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(54) **Liquefied petroleum gas tank for a vehicle, and fuel supply system including said tank**

Autogastank für ein Fahrzeug und Kraftstoffzufuhrsystem mit besagtem Tank

Réservoir de pétrole liquéfié pour véhicule, et système d'alimentation en carburant incluant ce réservoir

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Description

[0001] The present invention relates to a fuel supply system with a liquefied petroleum gas tank.

[0002] In vehicles provided with an internal combustion engine, liquefied petroleum gas, commonly known by the acronym LPG, is used as an alternative fuel to petrol or diesel to define what is known as a "multifuel" type of fuel supply system.

[0003] Said system has two tanks, one for the LPG and the other for the petrol (or other fuel), and comprises an electronic control unit which controls and regulates the supply of the two fuels to the engine. When the engine is started, especially when starting in cold climates, or in any case when the engine and supply system are "cold", the control unit sets the fuel supply system to use petrol, and switches to the gas supply system after a warming-up phase.

[0004] This setting is automatic and necessary in order to ensure correct engine operation. Such systems are not provided with a supply pump for the LPG, and it is merely the pressure of the tank that makes the LPG flow towards a pressure reducer upstream of the engine, so that in certain cold temperature conditions the pressure of the LPG might not be high enough to supply the injection system, especially in turbocharged engines. This phenomenon means the control unit must supply the engine with petrol (or other fuel) and delay switching to LPG until the temperature and, thus, the pressure, are high enough to ensure the continuous supply of LPG.

[0005] The amount of time that passes before automatically switching to supply of LPG depends greatly on the climatic conditions. In other words, in severe climatic conditions, there may be some delay before the ideal pressure and temperature conditions are established in the tank.

[0006] Since, in such conditions, the engine runs on petrol (or on another fuel), especially if the journey is particularly short, the LPG system cannot be exploited in the desired manner.

[0007] One solution could consist of installing a pump to suck the LPG and increase the supply pressure of the LPG towards the engine, but this would not be very reliable, in that said pump would be liable to faulty operation in the presence of "poor" quality fuel, which is fairly common in the case of LPG.

[0008] GB804500A discloses a device comprising a cylindrical tank, which is adapted to contain a liquefied gas and has, at one end, an inlet for a pressurising gas and, at the other end, an outlet for the liquefied gas stored within the tank. The interior of the tank is divided by a flexible membrane into two separate chambers, for the pressurising gas and the liquefied gas respectively. The membrane is made of a material which is both flexible and impermeable.

[0009] US5447142, which corresponds to the preamble of claim 1, and is considered as closet prior art, discloses a method for maintaining the pressure of a com-

pressible fuel resident in a reservoir above a predetermined minimum. Compressed air is withdrawn from an internal combustion engine combustion chamber, is further compressed by a compressor, and is transmitted to an expandable air compartment which occupies part of the interior of the reservoir. The expandable air compartment and the fuel compartment are separated by a movable barrier.

[0010] The object of the present invention is to provide a liquefied petroleum gas tank, which overcomes the drawbacks described above in a simple and cost-effective manner.

[0011] According to the present invention, there is provided a fuel supply system as defined in claim 1.

[0012] In order to better understand the present invention a non-limiting preferred embodiment thereof will now be described by way of example with reference to the accompanying figure 1, which is a diagram of a preferred embodiment of the fuel supply system according to the present invention.

[0013] In the attached drawing, designated as a whole by number 1 is a fuel supply system (schematically and partially illustrated), which constitutes part of a motor vehicle and comprises a liquefied petroleum gas (LPG) tank 2.

[0014] The tank 2 comprises a shell 3, which is preferably toroidally shaped and defines an inner chamber 4, one portion 5 of which is occupied inferiorly by the liquid phase and superiorly by the gaseous phase of the LPG.

[0015] The tank 2 also comprises: an inlet device (not illustrated) to supply LPG into the chamber 4; and an outlet device 7 arranged on a lower portion of the shell 3 and connected to a supply circuit (not illustrated), which places the chamber 4 in communication with a pressure reducer (not illustrated) arranged in the engine of the vehicle, upstream of one or more fuel injectors.

[0016] An upper portion of the shell 3 carries a pressure sensor 8, which measures the pressure of the gaseous phase of the LPG in the portion 5 of the chamber 4.

[0017] The chamber 4 houses a member 10, which is carried by the shell 3 and is moveable to vary the volume available for the LPG and thus to vary the pressure of said LPG. In particular, the member 10 is defined by a bag, which is inflated with an inert fluid to reduce the volume available for the LPG, or deflated to achieve the opposite effect. In particular, the wall of the bag 10 is a membrane that comprises an inlet portion 11 fixed to the shell, separates the portion 5 of the fluid-tight chamber 4 from a portion 13 occupied by the inert fluid, and is extendable into the chamber 4 in response to the pressure of the inert fluid in the portion 13 to vary the volume of the portion 5.

[0018] The term "inert" is used to describe a non-oxidizing fluid. In particular, the fluid is defined by an inert gas, such as nitrogen.

[0019] Alternatively, instead of the bag, the member 10 could be defined by any other device or mechanism

able to vary the volume and, thus, increase the pressure in the chamber, raising it to a suitable level to enable supply: for example it could be defined by a piston moveable in a relative seat housed in the chamber 4.

[0020] A regulating device 14 inflates/deflates the bag 10 to automatically vary the volume available in the chamber 4 for the LPG according to the pressure measured by the sensor 8 and, consequently, to vary the pressure in the portion 5 of the chamber 4. The device 14 comprises a control and regulating unit 15, which receives the signal from the sensor 8 and activates a compressor or a pump 17 arranged along a pipe 18 in response to the value of said signal. The pipe 18 joins, in a fluid-tight manner, the inlet portion 11 to a tank 20, containing the fluid with which the bag 11 is to be inflated.

[0021] The compressor or pump 17 is associated with a two-way valve 22, which is arranged along the pipe 18 and is controlled by the unit 15 with the compressor or pump 17 to select the direction of the flow of the inert fluid between the tank 20 and the bag 10.

[0022] The unit 15 regulates the passage of fluid from and towards the bag 10 so as to maintain the pressure in the chamber 4 at around a desired value (for example approximately 15 bar), in order to ensure sufficient pressure upstream of said pressure reducer.

[0023] Alternatively or in combination with the pressure in the portion 5 of the chamber 4, the control performed by the unit 15 could be based on other parameters measured by suitable sensors, for example it could be based on the temperature measured in an area of the system 1 where it is bi-univocally related to the pressure of the LPG, and/or be based on the pressure of the LPG in another part of the system 1. For instance, the unit 15 could control the passage of fluid from and towards the bag 10 directly as a function of the pressure upstream of said pressure reducer, for example to maintain said pressure at values of around 3-4 bar.

[0024] When the vehicle is started and when the temperature of the tank 2 is relatively low, the pressure in the portion 5 of the chamber 4 is also relatively low; if the pressure of the LPG is lower than the self-supply threshold the unit 15 automatically activates the inflation of the bag 10: the increase in the volume of the bag 10 causes an increase in the pressure in the portion 5 up to the desired value and, thus, causes an increase in the pressure of the LPG in the supply circuit upstream of the pressure reducer, thus fostering the establishment of ideal conditions for supplying LPG to the injectors.

[0025] The device 14 is deactivated gradually, that is to say the bag 10 is gradually deflated so that the fluid returns to the tank 20, as the heat from, for instance, the vehicle exhaust system tends to increase the temperature and, thus, the pressure in the portion 5 of the chamber 4.

[0026] From the above description it is apparent that the device 14 enables the engine to run on LPG immediately even at start-up, that is to say without the need to supply another fuel while waiting for the system 1 to

warm up before supplying LPG: this satisfies the increasing demand for systems based on the exclusive use of a gaseous fuel to power the engine of the vehicle, instead of petrol or diesel.

[0027] Moreover, the bag 10 is relatively light, it is relatively simple to connect to the shell 3 and to the pipe 18 in order to guarantee fluid-tightness, and has no moving parts or parts that slide against one another and on which tightness must also be guaranteed.

[0028] Lastly, it is clear that modifications and variations may be made to the fuel supply system 1 described and illustrated herein without departing from the scope of the present invention, as set forth in the appended claims.

[0029] In particular, the pump or compressor 17 could be integrated into the tank 20. Instead of gas, the fluid for the bag 10 could also be defined by a liquid; and/or the bag 10 could be replaced with a flat membrane, joined along its entire edge to the shell 3 so as to divide the portions 5 and 13, and deformable or extendible in order to move in the chamber 4 and vary the volumes of the portions 5 and 13.

25 Claims

1. Fuel supply system (1) comprising:

- a liquefied petroleum gas tank (2) comprising:

a) a shell (3) defining an inner chamber (4) suitable to contain the liquefied petroleum gas;

b) a member (10) housed in said chamber (4) and movable in order to vary the volume available for the liquefied petroleum gas;

- a control device (14) comprising:

a) at least one sensor (6) to measure a value indicating the pressure of the liquefied petroleum gas;

b) a compressor or a pump (17) to move said member (10) and, consequently, vary the volume available for the liquefied petroleum gas in said tank (2);

c) control means (15) to control said compressor or a pump (17) in response to the measured value;

- a pipe (18) that connects said compressor or pump (17) to an isolated variable volume portion (13) constituting part of said chamber (4);

characterized by comprising a container (20) for an inert fluid, and in that said compressor or pump (17) is controlled in both directions to move said inert fluid between said isolated variable volume portion (13)

and said container (20).

2. System according to claim 1, **characterized in that** said organ (10) is defined by a membrane that divides said fluid-tight chamber (4) into two variable volume portions (5, 13), one for the liquefied petroleum gas, and the other for the inert fluid.
3. System according to claim 2, **characterized in that** said membrane is joined in a fixed position to said shell (3), and is deformable or extendible in response to the pressure of the inert fluid.
4. System according to claim 3, **characterized in that** said membrane is the wall of an inflatable bag (10).
5. System according to claim 4, **characterized in that** said inflatable bag (10) has an inlet portion (11) joined in a fixed position to said shell (3).
6. System according to any one of the previous claims, **characterized in that** said sensor is a pressure sensor (6) is carried by said shell (3) in a position such as to measure the pressure of the liquefied petroleum gas in said chamber (4).

Patentansprüche

1. Kraftstoffzufuhrsystem (1), umfassend:

- einen Flüssiggastank (2), umfassend:

- a) einen Mantel (3), der eine innere Kammer (4) definiert, die das Flüssiggas enthalten kann;
- b) ein Element (10), das in der Kammer (4) untergebracht und beweglich ist, um das für das Flüssiggas verfügbare Volumen zu variieren;

- eine Steuervorrichtung (14), umfassend:

- a) mindestens einen Fühler (6) zum Messen eines Werts, der den Druck des Flüssiggases anzeigt;
- b) einen Kompressor oder eine Pumpe (17), um das Element (10) zu bewegen und daher das für das Flüssiggas in dem Tank (2) verfügbare Volumen zu variieren;
- c) Steuermittel (15) zum Steuern des Kompressors oder einer Pumpe (17) als Reaktion auf den Messwert;

- ein Rohr (18), das den Kompressor oder die Pumpe (17) mit einem variablem isolierten Volumenabschnitt (13), der einen Teil der Kammer (4) bildet, verbindet;

dadurch gekennzeichnet, dass es einen Behälter (20) für ein inertes Fluid aufweist, und dass der Kompressor oder die Pumpe (17) in beide Richtungen gesteuert ist, um das inerte Fluid zwischen dem variablen isolierten Volumenabschnitt (13) und dem Behälter (20) zu bewegen.

2. System nach Anspruch 1, **dadurch gekennzeichnet, dass** das Organ (10) durch eine Membran definiert ist, die die fluiddichte Kammer (4) in zwei variable Volumenabschnitte (5, 13) unterteilt, einen für das Flüssiggas und den anderen für das inerte Fluid.

3. System nach Anspruch 2, **dadurch gekennzeichnet, dass** die Membran in einer stationären Position mit dem Mantel (3) verbunden und als Reaktion auf den Druck des inertes Fluids verformbar oder dehnbar ist.

4. System nach Anspruch 3, **dadurch gekennzeichnet, dass** die Membran die Wand eines aufblasbaren Beutels (10) ist.

5. System nach Anspruch 4, **dadurch gekennzeichnet, dass** der aufblasbare Beutel (10) einen Einlassabschnitt (11) hat, der in einer stationären Position mit dem Mantel (3) verbunden ist.

6. System nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der Sensor ein Drucksensor (6) ist, der von dem Mantel (3) in einer Position derart getragen wird, dass der Druck des Flüssiggases in der Kammer (4) gemessen wird.

Revendications

1. Système d'alimentation en carburant (1) comprenant :

- un réservoir de gaz de pétrole liquéfié (2) comprenant :

- a) une paroi (3) qui définit une chambre intérieure (4) appropriée pour contenir le gaz de pétrole liquéfié ;
- b) un élément (10) logé dans ladite chambre (4) et pouvant se déplacer pour faire varier le volume disponible pour le gaz de pétrole liquéfié ;

- un dispositif de commande (14) comprenant :

- a) au moins un capteur (6) destiné à mesurer une valeur qui indique la pression du gaz de pétrole liquéfié ;
- b) un compresseur ou une pompe (17) destiné à déplacer ledit élément (10) et à faire

varier en conséquence le volume disponible pour le gaz de pétrole liquéfié dans ledit réservoir (2) ;

c) des moyens de commande (15) destinés à commander ledit compresseur ou ladite pompe (17) en réponse à la valeur mesurée ; 5

- un tuyau (18) qui relie ledit compresseur ou ladite pompe (17) à une partie isolée à volume variable (13) qui constitue une partie de ladite chambre (4) ; 10

caractérisé en ce qu'il comprend un récipient (20) pour un fluide inerte et **en ce que** ledit compresseur ou ladite pompe (17) est commandé (e) dans les deux sens pour déplacer ledit fluide inerte entre ladite partie isolée à volume variable (13) et ledit récipient (20). 15

2. Système selon la revendication 1, **caractérisé en ce que** ledit organe (10) est défini par une membrane qui divise ladite chambre étanche au fluide (4) en deux parties à volume variable (5, 13), l'une pour le gaz de pétrole liquéfié et l'autre pour le fluide inerte. 20 25

3. Système selon la revendication 2, **caractérisé en ce que** ladite membrane est fixée dans une position fixe à ladite paroi (3) et **en ce qu'elle** se déforme ou se dilate en réponse à la pression du fluide inerte. 30

4. Système selon la revendication 3, **caractérisé en ce que** ladite membrane est la paroi d'un sac gonflable (10). 35

5. Système selon la revendication 4, **caractérisé en ce que** ledit sac gonflable (10) a une partie d'entrée (11) fixée à ladite paroi (3) dans une position fixe.

6. Système selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit capteur est un capteur de pression (6) supporté par ladite paroi (3) dans une position telle qu'il mesure la pression du gaz de pétrole liquéfié dans ladite chambre (4). 40 45

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REFERENCES CITED IN THE DESCRIPTION

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