuel. The management unit therefore comprises a means for determining the volume of fuel added to the fuel tank during a filling cycle. The volume of fuel added is generally determined by a comparison of the fuel levels before and after the filling cycle.

After the filling phase, the liquid additive injection cycle starts. The expression "injection cycle" is understood to mean the set of piston strokes needed for the injection of the desired volume of additive. Generally, this comprises a given number of complete strokes and a last incomplete stroke (aiming to adjust the exact amount of additive needed). However, it could be that the driver only moves his vehicle a few metres to park it and take a break. This is, for example, very often the case at motorway service areas. The time to park a vehicle generally does not complete the additive injection cycle, which is then interrupted by the engine switching off. The management unit comprises a means for detecting such an interruption. Owing to the storage means, in which information on the number of piston strokes at the time of the interruption may be stored, the additive injection cycle may, when the engine is started again and the power supply to the metering pump is restored, restart exactly at the point where it was interrupted to thus reach its conclusion. The precise metering of the liquid additive into the fuel tank can thus be guaranteed.

Preferably, the information on the status of the injection cycle comprises :

- the number of strokes (suction/injection) carried out by the piston at the time of the interruption and/or the number of strokes still to be carried out; and

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- either the volume of liquid additive that remains to be injected, or the total volume of liquid additive to be injected and the volume of liquid additive already injected.

5 This information can be stored in a loop with the information stored previously being replaced by an updated version. As a variant, storage of the information may be carried out punctually when an interruption is detected.

The various aspects of the invention described above are preferably used in combination. It should however be noted that the various aspects of the metering pump may also be used independently and individually to provide a compact
10 metering pump capable of guaranteeing the precise metering of liquid additive into the fuel tank.

Description with the aid of the figures

Other particular aspects and features of the invention will become apparent from the description of a few advantageous embodiments presented below, by
15 way of illustration, with reference to the appended figures which show :

Fig. 1 : a schematic view through a metering pump according to the invention;

Fig. 2 : a schematic view of the part of the metering pump around the pump membrane from Fig. 1, in which the piston is illustrated in its deployed position;

20 Fig. 3 : a schematic view of the part of the metering pump around the pump membrane from Fig. 1, in which the piston is illustrated in its rest position;

Fig. 4 : a cross-sectional view of a piston according to one aspect of the invention;

25 Fig. 5 : a perspective view of the piston from Fig. 4, in which the piston is illustrated in its deployed position; and

Fig. 6 : a cross-sectional view through the non-return valve according to one aspect of the invention.

30 Identical reference signs in the various figures denote identical or similar components.

The metering pump of the membrane syringe type is described in an overall manner by jointly referring to Figures 1, 2 and 3. The metering pump
10 comprises a hollow pump body 12. A membrane 14 is arranged inside the pump body 12 and divides the inside of the pump into a metering chamber 16 and an actuating chamber 18. The pump body 12 additionally comprises an inlet port
35 20 and an outlet port 22 in communication with the metering chamber 16. The

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volume of the metering chamber 16 is variable owing to the displacement of the membrane 14 resulting from the displacement of a piston 24 positioned in the actuating chamber 18.

5 The piston 24 comprises a piston head 26 connected to the membrane 14 and a rod 28 that extends from the piston head 26 to an actuator 30. The actuator 30 is preferably a linear actuator comprising a stepper motor mounted in the actuating chamber 18. The actuator 30 cooperates with a threaded portion 31 of the rod 28 to thus control the displacement of the piston 26 driving the displacement of the membrane 14 connected to a central part of the piston
10 head 26. The piston 24 can be moved between a rest position and a deployed position. In the rest position, the piston 24 is in a position in which the membrane 14 is sandwiched between the piston head 26 and an end wall 32 of the pump body 12, the end wall 32 comprising the inlet port 20 and the outlet port 22. When the piston 24 is in its rest position, the membrane 14 rests against
15 the end wall 32. Opening of the valves is impossible : the membrane ensures the closure of the hydraulic circuit in addition to the closure of the valves. The volume of the metering chamber 16 – that is to say the volume described by the space between the membrane 14 and the end wall 32 – is therefore defined by the structure of the metering pump 10. In the rest position, the volume of the
20 metering chamber 16 is consequently always identical. Preferably, the surface area of the end wall 32 and the surface area of the piston head 26 facing the end wall 32 are complementary. Thus, the volume of the metering chamber 16 is substantially zero when the piston 24 is in its rest position. Due to the fact that the volume of the metering chamber is always identical when the piston 24 is in
25 its rest position, the metering pump must therefore only be moved accurately when the additive is sucked up.

When additive has to be injected into the fuel tank, the actuator exerts a force on the rod 28 of the piston 24 which moves in the direction of its deployed position. This movement of the piston 24 drives a movement of the
30 membrane 14 connected to the piston head 26. In turn, the movement of the membrane 14 leads to an increase in the volume of the metering pump and to suction of additive through the inlet port 20 connected to an additive tank (not shown) by an inlet pipe 36. The volume of additive sucked into the metering chamber 16 may be accurately determined as a function of the movement of the
35 piston 24. When the volume of the metering chamber has reached a predetermined volume, the actuator 30 exerts a force on the rod 28 of the

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piston 24 which moves to its rest position. The volume of the metering chamber 16 is again reduced and the additive is discharged from the metering chamber 16 through the outlet port 22 connected to a fuel tank (not shown) by an outlet pipe 38. For the correct operation of the metering pump 10, the inlet port 20 and the outlet port 22 are each provided with a non-return valve 40, 40'.

A first aspect of the invention relates to a guiding member 42 that limits rotational movement of the head 26 of the piston 24 about its axis. According to the invention, the guiding member 42 is positioned between the piston head 26 and the side wall 44 of the pump body 12. The stepper motor specifically turns and moves the rod forward as explained previously, whereas the piston, itself, has only to move forwards or move backwards to inject/suck up the additive. The guiding member 42 may be described in more detail by referring to Figures 4 and 5, which show a piston 24 according to the invention. The guiding member 42 comprises at least one longitudinal slider 46, 46' that extends parallel to the axis of the piston 24 from the piston head 26 in the direction of the actuator 30. The slider 46, 46' engages in a guide (not shown) formed on the inner side wall 44 of the pump body 12. The guide may be formed by radial protuberances on the inner side wall 44 of the pump body 12 to receive the slider 46, 46' between two such radial protuberances. Alternatively, the guide may be formed by a groove that receives a radial protuberance formed on at least one part of the slider 46, 46'. Figure 4 also shows the connection between the piston head 26 and the rod 28 of the piston 24, and also the connection between the membrane 14 and the piston head 26. As illustrated in Figure 4, the head of the rod 28 comprises a lubricated groove (28') which makes it much easier to decouple the piston head 26 and the rod 28 (theoretically, the membrane 14 could, by itself, make it possible to prevent the rotation of the head 26 but with a risk of tearing through fatigue).

Another aspect of the invention relates to the non-return valve 40, 40' attached to the inlet port 20 and to the outlet port 22 respectively. Such a non-return valve 40 is illustrated schematically in Figure 6. The non-return valve 40 comprises a valve seat 47 that surrounds a passage opening 48 and an umbrella-type valve 50, the valve 50 comprising an axial rod 52 that passes through the passage opening 48 and a stopper 54 connected to an upstream end 55 of the axial rod 52. According to the invention, the stopper 54 comprises, in a peripheral region of the stopper 54, a first protuberance 56 directed towards the valve seat 47 and the valve seat comprises a second protuberance 58 directed

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5 towards the stopper 54. The first protuberance 56 and the second protuberance 58 are arranged around the passage opening 48 so as to form a labyrinth-type seal when the stopper 54 rests on the valve seat 47. The valve 50 moreover comprises a travel-limiting component 60 connected to a downstream end 62 of the axial rod 52 to limit the degree of opening of the non-return valve 40.

10 The non-return valve illustrated in Figure 6 is the non-return valve 40 associated with the inlet port 20. When the metering pump 10 operates in suction mode, a vacuum is created in the inlet port 20 and the valve 50 is moved into its open position as illustrated in Figure 6. The additive coming from the inlet pipe 36 passes through the passage opening 48 and ends up in the metering chamber 16 through the inlet port 20. On the other hand, when the metering pump 10 operates in injection mode, an overpressure is created in the inlet port 20 and the valve 50 is moved into its closed position in which the first protuberance 56 presses against the valve seat 47 and the second protuberance 58 presses against the stopper 54. The first protuberance 56 and the second protuberance 58 thus form a labyrinth seal preventing leakage paths for the additive. The protuberances 56, 58 are preferably formed from an elastic material. An additional layer 64 made from an elastic material may be deposited on the valve seat 47 to receive the first protuberance 56.

20 According to another aspect of the invention, the actuating chamber 18 moreover comprises a pressure-regulating port 66 (represented in Figure 1) that provides communication with the atmosphere. The pressure-regulating port 66 makes it possible to keep the actuating chamber 18 at atmospheric pressure to thus prevent a pressure increase in the actuating chamber 18 due to heating up of the actuator 30 and of the environment around the actuator 30.

30 According to another aspect of the invention, the metering pump 10 moreover comprises a control unit 68, represented schematically in Figure 1 outside of the metering pump 10. The control unit 68 comprises a connection to a temperature sensor (not shown) for measuring the temperature of the liquid additive and a means (not shown) for controlling the actuator as a function of the temperature measured. The temperature sensor may be located in the additive tank. Preferably, on the other hand, the temperature sensor is positioned on the actuator 30. This is because the proximity of the actuator 30 and the additive tank only results in a minimal temperature difference between the actuator and

35

the additive in the additive tank. Thus, the temperature sensor and the control unit 68 may be integrated into the metering pump 10.

Owing to the control unit 68, the actuator 30 of the metering pump 10 may be controlled as a function of the temperature so as to adjust the displacement rate of the piston 24, to adjust the force applied by the actuator 30 or to adjust a
5 predetermined volume of additive to be injected to thus reduce or even eliminate the compromising effect of a certain temperature range.

According to another aspect of the invention, the metering pump 10 comprises an actuator 30 which is a linear actuator that comprises a stepper
10 motor which is supplied with supply electric current (to condition the movement of the rod 28) and holding electric current (to keep the piston 24 in its rest position, if necessary, i.e. outside of the injection cycles, when the motor of the vehicle is turning and when vibrations can occur). The control unit 68 comprises at least one temperature sensor for measuring the temperature of the actuator 30
15 and a means for increasing the holding current when the temperature measured is below a threshold temperature. At low temperature, the force of the actuator 30 is reduced. Furthermore, in view of the increased viscosity of the liquid additive at low temperature, the force needed to displace the piston 24 is higher. By increasing the holding current of the actuator 30, an energy dissipation occurs
20 which results in heating of the actuator 30. Thus, the application of a higher holding current results in restoring the force of the actuator 30. Furthermore, heating of the actuator 30 also leads to heating of the liquid additive and therefore to a lower viscosity. Thus, the proper operation of the metering pump 10 may be ensured even in the case of very low temperature as the additive
25 is heated when the pump is at rest and is therefore ready to be injected at a good viscosity when an injection cycle has to be started.

The control unit 68 may moreover comprise a means for detecting a step loss of the stepper motor and a means for increasing the supply current when a step loss is detected. Such a step loss is generally an indication that the
30 temperature of the actuator is not high enough. When a step loss is detected, the supply current is increased to heat the actuator 30 and thus guarantee the proper operation of the metering pump.

It should be noted that the control unit 68 preferably comprises both the means needed for adjusting the control of the piston and the means needed for
35 adjusting the supply current and holding current. It is not however excluded to separately provide a first control unit comprising the means needed for adjusting

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the control of the piston and a second control unit comprising the means needed for adjusting the supply current and holding current.

According to another aspect of the invention, the metering pump 10 moreover comprises a management unit 70, represented schematically in Figure 1. Preferably, the management unit 70 is integrated into the metering pump 10. Moreover, the control unit 68 and the management unit 70 preferably form a common unit. The management unit 70 comprises a means for determining the volume of liquid additive to be injected into the fuel tank. A sensor of the fuel level in the fuel tank may be used to measure the fuel level before and after the fuel tank filling phase. Based on the difference in volume thus determined, the management unit 70 determines the volume of additive to be injected into the fuel tank. This determination may be carried out thanks to an algorithm or table stored in the memory. The management unit 70 comprises a means for determining an interruption of the power supply to the actuator and a storage means for storing, in case of such an interruption, information on the volume injected and information on the status of the injection cycle at the time of the interruption. The information on the injection cycle comprises the number of piston strokes at the time of the interruption. The information on the volume injected preferably comprises the volume of liquid additive that remains to be injected. Alternatively, the information on the volume injected may comprise the total volume of liquid additive to be injected and the volume of liquid additive already injected. The management unit 70 enables the metering pump 10 to restart the additive injection cycle at the precise moment of the interruption to thus ensure the correct metering of additive.

Reference signs

10	metering pump	44	side wall
12	pump body	46,46'	slider
14	membrane	47	valve seat
16	metering chamber	48	passage opening
18	actuating chamber	50	valve
20	inlet port	52	axial rod
22	outlet port	54	stopper
24	piston	55	upstream end of the axial rod
26	piston head	56	first protuberance
28	rod	58	second protuberance
28'	lubricated groove	60	travel-limiting component
30	actuator	62	downstream end of the axial rod
31	threaded portion		
32	end wall	64	layer made from elastic material
36	inlet pipe		
38	outlet pipe	66	pressure-regulating port
40	non-return valve	68	control unit
40'	non-return valve	70	management unit
42	guiding member		

CLAIMS

1. Metering pump of the membrane syringe type, in particular for injecting a liquid additive into a fuel tank, the pump comprising a hollow pump body, arranged in which are :

- 5 • a membrane dividing the inside of the pump into a metering chamber and an actuating chamber;
- an actuator in the actuating chamber;
- a piston having a piston head connected to the membrane and a rod that extends from the piston head towards the actuator, the actuator and the rod
- 10 cooperating so as to move the piston between a rest position and a deployed position; and
- a guiding member that limits rotational movement of the piston about its axis,
- characterized in that the guiding member is positioned between the piston head and the inner side wall of the pump body.

- 15 2. Metering pump according to Claim 1, in which the guiding member comprises a slider connected to the piston head, the slider cooperating with a guide in the inner side wall of the pump body.

3. Metering pump according to Claim 2, in which the guide is formed by radial protuberances on the inner side wall of the pump body, the radial
- 20 protuberances being arranged so as to receive the slider between two such radial protuberances.

4. Metering pump according to Claim 2, in which the guide is formed by a groove in the inner side wall of the pump body, the groove receiving a radial protuberance formed on at least one part of the slider.

- 25 5. Metering pump according to any one of Claims 2 to 4, in which the guide and the slider are parallel to the axis of the piston.

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5 6. Metering pump according to any one of the preceding claims, in which the metering chamber comprises an inlet port intended to be connected to an additive tank and an outlet port intended to be connected to a fuel tank, the inlet port and the outlet port each comprising a non-return valve, characterized in that :

- the non-return valve comprises a valve seat with a passage opening and an umbrella-type valve comprising a rod that passes through the passage opening and a stopper, the stopper comprising, in a peripheral region, a first protuberance directed towards the valve seat;
- 10 • the non-return valve moreover comprises a second protuberance on the valve seat directed towards the stopper; and
- the first protuberance and the second protuberance being arranged so as to form a labyrinth-type seal when the stopper rests on the valve seat.

15 7. Metering pump according to any one of the preceding claims, in which the actuating chamber comprises a communication with the atmosphere.

8. Metering pump according to any one of the preceding claims, moreover comprising a control unit with at least one temperature sensor for measuring the temperature of the liquid additive, and a means for influencing the control of the actuator as a function of the temperature measured.

20 9. Metering pump according to Claim 8, comprising a means for controlling the actuator so as to :

- adjust the displacement rate of the piston;
- adjust the force applied by the actuator; and/or
- adjust a predetermined volume of additive to be injected.

25 10. Metering pump according to any one of the preceding claims, in which the actuator is a linear actuator comprising a stepper motor which is supplied by a holding current to keep the piston in its rest position, the metering pump comprising :

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- a control unit with at least one temperature sensor for measuring the temperature of the actuator; and
- a means for applying a higher holding current to this motor when the temperature measured is below a threshold temperature.

5 11. Metering pump according to Claim 10, in which the control unit comprises :

- a means for detecting a step loss of the stepper motor; and
- a means for applying a higher supply current when a step loss is detected.

10 12. Metering pump according to any one of the preceding claims, moreover consisting of a management unit comprising :

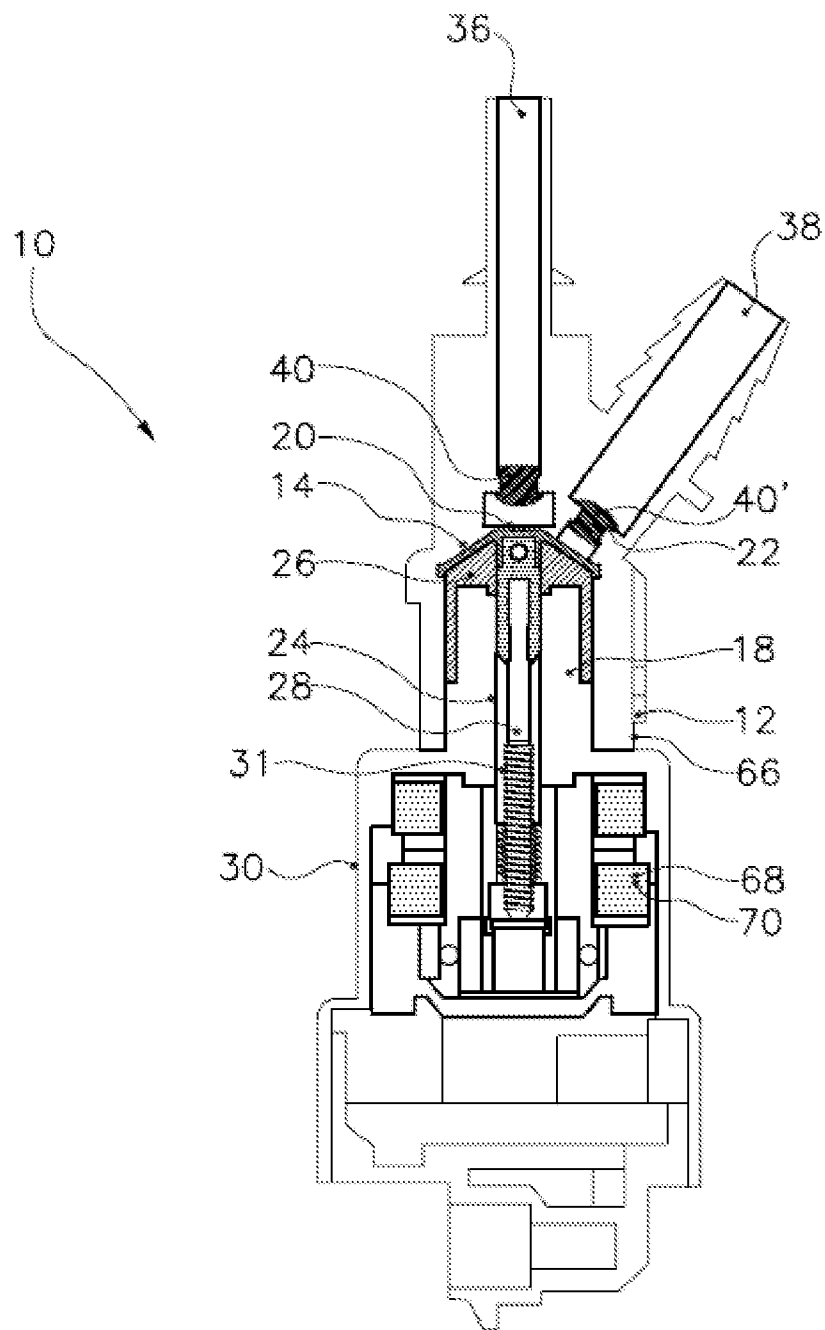
- a means for determining the volume of liquid additive to be injected into the fuel tank;
- a means for detecting an interruption of the power supply to the actuator; and
- 15 • a storage means for storing, in case of such an interruption, information on the volume injected and information on the status of the injection cycle at the time of the interruption.

 13. Metering pump according to Claim 12, in which the information on the status of the injection cycle comprises :

- 20 • the number of strokes (suction/injection) carried out by the piston at the time of the interruption and/or the number of strokes still to be carried out; and
- the information on the volume injected comprises either the volume of liquid additive that remains to be injected, or the total volume of liquid additive to be injected and the volume of liquid additive already injected.

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Fig. 1



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Fig. 2

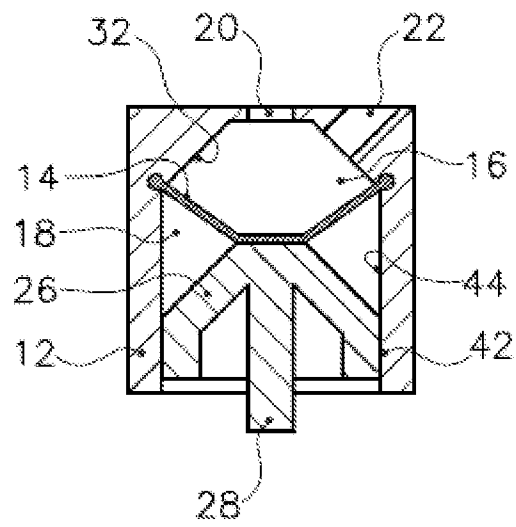


Fig. 3

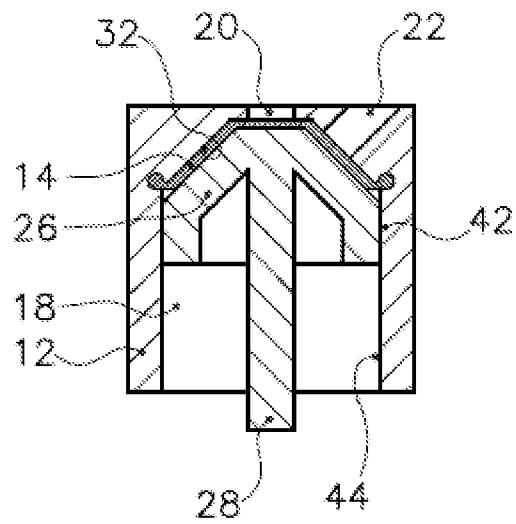
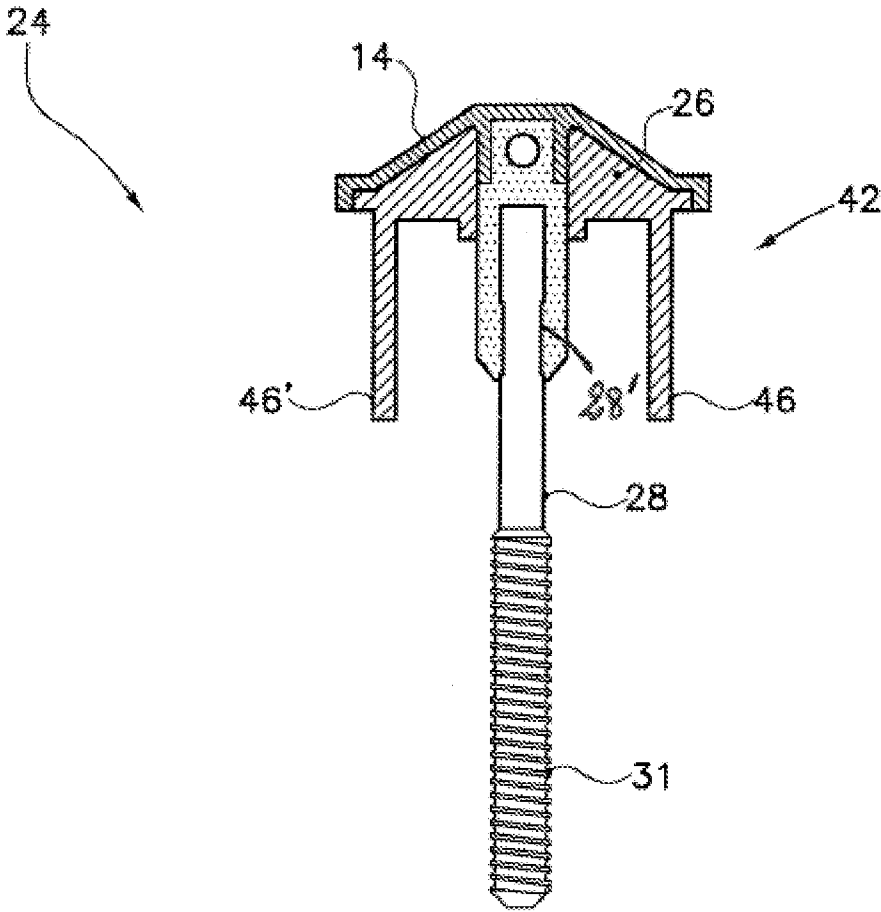
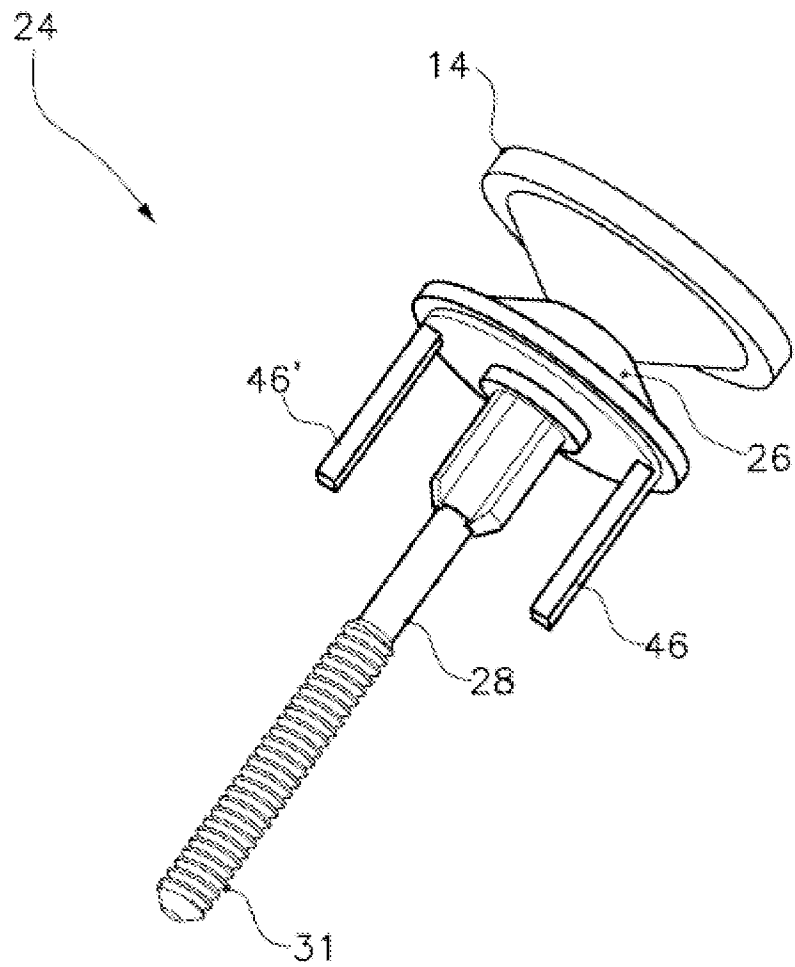


Fig. 4



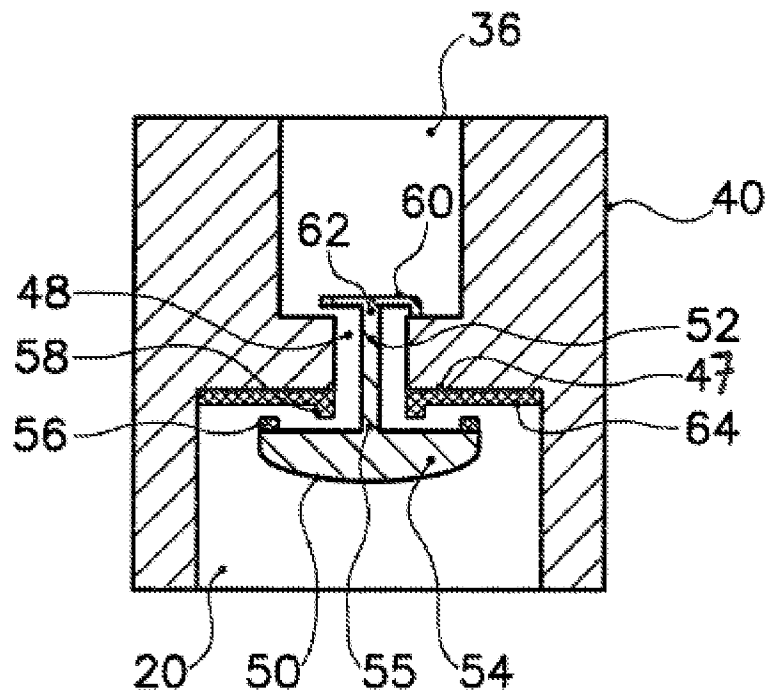
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Fig. 5



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Fig. 6



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/050678

A. CLASSIFICATION OF SUBJECT MATTER
INV. F04B13/00 F04B43/02 F01N3/023 F01N3/029

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)
F04B F01N

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 practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	DE 41 30 166 C1 (LANG APPARATEBAU GMBH, 8227 SIEGSDORF, DE) 11 March 1993 (1993-03-11) the whole document	1-13

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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Date of the actual completion of the international search

16 April 2008

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09/05/2008

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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