(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 690 218 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
03.01.1996 Bulletin 1996/01

(51) Int Cl.[6]: **F02M 25/08**

(21) Application number: **95304404.7**

(22) Date of filing: **22.06.1995**

(84) Designated Contracting States:
DE FR IT

(30) Priority: **30.06.1994 GB 9413164**

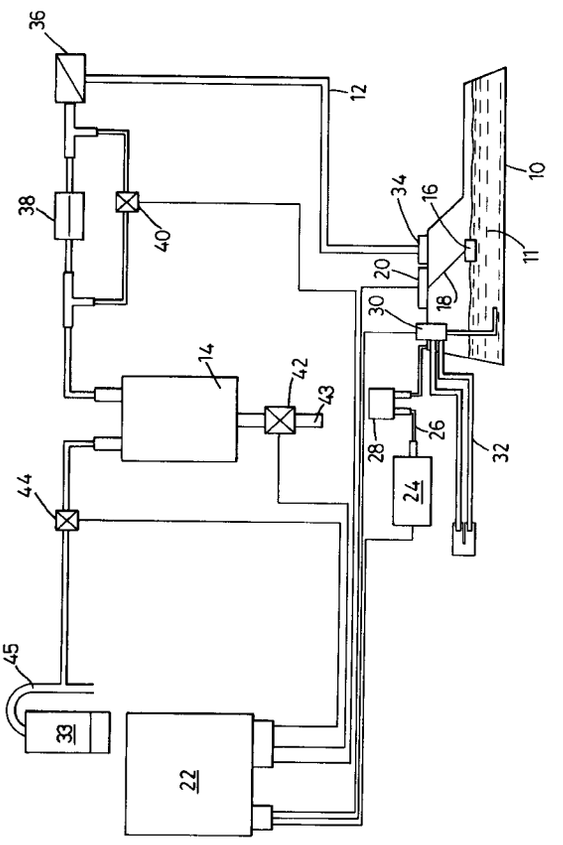
(71) Applicant: **ROVER GROUP LIMITED**
Bickenhill, Birmingham B37 7HQ (GB)

(72) Inventor: **Boyce, Christopher Robert**
West Midlands, B90 2PX (GB)

(74) Representative: **Wilson, Alan Stuart**
Lighthorne, Warwick CV35 0RG (GB)

(54) A method of and apparatus for determining whether a leak is present in a fuel system

(57) A method of determining whether a leak is present in a fuel system between a fuel tank 10 and a canister 14 for removing fuel vapour upstream of a venting outlet 42, the method comprising the steps of: sensing the level of fuel in the fuel tank 10 using a fuel level sensor 16, 20, reducing the pressure between the fuel tank and the canister, and subsequently sensing the pressure rise again using a pressure sensor 24, the determination being made on the basis of the sensed pressure and signals from the level sensor so that the volume of air in the tank, and the vibration of the fuel and resulting accelerated evapouration, can be taken into account.



EP 0 690 218 A1

Description

The invention relates to a method of determining whether a leak is present in a fuel system and apparatus for carrying out the method.

A known fuel system in a vehicle includes a fuel tank which is connected through a passageway to a charcoal canister which includes a normally open vent valve connected to atmosphere and a normally closed purge valve connected to the engine inlet manifold. A pressure sensor is provided for the system. In order to check for a leak in the system, the canister vent valve is closed and the purge valve is opened to evacuate the system. The purge valve is then closed and the engine management control unit monitors the decay of the induced vacuum in the fuel system. If the vacuum decays slowly then this is an indication that no leaks are present.

A similar system is disclosed in US 5193512.

A problem with the known system is that, if there is heavy movement of fuel, there will be a greater rate of evaporation and so the vacuum will be caused to decay more quickly, or the over pressure more slowly. This factor may now be taken into account.

According to one aspect of the invention there is provided a method of determining whether a leak is present in a fuel system having a fuel tank, a fuel level sensor, a venting line with a venting outlet, fuel vapour removing means in the venting line upstream of the venting outlet, the method comprising the steps of: changing the pressure between the fuel tank and the fuel vapour removing means, subsequently sensing the pressure between the fuel tank and the fuel vapour removing means, and making a determination on the basis of the sensed pressure whether a leak is present, wherein the method further comprises the step of sensing changes in the level of fuel in the fuel tank, and the determination is also dependant on the sensed changes in the level of fuel.

Preferably the step of sensing the changes in the level of fuel in the fuel tank comprises sensing the amplitude of vibrations of the fuel, and the determination is also dependant on said amplitude.

Preferably the step of sensing the changes in the level of fuel in the fuel tank comprises sensing the frequency of vibrations of the fuel, and the determination is also dependant on said frequency.

Preferably the step of sensing the changes in the level of fuel in the fuel tank comprises sensing the amplitude of vibrations of the fuel within a range of frequencies of interest, and the determination is also dependent on said amplitude.

The step of changing the pressure between the fuel tank and the filter most conveniently comprises reducing the pressure between the fuel tank and the filter.

The present invention also provides fuel system comprising a fuel tank, a fuel level sensor, a venting line for the fuel tank having a venting outlet, and fuel vapour removing means in the venting line upstream of the venting outlet, means for changing the pressure between a fuel tank and the fuel vapour removing means, a pressure sensor and a control unit, wherein the control unit is arranged to cause the pressure changing means to change the pressure between the fuel tank and the fuel vapour removing means, and to make a determination on the basis of the sensed pressure whether a leak is present, wherein the method further comprises the step of sensing changes in the level of fuel in the fuel tank, and the determination is also dependant on the sensed changes in the level of fuel.

The system may be arranged to carry out the method of any aspect of the present invention as described.

Most conveniently the pressure changing means comprises a source of low pressure and a valve to establish communication with said source, which may comprise an engine inlet manifold.

The present invention further provides a vehicle having a fuel system according to any aspect of the invention as described.

One embodiment of the invention will now be described by way of example and with reference to Figure 1 of the accompanying drawing which is a schematic view. The drawing shows a fuel tank 10 containing fuel 11 connected through a passageway 12 to a charcoal canister 14.

A float 16 is provided in tne fuel tank 10 and is connected by an arm 18 to a transducer 20 for measuring fuel level and fuel movement. The transducer 20 is connected to a control unit 22. A pressure sensor 24 is connected to the volume of the fuel tank 10 through a pipe 26 which includes a fuel trap 28. The pressure sensor 24 is also connected to the control unit 22. A fuel pump 30 is provided for the fuel tank 10 and is connected through pipes 32 to the engine 33.

A roll-over valve 34 is provided between the fuel tank 10 and the passageway 12. The passageway 12 leads from the roll-over valve 34 to a liquid/vapour separator 36. The passageway 12 then forks and re-combines and a two-way valve 38 and a bypass valve 40 are provided in parallel. The bypass valve 40 is connected to the control unit 22. The passageway 12 then leads to the charcoal canister 14. The charcoal canister 14 has two outlet valves 42,44 which are controlled by the control unit 22. The first valve is a canister vent valve 42 which is connected to atmosphere through a venting outlet 43 and the second valve is a purge valve 44 which is connected to the inlet manifold 45 of the vehicle engine 33.

In use, the transducer 20 provides a continuous signal to the control unit which varies with the fuel level in the fuel tank 10. It therefore provides the control unit 22 with information about the level of fuel at any particular time, and the amount of movement of the fuel 11 in the tank. The pressure sensor 24 provides information to the control unit 22 about the pressure in the tank 10 and is protected by the fuel trap 28 from fuel condensing in the sensor 24 and upsetting its operation.

The roll-over valve 34 prevents fuel from entering the passageway 12 if the vehicle should ever be upside

down. The two-way valve 38 prevents vapour from passing through from the tank 10 to the charcoal canister 14 unless the air/vapour mixture is above a certain pressure which is slightly above atmospheric pressure. This helps to retain fuel vapour in the tank 10. The two-way valve 38 will allow the air/vapour mixture back towards the tank 10 when the pressure difference across the valve 38 is above a certain level. The bypass valve 40 is normally closed so that the two-way valve 38 is in operation. The purge valve 44 is normally closed and the canister vent valve 42 normally open.

In use, then, a mixture of air, fuel vapour and liquid fuel travels through the passageway 12 to the liquid/vapour separator 36 where the liquid fuel is removed. If the pressure rises above a certain level, the air/vapour mixture will pass through the two-way valve 38 to the charcoal canister 14 which will absorb vapour so that a minimum amount of fuel is emitted through the canister vent valve 42.

In order to test the system, the canister vent valve 42 is closed, the bypass valve 40 is opened and the purge valve 44 is opened to connect the system to the engine inlet manifold 45. This provides suction on the system to evacuate it to low pressure. The purge valve 44 is then closed and the rise in pressure is monitored by the control unit 22 through the pressure sensor. The control unit 22 determines whether a leak is present on the basis of the rate of change of pressure as air re-enters the system. The critical rate if change which is taken to indicate a leak varies to take into account the signal from the transducer 20. If there is a high level of fuel in the tank, then the critical rate of change is high because the pressure of the small volume of air in the tank will change rapidly as air enters the tank. If there is a low level of fuel, then the critical rate of change will be lower. Similarly if there is a lot of movement of the fuel in the tank then the critical rate of change will be higher because the pressure will be increasing as a result of fuel evapouration as well as air re-entering the system. The measurement of fuel movement can be simply related to the total movement of the surface of the fuel over a set period, or can be frequency and/or amplitude dependent to account for the fact that low frequency movement is unlikely to affect the evapouration rate, whereas higher frequency, higher amplitude movement causes more disturbance of the fuel and hence increases the evapouration rate.

The control unit 22 samples the position of the float 16 continually at a rate of about 200 times per second. From the resulting data the control unit 22 can filter out the amplitude of vibrations at any particular frequency or frequencies or the mean amplitude over a range of frequencies. Since the effect on the evapouration rate varies with the frequency of vibration of the fuel, the control unit can have stored in memory one or more frequencies of interest or a range of frequencies of interest at which vibrations will have a significant effect on the vibration rate. The amplitude of vibrations at those frequencies can then be taken into account when calculating the critical rate of change of pressure.

The control unit 22 may carry out the check automatically, for example, being triggered by an engine idle period of 20 or 30 seconds.

Claims

1. A method of determining whether a leak is present in a fuel system having a fuel tank (10), a fuel level sensor (16), a venting line (12) with a venting outlet, fuel vapour removing means (14) in the venting line upstream of the venting outlet (43), the method comprising the steps of: changing the pressure between the fuel tank (10) and the fuel vapour removing means (14), subsequently sensing the pressure between the fuel tank (10) and the fuel vapour removing means, and making a determination on the basis of the sensed pressure whether a leak is present, characterized in that the method further comprises the step of sensing changes in the level of fuel (11) in the fuel tank, and the determination is also dependant on the sensed changes in the level of fuel (11).

2. A method as claimed in claim 1, characterized in that the step of sensing the changes in the level of fuel (11) in the fuel tank (10) comprises sensing the amplitude of vibrations of the fuel, and the determination is also dependant on said amplitude.

3. A method as claimed in claim 1 or claim 2, characterized in that the step of sensing the changes in the level of fuel (11) in the fuel tank (12) comprises sensing the frequency of vibrations of the fuel, and the determination is also dependant on said frequency.

4. A method as claimed in any one of claims 1 to 3 characterized in that the step of sensing the changes in the level of fuel (11) in the fuel tank (12) comprises sensing the amplitude of vibrations of the fuel within a range of frequencies of interest, and the determination is also dependent on said amplitude.

5. A method as claimed in any one of claims 1 to 4 characterized in that the step of changing the pressure between the fuel tank (12) and the fuel vapour removing means (14) comprises reducing the pressure between the fuel tank (12) and the fuel vapour removing means (14).

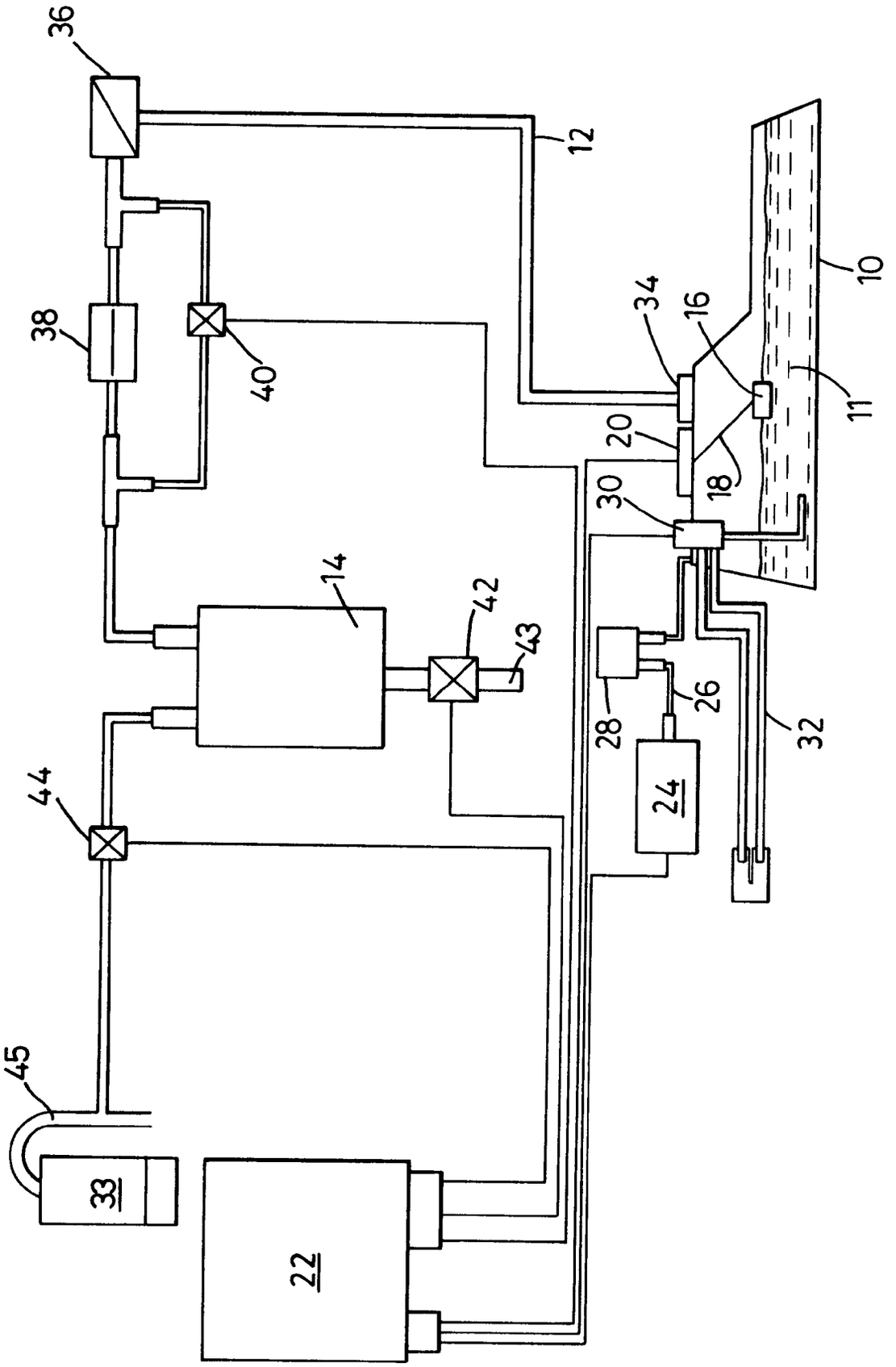
6. A fuel system comprising a fuel tank (10), a fuel level sensor (20), a venting line (12) for the fuel tank having a venting outlet, and fuel vapour removing means (14) in the venting line upstream of the venting outlet, means (44) for changing the pressure between a fuel tank and the fuel vapour removing

means, a pressure sensor (24) and control means (22) , wherein the control means is arranged to cause the pressure changing means (44) to change the pressure between the fuel tank (10) and the fuel vapour removing means (14), and to make a determination on the basis of the sensed pressure whether a leak is present, characterized in that the control means (22) , is further arranged to sense changes in the level of fuel (11) in the fuel tank (12), and the determination is also dependant on the sensed changes in the level of fuel.

7. A system as claimed in claim 6, characterized in that the control unit (22) is arranged to carry out the method according to any one of claims 2 to 5.

8. A system as claimed in claim 10 characterized in that the pressure changing means (44) comprises a source of low pressure and a valve to establish communication with said source.

9. A vehicle having a fuel system as claimed in any one of claims 6 to 13.


36
12
10
38
40
34
16
11
20
18
30
14
42
43
26
28
32
24
44
45
33
22

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 4404

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	WO-A-92 18765 (BOSCH) * page 9, paragraph 2 - page 10, line 1 * * page 12, paragraph 4 - page 13, line 6 *	1,6,9	F02M25/08
P,A	US-A-5 345 917 (MARUYAMA) * column 5, line 66 - column 6, line 21 * * column 9, line 7 - line 41 * * column 10, line 37 - column 11, line 4 * * column 11, line 13 - line 19 *	1,6,9	
A	GB-A-2 254 318 (NIPPONDENSO) * page 36, line 24 - page 37, line 5 * * page 37, line 18 - line 22 * * page 39, line 21 - page 40, line 4 * * page 40, line 19 - page 42, line 9 * * page 51, line 4 - page 52, line 10 *	1,6,9	
A	WO-A-91 12426 (BOSCH) * page 3, last paragraph * * page 6, paragraph 1 * * page 7, paragraph 3 - page 8, paragraph 2 *	1,6,9	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
P,X	EP-A-0 611 674 (LUCAS) * column 3, line 7 - line 10 * * column 3, line 32 - column 4, line 42 * * column 5, line 12 - line 35 * * column 5, line 48 - line 54; figures 1,4,5 *	1,2,5-9	F02M
P,X	WO-A-94 25747 (PILOT INDUSTRIES) * page 3, line 3 - line 25 * * page 4, line 11 - line 19 * * page 5, line 1 - line 9 * * page 5, line 26 - page 7, line 15; claims 1,10 *	1,5,6,8,9	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	6 October 1995	Joris, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)