Title: AN LPG FUEL SYSTEM FOR PETROL INJECTION ENGINES

Abstract: The object of the invention is an LPG fuel system for petrol injection engines, which, firstly, provides LPG in the liquid phase to the engine, at a constant pressure, and, secondly, envisages mechanical, electronic or electromechanical devices for preventing the petrol from reaching the engine when this is powered by LPG, and mechanical, electronic or electromechanical devices for preventing the LPG from reaching the engine when this is powered by petrol.
Description

An LPG fuel system for petrol injection engines

Technical field

This invention relates to an automotive LPG fuel system for petrol injection engines, without the need to install an aftermarket electronic control unit (ECU), using the one installed by the car manufacturer.

Background of Art

At present, all engines mounted on the most widespread petrol-powered means of transport - such as motor cars, buses and trucks - are fitted/equipped with fuel injection systems controlled by an electronic control unit (ECU).

When mapping the ECU, i.e. regulating the fuel injection parameters according to the different conditions of use, account must be taken of a number of variables, of anti-pollution regulations/standards and the engine tolerances, which are all perfectly identical.

The result can include up to 6,000 calibration points and despite this it can occur that in motorcars there manifest themselves conditions of use that have not been tested on the prototypes and first models and this may entail malfunctioning.

Currently, LP gas conversion of motor cars powered by electronic injection engines provides, inter alia, the fitting of an aftermarket ECU, with the specific “mapping” of the autogas fuel system.

As mentioned above, given the complexity of mapping ECUs, not always the aftermarket ECU determine the perfect running of the engine in all conditions of use after
LPG conversion; besides this, the solution of using an aftermarket ECU in autogas conversion entails problems, such as:

- the need - to effect the conversion - of being in possession of dedicated ECUs for each engine type;

- a high degree of installation difficulty and regulation of the electronic part of the autogas system;

- high costs for both purchasing and installing the ECU;

- the impossibility to find the suitable ECU for engines that are not common or that are rarely predisposed for conversion to LPG, because the manufacturers of ECUs for autogas systems produce them, for obvious reasons, only for the makes and models that most widely convert to LPG;

- greater possibility of failure and/or malfunctioning of the aftermarket ECU compared to the standard one.

Disclosure of invention

The task that this invention aims at is to eliminate the shortcomings previously lamented by means of an LPG fuel system for electronic injection engines that does not require the mounting of an aftermarket ECU, employing the standard ECU installed on the car also for the autogas system, without any alterations or new mapping and/or calibration.

This task is achieved by means of a system that, (i) supplies LPG in the liquid phase to the fuel system, at a predetermined and practically constant pressure, and (ii) is provided with mechanical, electronic and electromechanical devices for preventing the petrol from passing through to the engine, when this is running on autogas, and
mechanical, electronic and electromechanical devices preventing the autogas from passing through to the engine, when this is running on petrol.

**Brief description of the drawings**

A specific embodiment of the invention will now be described by way of example with reference to the accompanying drawing in which:

Fig. 1 shows a general diagram of the system.

Fig. 2 shows a detail of the switching unit.

Fig. 3 shows a detail with the petrol and autogas injectors installed directly on the manifold/collettore.

Fig. 4 shows a detail of the installment of the autogas injectors by means of a joint and adapter, directly beneath the petrol injector, without the need to make a hole in the manifold/.

Fig. 5 shows a detail with the petrol and autogas injectors installed on the manifold/ by means of joints and pipes.

**Detailed description of a preferred embodiment**

Referring to the drawing, in the preferred embodiment of this invention the system comprises a set of LPG injectors (2), alongside the standard petrol injectors (1) installed on the manifold (14) by the vehicle manufacturer.

The autogas injectors (2) are fitted directly onto the manifold (14), at a minimum distance from the injection point, compared to the injection point of the petrol injectors (1) (figs. 3,4 and 5); alternatively, the autogas injectors (2) may be installed elsewhere (fig. 4) and connected by means of pipes (15), if necessary provided with transition fittings or adaptors (16), directly beneath the petrol injectors (1), thus avoiding to have to
remove, perforate and re-install the manifold, for considerable savings of time and money.

Both the petrol injectors (1) and LPG injectors (2) are connected to a switching unit (3), shown in greater detail in fig. 2, which, in turn, is connected to the vehicle’s ECU (4), by means of the petrol injector (1) pins and suitable cabling (17).

A further connection is achieved between the switching unit (3) and the control switch / level indicator (5).

The petrol injector set (1) is connected - by the vehicle manufacturer - to the fuel tank (6) by means of a fuel delivery pipe (7) and a fuel return pipe (8).

The aftermarket autogas injector set (2) too is connected to the LPG tank (9) by means of a delivery pipe (10) and a return pipe (11); on the return pipe is fitted a pressure regulator (12), for maintaining the pressure of the LPG at the set value, i.e. about 7/8 bars.

The LPG tank (9) contains a pump (13) for continuously supplying the LPG in the liquid phase.

The working of the system is based on the fact that, (a) the LPG is supplied to the injectors at a set pressure - for example, 7/8 bars - and, (b) the switching unit (3) can switch from the petrol injectors (1), the standard ones installed by the vehicle manufacturer, to the autogas injectors (2), installed at the LPG conversion (and vice versa), according to whether the vehicle is powered by petrol or LPG.

In practical terms, by setting the control switch (5) in the LPG mode, the switching unit (3) enables the LPG injectors (2), LPG pump (13), electronic shut-off valve (18), and pressure regulator (12); on the contrary, when the control switch is set in the petrol mode, the petrol injectors (1) and standard petrol fuel system are enabled.
To maintain the functionality of the petrol injectors while the vehicle is powered by LPG, a device has been provided for that automatically switches to the petrol mode every time the engine is turned off, thus allowing the engine to ignite and run with petrol (for several tens of seconds), to lubricate the injectors and keep them in working order, and, with the LPG pump running at the same time, to deliver LPG in the liquid phase to the injectors removing any traces of LPG there in the gaseous phase - due to the high temperatures of the engine; after a set time the switching unit automatically switches the engine to the LPG fuel mode.

In order to ensure the use of the standard ECU, the invention provides for a special switching unit (3), the operation of which is described in the following paragraphs:

- if the control switch (5) is set to the autogas mode, on ignition the engine starts in the petrol mode, because the switching unit's double-contact relays - de-energized by the device inserted in the unit - allow the signals from the ECU to the petrol injectors to pass through.

Once the set temperature for the correct working of the engine has been reached, the timer goes off and - after a set time - transmits the power to the relays which, being double-contact relays, switch on to the other contact, transmitting the signals from the ECU to the LPG injectors (2).

By setting the switch to the petrol mode the engine works just as it normally would do.

Furthermore, to ensure the correct operation of the LPG pump when the LPG in the tank (9) is finished, the switching unit (3) automatically switches to the petrol mode (indicating this with a LED), by means of a level indicator or device capable of detecting any differences in the amperes absorbed, to prevent any damage to the LPG pump.
In a nutshell, the switching unit (3), by means of cables, receives the signals for the injectors from the original ECU (4) and sends them on to either the petrol injectors (1) or LPG injectors (2), via the double-contact relays.

1) When the relays are de-energized, they transmit the signals from the ECU to the petrol injectors (1);

2) When the relays are energized, they transmit the signals from the ECU to the LPG injectors (2).

The switching unit (3) also handles the current transmitted to the injectors (positive): directly, in the case of the petrol injectors; through interposed resistances in the case of the autogas injectors, to ensure their correct operation.

It is clear, therefore, that the ECU (4) performs its normal function of controlling both the fuel systems without the need for major alterations.

To better understand how the invention works there follows the description of the preferred embodiment, given solely by way of example, for a bi-fuel 4-cylinder engine.

Based on the above drawing, this embodiment comprises the components as follows:

- petrol injectors (1), of the standard type installed by vehicle manufacturers;
- LPG injectors (2), with flow-rate characteristics similar to the petrol system;
- a switching unit (3) of the multiple double-contact relay type, according to the injectors to be switched (see the diagram in fig. 2) and essentially comprising:
  - double-contact relays (the number of which varies according to the number of injectors (1);
  - a temperature sensing device or, alternatively, a starter and engine RPM on the coil;
- resistances in variable numbers, according to the number of LPG injectors installed;
- a 0°/30° timer;
- an automatic switching device to petrol power, when the vehicle runs out of LPG;
- cabling, such as to avoid having to tamper with the standard wiring;
- an electronic control unit (ECU) (4) of the standard type installed by the vehicle manufacturer;
- an automatic control switch (5);
- a spring pressure controller.

The abovementioned system permits the use of the LPG fuel system without having to install an additional aftermarket ECU, as is usually the case when converting to autogas, and ensures the smooth running of the engine at all rpms; furthermore, the exhaust parameters comply with the applicable anti-pollution regulations.

It can, therefore, be seen how the invention achieves its proposed aims and, in particular, the fact can be stressed that conversion to LPG with this system is very fast and efficient, with installation times approx. 80% quicker than the conventional systems, on all types of vehicles, at an affordable price.

Furthermore, as mentioned many times above, the fact that no additional aftermarket ECU is needed ensures that the vehicle is not unduly tampered with and maintains the reliability guaranteed by the manufacturer.

The principles of the invention are described hereinabove by describing the construction and operation of a preferred embodiment. It is to be remembered that this exemplary embodiment can be modified or changed without departing from the spirit or scope of the invention as defined by the following claims.
CLAIMS

1. An LPG fuel system for petrol injection engines comprising:
   a set of LPG injectors (2); a switching unit (3) connected to the standard petrol injectors
   (1), to the LPG injectors (2) and to the standard ECU (4) installed by the vehicle
   manufacturer; the control switch (5) of the switching unit (3); a pressure regulator (12)
   fitted on the LPG return pipe to the tank (9); a pump (13) for delivering the LPG in the
   liquid phase to the injectors (2).

2. The LPG fuel system for petrol injection engines described in claim 1 wherein the
   LPG injectors (2) are fitted directly onto the manifold (14) at a minimum distance from
   the petrol injectors (1).

3. The LPG fuel system for petrol injection engines described in claim 1 wherein the
   LPG injectors (2) are installed elsewhere and connected to the manifold by means of
   pipes (15), provided with transition fittings or adaptors (16), if necessary, directly beneath
   the petrol injectors (1).

4. The LPG fuel system for petrol injection engines described in the preceding
   claims wherein the switching unit (3) allows the engine to be powered either by the petrol
   system and relevant set of injectors (1), or the LPG system and relevant set of injectors
   (2).

5. The LPG fuel system for petrol injection engines described in the preceding
   claims wherein the switching unit is of the multiple double-contact relay type, based on
   the number of injectors to be switched.

6. The LPG fuel system for petrol injection engines described in the preceding
   claims wherein the switching unit (3) comprises: double-contact relays (the number of
   which varies according to the number of injectors (1); a temperature sensing device or,
alternatively, a starter and engine RPM on the coil; resistances in variable numbers, according to the number of LPG injectors installed; a 0°/30° timer; an automatic switching device to petrol power, when the vehicle runs out of LPG; cabling, such as to avoid having to tamper with the standard wiring;

7. The LPG fuel system for petrol injection engines described in the preceding claims wherein the LPG injectors (2) have flow-rate characteristics similar to the petrol system.

8. The LPG fuel system for petrol injection engines described in the preceding claims wherein if the control switch (5) is set to the autogas mode, on ignition the engine starts in the petrol mode, because the switching unit’s double-contact relays - de-energized by the device inserted in the unit - allow the signals from the ECU to the petrol injectors to pass through. Once the set temperature for the correct working of the engine has been reached, the timer goes off and - after a set time - transmits the power to the relays which, being double-contact relays, switch on to the other contact, transmitting the signals from the ECU to the LPG injectors (2).

9. The LPG fuel system for petrol injection engines described in the preceding claims wherein when the LPG in the tank (9) is finished, the switching unit (3) automatically switches to the petrol mode (indicating this with a LED), by means of a level indicator or device capable of detecting any differences in the amperes absorbed.
### INTERNATIONAL SEARCH REPORT

#### A. CLASSIFICATION OF SUBJECT MATTER

| IPC    | F02B43/00 | F02D19/02 | F02M21/02 |

According to International Patent Classification (IPC) or to both national classification and IPC.

#### B. FIELDS SEARCHED

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

#### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>PATENT ABSTRACTS OF JAPAN vol. 2000, no. 25, 12 April 2001 (2001-04-12) &amp; JP 2001 234829 A (NIPPON SOKEN INC; TOYOTA MOTOR CORP), 31 August 2001 (2001-08-31) abstract</td>
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**Further documents are listed in the continuation of this report.**

**Patient family members are listed in annex.**

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<td>European Patent Office, P.B. 5816 Patentlaan 2 NL – 2280 HV Rijswijk</td>
<td>Wassenaar, G</td>
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