(54) Title of the Invention: A fuel tank anti-theft device
Abstract Title: A fuel tank anti-theft device

(57) An anti-theft device for a fuel tank (16), comprises: a refuelling monitor (8) configured to be connected to a fuel tank (16) and to measure a quantity of fuel introduced into the fuel tank in a refuelling process; and an electronic processing unit (10) comprising a memory, the electronic processing unit (10) being connected to the refuelling monitor (8) and being configured to store refuelling information in the memory, the refuelling information including the quantity of fuel introduced into the fuel tank in one or more refuelling processes. The refuelling monitor may comprise a load cell and may measure an increase in weight of the fuel tank during the or each refuelling process. The owner of a vehicle may compare the stored refuelling quantities to receipts or invoices for fuel purchases which they receive, for example from an employee driving the vehicle. Cross-checking refuelling quantities with receipts may allow billing for fuel which has not been put into the fuel tank to be detected.

Figure 3

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.
A FUEL TANK ANTI-THEFT DEVICE

The present invention relates to an anti-theft device for a fuel tank which is particularly, but not exclusively, for use on a heavy goods vehicle.

Fuel theft has been a long-standing problem, particularly for haulage and other companies using heavy goods vehicles (HGV) – otherwise known as large goods vehicles (LGV). The perpetrators of such fuel thefts are typically third parties, however it is also acknowledged that a large proportion of fuel thefts are in fact carried out by the employees of such companies.

With ever increasing fuel prices, fuel theft is becoming both more enticing for perpetrators and more costly for victims. Accordingly, measures are being taken to actively prevent fuel theft. For example, anti-siphon devices are known which prevent fuel from being siphoned out of a fuel tank. However, such devices are not able to prevent an employee from charging their employer for fuel which never enters the fuel tank of the company’s vehicle, but instead is used to refill their personal vehicle.

It is therefore desirable to provide a device which is capable of preventing employee fuel theft.

In accordance with an aspect of the invention, there is provided an anti-theft device for a fuel tank, the device comprising: a refuelling monitor configured to be connected to a fuel tank and to measure a quantity of fuel introduced into the fuel tank in a refuelling process; and an electronic processing unit comprising a memory, the electronic processing unit being connected to the refuelling monitor and being configured to store refuelling information in the memory, the refuelling information including the quantity of fuel introduced into the fuel tank in one or more refuelling processes.

The owner of the vehicle is therefore able to compare the records stored in the memory of the EPU with the receipts or invoices they receive. The cross-checking of the records provided by the EPU against the receipts or invoices allows any discrepancies to be highlighted. For example, if an employee were to use a fuel card to purchase fuel which does not enter the fuel tank, it will be highlighted to the company who can then make enquiries with the responsible employee.
The refuelling information may further comprise date and/or time information regarding the or each refuelling process.

The refuelling information may further comprise geographical information regarding the or each refuelling process.

The refuelling monitor may be configured to measure an increase in weight of the fuel tank during the or each refuelling process.

The electronic processing unit may be configured to calculate the quantity (i.e. volume) of fuel introduced into the fuel tank by dividing the increase in weight of the fuel tank by a density of the fuel.

The raw weight information may be stored in the memory as refuelling information. Alternatively, or in addition, the volume of fuel may be stored in the memory as refuelling information.

The density used by the electronic processing unit may be configurable. In other words, a specific density value can be set for the electronic processing unit.

A density used by the electronic processing unit may correspond to a selected one of a plurality of fuel-types which are pre-programmed into the electronic processing unit.

The electronic processing unit may be pre-programmed with a density of a predetermined fuel-type.

The refuelling monitor may be a load cell which produces an electrical signal corresponding to the force applied to it. For example, a strain-gauge based load cell may be used. In particular, the load cell may comprise four strain gauges arranged in a wheatstone bridge.

The anti-theft device may further comprise a hollow box which is configured to house and support the fuel tank. The box may be constructed of a stainless steel frame and stainless steel panels. The box may act as a fuel bund which captures fuel from the
fuel tank in the event of a leak. The box may also prevent the fuel tank from being punctured so as to steal the fuel within the tank.

The load cell may be adjacent a bottom wall of the box such that, in use, it is disposed between the fuel tank and the bottom wall.

The load cell may be arranged so as to support that fuel tank at its centre. The anti-theft device comprise four additional load cells located in the corners of the bottom wall to provide improve stability. Alternatively, the anti-theft device may use a single load cell which has a much larger surface area which occupies most or all of the bottom wall. On the other hand, this increased surface area could be achieved using a large number of small load cells.

The box may comprise an internal stabilising structure which supports the fuel tank. The stabilising structure may prevent the fuel tank from moving as a result of the fuel sloshing around inside during use.

The box may comprise an inlet which is arranged to be aligned with an inlet of the fuel tank. The inlet of the box may be provided with an anti-siphon device.

The electronic processing unit may further comprise means for downloading the refuelling information to an external device, such as a computer or a USB flash drive.

For example, a wireless transmitter may be provided which is configured to transmit the refuelling information to the external device (i.e. a computer or other similar device, such as a tablet or smartphone) via a wireless connection.

Alternatively, or in addition, an external connector may be provided which configured to connect to the external device and to transmit the refuelling information to the external device via a wired connection. The external connector may be a USB connector. This may be used to connect the device to a USB flash drive which can be used to transfer the refuelling information to a computer. Alternatively, a computer can be connected directly to the external connector to download the refuelling information.

The refuelling monitor and/or electronic processing unit may be configured to detect a refuelling process. This may be used to measure the quantity of fuel introduced during
the refuelling process. Alternatively, the quantity of fuel in the fuel tank can be periodically measured to determine when fuel has been introduced into the fuel tank. On the other hand, the quantity of fuel may simply be measured when the engine of the vehicle is switched on and when the engine of the vehicle is switched off. As refuelling must be performed with the engine switched off, this technique ensures that measurements are taken before and after any refuelling process.

In accordance with another aspect of the invention, there is provided a fuel tank comprising an anti-theft device as described previously.

An inlet of the fuel tank may be provided with an anti-siphon device.

For a better understanding of the present disclosure, and to show more clearly how it may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figure 1 is an exploded view of an anti-theft device and a fuel tank according to an embodiment of the invention;

Figure 2 is a perspective view of the assembled anti-theft device; and

Figure 3 is a cross-section through the anti-theft device along the plane A shown in Figure 2.

Figure 1 shows an anti-theft device for a fuel tank of a vehicle according to an embodiment on the invention. The anti-theft device is particularly suited to heavy goods vehicles (HGV), however it may also find application in other types of vehicle.

As shown in Figure 1, the anti-theft device comprises a lower panel 4 which is fabricated from stainless steel. The lower panel 4 is provided with a recess 6 for receiving a load cell 8. The recess 6 is sized so that an upper surface of the load cell 8 sits just above the surface of lower panel 4.

The load cell 8 is configured to produce an electrical signal which corresponds to a force applied to it. The load cell 8 may comprise one or more (preferably four) strain gauges which deform under force, creating a change in the electrical resistance of the
strain gauge. The change in resistance can be measured using a wheatstone bridge or other similar arrangement. This value can be converted (possibly after suitable amplification) to a corresponding force using the gauge factor of the strain gauge. Essentially, the load cell is arranged to operate as a refuelling monitor, as will be described in more detail below.

The load cell 8 is connected to an electronic processing unit 10 through a wired connection 12. As shown, the electronic processing unit (EPU) 10 may be located externally to the lower panel 4 to provide easy access to the EPU 10. For example, the wired connection 12 may extend from the lower panel 4 and into the cab of the vehicle or another suitable location for the EPU 10.

The wired connection 12 may terminate in a connector (not shown) which is affixed within the recess 6. The load cell 8 may be provided with a complementary connector which is arranged so that insertion of the load cell 8 into the recess 6 causes the connector of the load cell 8 to engage the connector of the wired connection 12.

The load cell 8 is retained in the recess 6 by a stainless steel cover plate 14 which overlies the lower panel 4 and is spaced a short distance from the lower panel 4 by the load cell 8.

A fuel tank 16 of the vehicle is housed within a hollow box 18. The box 18 is formed of a stainless steel framework which is closed on all sides by stainless steel panels, with the bottom wall of the box 18 being formed by the lower panel 4.

As shown in Figure 1, the lower panel 4 is detachable from the remainder of the box 18 to allow the fuel tank 16 to be introduced into the box 18. After insertion of the fuel tank 16 into the box 18, the box 18 is sealed by attaching the lower panel 4 using a suitable fastening technique. Accordingly, the fuel tank 16 is enclosed within the completed box 18 and its weight is supported by the lower panel 4.

As described above, the box 18 is sealed by the lower panel 4. The box 18 therefore acts as a fuel bund which prevents fuel from escaping in the event of a leak from the fuel tank 16. The stainless steel construction of the box 18 also protects the fuel tank 16 from being tampered with.
The cover plate 14, lower panel 4, load cell 8 and the wired connection 12 are provided with rubber insulation to ensure that fuel cannot leak from the box 18 and to protect the electrical components from being damaged by fuel spills.

A fuel inlet 20 is provided in an upper wall of the box 18. The fuel tank 16 is arranged within the box 18 such that the fuel inlet 20 of the box 18 is aligned with a fuel inlet 22 of the fuel tank 16. This allows the fuel tank 16 to be filled through the box 18. The fuel inlet 20 of the box 18 or the fuel inlet 22 of the fuel tank 16 may be provided with an anti-siphon device to prevent fuel from being siphoned out of the fuel tank 16.

The box 18 with the fuel tank 16 disposed within can be attached to the vehicle in a conventional manner using a pair of mounting straps 22. The straps 22 may be formed of plastic, rubber, stainless steel or any other suitable material.

Figure 2 shows the fully assembled anti-theft device with the fuel tank 16 disposed within the box 18.

The operation of the anti-theft device will now be described with reference to Figure 3. Figure 3 shows a cross-section of the assembled anti-theft device with the fuel tank 16 partially filled with fuel to the level 24.

The weight of the fuel tank 16 (and the fuel therewith) applies a force to the load cell 8 via the cover plate 14. As described previously, the load cell 8 is able to measure this force (i.e. the weight of the fuel tank 16) using the change in resistance of the strain gauges within the load cell 8.

The weight of the fuel tank 16 measured by the load cell 8 is output to the EPU 10 where it can be recorded in a memory, such as a hard disk drive.

The weight of the fuel tank 16 may be periodically recorded to the memory of the EPU 10 so as to track changes in the weight of the fuel tank 16. Alternatively, the weight of the fuel tank 16 may be measured immediately before a refuelling process is carried out. This measurement may be triggered by the removal of a fuel cap, the insertion of the pump nozzle, the detection of inflowing fuel, or another similar trigger condition.
The measurement of the weight of the fuel tank 16 is repeated after the refuelling process has been completed. Again, this measurement may be triggered using a similar trigger condition such as the replacement of the fuel cap, the withdrawal of the pump nozzle, or simply after the lapse of a predetermined duration of time. The quantity of fuel introduced into the fuel tank 16 (indicated by the hatched area in Figure 3) can then be calculated by the EPU 10 by subtracting the initial weight from the final weight. The weight of the fuel introduced during the refuelling process can subsequently be converted into a volume (in litres) by dividing the weight by the density of the fuel.

In an alternative arrangement, the weight of the fuel tank 16 may be measured and recorded to the memory of the EPU 10 every time the engine of the vehicle is switched off and every time the engine of the vehicle is switched on. As it is necessary for the engine to switched off when refuelling, this technique ensures that a measurement is taken immediately before and after (i.e. before any fuel is used by the vehicle) a refuelling process.

The density can be determined for the specific fuel-type used by the vehicle. This value may be preset in the EPU 10 or it may be configured by a user. Alternatively, the EPU 10 may contain the densities of a plurality of different fuel-types and the user can select the appropriate density for the fuel-type of the vehicle.

The volume of fuel introduced into the fuel tank 16 during the refuelling process is recorded in the memory of the EPU 10 as refuelling information. The refuelling information may also include a record of the date, time and/or geographical location at which the refuelling process was performed. The geographical location of the refuelling process may be provided from a vehicle tracking system installed on the vehicle. Alternatively, the date and time information may be compared (either manually or automatically) with the records of the vehicle tracking system to establish the location of the vehicle at that date and time.

The EPU 10 records the refuelling information for every refuelling process. Accordingly, the owner of the vehicle can compare the records stored in the memory of the EPU 10 with the receipts or invoices they receive. The cross-checking of the records provided by the EPU 10 against the receipts or invoices allows any discrepancies to be highlighted. For example, if an employee were to use a fuel card
to purchase fuel which does not enter the fuel tank 16, it will be highlighted to the company who can then make enquiries with the responsible employee.

The refuelling information may be downloaded from the memory of the EPU 10 to a suitable external device on which to perform further analysis. For example, the refuelling information may be downloaded to a computer or other similar device, such as a tablet or smartphone. The EPU 10 may comprise a wireless transmitter which allows the refuelling information to be wirelessly downloaded to the external device. Such wireless transmission may be provided over a short distance using a Bluetooth connection or may be carried out over much greater distances using wireless telecommunication links. In the latter case, the memory may only be required to hold the refuelling information until it is transmitted to the external device.

Alternatively, or in addition, the EPU 10 may comprise a suitable connection, such as a USB connector, which allows an external device to be connected to the EPU 10. The refuelling information can then be downloaded to the external device, such as a computer, for further analysis. On the other hand, the external device may be a USB flash drive or other similar device which can be used to transfer the refuelling information from the memory to a computer or other similar device on which to process and analyse the refuelling information. Further still, the memory may be removable (e.g. a USB flash drive) from the anti-theft device and the vehicle to allow it to be connected to an external device on which to process and analyse the refuelling information.

Although shown as being external to the lower panel 4, the EPU 10 may be housed within the lower panel 4 in a similar manner to the load cell 8.

The EPU 10 may be any suitable device having the required functionality. In its simplest form, the EPU 10 is only required to write the refuelling information to the memory, however it may also be required to calculate the change in weight of the fuel tank 16 and to convert this value into the volume of fuel introduced into the fuel tank 16 during the refuelling process. The EPU 10 may also allow user interaction through suitable input and output means. Although the memory is said to be part of the EPU 10, this includes where the memory is an external component which is connected to the EPU 10. Indeed, the memory may be removable from the EPU 10, as is described above.
The anti-theft device may utilise any number of load cells. For example, four additional load cells may be located in the corners of the lower panel 4 to provide improve stability. Alternatively, the anti-theft device may use a single load cell which has a much larger surface area which occupies most or all of the lower panel 4. On the other hand, this increased surface area could be achieved using a large number of small load cells.

Whilst the load cell 8 has been described as converting the change in resistance to a force value, this operation may in fact be performed by the EPU 10 or indeed by an external device after downloading the raw information. Further, it is not necessary for the EPU 10 to convert the weight of the fuel into the volume since this may also be performed at an external device.

Indeed, although the refuelling monitor has been described as a load cell, different types of sensor may be used to measure the quantity of fuel introduced into the fuel tank in a refuelling process. For example, the refuelling monitor may be a flow detector which measures the fuel flowing into the fuel tank 16 through the fuel inlet 22. With such a refuelling monitor, it may be possible to dispense with the box 18 housing the fuel tank 16. In any case, it may be possible to dispense with the cover plate 14 such that the fuel tank 16 rests directly on the load cell 8.

Although, the box has been described as being hollow, it may comprise an internal stabilising structure which supports the fuel tank. This structure is designed to prevent from fuel tank from moving as a result of the fuel sloshing around inside during use.
Claims

1. An anti-theft device for a fuel tank, the device comprising:
   a refuelling monitor configured to be connected to a fuel tank and to measure a
   quantity of fuel introduced into the fuel tank in a refuelling process; and
   an electronic processing unit comprising a memory, the electronic processing unit
   being connected to the refuelling monitor and being configured to store refuelling
   information in the memory, the refuelling information including the quantity of fuel
   introduced into the fuel tank in one or more refuelling processes.

2. An anti-theft device as claimed in claim 1, wherein the refuelling information
   further comprises date and/or time information regarding the or each refuelling process.

3. An anti-theft device as claimed in any preceding claim, wherein the refuelling
   process information further comprises geographical information regarding the or each
   refuelling process.

4. An anti-theft device as claimed in any preceding claim, wherein the refuelling
   monitor is configured to measure an increase in weight of the fuel tank during the or
   each refuelling process.

5. An anti-theft device as claimed in claim 4, wherein the electronic processing unit
   is configured to calculate the quantity of fuel introduced into the fuel tank by dividing
   the increase in weight of the fuel tank by a density of the fuel.

6. An anti-theft device as claimed in claim 5, wherein the density used by the
   electronic processing unit is configurable.

7. An anti-theft device as claimed in claim 5, wherein a density used by the
   electronic processing unit corresponds to a selected one of a plurality of fuel-types
   which are pre-programmed into the electronic processing unit.

8. An anti-theft device as claimed in claim 5, wherein the electronic processing unit
   is pre-programmed with a density of a predetermined fuel-type.
9. An anti-theft device as claimed in any of claims 4 to 8, wherein the refuelling monitor is a load cell.

10. An anti-theft device as claimed in claim 9, further comprising a hollow box which is configured to house and support the fuel tank.

11. An anti-theft device as claimed in claim 10, wherein the load cell is adjacent a bottom wall of the box such that, in use, it is disposed between the fuel tank and the bottom wall.

12. An anti-theft device as claimed in any preceding claim, wherein the electronic processing unit further comprises means for downloading the refuelling information to an external device.

13. An anti-theft device as claimed in claim 12, wherein said means is a wireless transmitter which is configured to transmit the refuelling information to the external device via a wireless connection.

14. An anti-theft device as claimed in claim 12, wherein said means is an external connector configured to connect to the external device and to transmit the refuelling information to the external device via a wired connection.

15. An anti-theft device as claimed in any preceding claim, wherein the refuelling monitor and/or electronic processing unit is configured to detect a refuelling process.

16. An anti-theft device substantially as described herein with reference to and as shown in the accompanying drawings.

17. A fuel tank comprising an anti-theft device as claimed in any preceding claim.

18. A fuel tank as claimed in claim 17, wherein an inlet of the fuel tank is provided with an anti-siphon device.
**Patents Act 1977: Search Report under Section 17**

**Documents considered to be relevant:**

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<th>Category</th>
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<tr>
<td>X,Y</td>
<td>1-9, 12-15 at least</td>
<td>WO2008/142423 A2 (AIRMAX GROUP PLC et al.) Whole doc. is relevant, but see at least pg. 41 - pg. 43 line 7, pg. 51 line 28 - pg. 52 line 17.</td>
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<td>X,Y</td>
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<td>GB2449476 A (AIRMAX GROUP PLC) Whole doc. is relevant, but see at least pg. 33 line 12 - pg. 35 line 10.</td>
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<td>FR2871912 A1 (SOFIDE SOC EN COMMANDITE PAR A) Whole doc. is relevant but see at least pg. 13 lines 1-30 and fig. 4.</td>
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<td>FR2871740 A1 (SOFIDE SOC EN COMMANDITE PAR A) Whole doc. is relevant but see at least pg. 8 and fig. 4.</td>
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<td>1 at least</td>
<td>US2010/042340 A1 (PISZKO PETER) Whole doc. is relevant but see abstract and para 57 at least.</td>
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<tr>
<td>X</td>
<td>1 at least</td>
<td>US5902985 A (SHELL OIL CO) See at least fig. 3 and col. 3 lines 32-42.</td>
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<td>US2010/217630 A1 (I D SYSTEMS INC) Whole doc. is relevant but see at least abstract, figs and paras 16 and 25.</td>
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<tr>
<td>Y</td>
<td>4 and associated claims</td>
<td>DE102004021832 A1 (OPEL ADAM AG) See abstract and figs at least. X citations considered citable in their own right, but this doc. cited as possible Y doc. with one of those docs in respect of claim 4 and associated claims.</td>
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- **X** Document indicating lack of novelty or inventive step
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- **A** Document indicating technological background and/or state of the art.
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before the filing date of this invention.

E Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:
Search of GB, EP, WO & US patent documents classified in the following areas of the UKC

Worldwide search of patent documents classified in the following areas of the IPC
G01F; G06Q

The following online and other databases have been used in the preparation of this search report
WPI, EPODOC

International Classification:

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