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US 20100282757 A1 **US 20100264138 A1**
US 20100224260 A1

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(54) Title of the Invention: **Anti-siphon device**
Abstract Title: **Anti-siphon device**

(57) An anti-siphon device 12 comprising an inlet portion 14 configured to engage a first portion 10a of a fuel conduit, an outlet portion 16 configured to engage a second portion 10b of the fuel conduit, and an anti-siphon portion. The anti-siphon device 12 defines a flow passage configured to permit fluid flow between the inlet portion 14 and the outlet portion 16. The anti-siphon portion comprises an obstruction configured to inhibit the passage of a siphon tube through the anti-siphon device. Preferably the obstruction comprises three panels or formations 32 extending between opposite side portions, wherein said formations 32 are parallel to each other, are spaced apart both in the vertical and horizontal direction, and lie in the same plane. The inlet portion 14 and outlet portion 16 could be separate parts, and could be connected via an external threaded section 24 and an internal threaded section 26. Barbs 22 may be used for connection to the fuel conduit 10.

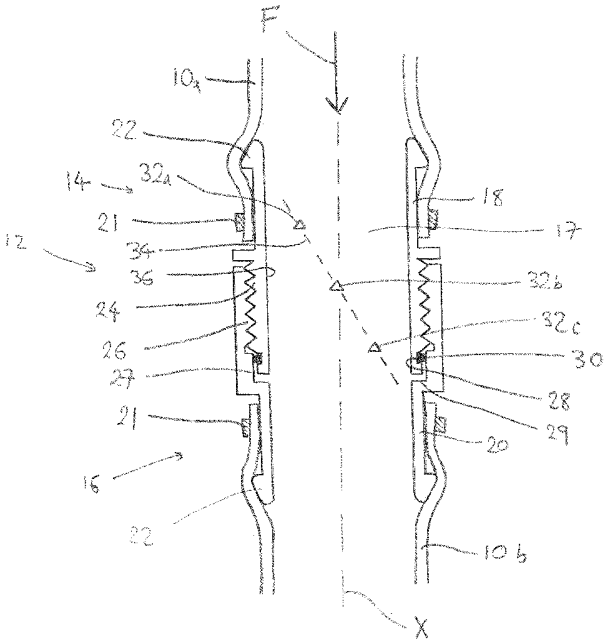

Figure 3

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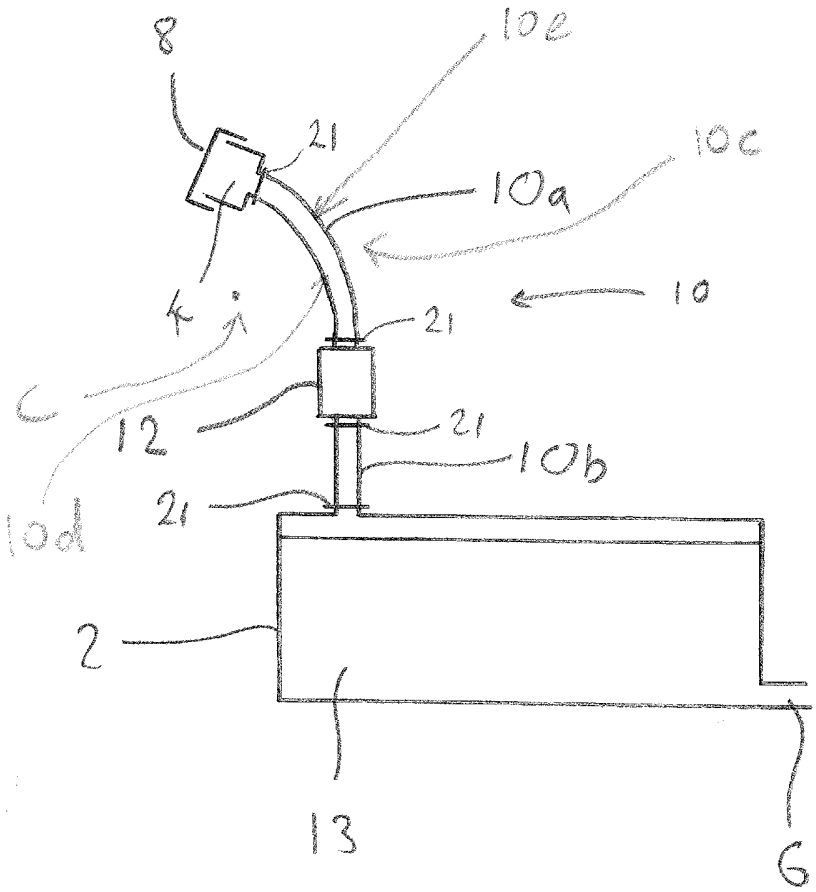


Figure 1

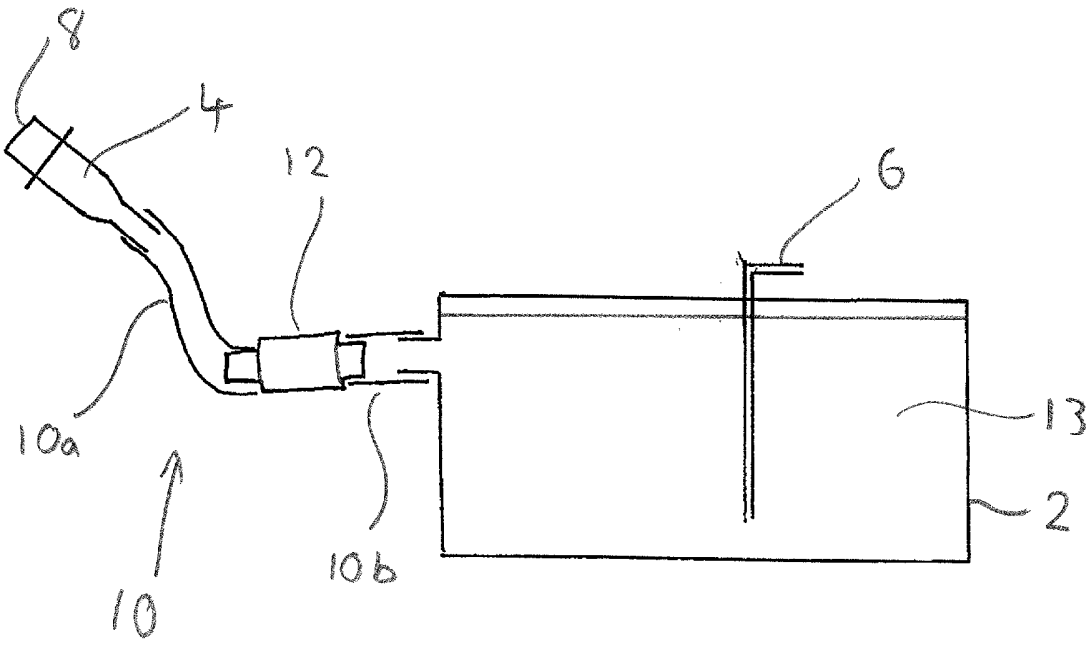
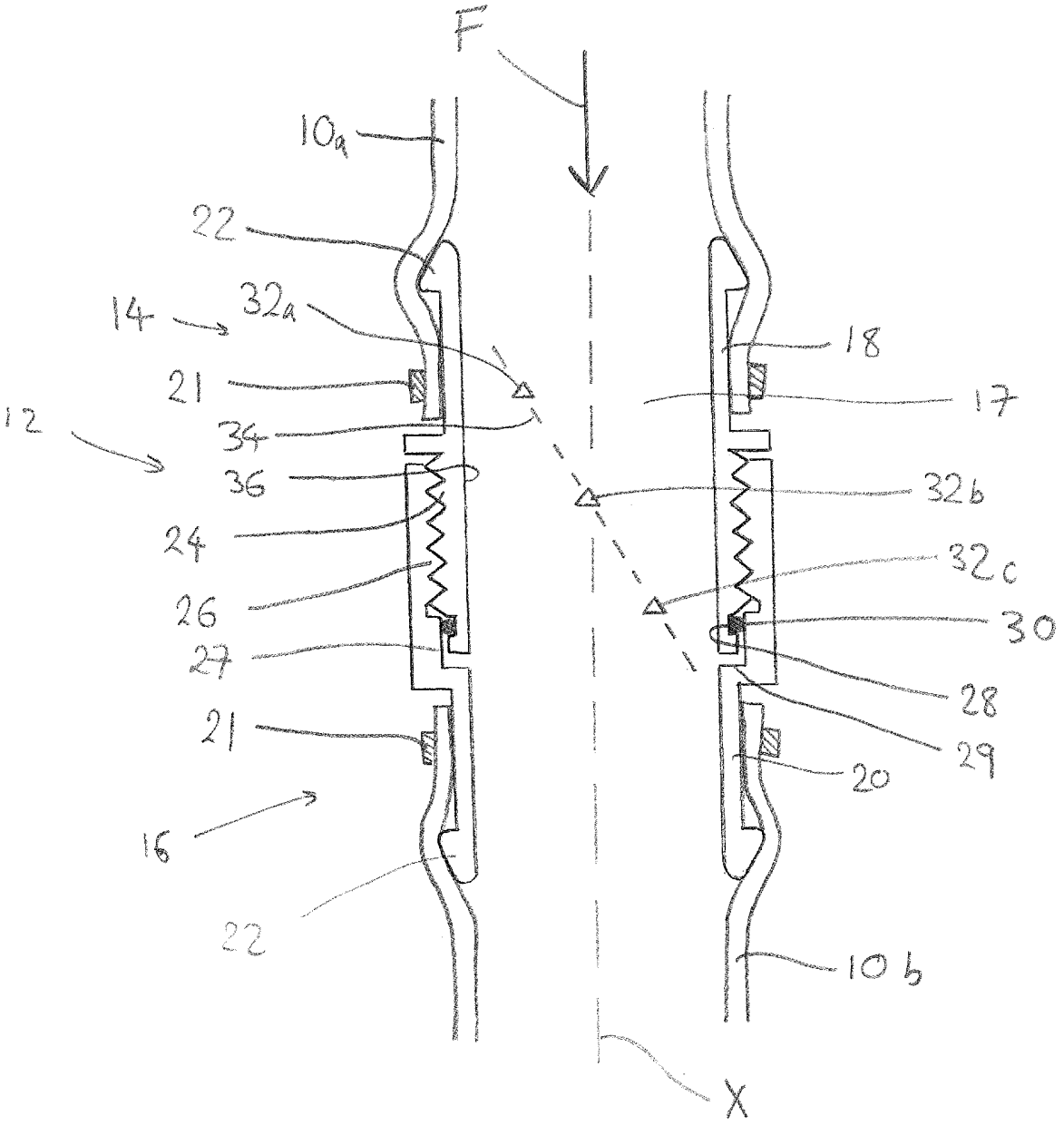


Figure 2


F
10a
22
14
32a
21
12
34
36
24
26
27
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16
22
18
17
32b
32c
30
28
29
20
10b
X

Figure 3

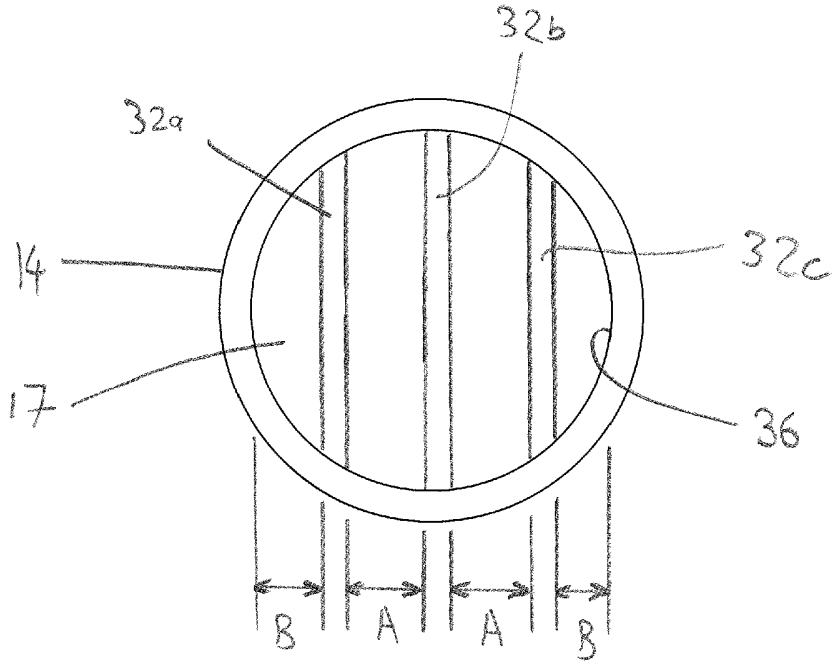

Figure 4

Anti-Siphon Device

The present invention relates to an anti-siphon device, a method of fitting an anti-siphon device, and a vehicle fuel storage system comprising an anti-siphon device. In particular, the present invention relates to an in-line anti-siphon device that is connectable to a fuel conduit of a fuel storage system of a vehicle.

The theft of fuel by siphoning from the fuel tanks of vehicles, and in particular from the fuel tanks of commercial road vehicles, is a recognised problem. It is known to fit vehicles with a lockable fuel tank filler cap to prevent unauthorised access to the tank inlet. However, since the fuel filler cap is easily accessible to a potential thief, it is vulnerable to tampering and can often be forced open. In addition, it is not always practical to fit a vehicle with a lockable fuel filler cap.

It is known to provide vehicles with an anti-siphon device fitted to the inlet of the fuel tank. The applicant's European patent EP1807280 discloses one such anti-siphon device comprising a tubular body having an inlet aperture located at a first end of the body, and a baffle comprising a metal plate provided with a plurality of fuel outlet holes located at a second, substantially opposite, end of the body. The anti-siphon device is held in place by a mounting that locates the anti-siphon device within the inlet aperture. The mounting defines a seat and skirt arranged to be located over the neck of the inlet aperture and is permanently secured to the inlet aperture by a bonding and/or riveting. The mounting further comprises locking features configured to engage a filler cap, such that the cap is lockable to the mounting. Should a thief disengage the filler cap from the mounting of the anti-siphon device, the presence of the baffle within the body of the anti-siphon device prevents a thief from inserting a siphon hose into the fuel tank, thus preventing fuel theft from the tank.

Installation of such anti-siphon devices is often difficult and time consuming. In addition, anti-siphon devices often take up a relatively large amount of space above (i.e. to the exterior of) the fuel tank inlet. If insufficient space is available between the fuel tank inlet and another portion of the vehicle's bodywork, it will not be possible to install an anti-siphon device. Furthermore, in some cases the diameter of the fuel inlet may not be sufficient to accommodate an anti-siphon device.

It is an object of the present invention to obviate or mitigate one or more problems of the prior art, whether identified herein or elsewhere. It is another object of the present invention to provide an alternative anti-siphon device.

According to a first aspect of the invention there is provided an anti-siphon device comprising an inlet portion configured to engage a first portion of a fuel conduit; an outlet portion configured to engage a second portion of the fuel conduit; and an anti-siphon portion; wherein the anti-siphon device defines a flow passage configured to permit fluid flow between the inlet portion and the outlet portion, and wherein the anti-siphon portion comprises an obstruction configured to inhibit the passage of a siphon tube through the anti-siphon device.

It will be understood that the obstruction of the anti-siphon portion provides a barrier configured to block the path of a siphon tube inserted into the fuel conduit to thereby prevent theft of fuel from a fuel tank connected to the fuel conduit. For example, the fuel conduit may extend between a fuel inlet of a vehicle (configured to receive fuel from a fuel delivery device such as a fuel filler nozzle) and a fuel tank of the vehicle. The anti-siphon device may be connected to the fuel conduit at a point along the fuel conduit such that the fuel conduit is split into first and second portions either side of the anti-siphon device.

It will be appreciated that because the anti-siphon device is connectable to (or configured to engage with) the fuel conduit, the anti-siphon device may be retro-fitted to any vehicle comprising such a fuel conduit. Such fuel conduits are typically formed from flexible tubing that is easy to cut, and therefore the anti-siphon device may be retro-fitted by cutting the fuel conduit into two pieces and installing (or engaging) the ends of the cut pieces of fuel conduit to the inlet portion and outlet portion of the anti-siphon device. An example of flexible material from which the fuel conduit may be formed is rubber fuel hosing, such as cord-reinforced rubber or nitrile. Alternatively, the anti-siphon device may be fitted to fuel conduits which are composed of a relatively rigid material, such as metal or plastic. For additional security, the fuel conduit may be secured to the anti-siphon device using a retention member such as a jubilee clip or an o-clip. As such, installation of the anti-siphon device is simple and easy. It will further be appreciated that because in general the fuel conduit extends between the fuel inlet and the fuel tank behind a body panel of the vehicle of which the fuel conduit forms

part, when fitted to the fuel conduit the anti-siphon device will not be visible from an exterior of the vehicle.

The obstruction of the anti-siphon portion may comprise a formation which extends into the flow passage in a direction perpendicular to a centreline of the flow passage.

It will be appreciated that the "formation" may be any feature of the anti-siphon portion that is configured to prevent the passage of a siphon tube through the anti-siphon device. It will be appreciated that by "extends into the flow passage" it is meant that the formation extends from a wall of the anti-siphon device defined by the flow passage into the flow passage itself. As such, the formation is configured to obstruct the path of a siphon tube inserted into the flow passage. It will be appreciated that "extends into the flow passage" does not mean that the formation extends only perpendicular to the centreline. As such the formation may extend both perpendicular to and along the centreline (i.e. in a direction parallel to the centreline).

It will be appreciated that "centreline" means a line extending through the flow passage that is substantially central to the flow passage. When fluid flows through the flow passage the fastest velocity fluid may be observed along the centreline. It will be appreciated that the centreline may bend or twist depending upon the shape of the flow passage. Where the flow passage is generally cylindrical, the centreline will be a longitudinal axis of the flow passage.

A cross-section of the formation may define a vertex directed towards the inlet portion of the anti-siphon device.

The vertex is located upstream of the remainder of the formation relative to the direction of fluid flow. As such, the vertex acts to split the flow of fluid and thereby reduce the drag caused to the fluid by the presence of the formation within the flow passage.

The formation may comprise a planar surface that is inclined at an angle relative to the centreline.

For example, the cross-section of the formation may be triangular such that the formation defines three planar surfaces. At least one of these surfaces may be inclined relative to the longitudinal axis of the flow passage.

The formation may extend between opposite side portions of the flow passage.

It will be appreciated that the opposite side portions of the flow passage are side portions of the flow passage that are on opposite sides of the centreline of the flow passage. It will be appreciated that the opposite side portions of the flow passage may form part of a single wall of the flow passage. For example, the flow passage may define a wall having a generally circular cross-section and the formation may define a chord of the circular cross-section. It will be appreciated that in alternative embodiments of the invention the formation may not extend across the full width of the flow passage (i.e. the formation may be a cantilever of the anti-siphon portion).

The formation may be a first formation, and wherein the anti-siphon portion comprises a second formation which extends into the flow passage in a direction perpendicular to the centreline of the flow passage.

It will be appreciated that the second formation may be substantially identical to the first formation. Alternatively, the second formation be different to the first formation, for example the second formation may comprise a different cross-sectional shape to the first formation.

The first and second formations may extend generally parallel to one another.

The first and second formations may be spaced apart from one another in a direction perpendicular to the centreline of the flow passage.

The direction perpendicular to the centreline may be considered to be a lateral direction. It will be appreciated that by being spaced apart from one another in the lateral direction, a siphon tube having a diameter wider than the spacing between the formations will be blocked by the formations. In a preferred embodiment, the spacing between the formations in the lateral direction is less than 6mm.

The first and second formations may be spaced apart from one another in a direction parallel to the centreline of the flow passage.

The direction parallel to the centreline may be considered to be a longitudinal direction. It will be appreciated that the first formation may therefore be upstream of the second formation relative to the direction of fuel delivery. It will be appreciated that when the first and second formations are spaced apart both longitudinally and laterally, the maximum spacing between the formations is increased (as compared to the first and second formations have the same lateral spacing, but are not longitudinally spaced). As such, the area available for fluid flow between the formations is increased, and therefore the disturbance to the fluid flowing through the anti-siphon device caused by the presence of the formations within the flow passage is minimised. Consequently the maximum fluid flow rate through the anti-siphon device is increased. When the first and second formations are spaced apart both longitudinally and laterally they may be said to be stepped. For the avoidance of doubt, when it is said that the first and second formations are spaced apart from one another in a direction parallel to the centreline of the flow passage, this encompasses the first and second formations being spaced apart in a direction which has a component which is parallel to the centreline and a component which is perpendicular to the centreline.

The anti-siphon portion may comprise a third formation, and the first formation, the second formation and the third formation may all lie on the same plane. It will be appreciated that the anti-siphon portion may comprise more than three formations. Again, in some embodiments, all of the formations defined by the anti-siphon portion may lie on the same plane. It will further appreciated that in some embodiments the formations may lie on different planes. That is to say, in some embodiments there may be a plurality of groups of formations and the formations of each group may lie on a respective plane, the plane of each group being different to the others.

The anti-siphon device may comprise a first body portion defining the inlet portion and a second body portion defining the outlet portion, the first and second body portions being separate.

That is to say, the first and second portions may be separate pieces. It will be appreciated that in some embodiments the formation(s) may be a separate component

to the first and second body portions. For example, where the anti-siphon portion comprises plurality of formations, the plurality of formations may be defined as a single component separate to the first and second body portions. In such embodiments the formations may be said to define a ladder. The ladder may be formed of a piece of flat material which is preferably plastic or metal. The ladder may be configured for receipt by an elongate slot defined by the first and/or second body portions, such that the formations extend substantially across the flow passage when received within the slot. The first and/or second body portions may comprise a pair of slots configured to receive the ladder, the slots being positioned on substantially opposite sides of the flow passage.

The first and second body portions may be generally tubular. As such, it will be appreciated that the first and second body portions may be hollow. For example, the first and second portions may be generally formed as hollow cylinders. It will be appreciated that the first and second body portions may define any suitable shape. For example, the first and second body portions may define generally hollow rectangular prisms. It will be appreciated that the hollow parts of the first and second body portions may at least partially define the flow passage.

The first body portion may define a first threaded portion and the second body portion defines a second threaded portion, the first and second threaded portions being configured to engage so as to engage the first body portion to the second body portion. It will be appreciated that in alternative embodiments of the invention the first and second portions may be configured to engage via any suitable mechanism, such as for example via a snap-fit or bayonet arrangement. Such mechanisms may comprise a first engagement portion (for example a male component) defined by one of the body portions which is configured to be received by a second engagement portion (for example a female component) defined by the other of the body portions. Additionally or alternatively, the first and second body portions may be engaged via an adhesive and/or via a fixture such as screws (i.e. grub screws).

The first body portion may be configured to be at least partially received within the second body portion.

For example, the first threaded portion may be an outer thread and the second threaded portion may be an inner thread configured to receive the outer thread of the first threaded portion.

The first body portion may comprise the anti-siphon portion.

The inlet portion may comprise a barb configured to engage the first portion of the fuel conduit, and wherein the outlet portion comprises a barb configured to engage the second portion of the fuel conduit. Alternatively, where the fuel conduit is composed of a stiff material, the inlet portion and the outlet portion may be comprise first and second engagement portions respectively, which are engageable with the first and second portions of the fuel conduit, respectively, in any suitable manner, such as for example via a push-fit (i.e. by friction). Furthermore, the inlet portion and/or the outlet portion may comprise a sealing member configured to engage the first and/or second portions of the fuel conduit so as to substantially form a fluid-tight seal therebetween.

The anti-siphon device may comprise a sealing member configured to provide a substantially fluid-tight seal between the first body portion and the second body portion.

For example, the sealing member may be an o-ring.

During use the sealing member may be positioned at a distal end of the first body portion relative to the inlet portion.

It will be understood that the distal end of the first body portion is the part of the first body portion which is furthest away from the inlet portion in the direction of flow through the anti-siphon device. During use the anti-siphon device may hang vertically downwards under the action of gravity. Because the seal is formed at a distal end of the first body portion, any fluid which leaks from the seal will be trapped between the screw thread defined between the first body portion and the second body portion under the action of gravity. As such, the leak fluid must travel vertically upwards against the action of gravity in order to escape the anti-siphon device. It will be appreciated that this type of sealing arrangement may be considered a labyrinth seal. Although the anti-siphon device may hang such that it is vertically oriented, it will be appreciated that the

anti-siphon device may be oriented in substantially any orientation with respect to the vertical. For example, the anti-siphon device may be horizontally oriented.

According to a second aspect of the invention there is provided a method of fitting an anti-siphon device according to any preceding claim, wherein the method comprises: cutting a fuel conduit into a first portion and a second portion; inserting the inlet portion of the anti-siphon device into an end of first portion of the fuel conduit; and inserting the outlet portion of the anti-siphon device into an end of the second portion of the fuel conduit.

The method may further comprise: securing the first portion of the fuel conduit to the inlet portion using a first retention member, and securing the second portion of the fuel conduit to the outlet portion using a second retention member. It will be appreciated that where the fuel conduit is composed of a stiff material, the first and second portions of the fuel conduit may be secured to the anti-siphon device by push-fitting (i.e. by friction). For example, the inlet portion and outlet portion may have an outer diameter which is slightly less than the inner diameter of the first portion and the second portion respectively. In this way the first portion and second portion can be slid over the outer diameters of the inlet portion and the outlet portion respectively such that a friction fit (or interference fit) is formed. In other embodiments, adhesive, fastenings, welding, or the like may be used to secure the first portion to the inlet portion, and the second portion to the outlet portion.

The retention member may be a jubilee clip, o-clip or any other suitable fastening member such as a cable tie or the like.

According to a third aspect of the invention there is provided a vehicle fuel storage system, the fuel storage system comprising: a fuel inlet configured to receive fuel from a fuel dispenser; a fuel tank configured to store fuel; an anti-siphon device; and a fuel conduit comprising a first portion extending from the fuel inlet to an inlet of the anti-siphon device, and a second portion extending from an outlet of the anti-siphon device to the fuel tank.

The first formation may be located upstream of the second formation. The first portion of the fuel conduit may comprise a bend having a centre of curvature. Relative to the

centre of curvature, the first portion of the fuel conduit may include a radially inboard side and a radially outboard side. The first formation may positioned on the radially outboard side the fuel conduit. That is to say, the first formation may be located adjacent the radially outboard side the fuel conduit (i.e. remote from the radially inboard side the fuel conduit). The first formation may be located closer to the radially outboard side of the conduit than to the radially inboard side of the conduit. The spacing between the first formation and the radially outboard side the fuel conduit, in a direction perpendicular to the centreline of the anti-siphon device, may be less than the spacing between the second formation and the radially outboard side the fuel conduit, in a direction perpendicular to the centreline of the anti-siphon device.

The anti-siphon device may be an anti-siphon device according to the first aspect of the invention.

A detailed description of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of a fuel tank comprising an anti-siphon device in accordance with the present invention in which the anti-siphon device is oriented vertically;

Figure 2 is a schematic view of a fuel tank comprising an anti-siphon device in accordance with the present invention in which the anti-siphon device is oriented horizontally;

Figure 3 is a schematic cross-sectional view of an anti-siphon device in accordance with the present invention; and

Figure 4 is a schematic cross-sectional top view of an anti-siphon device in accordance with the present invention.

Figure 1 shows a fuel storage system for a vehicle. The fuel storage system comprises a fuel tank 2, a fuel inlet 4 and an outlet 6. The fuel inlet 4 defines an opening configured to receive fuel from a fuel delivery device, and comprises a removable filler cap 8 configured to substantially enclose the opening so as to prevent access to an

interior 13 of the fuel tank 2. The inlet 4 is connected to a fuel conduit 10 configured to deliver fuel to the interior 13 of the fuel tank 2. An anti-siphon device 12 is positioned along the fuel conduit 10, and is configured to prevent fuel theft by a siphon tube inserted through the inlet 4. A first portion 10a of the fluid conduit 10 extends between the fuel inlet 4 and an inlet of the anti-siphon device 12. A second portion 10b of the fuel conduit 10 extends between an outlet of the anti-siphon device 12 and an inlet opening of the fuel tank 2 defined by a top portion of the fuel tank 2. The outlet 6 is configured to convey fuel from the interior 13 to an engine of the vehicle.

The anti-siphon device 12 of Figure 1 is oriented vertically, however it will be appreciated that the anti-siphon device 12 may be inclined at substantially any angle relative to the vertical. With reference to Figure 2, the inlet opening of the fuel tank 2 may be defined by a side portion of the fuel tank 2, and as such the anti-siphon device 12 may be oriented horizontally.

Furthermore, in some fuel tanks, such as that shown in Figure 2, the outlet 6 may be a conduit which extends from a top portion of the fuel tank 2 to an exterior of the fuel tank. In order to convey fuel from the interior 13 of the fuel tank 2 to the engine of the vehicle, the outlet 6 may be connected to a fuel pump (not shown).

It will be appreciated that due to the shape of the vehicle's bodywork, the internal structure of the vehicle, and/or the desired location of the fuel tank and desired location of the fuel inlet, it may not be possible to position the fuel inlet 4 proximate to the fuel tank 2. The fuel conduit 10 is configured to convey fuel from the fuel inlet 4 to the fuel tank 2. In some applications this may enable the fuel inlet 4 to be positioned away from the fuel tank 2 and at a location easily accessible by a user. The path between the fuel inlet 4 and the fuel tank 2 may be tortuous, and therefore the fuel conduit 10 may be composed of a flexible material (e.g. cord-reinforced rubber or nitrile, or the like) so as to permit bending of the fuel conduit 10. Alternatively, the fuel conduit 10 may be composed of a relatively rigid (or stiff) material (i.e. resistant to flexing) such as metal or plastic tubing. It will be appreciated that the path of the fuel conduit 10 between the fuel inlet 4 and the fuel tank 2 may comprise both vertical and horizontal sections.

Referring to Figure 3, the anti-siphon device 12 comprises a first body portion 14 and a second body portion 16 which are generally tubular and define a flow passage 17

configured to permit fluid flow through the anti-siphon device 12 in the direction of the arrow F along a longitudinal axis X. It will be appreciated that the longitudinal axis X may be considered to be a centreline of the anti-siphon device. The first body portion 14 comprises an inlet portion 18 configured to engage the first portion 10a of the fuel conduit, and the second body portion 16 comprises an outlet portion 20 configured to engage the second portion 10b of the fuel conduit. The inlet portion 18 and the outlet portion 20 are generally annular, and are provided with barbs 22 configured for receipt by an interior of the first and second portions 10a, 10b of the fuel conduit. The first body portion further defines an inner wall 36 which is generally cylindrical.

During use, the first portion 10a of the fuel conduit 10 is pushed over the barb 22 of the inlet portion 18 so as to substantially form a seal therebetween. In the example embodiment, the first portion 10a of the fuel conduit 10 is pushed along the outside of the inlet portion 18 such that the first portion 10a of the fuel conduit 10 extends beyond the barb 22 in an axial direction (i.e. towards the outlet portion 20). As such, an overlap is provided between the inlet portion 18 and the first portion 10a of the fuel conduit 10. A retention member 21 substantially surrounds the first portion 10a of the fuel conduit 10 in the region overlapping the inlet portion 18 and is configured to compress the first portion 10a of the fuel conduit 10 against the inlet portion 18. As such, a further seal is provided between the first portion 10a of the fuel conduit 10 and the inlet portion 18 of the anti-siphon device 12. Furthermore, the retention member is secured tightly such that the first portion 10a of the fuel conduit and retention member cannot pass back over the barb 22, thereby securing the first portion 10a of the fuel conduit to the inlet portion 18. The retention member may be any member suitable for exerting a compressive force upon the first portion 10a of the fuel conduit 10, such as for example a jubilee clip, an o clip, a cable tie or the like. It will be appreciated that the second portion 10b of the fuel conduit 10 is engaged with the outlet portion 20 of the anti-siphon device 12 in a substantially identical manner as described above in relation to the first portion 10a of the fuel conduit 10. Furthermore, the fuel conduit 10 may be connected to the fuel inlet 4 and the inlet of the fuel tank 2 in substantially the same manner.

As noted above, it will be appreciated that in alternative embodiments of the invention the first and second portions 10a, 10b of the fuel conduit may be formed of metal or plastic tubing. In such embodiments, the inlet portion 18 and the outlet portion 20 may

be connected to the first and second portion 10a, 10b of the fuel conduit by any appropriate connection. For example, the first portion 18 and the second portion 20 may not comprise barbs 22, and may therefore be configured to be received within the first and second portions 10a, 10b of the fuel conduit by a push fit. Alternatively, the first and second portions 10a, 10b of the fuel conduit may be received within the inlet portion 18 and the outlet portion 20. Additionally, the inlet portion 18 and the outlet portion 20 may each be provided with a sealing member (such as an o-ring) configured to form a seal against the first and second portions 10a, 10b of the fuel conduit. It will be appreciated that the sealing member may be integrally formed with the inlet portion 18 and the outlet portion 20, for example the inlet portion 18 and outlet portion 20 may comprise barbs 22 which are rubberised. Alternatively, where the sealing member is an o-ring, the sealing member may be received within a circumferentially extending groove of the inlet portion 18 and the outlet portion 20.

The first body portion 14 is provided with an external thread portion 24 which is configured to engage an internal thread portion 26 of the second body portion 16. The first body portion 14 is further provided with a circumferentially extending groove 28 configured to receive a sealing member 30. In the example embodiment the sealing member is an O-ring. The circumferentially extending groove 28 is positioned at a distal end of the first body portion 14 relative to the inlet portion 18. During use, to assemble the anti-siphon device 12, the second body portion 16 is wound onto the first body portion 14 such that the internal thread portion 26 engages the external thread portion 24. As the first body portion 14 and second body portion 16 are wound together, the sealing member 30 engages a sealing surface 27 of the second body portion 16 so as to substantially form a seal therebetween. The sealing surface 27 is generally cylindrical and engages the sealing member 30 such that sealing contact between the sealing surface 27 and the sealing member 30 extends around substantially the entire circumference of the sealing surface 27.

It will be appreciated that in order to permit the internal thread portion 26 to be wound onto the external thread portion 24, a small clearance is present between the teeth of both thread portions 24, 26.. It is advantageous that the sealing member 30 is positioned at a distal end of the first body portion relative to the inlet portion 18 because any fuel which leaks from the seal formed between the sealing member 30 and the sealing surface 27 and into the clearance between the internal thread portion

26 and the outer thread portion 24 will be trapped in the clearance region under gravity. That is to say, fluid leaking beyond the sealing member 30 must flow upwards against the action of gravity in order to leak from the anti-siphon device 12. It will be appreciated that such a sealing arrangement may be considered a labyrinth seal.

It will be appreciated that, although first body portion 14 and the second body portion 16 of the present embodiment are connected via threaded portions 24, 26, in alternative embodiments of the invention the first body portion 14 and second body portion 16 may be connectable to one another by any appropriate mechanism. For example, the first body portion 14 and the second body portion 16 may be connected via a snap-fit or bayonet arrangement. Additionally or alternatively, the first body portion 14 and second body portion 16 may be connected to one another using adhesive or screws.

It will be appreciated that in alternative embodiments of the invention a seal may be provided between the first body portion 14 and the second body portion 16 by a sealing member 30 that is integrally formed with either the first body portion 14 or the second body portion 16. Additionally or alternatively, the sealing member 30 may be positioned on an end face of the first body portion 14 such that the sealing member 30 directly engages an annular ledge 29 of the second body portion 16.

Referring to Figures 3 and 4, the anti-siphon device 12 further comprises three formations in the form of crosspieces 32a,b,c configured to prevent a siphon tube inserted into the fuel tank inlet 4 from passing through the anti siphon device into the second portion 10b of the fuel conduit 10, and thereby prevent access to the fuel in the interior 13 by a thief. The crosspieces 32a,b,c are oriented parallel to one another and extend across the flow passage 17 in a direction substantially perpendicular to the longitudinal axis X. As is best shown in Figure 3, the crosspieces 32a,b,c are spaced apart along the longitudinal axis X such that a first crosspiece 32a is positioned upstream of a second crosspiece 32b, and the second crosspiece 32b is positioned upstream of a third crosspiece 32c. The spacing between the crosspieces 32a,b,c parallel to the longitudinal axis X may be considered to be a longitudinal spacing of the crosspieces 32a,b,c. The crosspieces 32a,b,c are further spaced apart from one another in a direction perpendicular to the longitudinal axis X (i.e. from left to right in Figures 3 and 4). The spacing between the crosspieces 32a,b,c perpendicular to the

longitudinal axis X may be considered to be a lateral spacing of the crosspieces 32a,b,c.

In the example embodiment, the crosspieces 32a,b,c are spaced laterally and longitudinally such that they lie on a plane 34 inclined at an angle to the longitudinal axis X. It will be appreciated that the spacing between the crosspieces 32a,b,c within the plane 34 is larger than the spacing between the crosspieces 32a,b,c in either the lateral direction or the longitudinal direction. As such, because the crosspieces 32a,b,c are spaced both laterally and longitudinally, the maximum distance between adjacent crosspieces 32a,b,c is increased (as compared to the situation in which the crosspieces are spaced laterally, but not longitudinally), and therefore the available area for fluid flow between the crosspieces 32a,b,c is also increased. It will be appreciated that the obstruction to the flow of fluid through the flow passage 17 caused by the presence of the crosspieces 32a,b,c is reduced by spacing the crosspieces 32a,b,c both laterally and longitudinally. As such the maximum flow rate of fluid through the anti-siphon device 12 is increased.

It will be appreciated that the lateral spacing between the crosspieces 32a,b,c and the inner wall 36 of the flow passage 17 may be dependent upon the diameter of siphon hose that the anti-siphon device 12 is designed to prevent accessing the fuel in the interior 13. Figure 4 shows a top-down view through the anti-siphon device in the direction of the arrow F of Figure 3. The lateral spacing between the crosspieces 32a,b,c is denoted by the letter A, and a lateral spacing between the first and second crosspieces 32a,b and the inner wall 36 is shown by the letter B. In a preferred embodiment, the lateral spacings A and B are less than 6mm. As such, a siphon tube having a width of 6 mm or larger is prevented from entering fuel tank 2 by the crosspieces 32a,b,c. It will be appreciated that the width of siphon tube that the anti-siphon portion is designed to block may determine the spacing between the crosspieces. That is to say, the crosspieces 32a,b,c should be spaced apart by a distance which is less than the width of the siphon tube that the anti-siphon portion is configured to block. For example, in some embodiments of the invention the crosspieces 32a,b,c may be positioned less than 6 mm apart so as to prevent siphon tubes narrower than 6 mm from entering the fuel tank 2.

During use the anti-siphon device 12 may be positioned along the fuel conduit 10 such that the longitudinal axis of the anti-siphon device 12 is at an angle relative to (i.e. non parallel to) the action of gravity. In addition, or alternatively, due to the shape of the fuel conduit 10 between the inlet 4 and the tank 2, the anti-siphon device 12 may be positioned on or after a bend of the fuel conduit 10. Such a situation can be seen in Figure 1. The anti-siphon device is located after (or downstream of) bend portion 10c of the fuel conduit 10. The bend portion has a centre of curvature C of the bend. Relative to the centre of curvature C there is a radially inner (or inboard) side 10d of the fuel conduit portion 10a and a radially outer (or outboard) side 10e of the fuel conduit portion 10a. It will be appreciated that when the anti-siphon device 12 is positioned on or after a bend of the fuel conduit 10 it is preferable for the first crosspiece 32a (i.e. the crosspiece which is the furthest upstream) to be positioned on the radially outboard side 10e of the fuel conduit relative to the bend. In such an orientation of the anti-siphon device 12, a siphon tube inserted through the fuel tank inlet 4 will be guided around the bend in the fuel conduit 10 by a radially outboard part of first portion 10a. As the siphon tube is further inserted into the fuel conduit 10, the siphon tube will contact the inner wall 36 of the first body portion 14 and the first crosspiece 32a. Because the lateral spacing B between the inner wall 36 and the first crosspiece is less than the diameter of the siphon tube, the path of the siphon tube is blocked and therefore theft of fuel in the interior 13 of the fuel tank 2 is prevented. This arrangement is preferable in that it is the crosspiece which is furthest upstream which is abutted by an inserted siphon tube – consequently the distance along the fuel conduit which the siphon tube is allowed to pass is minimised (as compared to, say, if the siphon tube were to abut the second or third crosspiece, which are further downstream than the first crosspiece).

As is best shown in Figure 3, the crosspieces 32a,b,c are generally triangular in cross-section, and are oriented such that a vertex of the triangular cross-section points directly into the oncoming flow of fluid (i.e. in the opposite direction to the arrow F). As such, the faces of the crosspieces 32a,b,c flanking the vertex are inclined at an angle relative to the centreline (or longitudinal axis X) of the anti-siphon device 12. It will be appreciated that because the vertices are oriented towards the oncoming flow, during use the drag caused by the presence of the crosspieces 32a,b,c on the fluid flowing through the flow passage 17 is reduced. As such, the presence of the crosspieces 32a,b,c in the flow will not adversely affect delivery of fuel to the fuel tank 2. Although in the present embodiment the faces of each crosspiece which flank the vertex are flat, in

other embodiments this need not be the case. It will be appreciated that in alternative embodiments of the invention the crosspieces 32a,b,c may have any suitable cross-sectional shape (the cross-section being perpendicular to the longitudinal extent of the relevant crosspiece) . For example, the cross-sectional shape of the crosspieces 32a,b,c may be generally polygonal. For example, the faces may be convex. The cross-sectional shape of the crosspieces 32a,b,c may be constant along substantially the entire length of the crosspieces 32a,b,c, or may be varied. Each of the crosspieces 32a,b,c may comprise a different cross-sectional shape, such as for example: circular, square, pentagonal etc. Where the cross-sectional shape of the crosspieces 32a,b,c comprises a vertex, the vertex may be oriented at any suitable angle relative to the direction of flow of the anti-siphon device 12.

It will be appreciated that the anti-siphon device 12 may be provided with markings on an exterior of the anti-siphon device 12 to identify the intended direction of flow through the flow passage 17.

In the example embodiment the crosspieces 32a,b,c form part of the first body portion 14. The crosspieces 32a,b,c may be integrally formed with the first body portion 14. However, it will be appreciated that in alternative embodiments of the invention the crosspieces 32a,b,c may form part of the second body portion 16. The crosspieces may be integrally formed with the second body portion. Additionally or alternatively, the crosspieces 32a,b,c may be formed as a separate component to the first body portion 14 and the second body portion 16. For example, the crosspieces maybe insertable into one or more apertures formed in the inner wall 36 of the first and/or second body portion 14, 16. Alternatively, the crosspieces 32a,b,c may be formed as a sleeve insertable between the first and second body portions 14, 16. Alternatively, the crosspieces 32a,b,c may be formed together as a single component which is inserted into an elongate slot formed in the side of the first body portion 14 or the second body portion 18, the slot being inclined relative to the longitudinal axis X at an angle. Alternatively, the single component may be received in two corresponding diametrically opposed elongate slots in the side of the first body portion 14 or the second body portion 18. Again, the corresponding slots may be inclined relative to the longitudinal axis X at an angle. The single component may resemble a ladder having curved (i.e. bowed) sides so that the sides of the ladder lie substantially flush with the inner wall 36 of the flow passage 17. The ladder may be composed of any suitable material, such as

for example plastic or metal. The ladder may be manufactured from a flat sheet of material, such as for example, by laser or waterjet cutting.

It will be appreciated that in alternative embodiments of the invention, the anti-siphon device may comprise an anti-siphon portion including an obstruction of any suitable type. For example, rather than comprising crosspieces 32a,b,c, the anti-siphon device 12 may comprise a mesh. Additionally or alternatively, the anti-siphon device 12 may comprise a baffle provided with a plurality of outlet holes of a diameter narrower than the diameter of a siphon tube. It will further be appreciated that the crosspieces 32a,b,c may extend partially across the flow passage 17 (i.e. such that the crosspieces 32a,b,c are cantilevers). It will be appreciated that an anti-siphon device according to the present invention may comprise substantially any appropriate number (one or more) of crosspieces.

The first and second body portions 14, 16 may be composed of any suitable material, such as for example a plastics material (e.g. polyethylene, polypropylene) or a metal (e.g. stainless steel, aluminium). It will be appreciated that the first and second body portions 14, 16 may be manufactured using any suitable manufacturing technique, such as for example injection moulding or machining.

It will be appreciated that a vehicle which does not comprise an anti-siphon device 12 according to the present invention may have a fuel conduit 10 which extends directly from the fuel inlet 4 to the fuel tank 12. In order to install (or retrofit) the anti-siphon device 12 of the present invention within such a vehicle, the user may simply cut the fuel conduit 10 at an appropriate position between the fuel inlet 4 and the fuel tank 2 and insert the first and second portions 10a,b of the fuel conduit 10 onto the inlet portion 18 and outlet portion 20 of the anti-siphon device 12 respectively. If required, the first and second portions 10a,b of the fuel conduit 10 may be secured to the inlet and outlet portions 18, 20 using retention members 21 (e.g. jubilee clips) in the manner described above with reference to Figure 3. As such, it will be appreciated that the anti-siphon device 12 may be easily retro-fitted to any vehicle comprising a suitable fuel conduit 10.

It will be appreciated that whilst the description above has related to an in-line anti-siphon device in which the anti-siphon device is a separate component, in other

embodiments the anti-siphon device may be incorporated into another component – for example, the anti-siphon device may be incorporated into the fuel conduit itself, incorporated into the fuel tank or incorporated into the fuel inlet, or incorporated into any other appropriate portion of the fuel system.

CLAIMS:

1. An anti-siphon device comprising

an inlet portion configured to engage a first portion of a fuel conduit;

an outlet portion configured to engage a second portion of the fuel conduit; and

an anti-siphon portion;

wherein the anti-siphon device defines a flow passage configured to permit fluid flow between the inlet portion and the outlet portion, and wherein the anti-siphon portion comprises an obstruction configured to inhibit the passage of a siphon tube through the anti-siphon device.

2. An anti-siphon device according to claim 1, wherein the obstruction of the anti-siphon portion comprises a formation which extends into the flow passage in a direction perpendicular to a centreline of the flow passage.

3. An anti-siphon device according to claim 2, wherein a cross-section of the formation defines a vertex directed towards the inlet portion of the anti-siphon device.

4. An anti-siphon device according to claim 3, wherein the formation comprises a planar surface that is inclined at an angle relative to the centreline.

5. An anti-siphon device according to any of claims 2 to 4, wherein the formation extends between opposite side portions of the flow passage.

6. An anti-siphon device according to any of claims 2 to 5, wherein the formation is a first formation, and wherein the anti-siphon portion comprises a second formation which extends into the flow passage in a direction perpendicular to the centreline of the flow passage.

7. An anti-siphon device according to claim 6, wherein the first and second formations extend generally parallel to one another.

8. An anti-siphon device according to claim 6 or 7, wherein the first and second formations are spaced apart from one another in a direction perpendicular to the centreline of the flow passage.

9. An anti-siphon device according to any of claims 6 to 8, wherein the first and second formations are spaced apart from one another in a direction parallel to the centreline of the flow passage.

10 An anti-siphon device according to any of claims 6 to 9, wherein the anti-siphon portion comprises a third formation, and wherein the first formation, the second formation and the third formation all lie on the same plane.

11. An anti-siphon device according to any preceding claim, wherein the anti-siphon device comprises a first body portion defining the inlet portion and a second body portion defining the outlet portion, the first and second body portions being separate.

12. An anti-siphon device according to claim 11, wherein the first and second body portions are generally tubular.

13. An anti-siphon device according to claim 11 or 12, wherein the first body portion defines a first threaded portion and the second body portion defines a second threaded portion, the first and second threaded portions being configured to engage so as to engage the first body portion to the second body portion.

14. An anti-siphon device according to any of claims 11 to 13, wherein the first body portion is configured to be at least partially received within the second body portion.

15. An anti-siphon device according to any of claims 11 to 14, wherein the first body portion comprises the anti-siphon portion.

16. An anti-siphon device according to any preceding claim, wherein the inlet portion comprises a barb configured to engage the first portion of the fuel conduit, and wherein the outlet portion comprises a barb configured to engage the second portion of the fuel conduit

17. An anti-siphon device according to any preceding claim, wherein the anti-siphon device comprises a sealing member configured to provide a substantially fluid-tight seal between the first body portion and the second body portion.

18. An anti-siphon device according to claim 17, wherein during use the sealing member is positioned at a distal end of the first body portion relative to the inlet portion.

19. A method of fitting an anti-siphon device according to any preceding claim, wherein the method comprises:

cutting a fuel conduit into a first portion and a second portion;

inserting the inlet portion of the anti-siphon device into an end of first portion of the fuel conduit; and

inserting the outlet portion of the anti-siphon device into an end of the second portion of the fuel conduit.

20. The method of claim 19, wherein the method further comprises:

securing the first portion of the fuel conduit to the inlet portion using a first retention member, and

securing the second portion of the fuel conduit to the outlet portion using a second retention member.

The retention member may be a jubilee clip or any other suitable fastening memer such as a cable tie.

21. A vehicle fuel storage system, the fuel storage system comprising:

a fuel inlet configured to receive fuel from a fuel dispenser;

a fuel tank configured to store fuel;

an anti-siphon device; and

a fuel conduit comprising a first portion extending from the fuel inlet to an inlet of the anti-siphon device, and a second portion extending from an outlet of the anti-siphon device to the fuel tank.

22. A vehicle fuel storage system according to claim 21, wherein the anti-siphon device is an anti-siphon device according to any of claims 1 to 18.

23. A vehicle fuel storage system according to claim 22, when dependent on claim 9 or any claim dependent on claim 9, wherein the first formation is located upstream of the second formation,

wherein the first portion of the fuel conduit comprises a bend having a centre of curvature,

wherein, relative to the centre of curvature, the first portion of the fuel conduit includes a radially inboard side and a radially outboard side, and

wherein the first formation is positioned on the radially outboard side the fuel conduit.

Application No:	GB1611860.6	**Examiner:**	Mr Samuel Taylor
Claims searched:	1-23	**Date of search:**	25 November 2016

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-8, 10	US 2010/282757 A1 (EATON) Particularly figures 2 and 4.
X,Y	1, 2, 5, 17, 19-22	US 2010/224260 A1 (AVAKIAN) Particularly figures 1 and 4.
Y	1-3, 5-10	US 2010/264138 A1 (BRAMSON) Particularly figure 4.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	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^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

B60K

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

WPI, EPODOC

International Classification:

Subclass	Subgroup	Valid From
B60K	0015/04	01/01/2006