A system and method for fuel balancing is disclosed. The system and method measures the difference in fuel levels between two fuel tanks. In one case, when the difference in the two fuel levels exceeds a predetermined amount, an indicator is activated. In another case, when the difference in the two fuel levels exceeds a predetermined amount, the fuel is only drawn from the fuel tank containing the most fuel.
Monitor delta in fuel level between two fuel tanks.

Is delta > limit?

Indicate fuel imbalance.
Monitor delta in fuel level between two fuel tanks 402

Is delta > limit 404

Stop flow from fuel tank with the least amount of fuel 406
SYSTEM AND METHOD FOR FUEL BALANCING

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

The invention is related to the field of fuel systems, and in particular, to balancing fuel usage between multiple fuel tanks.

[0002] 2. Description of the Prior Art

Large trucks typically have multiple fuel tanks. In many cases these tanks are distributed on each side of the trucks. The fuel tanks may hold large amounts of fuel in each tank. Due to the large amount of fuel held in each fuel tank, the weight of the fuel may be substantial. If the truck uses all the fuel from one fuel tank on one side of the truck before using any fuel from a corresponding fuel tank on the other side of the truck, the truck may become unbalanced due to the uneven distribution of fuel between the two tanks. Currently this problem is solved by connecting the fuel tanks on either side of the truck with a pipe attached to the bottoms of the two fuel tanks. Connecting the fuel tanks with a pipe effectively creates one large fuel tank. As fuel is drawn from either tank, gravity keeps the level of fuel in both fuel tanks equal. Unfortunately, this system has problems. If a leak occurs in either fuel tank, or in the pipe connecting the fuel tanks, all the fuel from both fuel tanks may be lost. In addition, the pipe connecting the two fuel tanks must be connected at the bottom of the fuel tanks. This may create a low clearance area that extends from one side of the truck to the other side of the truck. In many cases, due to the low clearance, the pipe becomes damaged with a resultant loss of fuel.

[0005] Another solution used today is a pump system that can transfer fuel back and forth between the two fuel tanks. This system works well but is costly to implement.

[0006] Therefore there is a need for a different system and method for fuel balancing.

SUMMARY OF THE INVENTION

[0007] A system and method for fuel balancing is disclosed. The system and method measures the difference in fuel levels between two fuel tanks. In one case, when the difference in the two fuel levels exceeds a predetermined amount, an indicator is activated. In another case, when the difference in the two fuel levels exceeds a predetermined amount, the fuel is only drawn from the fuel tank containing the most fuel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 is a block diagram of fuel system 100 in an example embodiment of the invention.

[0009] FIG. 2a is an isometric view of one example implementation of a switching device using two solenoids.

[0010] FIG. 2b is an isometric view of one example implementation of a switching device using two solenoids connected in a fuel system.

[0011] FIG. 3 is a flow chart showing one example embodiment of the invention.

[0012] FIG. 4 is a flow chart showing another example embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0013] FIGS. 1-4 and the following description depict specific examples to teach those skilled in the art how to make and use the best mode of the invention. For the purpose of teaching inventive principles, some conventional aspects have been simplified or omitted. Those skilled in the art will appreciate variations from these examples that fall within the scope of the invention. Those skilled in the art will appreciate that the features described below can be combined in various ways to form multiple variations of the invention. As a result, the invention is not limited to the specific examples described below, but only by the claims and their equivalents.

[0014] FIG. 1 is a block diagram of fuel system 100 in an example embodiment of the invention. Fuel system 100 comprises fuel tanks 102 and 104, switching device 106, fuel lines 108, 110, and 112, fuel pump 114, fuel gages 118 and 120, comparator 122, and indicator 124. Fuel tank 102 is connected to switching device 106 by fuel line 108. Fuel tank 104 is connected to switching device 106 by fuel line 110. Switching device 106 is connected to fuel pump 114 by fuel line 112. Switching device is configured to switch the connection from fuel pump 114 to one of the two fuel tanks. Fuel gage 118 is attached to fuel tank 102 and configured to measure the amount of fuel in fuel tank 102. Fuel gage 120 is attached to fuel tank 104 and configured to measure the amount of fuel in fuel tank 104. Comparator 122 is connected to fuel gage 118 and to fuel gage 120 and configured to determine a difference between the amount of fuel in fuel tank 102 and the amount of fuel in fuel tank 104. Comparator 122 is connected to indicator 124 and to switching device 106.

[0015] In one example embodiment of the invention, comparator 124 determines the difference between the amount of fuel in the two fuel tanks (102 and 104) by using the signals from fuel gages 118 and 120. When the difference exceeds a predetermined amount, comparator will activate indicator 124 to indicate that a fuel imbalance has occurred. A user can then activate switching device 106 and change which fuel tank is currently being used.

[0016] In another example embodiment of the invention, comparator 124 determines the difference between the amount of fuel in the two fuel tanks (102 and 104) by using the signals from fuel gages 118 and 120. When the difference exceeds a predetermined amount, comparator will activate switching device 122 and change which fuel tank is currently being used.

[0017] Comparator 122 may be implemented in hardware as a simple differential circuit, as firmware running on a processor, or the like. Fuel gages 118 and 120 may be implemented as level detectors that measure the fluid level inside the fuel tanks (for example float gages), as strain gages that measure the weight of the fuel tanks, or the like.

[0018] Switching device 106 may be implemented in any number of ways. In one example embodiment of the invention, switching device may be implemented as a 3-way valve. In another example embodiment of the invention,
switching device 106 may be implemented as two 2-way solenoids feeding into a common manifold that is connected with the fuel pump. FIG. 2a is an isometric view of one example implementation of a switching device 206 using two solenoids. Solenoids 232 and 234 have input ports 240 and 242 respectively. Solenoids 232 and 234 switchably connect their respective input ports to common output manifold 248. FIG. 2b is the switching device from FIG. 2a in a fuel system. A fuel line from a first fuel 202 tank attaches to the input port of solenoid 232. A fuel line from a second fuel tank 204 attaches to the input port of solenoid 234. A fuel line attached at the common manifold leads to a fuel pump 214. In operation, when fuel is to be drawn from the first fuel tank by the fuel pump, solenoid 232 would be open and solenoid 234 would be closed. When fuel is to be drawn from the second fuel tank by the fuel pump, solenoid 232 would be closed and solenoid 234 would be open. By switching which solenoid is open and which solenoid is closed, switching device 206 can determine which fuel tank is being used. In one example embodiment, fuel would only be drawn from one tank at a time.

[0019] In another example embodiment, both solenoids may be open and allow fuel to be drawn from both fuel tanks simultaneously. When comparator 122 detects an imbalance in the fuel amount between the two tanks that exceeds a predetermined amount, the solenoid corresponding to the fuel tank with the least amount of fuel would be closed. In this way fuel would be drawn from the fuel tank that had the most fuel. Once the fuel imbalance has been reduced or eliminated, the closed solenoid could be reopened such that once again the fuel would be drawn from both fuel tanks.

[0020] FIG. 3 is a flow chart showing an example embodiment of the invention. At step 302 the difference in the amount of fuel in two fuel tanks is monitored. At step 304 the difference in the fuel levels is compared against a limit. When the difference is smaller than the limit, flow returns to step 302. When the difference is larger than the limit, a fuel imbalance is indicated in step 306. Any type of indicator may be used at step 306. The indicator may be a visual indicator, for example a flashing light, a change in color, or the like. The indicator may be an audio indicator, for example a buzzer. The indicator could also be a combination audio/visual indicator.

[0021] FIG. 4 is a flow chart showing another example embodiment of the invention. At step 402 the difference in the amount of fuel in two fuel tanks is monitored. At step 404 the difference in the fuel levels is compared against a limit. When the difference is smaller than the limit, flow returns to step 402. When the difference is larger than the limit, the flow of fuel from the fuel tank with the least amount of fuel is stopped at step 406. In one example embodiment where fuel is drawn from only one fuel tank at a time, the fuel flow is stopped in step 406 by switching the flow of fuel from one fuel tank to the other fuel tank. In another example embodiment where the fuel may be drawn from both fuel tanks simultaneously, the flow of fuel is stopped in step 406 by disabling the connection to the fuel tank that contains the least amount of fuel.

[0022] The invention described above is not limited to implementations where the fuel pump is external to the fuel tanks. There could be multiple fuel pumps, one inside each fuel tank. There could also be more than 2 fuel tanks, for example 2 side fuel tanks and one center tank, or 2 fuel tanks on each side for a total of 4 fuel tanks. This invention applies to fuel systems for any type of fuel, for example diesel, gasoline, natural gas, and the like.

We claim:
1. A method, comprising:
   monitoring a difference between at least a first amount of fuel in a first fuel tank and a second amount of fuel in a second fuel tank;
   indicating when the difference exceeds a predetermined amount.
2. The method of claim 1 where the difference is monitored by comparing a first fuel level in the first fuel tank with a second fuel level in the second fuel tank.
3. The method of claim 1 where the difference is monitored by comparing a first weight of the first fuel tank with a second weight of the second fuel tank.
4. The method of claim 1 where a visual signal is used to indicate when the difference exceeds the predetermined amount.
5. The method of claim 1 where an audio signal is used to indicate when the difference exceeds the predetermined amount.
6. The method of claim 1 where the first fuel tank is on a first side of a truck and the second fuel tank is on a second side of the truck.
7. A method, comprising:
   monitoring a difference between at least a first fuel level in a first fuel tank and a second fuel level in a second fuel tank;
   switching from a first connection to a second connection when the difference exceeds a predetermined amount, where the first connection is between the first fuel tank and a fuel pump and the second connection is between the second fuel tank and the fuel pump.
8. The method of claim 7 where the switching occurs automatically.
9. A method, comprising:
   balancing a fuel use between at least a first fuel tank and a second fuel tank by drawing fuel from at least one of the fuel tanks;
   monitoring a difference in an amount of fuel in the first fuel tank and an amount of fuel in the second fuel tank;
   automatically stopping the fuel from being drawn from the fuel tank that has the least amount of fuel, when the difference between the amount of fuel in the first fuel tank and the amount of fuel in the second fuel tank reaches a predetermined amount.
10. The method of claim 9 where the fuel is initially drawn from both fuel tanks.
11. The method of claim 9 where the fuel is stopped by switching the fuel use from the first fuel tank to the second fuel tank.
12. A fuel system, comprising:
   a first fuel tank and a second fuel tank;
   a first fuel monitor configured to measure an amount of fuel in the first fuel tank;
   a second fuel monitor configured to measure an amount of fuel in the second fuel tank;
a comparator configured to compare the measured amount of fuel from the first fuel monitor with the measured amount of fuel from the second fuel monitor;

the comparator configured to activate an indicator when the difference between the amount of fuel in the first fuel tank and the amount of fuel in the second fuel tank exceeds a predetermined amount;

13. The fuel system of claim 12 where the fuel system is for a diesel truck.

14. A fuel system, comprising:

a first fuel tank and a second fuel tank;
a switching device connecting the first fuel tank to a fuel pump;
the switching device connecting the second fuel tank to the fuel pump;
a first fuel monitor configured to measure an amount of fuel in the first fuel tank;
a second fuel monitor configured to measure an amount of fuel in the second fuel tank;
a comparator configured to compare the measured amount of fuel from the first fuel monitor with the measured amount of fuel from the second fuel monitor;
the comparator configured to signal the switching device when the difference between the amount of fuel in the first fuel tank and the amount of fuel in the second fuel tank exceeds a predetermined amount;

15. The fuel system of claim 14 where the switching device configured to disconnect the fuel tank that has the least amount of fuel from the fuel pump when signaled by the comparator.

16. The fuel system of claim 14 where the switching device comprises a first solenoid and a second solenoid where the first and second solenoids feed into a common manifold.

17. The fuel system of claim 14 where the fuel system is for a diesel vehicle.

18. The fuel system of claim 14 where the fuel system is for a gasoline vehicle.

19. The fuel system of claim 14 where the fuel system is for a natural gas vehicle.

20. The fuel system of claim 14 where the comparator is implemented in hardware.

21. The fuel system of claim 14 where the comparator is implemented using a processor running firmware.

22. A fuel system comprising:
a first fuel tank and a second fuel tank;
a means for monitoring a difference between a first fuel level in the first tank and a second fuel level in the second tank;
a means for switching a connection to a fuel pump from the first fuel tank to the second fuel tank when the difference exceeds a predetermined amount.