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(54) **LOW PRESSURE FUEL MANAGEMENT AND DELIVERY SYSTEM FOR A LIQUEFIED NATURAL GAS RAIL LOCOMOTIVE TENDER**

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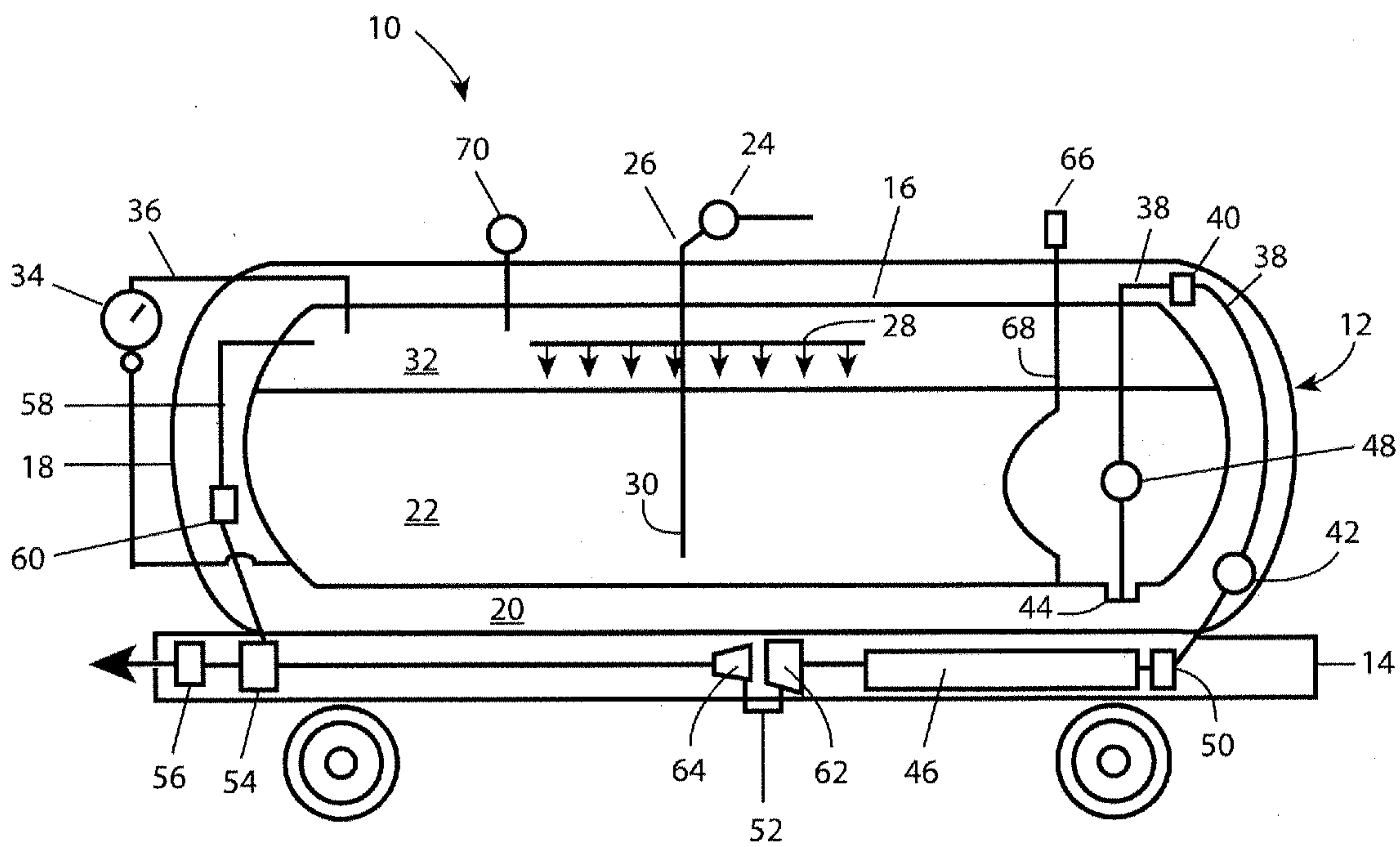
(57) **ABSTRACT**

A low-pressure fuel management and delivery system 10 for a liquefied natural gas (LNG) rail tender is disclosed. The system provides a rail tender that is inherently safer in operation to known LNG rail tenders through its use of a double-hulled tank design 12, which lacks any penetration of the bottom surface of the first inner tank 16 by any portion of the fuel supply portion of the system 10; the lower pressure storage of the fuel 22 in the first inner tank 16; the inclusion of a gas return line 58 for directing fuel 22 trapped in the LNG flow lines 38, the heat exchanger 46, or the multistage gas compressor 52 to the vapor space 32 of the first inner tank 16 at safe pressures and temperatures; the lack of cryogenic pumps within the first inner tank 16 to drive the fuel supply portion of the system 10; and the location of all the flow controlling valves 40, 42, 50, and 56 in positions that afford them improved physical protection from potential damage due to vehicular collisions or other railroad accidents. During operation, the fuel management and delivery system 10 provides required fuel flow rates and temperatures to an associated locomotive through the use of hydrostatic pressure differences between the LNG fuel 22 and the vapor space 32 within first inner tank 16, as well as a heat exchanger 46 and a multi-stage compressor 52, which are preferably located external of the double-hulled fuel storage tank 12, but on the same rolling stock chassis 14.



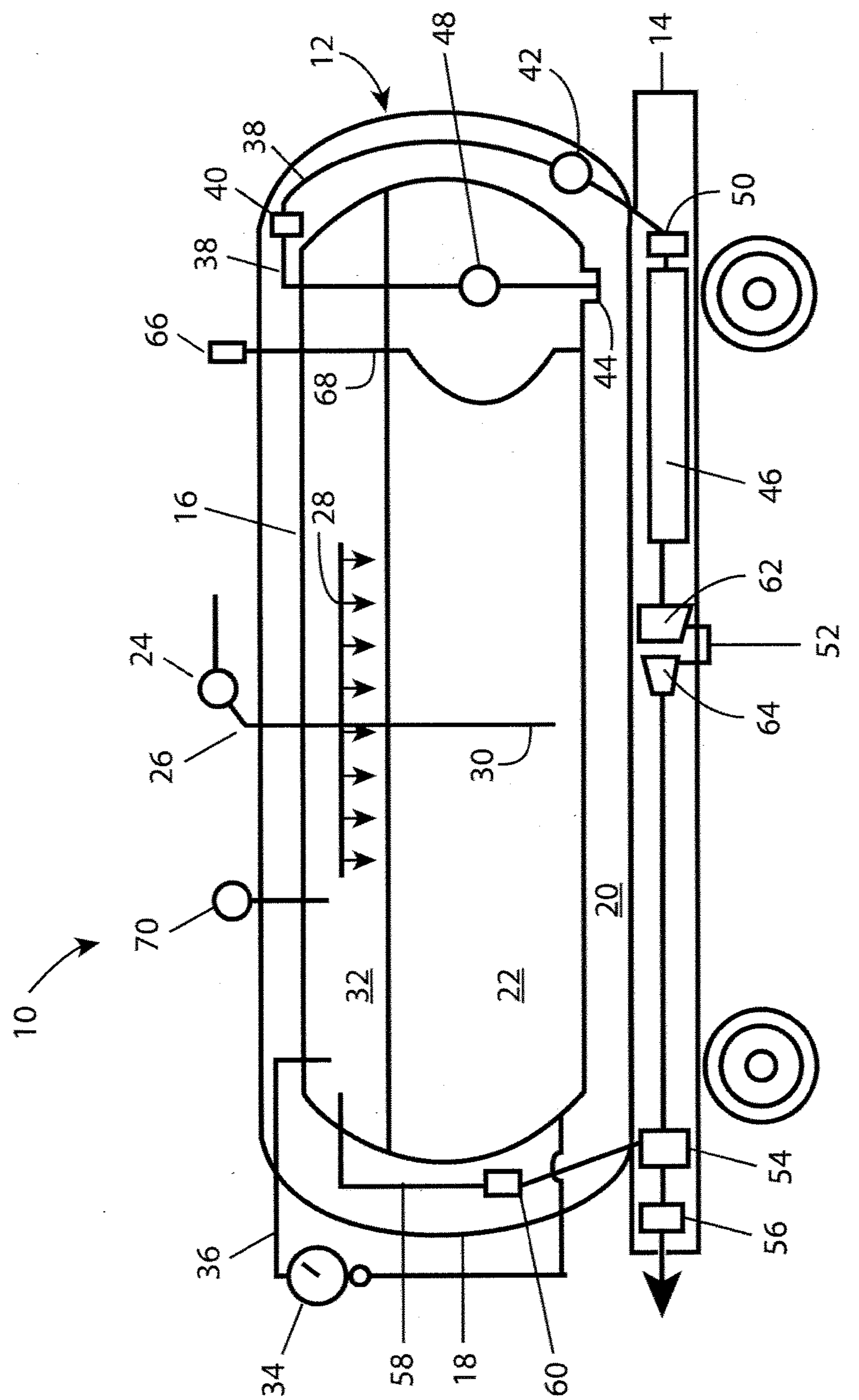

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Figure 1

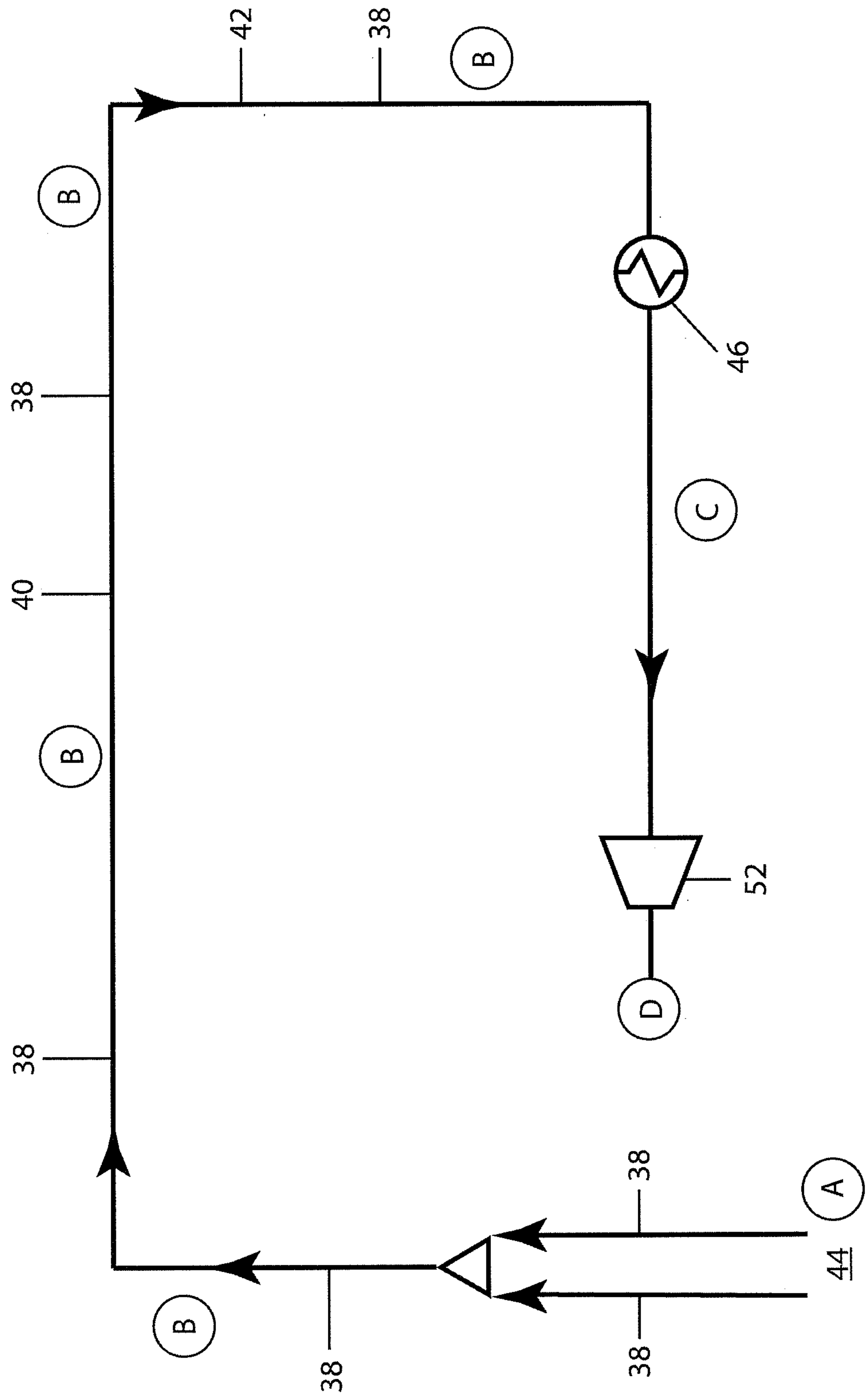

Figure 2

LOW PRESSURE FUEL MANAGEMENT AND DELIVERY SYSTEM FOR A LIQUEFIED NATURAL GAS RAIL LOCOMOTIVE TENDER

FIELD OF THE DISCLOSURE

[0001] The invention relates in general to a fuel management and delivery system. More particularly, the present invention relates to a fuel management and delivery system for a locomotive tender. More precisely, the invention relates to a liquefied natural gas fuel management and delivery system for a locomotive tender suitable for operating at low positive gage pressures or near-atmospheric pressures.

BACKGROUND OF THE DISCLOSURE

[0002] While rail moves only sixteen percent of freight by weight in the United States, it is the second most used means of transportation for freight, and by far its most efficient mode of transportation. With the growing concerns of the environmental impacts due to the burning of fossil fuels and transportation sector occupying the second place on the list of industries that contribute the most to the United States' annual greenhouse gas emissions, railroads are seeking, legislators are demanding, and regulators have established requirements for more fuel efficient and environmentally-friendly locomotives to help move the nation's freight. One fuel source that can ameliorate some of these concerns is liquefied natural gas (LNG).

[0003] In addition, because of significantly increased production of and self-sufficiency in natural gas in the United States, the costs of natural gas and LNG per unit of energy are lower, almost by half, compared to unit energy costs of diesel and other petroleum based fuels. The cost advantage in using LNG as a locomotive fuel is an additional incentive for the rail industry, which in recent years has spent over $11 billion for locomotive (diesel) fuel cost annually.

[0004] When natural gas, in its gaseous condition at atmospheric pressure and temperature, is cooled to 111 Kelvin (−260 degrees Fahrenheit) it becomes a liquid (LNG) at atmospheric pressure. Because of this liquefaction, the volume of the gaseous phase is reduced by a factor of more than 600 to form the liquid resulting in a significant increase in energy density (energy per unit volume, at atmospheric pressure). Therefore, the liquid (LNG) can be carried efficiently in manageable volumes, in locomotive tenders, to provide the necessary energy to run a locomotive on natural gas.

[0005] While natural gas is a potential solution to many of the present problems related to the continued use of coal, diesel fuel, or other hydrocarbon based fuel sources, the carriage of LNG in tenders comes with its own challenges, not the least of which is safety. To supply the locomotive engine gaseous natural gas at an engine-desired temperature and pressure (normally above 278 K [40° F.] and above 7 barg [100 psig], respectively) from a tender, it is necessary to maintain a LNG flow through a heat exchanger located on the tender. In one design, the LNG tank on the tender is maintained at a significant pressure (about 8.3 barg [120 psig] to 9.7 barg [140 psig]) to sustain the LNG flow and to provide the desired gaseous pressure to the engine. The higher the tender tank pressure the greater is the potential hazard area, if LNG is released from the tender due to an accident. As a result, concerns have arisen about the safety of current higher tank pressure based operational and design standards used for LNG rail tenders and the systems used to delivery such fuel from the tender to the locomotive. Alternatively, LNG can be maintained inside the tank at a relatively low positive gage pressure and the LNG flow pressure can be boosted through the heat exchanger by providing an electrically operated cryogenic pump inside the tank. Fixing pump failures and maintenance of a pump submerged in a very cold (111 K [−260° F.]) liquid pose technical and cost challenges.

[0006] The invention is a fuel management and delivery system for use on a liquefied natural gas rail locomotive tender which is suitable for operation at a lower storage tank pressure, while satisfying the temperature and pressure requirements for maintaining the natural gas in a liquid state and still satisfying the load demand requirements of its associated locomotive.

SUMMARY OF THE DISCLOSURE

[0007] An embodiment of the present invention provides a fuel management and delivery system that may supply liquefied natural gas (LNG) fuel from a rail tender to a locomotive at or near atmospheric pressures without requiring submerged, internal cryogenic pumps or penetration of the bottom of the tender's inner LNG tank.

[0008] A rail tender incorporating a low-pressure fuel management and delivery system for supplying liquefied natural gas according to one embodiment of the present invention includes a rolling stock base for supporting elements of the fuel management and delivery system and a double-hulled, pressurized LNG tank. The rolling stock base includes an upper support surface for carrying either a fully-integrated, partially-integrated, or removable double-hulled, pressurized LNG tank. The support surface of the rolling stock base may additionally house or have integrated into it various elements of the fuel management and delivery system.

[0009] The doubled-hulled, pressurized LNG tank includes a first inner tank and a second outer tank. The first inner tank is generally made of stainless steel, but can be made of any other material suitable to maintain the liquefied natural gas at temperatures at or below 111 K (−260° F.), while ensuring the required structural rigidity and strength needed for safe operation. The second outer tank is generally constructed of carbon steel to provide a protective envelope for the first inner tank and to maintain a near vacuum condition in the annular volume space between the inner and outer tanks. In addition, the purpose of the outer tank is to provide additional protection against damage to the inner tank in the event of an accident that would otherwise damage the first inner tank. The annular space between the first inner tank and the second outer tank is maintained at or near vacuum and filled with insulative materials for maintaining the first inner tank at or below a desired temperature. Further, the annular space may include various elements of the fuel management and delivery system.

[0010] In operation, the liquefied natural gas is fed from the cryogenically-maintained first inner LNG fuel tank via an insulated pipe to a heat exchanger located outside the double-hulled, pressurized LNG fuel tank. The heat exchanger vaporizes the liquefied natural gas at low gage pressures. The vaporized liquefied natural gas may then be fed to a gas compressor to raise its pressure in accordance with the operational needs of the locomotive. In an alternative embodiment of the invention (not shown), a liquid compressor (instead of a gas compressor) may be located on the rolling stock, external to the tanks and before the heat exchanger in the LNG flow path to boost the liquid pressure to that desired by the locomotive engine and to vaporize the higher-pressure liquid in the heat exchanger. The higher-pressure vaporized liquefied natural gas is then fed to the locomotive via a flexible hose across the coupler between locomotive engine and the LNG fuel rail tender.

[0011] Additional advantages of the disclosure are set forth in, or will be apparent to those of ordinary skill in the art, from the detailed description as follows. It should also be appreciated that modifications and variations to the specifically illustrated and discussed features and materials hereof may be practiced in various embodiments and uses of this disclosure without departing from the spirit and scope thereof. Such variations may include, but are not limited to, substitutions of equivalent individual elements, means, features, and materials for those shown or discussed, and the functional or positional reversal of various parts, features or the like.

[0012] Still further, it is to be understood that different embodiments of this disclosure may include various combinations or configurations of presently disclosed features, elements, or their equivalents (including combinations of features or configurations not expressly shown in the figures or stated in the detailed description).

[0013] These and other features, aspects and advantages of the present disclosure will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate at least one embodiment and, together with the descriptions, serve to explain the principles of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] A full and enabling disclosure, directed to one of ordinary skill in the art, is set forth in this specification, which makes reference to the appended figures, in which:

[0015] FIG. **1** is a conceptual view of one embodiment of the invention showing a system for delivering liquefied natural gas fuel; and

[0016] FIG. **2** is a sectional view illustrating a rail tender including a liquefied natural gas storage tank and a system for delivering liquefied natural gas fuel according to an embodiment of the present invention.

[0017] Repeated use of reference characters throughout the present specification and appended drawings is intended to represent the same or analogous features or elements of the present disclosure.

DETAILED DESCRIPTION

[0018] Reference will now be made in detail to a presently preferred embodiment or embodiments of the disclosure, examples of which are fully represented in the accompanying drawings. Such examples are provided by way of explanation of the disclosure, not a limitation thereof It should be apparent to those of ordinary skill in the art that various modifications and variations can be made to the presently disclosed embodiments without departing from the spirit and scope thereof For instance, features illustrated or described as part of one embodiment may be used on another embodiment to yield a further embodiment. Still further, variations in selection of materials and/or characteristics may be practiced, to satisfy particular desired user criteria. Thus, it is intended that the present disclosure cover such modifications and variations as coming within the scope of the present features and their equivalents.

[0019] As disclosed above the present invention is particularly concerned with a LNG fuel management and delivery system for a rail tender. In one preferred embodiment of the invention as depicted in FIG. **1**, a pressurized LNG rail tender **10** is provided. The LNG rail tender **10** includes a double-hulled tank **12** that rests on or may be fully- or partially-integrated into a rolling stock chassis **14**. The rolling stock chassis **14** and double-hulled tank **12** maybe sized to fit any gauge rail tracks for operation, including standard American gauge tracks of 1435 mm (4 feet, 8.5 inches).

[0020] Double-hulled LNG fuel tank **12** is comprised of a first inner tank **16** and a second outer tank **18**. The first inner tank **16** is a cryogenic tank intended to maintain the natural gas in a refrigerated liquid state for extended periods of time. The inner tank **16** may be made of stainless steel or any other suitable material sufficient to withstand the significantly lower operating temperatures to which it is exposed, while also providing sufficient structural integrity to serve as a pressure vessel for containing the LNG fuel **22**.

[0021] The second outer tank **18** of the double-hulled LNG fuel tank **12** serves as a protective envelope for the first inner tank **16**. Outer tank **18** may be made of carbon steel or other suitable material to maintain a vacuum in the annular space and to provide durability and protection to first inner tank **16** in the event of a collision or derailment of the rolling stock chassis **14**.

[0022] The annular space **20** between first inner tank **16** and second outer tank **18** is preferably maintained in a vacuum to allow the inner and outer tanks **16** and **18** to work in coordination to significantly reduce the transmission of heat to the first inner tank **16**. When in use, first inner tank **16** may be maintained between 0.1 Mpa and 0.27 Mpa absolute (0 and 25 psig), which corresponds to between 111 K and 125 K (−260 and 235° F.), in order to maintain the natural gas fuel **22** in a liquid state. To further assist in the prevention of heat transfer to the cryogenic liquid in first inner tank **16**, the annular space between the first inner tank **16** and the second outer tank **18** may be filled with an insulative substance, including closed-cell foam and other known insulating materials.

[0023] Alternatively, the first inner tank **16** may be wrapped in several layers of thin insulation material of extremely low thermal conductivity. Additionally, component elements of the fuel management and delivery system may be run within the annular space between the first inner tank **16** and the second outer tank **18** to provide both insulative and physical protection to the system components.

[0024] In use, the first inner tank **16** is filled with LNG fuel **22** through a liquid fill line with a shut off valve **24** located along the top of the second outer tank **18**. Fill shut off valve **24** is preferably a solenoid valve to allow for remote operation and the near-instantaneous termination of LNG fuel flow into the inner tank **16**. Fill shut off valve **24** is in fluid communication with the first inner tank **16** via a fill pipe **26**. Fill pipe **26** may be terminated within the first inner tank **16** by a sparging head **28**, or a pipe **30** that allows the first inner tank **16** to fill from the bottom.

[0025] In this preferred embodiment of the invention, the fill pipe **26** penetrates only the upper surfaces of both the first inner tank **16** and the second outer tank **18**. Fill operations are managed by on-board program logic controllers (not shown) and the flow control or shut off valve **24** in order to ensure the vapor space **32** of the first inner tank **16** is maintained at the desired pressure.

[0026] As filling operations for an LNG fuel tank **16** are generally performed using a closed-loop system—meaning any vapor displaced from the first inner tank **16** by LNG fuel **22** is recirculated to the vessel from which the LNG fuel **22** is provided—a means for determining the liquid fill level of the first inner tank **16** must be included. In this preferred embodiment of the invention, a differential pressure gauge **34** may be utilized to measure the hydrostatic head difference between the bottom of the liquid-filled first inner tank **16** and the vapor space **32** within first inner tank **16**. Gauging line **36** at one end may penetrate near the bottom of first inner tank **16** in fluid communication with the LNG fuel **22**. At its other end, after passing through differential pressure gauge **34**, gauging line **36** may penetrate near the top of first inner tank **16** so as to be in fluid communication with the vapor space **32** inside the first inner tank **16**. The markings on the differential pressure gage **34** may be calibrated to correspond to different liquid depths in the first inner tank **16**. Such arrangement allows a fill operator to easily monitor the depth of liquid (and from it the volume of liquid in the first inner tank **16**) at any time and to ensure that overfill of the first inner tank **16** does not occur.

[0027] In normal train operation, the fuel management and delivery system **10** serves to provide

[0028] LNG at the desired flow rate to the heat exchanger **46**. The heat exchanger vaporizes the liquid into a gaseous phase at about the same pressure as of the liquid **22**. Using only the pressure of the vapor space **32** in the first inner tank **16** and the hydrostatic pressure of liquid in the first inner tank **16**, the system **10** pushes fuel **22** from the first inner tank **16** through LNG flow line **38** past both a safety shutoff valve **40** and through a flow rate control valve **42**. Preferably, both control valves **40** and **42** are solenoid values providing an additional level of safety and LNG flow rate controllability; where in the event of a loss of electrical power the valves close automatically and terminate fluid flow to the associated locomotive.

[0029] First inner tank **16** has a sump **44**. The flow of LNG fuel **20** begins within the sump **44** where the lower end of LNG flow line **38**, preferably made of stainless steel, is submerged. Within the sump **44**, the hydrostatic pressure differential between the LNG fuel **20** and the vapor space **32** is the greatest. When safety shut off valve **40** and flow rate control valve **42** are open, LNG fuel **20** will flow through LNG flow line **38** to heat exchanger **46**. To ensure that no LNG fuel flows backward through the system, that portion of LNG flow line **38** within the first inner tank **16** may include a check valve **48**.

[0030] Along its entire length, LNG flow line **38** is preferably located within the annular space **20** between the first inner tank **16** and the second outer tank **18** as best seen in FIG. **1**. This placement serves to both further insulate the LNG flow line **38** from heat transfer from outside the second outer tank **18** and to take advantage of the physical security provided by the structural strength and rigidity of the second outer tank **18** in the event of an accident. Alternatively, LNG flow line **38** could run outside second outer tank **18**, but it would need to be heavily insulated to ensure the LNG fuel **22** within the flow line **38** remained below its saturation temperature.

[0031] In this embodiment of the invention, before exiting LNG flow line **38** and entering the heat exchanger **46**, the LNG fuel **22** passes through a manual flow shut off valve **50**. Within the heat exchanger, the LNG fuel **22** may interact with an external heat source in any of the known methods of heat exchange. One such example is through the use of a closed loop of glycol (not shown) that may be heated by the locomotive's exhaust gas heat.

[0032] Once converted back into a gaseous form within the heat exchanger **46**, the natural gas fuel **22** may be sent through a multistage compressor **52**. The multistage compressor **52** may be designed and/or operated to ensure that the gaseous form fuel exiting the compressor **52** corresponds closely to the gas specification required by the locomotive for its use. Such gaseous fuel may be transported across the rail coupler to the associated locomotive using any known delivery method.

[0033] Any required modification to either the pressure or temperature of the gaseous form fuel exiting the compressor may be achieved by the use of a gas flow control valve **54** and a pressure throttle valve **56**. As with the safety shut off valve **40** and the flow rate control valve **42**, gas flow control valve **54** and pressure throttle valve **56** are preferably solenoid valves controlled by on-board program logic controllers (not shown). Additionally, as part of the system's inherent safety features, gas flow control valve **54** is a three-way valve connecting the high temperature, high pressure gaseous fuel flow to the fuel delivery line crossing the coupler to the associated locomotive or alternatively to gas return line **58**.

[0034] In the event of a sudden decrease in the locomotive demand for fuel, in the presently preferred embodiment of the invention, the excess gas flow may be directed by gas flow control valve **54** to gas return line **58** for return to the first inner tank's vapor space **32**. Along gas return line **58** is a pressure throttle valve **60** suitable to reduce the pressure of the gaseous fuel entering the first inner tank **16**. In addition to the use of such gas pressure throttle valve **60**, the present invention contemplates redirecting the gaseous fuel flow from the lower pressure initial stage(s) **62** of the multi-stage compressor **52** instead of either directly from the latter higher pressure stages **64** of the compressor **52** or via the gas flow control valve **54** in order to enhance safer operation of the system **10** during such situations. These alternative flow paths are not shown in the figures.

[0035] In the event of a complete termination of demand for fuel or an emergency requiring immediate gas flow shut off to the associated locomotive, the presently preferred embodiment of the invention provides for the on-board program logic controllers to close all solenoid flow control valves, including safety shut off valve **40**, flow rate control valve **42**, gas flow control valve **54**, and pressure throttle valve **56**. The higher-pressure gas fuel trapped between the exit of the multistage compressor **52** and the coupler may be directed through gas flow control valve **54** to gas return line **58** and ultimately back to the vapor space **32** within the first inner tank **16**. The LNG remaining in the heat exchanger **46** may be allowed to slowly evaporate and the evaporated gas may be compressed by the first stage **62** of the multistage compressor **52** and may be directed to the vapor space **32** of the first inner tank **16** via the gas return line **58** and gas pressure throttle valve **60**.

[0036] The presently preferred embodiment contemplates multiple methods for the emergency evacuation of LNG fuel **22** from the first inner tank **16**. A first method is contemplated that works regardless of the orientation of the rail tender provided the first inner tank **16** is without damage or puncture to first inner tank **16**. First, all program logic controlled solenoid flow control valves **40**, **42**, **54**, and **56** are closed. Manual shut off valve **66** is opened. Valve **66** is in fluid communication with a flexible evacuation hose **68** that is longer than the internal diameter of the first inner tank **16** so that its end may always find the lowest point within the first inner tank **16**, irrespective of the orientation of the first inner tank **16**. To evacuate the LNG fuel **22** from the first inner tank **16**, emergency tank pressurization valve **70** is opened and connected to a higher-pressure source of a non-flammable gas, such as nitrogen. When first inner tank **16** is pressurized, the remaining LNG fuel **22** will be forced through the flexible evacuation hose **68** past open manual shut off valve **66** to a connected alternative storage solution.

[0037] An alternative embodiment of the present invention envisions manual flow shut off valve **50** as a three-way valve. Such embodiment provides an alternative means for removing LNG fuel **22** from first inner tank **16**, provided the rail tender is generally upright and lacks any damage or punctures. Using the hydrostatic pressure between the LNG fuel **22** and the vapor space **32**, with safety shut off valve **40** and flow control valve **42** both open, the remaining LNG fuel **22** may be driven through LNG flow line **38** toward manual flow shut off valve **50**. The evacuated LNG fuel **22** could be directed through manual flow shut off valve **50** to a connected alternative storage solution.

[0038] In yet another embodiment, emergency tank pressurization valve **70** could additionally serve as a bleed or venting valve allowing the release of boil off gas vapors in those situations requiring longer-term storage of LNG fuel **22** within the first inner tank **16**. Such venting would be necessary only for storage over twenty one days or where the lower pressure operation of the first inner tank necessitates. Venting of such boil off vapors would allow the remaining LNG fuel **22** to self-refrigerate.

[0039] As best seen in FIG. **2**, some exemplary pressure and temperature measurements at points along the fuel delivery portion of the management and delivery system **10** are provided for a LNG flow rate of **38** liters/min (**10** gpm) through the heat exchanger **46** and valve **56**. Within first inner tank **16** in sump **44** at location A, the head pressure of the LNG fuel **22** may be approximately 0.2 MPa absolute (14-15 psig) at an approximate temperature of 120.4 K (−243° F.). As the LNG fuel **22** passes through insulated LNG flow line **38**, safety shut off valve **40**, and flow rate control valve **42** at location B there is only a one to one and half degree Kelvin (two to three ° F.) increase in the temperature of the fuel **22**. Similarly, the pressure drop along this path is only 0.014 MPa to 0.02 MPa (two to three psig).

[0040] Upon exiting the heat exchanger **46** at location C, having associated with the high temperature glycol flow heated by the associated locomotive's exhaust gases to approximately 322 K (120° F.), the temperature of the vapor produced by the fuel **22** rises to approximately 216 K (−71° F.) with a negligible pressure drop. Finally, as the now gaseous form natural gas fuel **22** passes through the multi-stage compressor, it exits at location D at a temperature of approximately 284 K (52° F.) and a pressure of approximately 1 Mpa (130 psig)—suitable for use by the associated locomotive.

[0041] Although a detailed description of at least one preferred embodiment of the present disclosure has been expressed using specific terms and devices, such description is for illustrative purposes only. The words used are words of description rather than of limitation. It is understood that changes and variations may be made by those of ordinary skill in the art without departing from the spirit or scope of the present disclosure, which is set forth in the following claims. Additionally, it should be understood that aspects of various other embodiments may be interchanged either in whole or in part. Therefore, the spirit and scope of the appended claims should not be limited to the detailed description contained herein.

What is claimed is:

1. A liquefied natural gas fuel management system for a railroad locomotive, said system comprising:

an insulated rail tank car secured to a rolling stock chassis, said insulated rail tank car suited to retain liquefied natural gas fuel;

wherein a fuel delivery system is located within said insulated rail tank car and said rolling stock chassis; and

wherein said fuel delivery system operates at gage pressures between 0.1 MPa absolute to 0.27 MPa absolute (0 and 25 psig).

2. The system of claim **1**, wherein said insulated rail tank car is a double-hulled tank car.

3. The system of claim **2**, wherein an annular space between said double-hulls of said tank car is held in at a vacuum pressure and filled with insulating material.

4. The system of claim **2**, wherein said fuel delivery system comprises,

a liquid fuel flow line having a first end in fluid communication with said liquefied natural gas fuel inside said double-hulled tank car and a second end in fluid communication with a heat exchanger;

a safety shutoff valve, a fluid flow rate valve, and a manual shutoff valve, all in fluid communication with said liquid fuel flow line between said first end and said second end; and

a heat exchanger in fluid communication with said second end of said liquid fuel flow line, said heat exchanger suited to convert said liquefied natural gas to a gaseous form for use by said rail locomotive.

5. The system of claim **4**, wherein said fuel delivery system further comprises,

a gaseous fuel flow line segment having a first end in fluid communication with said heat exchanger and a second end in fluid communication with said rail locomotive;

a compressor in fluid communication with said gaseous fuel flow line segment and located between said heat exchanger and said gaseous fuel flow line segment second end for increasing the pressure of the gaseous form natural gas for use by said rail locomotive.

a gas flow control valve in fluid communication with said gaseous fuel flow line segment between said compressor and said gaseous fuel flow line segment second end;

a pressure throttle valve in fluid communication with said gaseous fuel flow line segment between said compressor and said gaseous fuel flow line segment second end; and

wherein said gas flow control valve and said pressure throttle valve serve to modify the pressure or temperature of the gaseous form natural gas fuel as needed before it is supplied to the rail locomotive via said gaseous fuel flow line segment second end.

6. The system of claim **5**, wherein said safety shutoff valve, fluid flow rate valve, gas flow control valve, and said pressure throttle valve are all solenoid valves.

7. The system of claim **5**, wherein said compressor is a multistage compressor.

8. The system of claim **1**, wherein said insulated rail tank car is filled using a differential pressure gauge measuring the hydrostatic head difference between the bottom of said insulated rail tank car and the vapor space within said insulated rail tank car to insure sufficient internal pressure for the system to function properly.

9. An integrated liquefied natural gas fuel management and delivery system for a railroad locomotive, said system comprising:

a double-hulled insulated rail tank car secured to a rolling stock chassis;

wherein a fuel delivery portion of said system is located between a first inner tank and a second outer tank of said double-hulled rail tank car and within said rolling stock chassis; and

wherein said integrated fuel management and delivery system operates at gage pressures between 0.1 MPa absolute to 0.27 MPa absolute (0 and 25 psig).

10. The integrated system of claim **9**, wherein an annular space between said first inner tank and said second outer tank is held in at a vacuum pressure and filled with insulating material.

11. The integrated system of claim **10**, wherein said first inner tank is a cryogenic tank and said second outer tank is a protective shell surrounding said first inner tank.

12. The integrated system of claim **10**, wherein said first inner tank maintains liquefied natural gas between 0.1 MPa absolute to 0.27 MPa absolute (0 and 25 psig) and between 111 K and 125 K (−260° F. and −235° F.).

13. The integrated system of claim **12**, wherein said fuel delivery portion of said integrated system comprises:

a liquid fuel flow line having a first end in fluid communication with said liquefied natural gas inside said first inner tank and a second end in fluid communication with a heat exchanger;

a safety shutoff valve, a fluid flow rate valve, and a manual shutoff valve, all in fluid communication with said liquid fuel flow line between said first end and said second end;

a heat exchanger in fluid communication with said second end of said liquid fuel flow line, said heat exchanger suited to convert said liquefied natural gas to a gaseous form for use by said rail locomotive; and

a compressor in fluid communication with said liquid fuel flow line and located before said heat exchanger with regard to the direction of fuel flow along said liquid fuel flow line, said compressor suited to increase the pressure of the liquefied natural gas prior to its passage into said heat exchanger.

14. The integrated system of claim **13**, wherein said fuel flow line further comprises,

a gaseous fuel flow line segment having a first end in fluid communication with said heat exchanger and a second end in fluid communication with said rail locomotive;

a gas flow control valve in fluid communication with said gaseous fuel flow line segment between said compressor and said gaseous fuel flow line segment second end;

a pressure throttle valve in fluid communication with said gaseous fuel flow line segment between said compressor and said gaseous fuel flow line segment second end; and

wherein said gas flow control valve and said pressure throttle valve serve to modify the pressure or temperature of the gaseous form natural gas fuel as needed before it is supplied to the rail locomotive via said gaseous fuel flow line segment second end.

15. The integrated system of claim **14**, wherein said safety shutoff valve, fluid flow rate valve, gas flow control valve, and said pressure throttle valve are all solenoid valves.

16. The integrated system of claim **15**, wherein said compressor is a multistage compressor.

17. The integrated system of claim **9**, wherein said system lacks any penetration of the bottom of said first inner tank.

18. An integrated liquefied natural gas fuel management and delivery system for use with a rail locomotive, wherein said system is capable of supplying said rail locomotive gaseous form natural gas at pressures and temperatures required for operation while retaining said liquefied natural gas between 0.1 MPa absolute to 0.27 MPa absolute (0 and 25 psig).

19. The integrated liquefied natural gas fuel management and delivery system of claim **18**, wherein said system includes a gaseous fuel recovery system comprising:

a plurality of shutoff valves and a plurality of fuel flow control valves, including a gas flow control valve, in fluid communication with a fuel delivery line running from a liquefied natural gas fuel source to said rail locomotive;

wherein said plurality of fuel flow control valves serve to regulate the pressure of said fuel through said fuel delivery line to said rail locomotive; and

wherein said plurality of shutoff valves serve to terminate the flow of fuel to the rail locomotive in the event of a cessation of demand for fuel.

20. The integrated liquefied natural gas fuel management and delivery system of claim **19**, wherein said three-way gas flow control valve, in the event of a termination of fuel demand from said rail locomotive, serves to redirect any fuel remaining in the fuel delivery line back to a vapor space within said liquefied natural gas fuel source at a pressure between 0.1 MPa absolute to 0.27 MPa absolute (0 and 25 psig).

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