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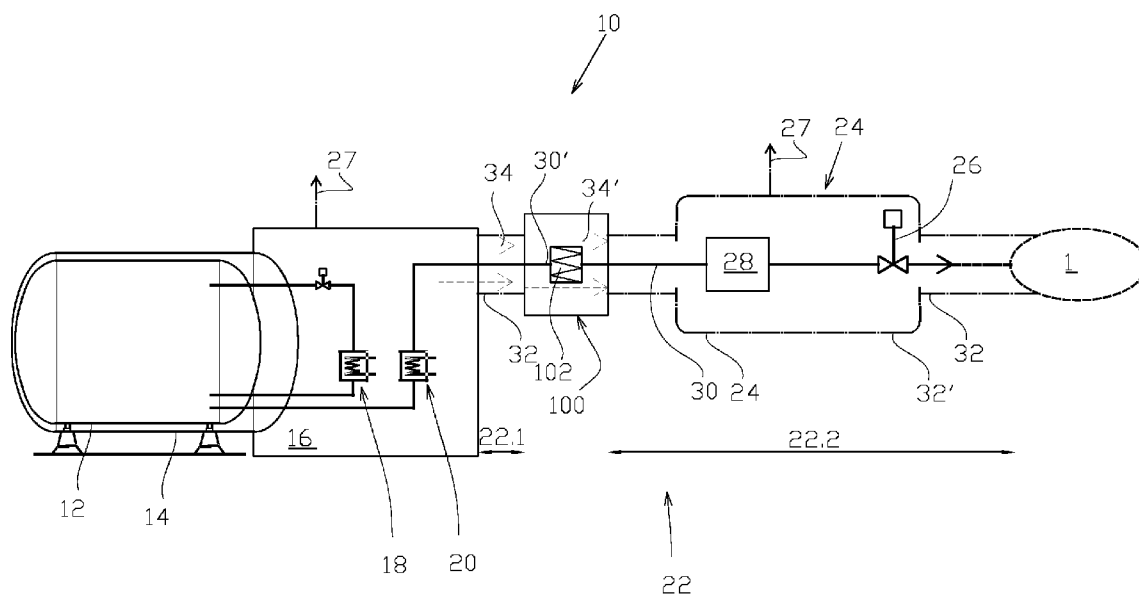


FIG. 1

(57) Abstract: Invention relates to a gaseous fuel feeding system (10), comprising a fuel supply line (22) enclosed by a barrier wall system (32,32') such that the fuel supply line (22) comprises a primary flow passage (30,30') for the gaseous fuel and a secondary flow passage (34,34') around the primary flow passage (30,30') inside the barrier wall system (32,32'). The fuel supply line (22) having a first fuel supply line section (22.1), and a second fuel supply line section (22.2), and there is a filter unit (100) in the system comprising a body (1 10) and at least two coupling adapters (1 12) arranged to the body (1 10), a filter element (102) disposed in the body (1 10), wherein the filter unit (100) comprises a primary flow passage (30') and a secondary flow passage (34') and the primary flow passage (30') is arranged to extend through the coupling adapters (1 12) and the filter element (102) of the filter unit (100), and the secondary flow passage (34') of the filter unit (100) is arranged to extend through the coupling adapters (1 12) and the body (1 10), and which

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secondary flow passage (34') is separate and parallel to the primary flow passage (30') in the filter unit (100), and wherein the filter unit (100) is coupled between the first and the second fuel supply line sections (22.1, 22.2) such that the primary flow passage (30) in the first fuel supply line section (22.1) is in flow connection with the primary flow passage (30) in the second fuel supply line section (22.2) via the primary flow passage (30') and the filter element (102) in the filter unit (100), and the secondary flow passage (34) in the first fuel supply line section is in continuous flow connection with the secondary flow passage (34) in the second fuel supply line section (16.2) via the secondary flow passage (34') in the filter unit (100).

A Gaseous Fuel Feeding System

Technical field

[001] The present invention relates to a gaseous fuel feeding system comprising a fuel supply line enclosed by a barrier wall system such that the fuel supply line comprises a primary flow passage for the gaseous fuel and a secondary flow passage around the primary flow passage inside the barrier wall system, according to the preamble of claim 1.

Background art

[002] Natural gas, or in general mixtures of hydrocarbons that are volatile enough to make the mixture appear in gaseous form in room temperature, constitutes an advantageous alternative to fuel oil as the fuel of internal combustion engines and will also enable more rapid transformation towards CO₂ neutral fuels. In marine vessels that use natural gas as fuel, the natural gas is typically stored onboard in liquefied form, giving rise to the commonly used acronym LNG (Liquefied Natural Gas). Natural gas can be kept in liquid form by maintaining its temperature below a boiling point, which is approximately -162 degrees centigrade (-260 degrees Fahrenheit).

[003] In internal combustion piston engines, for instance in the marine vessels, the output of the engines has constantly increased. In case the engine is powered by gaseous fuel, an unavoidable consequence is that the gas pressure in the fuel gas system is also increased. This has its consequences in dimensioning the fuel system components, meaning a need for increasing e.g. wall or material thicknesses to meet the demands set to the strength of the structures.

[004] Fuel systems for feeding gaseous fuel to an internal combustion engine in a marine vessel are commonly constructed such that a fuel supply line runs inside, i.e. is enclosed by a barrier wall system, in order to prevent direct leakage to surrounding should the fuel supply line leak.

[005] WO2015040267 A1 is referred to as an example of using gaseous fuel in one or more engines of a sea-going vessel. In particular it discloses an architecture of the system that is used to store the gaseous fuel in liquefied form and to deliver it to the engine or engines as gaseous gas comprising an LNG bunkering station located on the deck of the vessel which is used to fill up the system with LNG. There is provided an LNG fuel storage system comprising one or more thermally insulated tanks for storing the LNG in liquid form, and the so-called tank room where the LNG is controllably evaporated and its distribution to the engine(s) is arranged. The engine or engines of the vessel are located in an engine room. Each engine has its respective engine-specific Gas Valve Unit (GVU). The GVU includes for example a manual shut-off valve, a pressure control valve, a gas filter, and a block and bleed valve arrangement.

[006] Still, when the demands to enduring greater gas pressure increase, this also reflects to the demands of the barrier wall system. Also the GVU comprises a barrier wall system to controllably handle possible gas leak. Typically, the barrier wall system of the GVU comprises a vent line connecting the internal space of the GVU and the surroundings so that gas leakage can be vented out of the GVU in case of failure of the fuel supply line, such as a pipe rupture. However, the gas pressure inside barrier wall system can increase too much due the fact that vent line cannot purge the pressure caused by the leaking gas, and will eventually break the fuel system.

[007] An ease would be to increase the material thicknesses of the barrier wall systems. However, this can lead to material thicknesses increasing too massive. And still all the instruments would be subjected to the excessive pressure peak, which is not desired.

[008] An object of the invention is to provide a gaseous fuel feeding system in which the performance is considerably improved compared to the prior art solutions by enhancing the pressure control during possible leakage situations improving the system safety and reliability.

Disclosure of the Invention

[009] Objects of the invention can be met substantially as is disclosed in the independent claim and in the other claims describing more details of different embodiments of the invention.

5 [0010] According to an embodiment of the invention a gaseous fuel feeding system comprises a fuel supply line which is enclosed by a barrier wall system such that the fuel supply line comprises a primary flow passage for the gaseous fuel and a secondary flow passage around the primary flow passage inside the barrier wall system. The secondary flow passage among other things secures primary
10 flow passage from direct leak into the surroundings. The fuel supply line comprises a first fuel supply line section, and a second fuel supply line section and a filter unit between them. The filter unit comprises a body and at least two coupling adapters arranged to the body of the filter, a filter element disposed in the body of the filter, wherein the primary flow passage in the filter body is arranged to
15 extend through the coupling adapters and the filter element of the filter unit. The filter unit comprises a primary flow passage and a secondary flow passage, wherein the secondary flow passage of the filter unit is arranged to extend through the coupling adapters and the body. The secondary flow passage is separate and parallel to the primary flow passage in the filter unit, and the filter unit
20 is coupled between the first and the second fuel supply line sections such that the primary flow passage in the first fuel supply line section is in flow connection with the primary flow passage in the second fuel supply line section via the primary flow passage and the filter element in the filter unit, and the secondary flow passage in the first fuel supply line section is in continuous flow connection with
25 the secondary flow passage in the second fuel supply line section via the secondary flow passage in the filter unit. The filter element may be of any suitable type and structure being known for those skilled in the art.

[0011] According to an embodiment of the invention the fuel feeding system comprises a gas fuel tank configured to store the fuel in liquefied form, and a
30 liquefied gas evaporation system, in which fuel feeding system the fuel supply line is arranged to extend from the tank to a gas valve unit arranged in the system, and wherein the filter unit is arranged to the fuel supply line between the tank and the gas valve unit.

[0012] According to an embodiment of the invention the secondary flow passage in the filter unit is provided with a flow throttling section. The flow throttling section is advantageously arranged in connection with the secondary flow passage in the coupling adapter of the filter unit.

- 5 [0013] According to an embodiment of the invention the secondary flow passage in the filter unit is arranged to provide a continuous flow connection through the coupling adapters and the body of the filter unit.

- [0014] According to an embodiment of the invention the coupling adapters of the filter unit comprise a circular flange arranged perpendicularly to a center axis of
10 the primary flow passage, and the primary flow passage is an opening arranged to the center of the flange, and the secondary flow passage comprises at least one opening in the flange at a radial distance from the primary flow passage.

- [0015] According to an embodiment the gaseous fuel feeding system can be further developed by providing at least one one-way valve, such as a reed valve,
15 into the secondary flow passage for preventing, or at least minimizing, possible back flow of the leaked gas in the secondary flow passage. Advantageously the filter unit is provided with at least one one-way valve in the secondary flow passage.

- [0016] According to an embodiment of the invention gaseous fuel feeding system configured to feed gaseous fuel to more than one gas consumer wherein the
20 second fuel supply line section downstream the filter unit comprises several parallel branch sections, each one of which being provided with a gas valve unit, wherein the primary flow passage in the first fuel supply line section is in flow connection with the primary flow passage of each branch section of the second
25 fuel supply line section via the primary flow passage of the filter unit and the filter element of the filter unit, and the secondary flow passage in the first fuel supply line section is in continuous flow connection with the secondary flow passage of each branch of the second fuel supply line section via the secondary flow passage of the filter unit.

- 30 [0017] According to an embodiment of the invention the gaseous fuel feeding system can be further developed by providing at least one one-way valve, such

as a reed valve, into at least one, advantageously in each one, of the secondary flow passage of each branch of the second fuel supply line section preventing, or at least minimizing, possible back flow of the leaked gas from the second fuel supply section to the first fuel supply section in the secondary flow passage.

- 5 [0018] Invention is also applicable to power plant which are directly connected to a source of gas without a need of a gas fuel tank.

[0019] According to an embodiment of the invention the filter unit comprises a first flow connection path which opens into the first fluid passage at its first end and into an outer side of the filter unit at its second end for monitoring purposes.

- 10 [0020] According to an embodiment of the invention the first flow connection path is provided with a pressure transmitter.

[0021] According to an embodiment of the invention the first flow connection path is arranged to the at least one of the coupling adapters of the filter unit.

- 15 [0022] According to an embodiment of the invention the filter unit comprises a second flow connection path which opens into the second fluid passage at its first end and into an outer side of the filter unit at its second end for monitoring purposes.

[0023] According to an embodiment of the invention the second flow connection path is provided with a gas detector.

- 20 [0024] According to an embodiment of the invention the second flow connection path is arranged to the at least one of the coupling adapters of the filter unit.

- [0025] The exemplary embodiments of the invention presented in this patent application are not to be interpreted to pose limitations to the applicability of the appended claims. The filter unit according to invention is applicable to filter practically any gas. The verb "to comprise" is used in this patent application as an open limitation that does not exclude the existence of also unrecited features. The features recited in depending claims are mutually freely combinable unless otherwise explicitly stated. The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims.
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Brief Description of Drawings

[0026] In the following, the invention will be described with reference to the accompanying exemplary, schematic drawings, in which

Figure 1 illustrates a gaseous fuel feeding system according to an embodiment
5 of the invention,

Figure 2 illustrates a sectional view of a filter unit according to another embodiment of the invention,

Figure 3 illustrates a face view of a coupling flange of the filter unit according to still another embodiment of the invention,

10 Figure 4 illustrates a gaseous fuel feeding system according to another embodiment of the invention,

Figure 5 illustrates a gaseous fuel feeding system according to another embodiment of the invention, and

Figure 6 illustrates a filter unit according to another embodiment of the invention.

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Detailed Description of Drawings

[0027] Figure 1 depicts schematically a gaseous fuel feeding system 10 configured to feed gaseous fuel to a gas consumer 1 such as a gas engine according to an embodiment of invention. The gaseous fuel feeding system 10 comprises
20 a gas fuel tank 14 configured to store the fuel mainly in liquefied form, the fuel being e.g. liquefied natural gas. The tank has an inner shell 12 and an outer shell 14 between which an insulation is arranged. There is a tank connection space 16 arranged in connection with the tank. The tank connection space is housing auxiliaries such as various valves and cryogenic pump (if needed) by means of
25 which the emptying of the tank and fuel introduction to the engine is controlled. The tank connection space is arranged gas tight but also accessible e.g. for maintenance. The tank connection space is usually provided at one end of the tank 14 attached to the tank, but can also located within a distance of the tank

14. The tank fuel feeding system 10 may comprise also a pressure build up system 18 in which an evaporator is arranged to evaporate the liquefied gas in the tank 14 and lead the evaporated gas back to the tank 14. Optionally instead of the pressure build up system 18, the fuel feeding system 10 may comprise a pump or alike in the primary flow passage 30. The pressure build-up system 18 is housed by the tank connection space 16. The tank fuel feeding system 10 may comprise also a main gas evaporator system 20 in which a main evaporator is arranged to evaporate the liquefied gas in the tank 14 and lead the evaporated gas to one or more gas consumers 1. The main evaporator is housed by the tank connection space 16.

[0028] The fuel feeding system 10 comprises a fuel supply line 22 arranged to extend from the tank 14 or the tank connection space 16, as is the case in the figure 1, to the gas consumer 1, which may be for example an internal combustion piston engine 1 such that the gas may be delivered to the engine 1 for use as its fuel. The gas evaporator system 20 is configured to evaporate the liquefied gas into gaseous form and optionally to heat the evaporated gas to a desired temperature suitable for the engine 1. The fuel feeding system 10 comprises a gas valve unit (GVU) 24 for each engine 1. The gas valve unit 24 is arranged, in connection with or before, in other words upstream to the engine 1 in the normal flow direction of the gas. The GVU 24 may comprise several control devices, such as gas feed pressure regulation device 26, a valve member and/or a number of desired optional instruments generally and collectively depicted by a box 28. The instruments may comprise necessary equipment for measuring, analysing, filtering or otherwise handling the gas and arranged in the gas valve unit 24.

[0029] The fuel supply line 22 is provided a primary flow passage 30 for the gaseous fuel, which may be in a form of an inner pipe. The fuel supply line 22 is also provided with a barrier wall system 32, or an outer pipe, which forms a double wall surrounding the primary flow passage 30. Advantageously the primary flow passage 30 is an inner pipe and the barrier is an outer pipe arranged substantially coaxially to each other. Should the inner pipe 30 leak, the leaked gas is controllably handled by the space between the inner pipe 30 and the outer pipe 32. The GVU 24 also comprises a barrier wall system 32' enclosing the gas handling devices inside the gas valve unit 24. The space between the primary flow passage 30 and the barrier wall 32, 32' forms a secondary flow passage 34 for the gas.

So, the possibly leaked gas is gathered into the secondary flow passage making it possible to safely handle the leaked gas, which may be highly toxic e.g. to environment and humans.

[0030] According to the invention, the fuel supply line 22 comprises, starting from the tank connection space 16, successively a first line section 22.1 and a second line section 22.2 and a filter unit 100 coupled between the first and the second fuel supply line sections 22.1, 22.2. The primary flow passage 30 in the first fuel supply line section 22.1 is in flow connection with the primary flow passage 30' in the second fuel supply line section 22.2 via a primary flow passage 30' of the filter unit 100. The primary flow passage 30' of the filter unit 100 comprises at least one filter element 102. The secondary flow passage 34 in the first fuel supply line section 22.1 is in continuous flow connection with the secondary flow passage 34 in the second fuel supply line section 22.2 via a secondary flow passage 34' of the filter unit 100. The secondary flow passage 34' and the primary flow passage 34 in the filter unit 100 are separate passages parallel with each other. The structure and operation of the filter unit 100 and the flow passages will be described later in more detailed manner.

[0031] In the figure 2 there is schematically shown a sectional view of the filter unit 100 according to an embodiment of the invention in more detail. The filter unit 100 comprises a body 110 and coupling adapters 112 at its opposite ends for coupling the filter unit 100 to the fuel supply line 20 between the first and the second fuel supply line sections 22.1, 22.2.

[0032] The filter unit 100 comprises a primary flow passage 30' and a secondary flow passage 34' fluidly separated from each other and arranged parallel to each other. The primary flow passage 30' of the filter unit 100 is arranged to extend through the coupling adapters 112 and through a filter element 114 provided in the body 110 of the filter unit 100. Instead of one filter element 114 there may be several filter elements arranged parallel to each other. The secondary flow passage 34' is arranged to extend through the coupling adapters 112 and the body 110 of the filter unit 100 so as to form a second flow connection through the filter unit 100. The secondary flow passage 34' is fluidly separated from the primary flow passage 30'.

[0033] Each one of the coupling adapters 112 comprise a circular flange arranged perpendicularly to a center axis A of the primary flow passage 30'. The flange 112 is arranged to the body of the filter unit such that the primary flow passage 30' is symmetrical to the center of the flange 112. According to the embodiment shown in the figure 1 the body 110 comprises a first enclosure 116 and a second enclosure 118 arranged between the coupling adapters 112 in length-wise. Both of the enclosures are generally of cylindrical shape having their axial ends attached to the flanges 112 in a gas tight manner.

[0034] According to an embodiment of the invention the filter unit 100 comprises a first flow connection path 61, which opens into the first fluid passage 30' at its first end and into an outer side of the of the valve unit 100 at its second end. The first flow connection path 61 is advantageously arranged to the at least one of the coupling flanges 112 of the valve unit 100. The first flow connection path may be advantageously a radial bore in the coupling flange. If needed or otherwise desired, such can be arranged in more than one of the coupling flanges 112. The first flow connection path 61 is arranged for e.g. measuring or detection purposes. The first flow connection path 61 may be provided with a pressure transmitter 60. Pressure measurements of the gas in the first fluid passage may be carried out via the first flow path 61. This allows the operation of filter unit 100 and the entire fuel feeding system to be controlled in more accurate manner. If a flow connection path 61 is provided at the coupling flanges at both ends of the filter unit 100 for pressure measurements, a differential pressure can be determined, and then monitor the function of filter unit 100, for example.

[0035] Further in the figure 2 there is shown a second flow connection path 62. The filter unit is provided alternatively, or in addition to the first flow connection path 61 the second flow connection path 62, which opens into the second fluid passage 34' of the filter unit 100 at its first end and into an outer side of the filter unit 100 at its second end. The second flow connection path 62 is arranged to the at least one of the coupling flanges 112. The second flow connection path may be advantageously a radial bore in the coupling flange. If needed, such can be arranged in more than one of for coupling flanges 112 as well. The second flow connection path 62 is advantageously provided with a gas detector and/or a pressure transmitter 64. By means of the second flow connection path 62 and

the gas detector / pressure transmitter 64 it is possible to detect if gas has leaked from the primary flow channel 30 to the secondary flow channel 34 of the gaseous fuel feeding system 10. The first and the second flow connection paths may be used also for other purposes.

5 [0036] In the body 110 the second enclosure 118 is arranged to enclose the first enclosure 116. The first enclosure 116 and the second enclosure 118 are arranged parallel to the center axis A of the primary flow passage. The primary flow passage 30' is inside the first enclosure 116 and the secondary flow passage 34' is arranged radially between the first enclosure 116 and the second enclosure
10 118. The filter element 114 is arranged inside the first enclosure 114. The filter element 114 is coupled to the first enclosure 116 in gas tight manner so that the gas flow cannot bypass the filter element 114 in the primary flow passage 30'. In the figure 2 the first enclosure 116 and the second enclosure 118 are arranged coaxially with respect to each other. That is not absolutely essential to the inven-
15 tion although it makes is easier to manufacture the filter unit 100 this way. The first and the second enclosures 116, 118 are arranged to extend between the coupling flanges 112. The filter element is of cylindrical form. The filter element provided with an inlet opening 120 at its first axial end and with an end wall 122 at its second axial end. This way the gas flowing in the primary flow passage 30' through the flange 112 enters inside the filter element 114 and is forced to flow
20 through filtration wall of the filter element 114 which captures impurities move along with the gas flow. The filter element divides the primary flow passage 30' into inlet side 30.1' and into outlet side channel 30.2'. Outlet 123 of the primary flow passage 30' opens into the outlet side channel 30.2' in the filter unit 100.

25 [0037] The filter unit 100 shown in the figure 2 can be coupled to the fuel feeding system 10 shown in the figure 1 such that the coupling flanges 112 of the filter unit 100 are attached to the fuel supply line 22 with a counter-flanges welded into the piping structure of the fuel supply line 22.

[0038] Figure 3 shows a face view of the coupling flanges 112 of the filter unit
30 100 according to the figure 2. As can be seen in the figure 3 the coupling flange 112 is provided with a first center opening 112.1 and plurality of second openings 112.2 arranged at a radial distance from the first opening 112.1 angularly distributed around the first opening 112.1. The first opening 112.1 forms as its part the

primary flow passage 30' and the second openings 112.2 form the secondary flow passage 34' of the coupling flange 112. There is also seen the first flow connection path 61, and the second flow connection path 62 in the coupling flange 112. Both the flow connection paths are formed by radial borings.

5 [0039] The number of second openings 112.2 and the distribution of the openings may vary depending on the case. The second openings 112.2 act as a throttling section providing suitable local pressure loss coefficient to potential gas flow in the secondary flow passage 34'. The secondary flow passage 34' forms a continuous flow connection through the coupling adapters 112 and the body 110
10 of the filter unit 100 surrounding the primary flow passage 30'.

[0040] As described above, the primary flow passage 30 in the first fuel supply line section 22.1 is in flow connection with the primary flow passage 30 in the second fuel supply line section 22.2 via the primary flow passage 30' of the filter unit 100. In other words, the primary flow passage 30' is arranged to provide a
15 flow connection through the coupling adapters, i.e. coupling flanges 112, the body 110 and the filter element 114. Also the secondary flow passage 34 in the first fuel supply line section 22.1 is in continuous flow connection with the secondary flow passage 34 in the second fuel supply line section 22.2 via the secondary flow passage 34' of the filter unit 100. In other words, the secondary flow
20 passage 34' is arranged to provide a continuous flow connection through the coupling adapters, i.e. extending through the coupling flanges 112 and the body 110. Thus it forms a passage parallel to the primary flow passage between the flanges 112.

[0041] Now referring back to the figure 3, according to embodiment of the invention, the second openings 112.2 in the flange 112 are advantageously arranged
25 to restrict the flow from the first fuel supply line section 22.1 to second fuel supply line section 22.2 through the filter unit 100. The second openings 112.2 therefore act as a flow throttling section. The size, form and number of openings 112.2 is defined and calculated on a case-specific basis. The openings 112.2 i.e. the flow
30 throttling section provides a local reduction to the face area of the secondary flow passage 34' of the filter unit 100. Advantageously the reduction to the face area is 10-70%. In case of equipment fail e.g. in tank connection space there could be a leak of gas through the secondary flow passage 34 towards the filter unit 100.

In such case also liquid LNG would leak and evaporate rapidly inside the secondary flow passage 34. With the throttling section it is possible to reduce risk of failure of the gas valve unit 24 and/or the sensitive instruments in the gas valve unit by decreasing the rate of pressure rise in the gas valve unit. Likewise should
5 there be a leak in the second fuel supply section 22.2 the throttling section minimizes the rate of pressure rise in the first fuel supply section 22.1.

[0042] As is schematically shown in the figures 2 and 3 (in connection with only one opening) the second openings 112.2 in the flange 112 may be advantageously provided with one-way valves 124 such that an allowed flow direction of
10 the gas of the valve is towards the gas valve unit 24. The one-way valve may be for example a reed valve comprising a flexible flap covering the second opening 112.2 providing an automatic flow control for the gas. The flap is fastened to the flange with suitable means, such as a screws of alike (not shown).

[0043] As is shown in the figure 3 the second openings 112.2 for the secondary
15 flow passage 34' are arranged at a radial distance from the first opening 112.2. The second openings 112.2 are also preferably angularly evenly distributed around the primary flow passage 30' in the flange 112. It is also an operable, if not preferred in all cases, that the second openings 112.2 are unevenly distributed. The second openings 112.2 can be in the form of various shapes, preferably
20 bly elongated or circular shapes.

[0044] Referring back to the figure 1, according to an advantageous embodiment of the invention, the filter unit 100 is arranged on the fuel supply line 22 between the tank 14 and the gas valve unit 24. The location is preferably selected so that the location is closer to the gas valve unit 24 than to the tank, although the location can be arranged in anywhere on the fuel supply line 22 depending on the
25 need, i.e., where the system requires protection against a pressure increase. Advantageously the filter unit 100 is right next to the gas valve unit 24. By means of the filter unit 100 according to the invention, effects of a leak in the primary flow passage 22.1 to the pressure development in the secondary flow passage 22.2
30 due to sudden increase on the pressure is efficiently limited to a certain sections of the fuel system.

[0045] As an example, the filter unit 100 according to the invention is advantageously utilized in a gaseous fuel feeding system in a following manner. Firstly, during normal operation of the system the filter unit 100 removes impurities from the gas flowing through the filter element 144. Should there emerge a rupture in the primary flow passage 30 of the first fuel supply line section 22.1, the flow communication of the primary flow passage 30 between the first and the second fuel supply line sections 22.1, 22.2 is also advantageously closed by a valve not shown in the figure 1. If the leak is in the first fuel supply line section 22.1 i.e. on the tank side of the filter unit 100, the leaked gas continues to flow into the secondary flow passage 34 of the gas valve unit 24 through the secondary flow passage 34' of the filter unit 100. The flow rate through the secondary flow passage 34' is kept restricted by the flow throttling section i.e. the second opening 112.2 in secondary flow passage 34' of the filter unit 100. The gas valve unit 24 comprises a vent channel 27 which opens into the secondary flow passage 34. Also the tank connection space may be provided with a vent channel 27. Only a certain flow rate of gas can be obtained through the vent channel and the flow rate into the gas valve unit 24 is restricted by the flow throttling section 112.2. The pressure rise in the gas valve unit is thus kept moderate and the construction of the gas valve unit 24 can be dimensioned to endure lower pressure level. Additionally the risk of damages caused to any instruments assembled in the gas valve unit is minimized. Thus, the flow rate of the leaking gas in the secondary flow passage 34 is considerably lower so that it will not cause damages to the gas valve unit 24 and the barrier wall system 32' of the gas valve unit 24. This way, if the first fuel supply line 30 is ruptured, rapid flow of the gas via the secondary flow passage 32 to inside the barrier wall system 32' of the gas valve unit 24 can be prevented.

[0046] According to other embodiment of the invention, the secondary flow passage 34' in the filter element 100 is provided with a separate flow throttling element removably assembled to the second opening 112.2. Throttling effect can also be accomplished by dimensioning the secondary flow passage 34' of the filter unit 100 such that it provides desired local pressure loss which limits the pressure raise rate in the gas valve unit 24.

[0047] Figure 4 depicts a further developed advantageous embodiment of that shown in the figure 1. The gaseous fuel feeding system 10 is configured to feed gaseous fuel to more than one gas consumer 1. The fuel feeding system 10 comprises a fuel supply line 22 arranged to extend from the tank 14 or the tank connection space 16 to more than one gas consumers 1, which may be for example internal combustion piston engines 1. The fuel supply line 22 comprises parallel branch sections which are branching downstream the filter unit 100. This way one filter unit 100 of the gaseous fuel feeding system is configured to serve more than one gas consumers.

10 [0048] Figure 5 depicts a further developed advantageous embodiment of that shown in the figure 4. The gaseous fuel feeding system 10 is configured to feed gaseous fuel to more than one gas consumer 1. The fuel feeding system 10 comprises a fuel supply line 22 arranged to extend from the tank 14 or the tank connection space 16 to more than one gas consumers 1, which may be for example
15 internal combustion piston engines 1. The fuel supply line 22 comprises parallel branch sections which are branching in the filter unit 100. This way one filter unit 100 of the gaseous fuel feeding system is configured to serve more than one gas consumers.

[0049] Now referring to both the figure 4 and 5 the fuel feeding system 10 comprises a gas valve unit 24 for each engine 1. The gas valve unit 24 is arranged
20 before, or upstream to each one of the engines 1, in the normal flow direction of the gas.

[0050] The fuel supply line 22 is provided a primary flow passage 30 for the gaseous fuel, which may be in a form of an inner pipe. The fuel supply line 22 is also
25 provided with a barrier wall system 32, or an outer pipe, which forms a double wall surrounding the primary flow passage 30. In the embodiment of the figure 5 the primary flow passage 30 in the first fuel supply line section 22.1 is in flow connection with the primary flow passage 30 in each parallel branch section of the second fuel supply line section 22.2 via the primary flow passage 30' and the
30 filter element 114 of the filter unit 100, and the secondary flow passage 34 in the first fuel supply line section 22.1 is in continuous flow connection with the secondary flow passage 34 in each parallel the second fuel supply line section 22.2 via the secondary flow passage 34' of the filter unit 22. In the figure 5 the second

fuel supply section 22.2 branches at one common branch point which in advantageous in the filter unit 100. It is also conceivable to arrange the branch point outside the filter unit 100, as is shown in the figure 4, even if in that case the fuel feeding system is more complex. Similarly to the embodiment of the figure 1, if there occurs a leak is in the first fuel supply line section 22.1 i.e. on the tank side of the filter unit 100, the leaked gas continues to flow into the secondary flow passage 34 of the gas valve unit 24 through the secondary flow passage 34' of the filter unit 100. The flow rate through the secondary flow passage 34' is kept restricted by the flow throttling section i.e. the second opening 112.2 in secondary flow passage 34' of the filter unit 100. Since only a certain flow rate of gas can be obtained through the vent channel 27 of each gas valve unit 24, the flow rate into the gas valve units 24 is restricted by the flow throttling section 112.2 of the common filter unit 100. The pressure rise in the gas valve unit is thus kept moderate and the construction of the gas valve units 24 can be dimensioned to endure lower pressure level.

[0051] As is depicted in the figure 5, but being well applicable to the embodiment of figure 4 also, each of the branch sections of the fuel supply line 22 is provided with at least one one-way valve 128 in connection with its secondary flow passage 34. The one-way valve may be for example a reed valve. The one-way valve is arranged in connection with the filter unit 100, advantageously integrated thereto. The one-way valve is arranged so as to prevent or at least minimize possible back flow of the leaked gas from a branch section to the upstream side of the filter unit 100 and to other branch sections.

[0052] Figure 6 discloses a filter unit 100 which has a provision of branching the second fuel supply line section 22.2 in connection with the filter unit 100. The filter unit is provided with a common inlet 121 comprising the primary flow passage 30 and the secondary flow passage 34. The filter unit 100 according to figure 5 has several outlets 123 in which the primary flow passages are opening into common outlet side channel 30.2' inside the filter unit 100, which may be referred to as a primary manifold section. Correspondingly the secondary flow passages are opening into a common outlet side channel 34' inside the filter unit 100, which may be referred to as a secondary manifold section. This provides a

straightforward and reliable coupling of the primary flow passage 30 and the secondary flow passage 34 between the branch sections and the first fuel supply line section 22.1. Thus, several parallel branch sections 22.2 are provided with a gas valve unit 24 and the primary flow passage 30 in the first fuel supply line section 22.1 is in flow connection with the primary flow passage 30 in each branch section of the second fuel supply line section 22.2 via the primary flow passage 30' and the filter element 102 of the filter unit 100, and the secondary flow passage 34 in the first fuel supply line section 22.1 is in continuous flow connection with the secondary flow passage 34 of each branch section of the second fuel supply line section 22.2 via the secondary flow passage 34' of the filter unit 100. In other words, the filter unit 100 is provided with a branch point of the primary flow passage and the secondary flow passage

[0053] While the invention has been described herein by way of examples in connection with what are, at present, considered to be the most preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but is intended to cover various combinations or modifications of its features, and several other applications included within the scope of the invention, as defined in the appended claims. The details mentioned in connection with any embodiment above may be used in connection with another embodiment when such combination is technically feasible.

Claims

1. A gaseous fuel feeding system (10), comprising a fuel supply line (22) enclosed by a barrier wall system (32,32') such that the fuel supply line (22) comprises a primary flow passage (30,30') for the gaseous fuel and a secondary flow passage (34,34') around the primary flow passage (30,30') inside the barrier wall system (32,32'), **characterized** in that the fuel supply line (22) comprises a first fuel supply line section (22.1), and a second fuel supply line section (22.2), and there is a filter unit (100) in the system comprising a body (110) and at least two coupling adapters (112) arranged to the body (110), a filter element (102) disposed in the body (110), wherein the filter unit (100) comprises a primary flow passage (30') and a secondary flow passage (34') and the primary flow passage (30') is arranged to extend through the coupling adapters (112) and the filter element (102) of the filter unit (100), and the secondary flow passage (34') of the filter unit (100) is arranged to extend through the coupling adapters (112) and the body (110) of the filter element (100), and which secondary flow passage (34') is separate and parallel to the primary flow passage (30') in the filter unit (100), and wherein the filter unit (100) is coupled between the first and the second fuel supply line sections (22.1, 22.2) such that the primary flow passage (30) in the first fuel supply line section (22.1) is in flow connection with the primary flow passage (30) in the second fuel supply line section (22.2) via the primary flow passage (30') and the filter element (102) in the filter unit (100), and the secondary flow passage (34) in the first fuel supply line section is in continuous flow connection with the secondary flow passage (34) in the second fuel supply line section (16.2) via the secondary flow passage (34') in the filter unit (100).

2. A gaseous fuel feeding system (10) according to claim 1, **characterized** in that the fuel feeding system (10) comprises a gas fuel tank (14) configured to store the fuel in liquefied form, and a liquefied gas evaporation system (20), in which fuel feeding system (10) the fuel supply line (22) is arranged to extend from the tank (14) to a gas valve unit (24) arranged in the system, and wherein the filter unit (100) is arranged to the fuel supply line (22) between the tank (14) and the gas valve unit (24).

3. A gaseous fuel feeding system (10) according to claim 1, **characterized** in that the secondary flow passage (32') in the filter unit (100) is provided with a flow throttling section (112).
4. A gaseous fuel feeding system (10) according to claim 1, **characterized** in that the secondary flow passage (34') in the filter unit (100) is arranged to provide a continuous flow connection through the coupling adapters (112) and the body (110) of the filter unit (100).
5. A gaseous fuel feeding system (10) according to claim 1, **characterized** in that coupling adapters (112) of the filter unit (100) comprise a circular flange (112) arranged perpendicularly to a center axis of the primary flow passage (30'), and the primary flow passage (30') is an opening (112.1) arranged to the center of the flange, and the secondary flow passage (34') comprises at least one opening (112.2) in the flange at a radial distance from the primary flow passage (30').
6. A gaseous fuel feeding system (10) according to claim 1 configured to feed gaseous fuel to more than one gas consumer (1), **characterized** in that the second fuel supply line section (22.2) downstream the filter unit (100) comprises several parallel branch sections (22.2), each one of which being provided with a gas valve unit (24), wherein the primary flow passage (30) in the first fuel supply line section (22.1) is in flow connection with the primary flow passage (30) of each branch section (22.2) of the second fuel supply line section (22.2) via the primary flow passage (30') of the filter unit (100) and the filter element (102) of the filter unit (100), and the secondary flow passage (34) in the first fuel supply line section (22.1) is in continuous flow connection with the secondary flow passage (34) of each branch of the second fuel supply line section (22.2) via the secondary flow passage (34') of the filter unit (100).
7. A gaseous fuel feeding system (10) according to claim 1 configured to feed gaseous fuel to more than one gas consumer (1), **characterized** in that filter unit (100) the primary flow passage (30') of the filter unit comprises a primary manifold section in which the primary flow passage (30') is branched into several parallel branch sections (22.2) and the secondary flow passage (34') of the filter unit comprises a second manifold section in which the secondary flow passage (34') is branched into several parallel branch sections (22.2).

8. A gaseous fuel feeding system according to claim 1, **characterized** in that the filter unit (100) comprises a first flow connection path (61) which opens into the first fluid passage (30') at its first end and into an outer side of the filter unit (100) at its second end.
- 5 9. A gaseous fuel feeding system according to claim 8, **characterized** in that the first flow connection path (61) is provided with a pressure transmitter (60).
- 10 10. A gaseous fuel feeding system according to claim 8, **characterized** in that the first flow connection path (61) is arranged to the at least one of the coupling adapters (112) of the filter unit (100).
11. A gaseous fuel feeding system according to claim 1 or 8, **characterized** in that the filter unit (100) comprises a second flow connection path (62) which opens into the second fluid passage (34') at its first end and into an outer side of the filter unit (100) at its second end.
- 15 12. A gaseous fuel feeding system according to claim 11, **characterized** in that the second flow connection path (62) is provided with a gas detector (64).
13. A gaseous fuel feeding system according to claim 11, **characterized** in that the second flow connection path (62) is arranged to the at least one of the coupling adapters (112) of the filter unit (100).
- 20 14. A gaseous fuel feeding system according to claim 1, **characterized** in that the fuel feeding system comprises at least one one-way valve (124,128) for minimizing possible back flow of the leaked gas in the secondary flow passage.
- 25 15. A gaseous fuel feeding system according to claim 14 **characterized** in that the filter unit (100) comprises at least one one-way valve (124) for minimizing possible back flow of the leaked gas in the secondary flow passage.

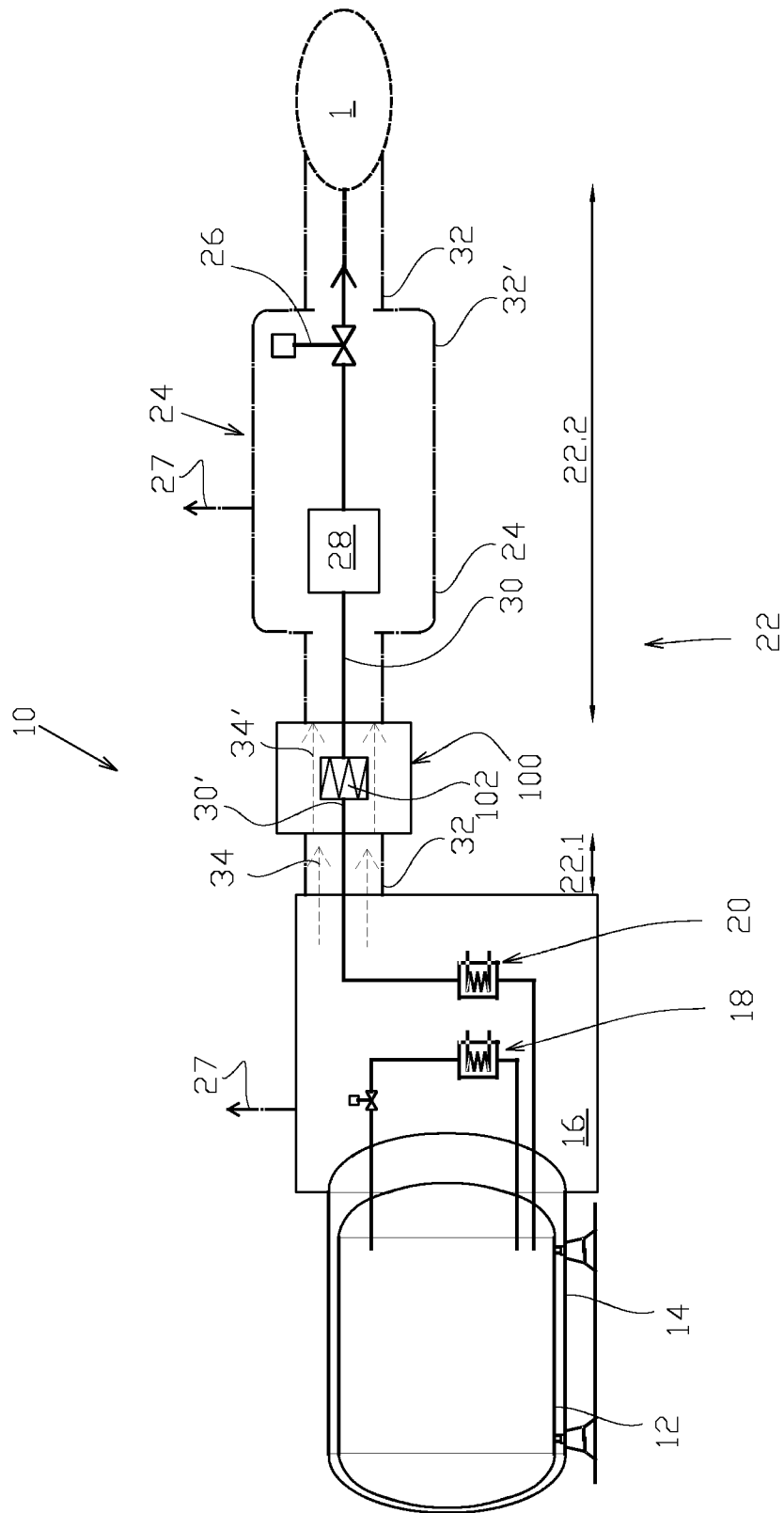


FIG-1

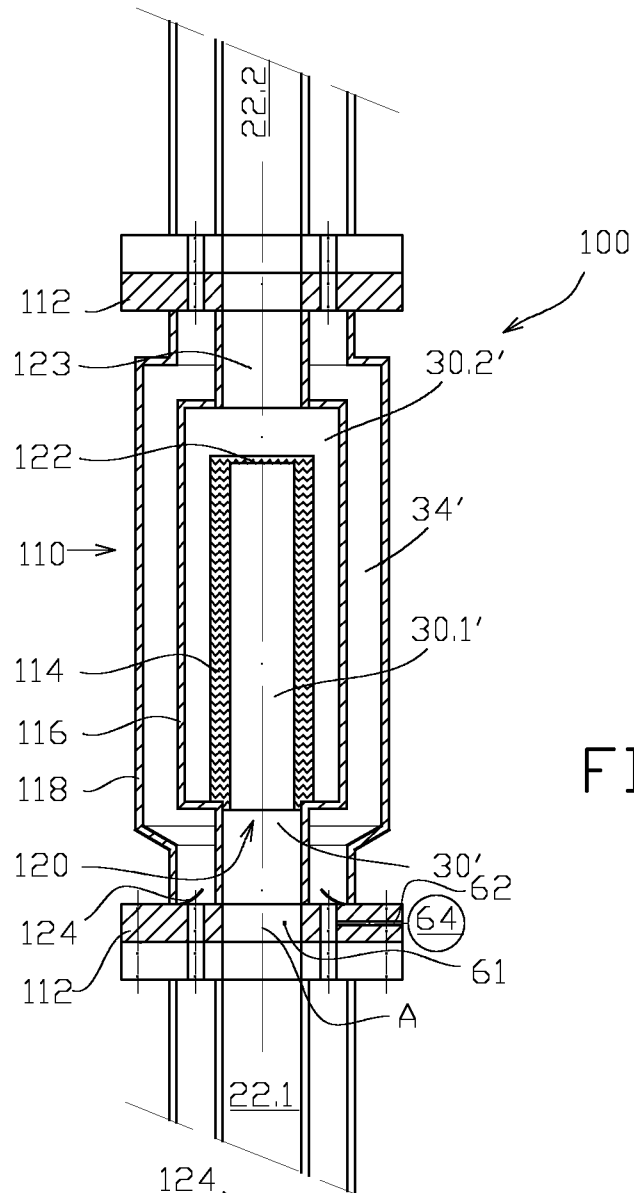


FIG. 2

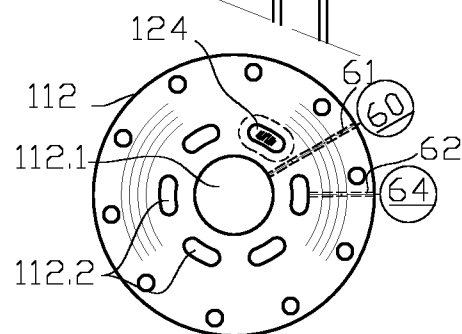


FIG. 3

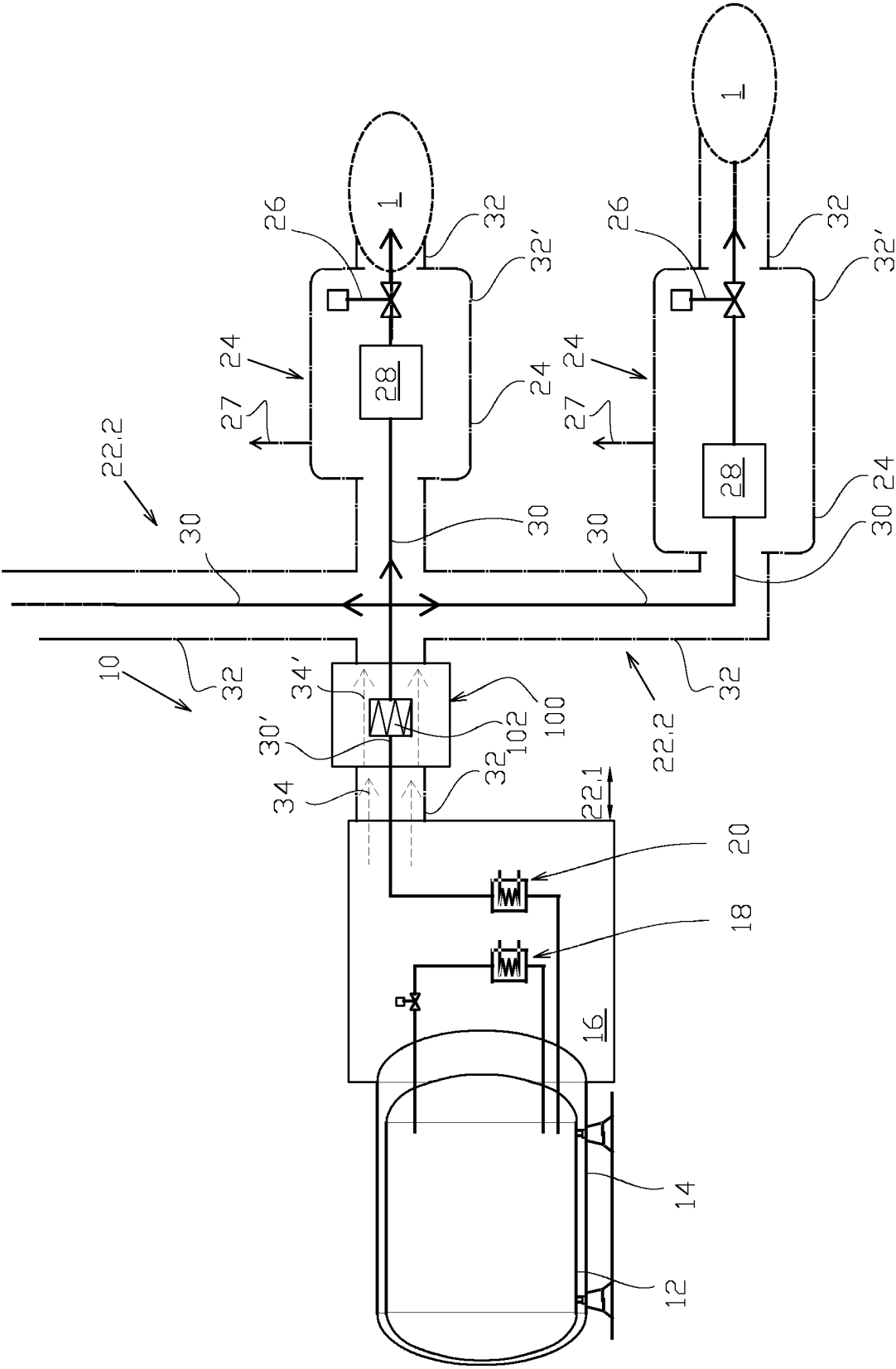


FIG. 4

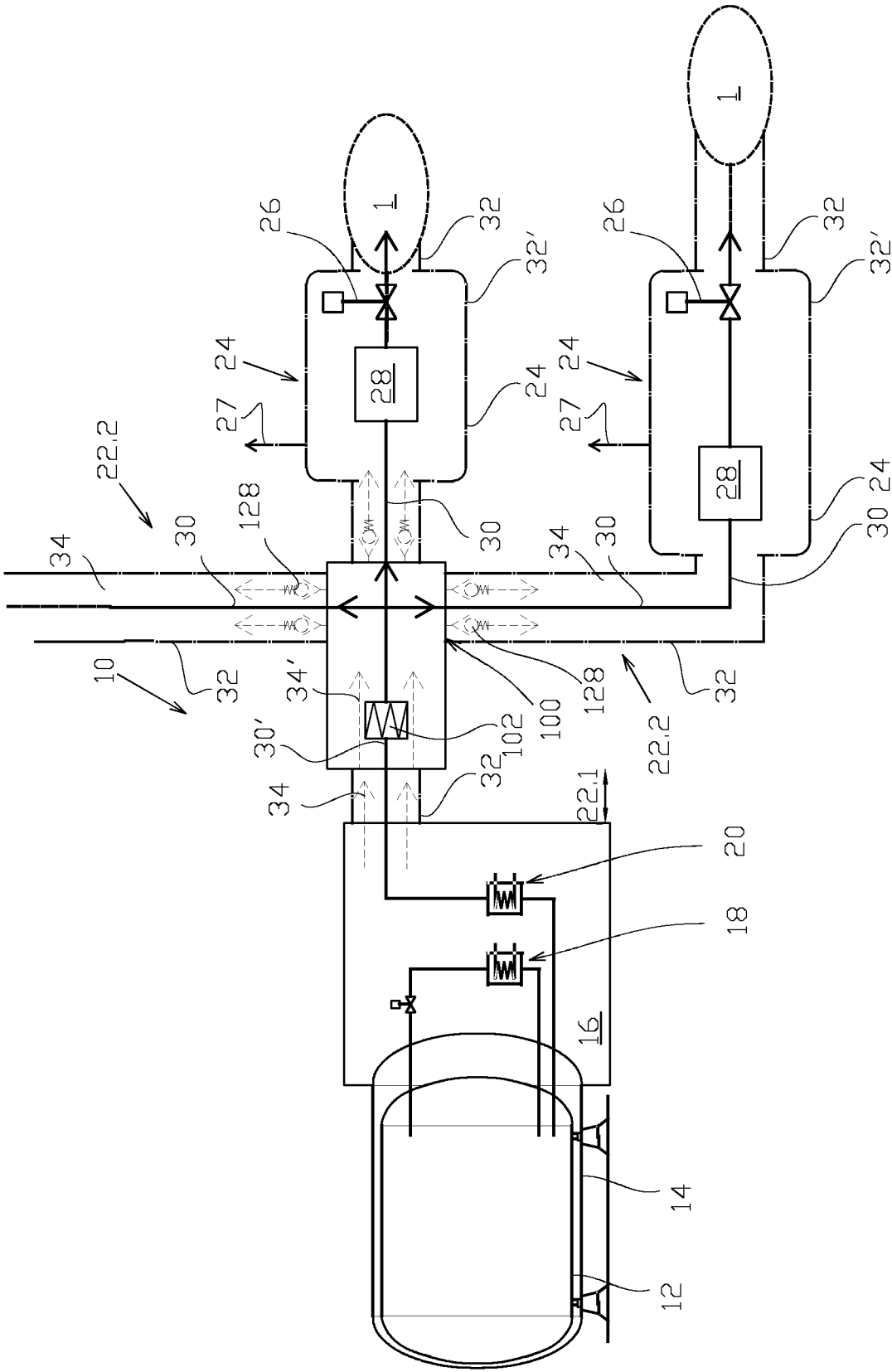


FIG. 5

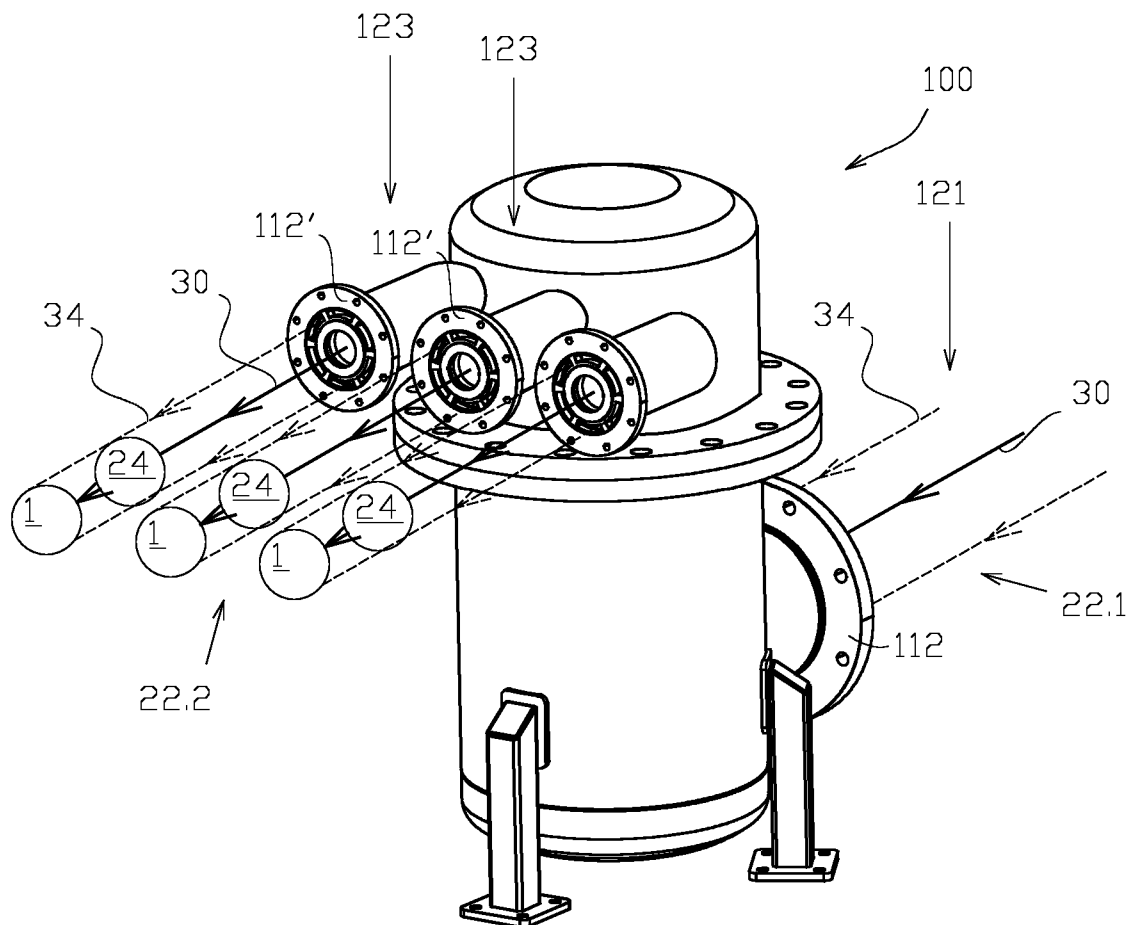


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/054191

A. CLASSIFICATION OF SUBJECT MATTER		
INV.	F02M21/02 F02M69/46	F02M55/00 F16L41/02
	F02M65/00 F16L41/00	F17C9/02 F16L39/00
ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) F02M F17C F16L		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2018/134437 A1 (ELTRONIC AS [DK]) 26 July 2018 (2018-07-26) page 1, line 9 - line 14 page 13, line 14 - page 15, line 4; figures 1, 2, 4, 5 page 18, line 10 - line 32; figures 12, 14, 21-25	1-15
X	WO 2018/087417 A1 (WAERTSILAE FINLAND OY [FI]) 17 May 2018 (2018-05-17) page 1, line 7 - line 28 page 3, line 28 - line 33 page 5, line 18 - page 8, line 24; figures 4, 6	1-5
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 9 October 2019		Date of mailing of the international search report 16/10/2019
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Rauch, Vincent

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2019/054191

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 3 098 430 A1 (CATERPILLAR MOTOREN GMBH & CO [DE]) 30 November 2016 (2016-11-30) paragraph [0026] - paragraph [0052]; figures 1, 2 -----	1-15
A	EP 2 589 791 A1 (CATERPILLAR MOTOREN GMBH & CO [DE]) 8 May 2013 (2013-05-08) paragraph [0027] - paragraph [0039]; figure 2 -----	6,7, 11-13

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Information on patent family members

International application No

PCT/EP2019/054191

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EP 2589791 A1	08-05-2013	CN 104040163 A EP 2589791 A1 KR 20140073558 A WO 2013064230 A1	10-09-2014 08-05-2013 16-06-2014 10-05-2013