The heat exchanger may include a heat radiating portion provided with first, second, and third connecting lines formed by stacking a plurality of plates, and adapted to receive first, second, and third operating fluids respectively into the first, second, and third connecting lines, the first, second, and third operating fluids exchanging heat with each other during passing through the first, second, and third connecting lines and the first, second, and third operating fluids supplied to the first, second, and third connecting lines not being mixed with each other and being circulated; first, second, and third inlets connected respectively to the first, second, and third connecting lines so as to supply the first, second, and third operating fluids respectively to the first, second, and third connecting lines; and first, second, and third outlets connected respectively to the first, second, and third connecting lines.
FIG. 2

100
FIG. 7

100 Liquid refrigerant of low temperature and low pressure

(S1)

111

131 Bomb

121 LPG fuel

100

(S2)

111

123

133 Compressor

141

151

(S3)

111

125

135

143

153

145

Gas refrigerant of moderate temperature and high pressure
HEAT EXCHANGER FOR LPI VEHICLE

CROSS-REFERENCE TO RELATED APPLICATION


BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a heat exchanger for an LPI vehicle. More particularly, the present invention relates to a heat exchanger for an LPI vehicle that is adapted for an LPG fuel to exchange heat with a refrigerant circulating through the air conditioning so as to cool the LPG fuel.

[0004] 2. Description of Related Art

[0005] Generally, an LPI (Liquefied Petroleum Injection: an apparatus for injecting LPG fuel in a liquid state) engine, different from mechanical injection type of LPG fuel depending on a pressure of a bomb, is provided with a fuel pump mounted in the bomb. The LPG fuel is pressurized to a high pressure (5 to 15 bar) and is liquefied by the fuel pump. The liquefied fuel is injected to a cylinder by using an injector so as to drive the engine.

[0006] Since the LPI engine is adapted to inject liquefied fuel, components such as a vaporizer and a mixer are not necessary. Instead, a high-pressure injector, a fuel pump mounted in the bomb, a fuel supply line, electric control apparatus (ECU) for the LPI engine, and a regulator unit for controlling fuel pressure are additionally necessary.

[0007] The electric control apparatus of the LPI engine receives input signals from various sensors so as to determine a condition of the engine, and controls the fuel pump, the injector, and an ignition coil so as to achieve optimal air/fuel ratio and to improve engine performance.

[0008] In addition, the electric control apparatus controls the fuel pump according to fuel amount demanded by the engine so as to supply the liquefied fuel to the engine, and the LPI injector sequentially injects the fuel into the cylinders so as to achieve the optimal air/fuel ratio.

[0009] Since high-temperature fuel returned from the engine is returned to the bomb according to a vehicle to which a conventional LPI system is applied, however, a temperature of the LPG fuel in the bomb is raised and accordingly an internal pressure of the bomb is also heightened. Particularly, in a case that the internal pressure of the bomb is higher than a charging pressure of an LPG station, LPG fuel cannot be charged in the bomb.

[0010] Since an additional fuel cooling apparatus should be mounted on a return line so as to lower a temperature of the fuel returned from the engine, manufacturing and installing cost may increase and the LPI engine may be hard to be installed in a small engine compartment.

[0011] The information disclosed in this Background of the Invention section is only for enhancement of understanding of the general background of the invention and should not be taken as an acknowledgement or any form of suggestion that this information forms the prior art already known to a person skilled in the art.
and the third outlet is formed at a position opposite to the third inlet in a width direction on the other surface of the heat radiating portion.

[0021] The LPG fuel circulates through the first inlet, the first connecting line, and the first outlet, the gas refrigerant circulates through the second inlet, the second connecting line, and the second outlet, and the liquid refrigerant circulates through the third inlet, the third connecting line, and the third outlet.

[0022] The first connecting line is positioned at a center portion in the heat radiating portion, the second connecting line is positioned adjacent to the first connecting line at an upper portion of the heat radiating portion and is positioned apart from the first connecting line at a lower portion of the heat radiating portion, and fluid-communicates therebetween via a first intermediate hole formed in the plurality of plates, and the third connecting line is positioned above the second connecting line at the upper portion of the heat radiating portion and is positioned between the first connecting line and the second connecting line at the lower portion of the heat radiating portion and fluid-communicates therebetween via a second intermediate hole formed in the plurality of plates.

[0023] The first, second and third connecting lines are aligned as the third, the first, the first, and the second connecting lines from the upper portion to the lower portion of the heat radiating portion in sequence.

[0024] The gas refrigerant and the liquid refrigerant flow in opposite directions in the second connecting line and the third connecting line, respectively.

[0025] The first inlet is connected to the engine, the second inlet is connected to the condenser of the air conditioning, and the third inlet is connected to the evaporator of the air conditioning.

[0026] The first outlet is connected to a bonbe in which the LPG fuel is returned to and is stored in, the second outlet is connected to a compressor of the air conditioning, and the third outlet is connected to an expansion valve of the air conditioning.

[0027] The heat radiating portion is a heat radiating portion of plate type where the plurality of plates is stacked.

[0028] The methods and apparatuses of the present invention have other features and advantages which will be apparent from or are set forth in more detail in the accompanying drawings, which are incorporated herein, and the following Detailed Description, which together serve to explain certain principles of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] FIG. 1 is a schematic diagram of an air conditioning to which a heat exchanger for an LPI vehicle according to an exemplary embodiment of the present invention is applied.

[0030] FIG. 2 is a front perspective view of a heat exchanger for an LPI vehicle according to an exemplary embodiment of the present invention.

[0031] FIG. 3 is a rear perspective view of a heat exchanger for an LPI vehicle according to an exemplary embodiment of the present invention.

[0032] FIG. 4 is a cross-sectional view taken along the line A-A in FIG. 2.

[0033] FIG. 5 is a cross-sectional view taken along the line B-B in FIG. 2.

[0034] FIG. 6 is a cross-sectional view taken along the line C-C in FIG. 2.

[0035] FIG. 7 is a cross-sectional view for showing operation of a heat exchanger for an LPI vehicle according to an exemplary embodiment of the present invention.

[0036] It should be understood that the appended drawings are not necessarily to scale, presenting a somewhat simplified representation of various features illustrative of the basic principles of the invention. The specific design features of the present invention as disclosed herein, including, for example, specific dimensions, orientations, locations, and shapes will be determined in part by the particular intended application and use environment.

[0037] In the figures, reference numbers refer to the same or equivalent parts of the present invention throughout the several figures of the drawing.

DETAILED DESCRIPTION

[0038] Reference will now be made in detail to various embodiments of the present invention(s), examples of which are illustrated in the accompanying drawings and described below. While the invention(s) will be described in conjunction with exemplary embodiments, it will be understood that the present description is not intended to limit the invention(s) to those exemplary embodiments. On the contrary, the invention(s) is/are intended to cover not only the exemplary embodiments, but also various alternatives, modifications, equivalents and other embodiments, which may be included within the spirit and scope of the invention as defined by the appended claims.

[0039] An exemplary embodiment of the present invention will hereinafter be described in detail with reference to the accompanying drawings.

[0040] Exemplary embodiments described in this specification and drawings are just exemplary embodiments of the present invention. It is to be understood that there can be various modifications and equivalents included in the spirit of the present invention at the filing of this application.

[0041] FIG. 1 is a schematic diagram of an air conditioning to which a heat exchanger for an LPI vehicle according to an exemplary embodiment of the present invention is applied, FIG. 2 is a front perspective view of a heat exchanger for an LPI vehicle according to an exemplary embodiment of the present invention, FIG. 3 is a rear perspective view of a heat exchanger for an LPI vehicle according to an exemplary embodiment of the present invention, FIG. 4 is a cross-sectional view taken along the line A-A in FIG. 2, FIG. 5 is a cross-sectional view taken along the line B-B in FIG. 2, and FIG. 6 is a cross-sectional view taken along the line C-C in FIG. 2.

[0042] Referring to the drawings, a heat exchanger 100 for an LPI vehicle according to an exemplary embodiment of the present invention is adapted to cause a refrigerant circulating through an air conditioning and an LPG fuel returned from an engine 3 to a bonbe 5 to exchange heat with each other such that the LPG fuel, after a temperature thereof being lowered, is flowed into the bonbe. Therefore, the heat exchanger 100 is adapted to prevent an internal pressure of the bonbe from increasing.

[0043] In addition, the refrigerant and the LPG fuel exchange heat with each other, and a liquid refrigerant of moderate temperature and high pressure supplied from a condenser 20 and a gas refrigerant of low temperature and low pressure supplied from an evaporator 40 exchange heat with each other. Therefore, cooling efficiency of the refrigerant may be improved by using overcool effect. Therefore, the
heat exchanger 100 is adapted to prevent performance deterioration of the air conditioning and improve cooling performance.

[0044] Herein, the heat exchanger 100 for the LPI vehicle according to an exemplary embodiment of the present invention, as shown in FIG. 1, is used for the air conditioning including a compressor 10 for compressing the refrigerant, the condenser 20 for receiving the compressed refrigerant from the compressor 10 and condensing the refrigerant, an expansion valve 30 for expanding the liquid refrigerant condensed by the condenser 20, and the evaporator 40 for evaporating the refrigerant expanded by the expansion valve 30 through heat-exchange with air.

[0045] The heat exchanger 100 is adapted to cool the LPG fuel of high temperature returned from the engine 3 in the LPI vehicle using the LPG fuel through heat-exchange with the refrigerant.

[0046] For this purpose, the heat exchanger 100 for the LPI vehicle according to an exemplary embodiment of the present invention, as shown in FIG. 2 and FIG. 3, includes a heat radiating portion 110, a plurality of inlets 120, and a plurality of outlets 130, and each constituent element will be described in detail.

[0047] The heat radiating portion 110 is formed by stacking a plurality of plates 111, and a plurality of connecting lines is formed between the neighboring plates 111. In addition, a plurality of operating fluids exchanges heat with each other when passing through the plurality of connecting lines.

[0048] The heat radiating portion 110 is a heat radiating portion of plate type (or disk type) where the plurality of plates 111 is stacked.

[0049] Herein, the plurality of operating fluids may include the LPG fuel returned from the engine 3, the liquid refrigerant of moderate temperature and high pressure supplied from the condenser 20 of the air conditioning, and the gas refrigerant of low temperature and low pressure supplied from the evaporator 40.

[0050] According to the present exemplary embodiment, the plurality of inlets 120 is formed at a surface of the heat radiating portion 110 and the plurality of operating fluids flows into the heat radiating portion 110 through the plurality of inlets 120. The plurality of inlets 120 is connected to the plurality of connecting lines.

[0051] In addition, the plurality of outlets 130 corresponds to the plurality of inlets 120 and is formed at the other surface of the heat radiating portion 110. The plurality of operating fluids flowing in the heat radiating portion 110 is exhausted through the plurality of outlets 130. The plurality of outlets 130 is connected to the plurality of connecting lines.

[0052] Herein, the plurality of inlets 120 includes first, second, and third inlets 121, 123, and 125 that are formed at a surface of the heat radiating portion 110 and are disposed apart from each other in a length direction.

[0053] In addition, the plurality of outlets 130 includes first, second, and third outlets 131, 133, and 135 corresponding respectively to the first, second, and third inlets 121, 123, and 125, formed at the other surface of the heat radiating portion 110, and disposed apart from each other. The first, second, and third outlets 131, 133, and 135 are connected respectively to the first, second, and third inlets 121, 123, and 125 through the plurality of connecting lines 141, 143, and 145.

[0054] According to the present exemplary embodiment, the first inlet 121 is formed at a corner portion on the surface of the heat radiating portion 110, and the first outlet 131 is formed at a corner portion diagonally facing the first inlet 121 on the other surface of the heat radiating portion 110.

[0055] In addition, the second inlet 123 is formed at a corner portion opposite to the first inlet 121 in the length direction on the surface of the heat radiating portion 110, and the second outlet 133 is formed at a corner portion opposite to the second inlet 123 in a width direction on the other surface of the heat radiating portion 110.

[0056] In addition, the third inlet 125 is formed apart from the first inlet 121 in the length direction on the surface of the heat radiating portion 110, and the third outlet 135 is formed at a position opposite to the third inlet 125 in the width direction on the other surface of the heat radiating portion 110.

[0057] Herein, the LPG fuel circulates through the first inlet 121 and the first outlet 131, the gas refrigerant of low temperature and low pressure circulates through the second inlet 123 and the second outlet 133, and the liquid refrigerant of moderate temperature and high pressure circulates through the third inlet 125 and the third outlet 135.

[0058] That is, the first outlet 131 is connected to the bombe 5 which the LPG fuel is return to and is stored in, the second outlet 133 is connected to the compressor 10 of the air conditioning so as to supply the gas refrigerant of low temperature and low pressure passing through the heat radiating portion 110 to the compressor 10.

[0059] In addition, the third outlet 135 is connected to the expansion valve 30 of the air conditioning so as to supply the liquid refrigerant of moderate temperature and high pressure passing through the heat radiating portion 110 to the expansion valve 30.

[0060] Meanwhile, connecting ports may be mounted respectively at the inlet 120 and the outlet 130 and are connected to the air conditioning, the engine 3 and the bombe 5 through connecting hoses connected to the connecting ports.

[0061] According to the present exemplary embodiment, the plurality of connecting lines includes first, second, and third connecting lines 141, 143, and 145 and will be described in detail.

[0062] The first connecting line 141, as shown in FIG. 4, is adapted for the LPG fuel flowing through the first inlet 121 to flow therein, and is disposed at a center portion in the heat radiating portion 110.

[0063] According to the present exemplary embodiment, the second connecting line 143, as shown in FIG. 5, is disposed close to the first connecting line 141 at an upper portion of the heat radiating portion 110 and is formed apart from the first connecting line 141 at a lower portion of the heat radiating portion 110. The second connecting line 143 at the upper portion of the heat radiating portion 110 and the second connecting line 143 at the lower portion of the heat radiating portion 110 are connected to each other through an intermediate hole 151 in the heat radiating portion 110 such that the gas refrigerant of low temperature and low pressure supplied through the second inlet 123 flows in the second connecting line 143.

[0064] That is, the LPG fuel passing through the first connecting line 141 exchanges heat with the gas refrigerant of low temperature and low pressure passing through the second connecting line 143 disposed above and close to the first connecting line 141 and is cooled.

[0065] In addition, the third connecting line 145, as shown in FIG. 6, is disposed above the second connecting line 143 at the upper portion of the heat radiating portion 110 and is
formed between the first connecting line 141 and the second connecting line 143 at the lower portion of the heat radiating portion 110. The third connecting line 145 at the upper portion of the heat radiating portion 110 and the third connecting line 145 at the lower portion of the heat radiating portion 110 are connected to each other through an intermediate hole 153 in the heat radiating portion 110 such that the liquid refrigerant of moderate temperature and high pressure supplied through the third inlet 125 flows in the third connecting line 145.

[0066] That is, the third connecting line 145 is adapted to connect the third connecting line 145 positioned above the first connecting line 141 with the third connecting line 145 positioned at the lower portion of the heat radiating portion 110 in the heat radiating portion 110.

[0067] Therefore, the gas refrigerant of low temperature and low pressure passing through the second connecting line 143 exchanges heat with the LPG fuel passing through the first connecting line 141 at the upper portion of the heat radiating portion 110 and with the liquid refrigerant of moderate temperature and high pressure passing through the third connecting line 145 at the lower portion of the heat radiating portion 110.

[0068] Therefore, the LPG fuel and the liquid refrigerant of moderate temperature and high pressure are cooled by heat-exchange with the gas refrigerant of low temperature and low pressure.

[0069] Since the second inlet 123 and the third inlet 125 are formed at opposite sides on the surface of the heat radiating portion 110, the gas refrigerant of low temperature and low pressure and the liquid refrigerant of moderate temperature and high pressure are adapted to flow in the second connecting line 143 and the third connecting line 145 to opposite directions.

[0070] Therefore, heat-exchange efficiency of the gas refrigerant of low temperature and low pressure and the liquid refrigerant of moderate temperature and high pressure may be improved.

[0071] In addition, non-condensed gas refrigerant contained in the liquid refrigerant of moderate temperature and high pressure passing through the third connecting line 145 is condensed by heat-exchange with the gas refrigerant of low temperature and low pressure passing through the second connecting line 143. Therefore, efficiency deterioration of the air conditioning due to the non-condensed gas refrigerant may be prevented and expansion efficiency of the expansion valve 30 may be enhanced.

[0072] Hereinafter, operation and function of the heat exchanger 100 for an LPI vehicle according to an exemplary embodiment of the present invention will be described in detail.

[0073] FIG. 7 is a cross-sectional view for showing operation of a heat exchanger for an LPI vehicle according to an exemplary embodiment of the present invention.

[0074] The LPG fuel of high temperature returned from the engine 3, as shown in (S1) of FIG. 7, flows in through the first inlet 121, passes through the first connecting line 141, and is exhausted to the boom 5 through the first outlet 131.

[0075] The gas refrigerant of low temperature and low pressure supplied from the evaporator 40, as shown in (S2) of FIG. 7, flows in through the second inlet 123, passes through the second connecting line 143, and is exhausted to the compressor 10 through the second outlet 133.

[0076] Herein, the LPG fuel flows in the first connecting line 141, and the gas refrigerant of low temperature and low pressure flows in the second connecting line 143 positioned above the first connecting line 141 at the upper portion of the heat radiating portion 110. Therefore, the LPG fuel is cooled through heat-exchange with the gas refrigerant of low temperature and low pressure.

[0077] In addition, the liquid refrigerant of moderate temperature and high pressure supplied from the condenser 20, as shown in (S3) of FIG. 7, passes through the third inlet 125, and is exhausted to the expansion valve 30 through the third outlet 135.

[0078] At this time, the gas refrigerant of low temperature and low pressure flows in the second connecting line 143, and the liquid refrigerant of moderate temperature and high pressure flows in the third connecting line 145 positioned above the second connecting line 143 at the upper portion of the heat radiating portion 110. In addition, the gas refrigerant of low temperature and low pressure and the liquid refrigerant of moderate temperature and high pressure flows to the opposite directions. Therefore, the liquid refrigerant of moderate temperature and high pressure exchanges heat with the gas refrigerant of low temperature and low pressure.

[0079] Since the liquid refrigerant of moderate temperature and high pressure passes through the third connecting line 145 positioned above the second connecting line 143 at the upper portion of the heat radiating portion 110, the liquid refrigerant of moderate temperature and high pressure prevents heat in an engine compartment from being directly transferred to the gas refrigerant of low temperature and low pressure and prevents temperature rise of the gas refrigerant.

[0080] Therefore, deterioration of cooling performance of the air conditioning due to temperature rise of the gas refrigerant may be prevented in advance.

[0081] In addition, the liquid refrigerant of moderate temperature and high pressure passes through the third connecting line 145 disposed under the first connecting line 141 at the lower portion of the heat radiating portion 110. Therefore, the LPG fuel passing through the third connecting line 141 is prevented from being overcooled when exchanging heat with the gas refrigerant of low temperature and low pressure and the LPG fuel is cooled to a desirable temperature.

[0082] As described above, the LPG fuel cooled to the desirable temperature is supplied to the boom 5 through the first outlet 131.

[0083] Therefore, the heat exchanger 100 is adapted to cause the LPG fuel of high temperature returned from the engine 3 to exchange heat with the gas refrigerant of low temperature and low pressure and the liquid refrigerant of moderate temperature and high pressure so as to cool the LPG fuel to the desirable temperature. After that, the heat exchanger 100 supplies the LPG fuel to the boom 5. Therefore, increase of the internal pressure in the boom 5 due to inflow of the high-temperature LPG fuel is prevented.

[0084] Meanwhile, the non-condensed gas refrigerant contained in the liquid refrigerant of moderate temperature and high pressure passing through the third connecting line 145 is condensed by heat-exchange with the gas refrigerant of low temperature and low pressure passing through the second connecting line 143. Therefore, efficiency deterioration of the air conditioning due to the non-condensed gas refrigerant may be prevented and expansion efficiency of the expansion valve 30 may be enhanced.
Therefore, the heat exchanger \textbf{100} for the LPI vehicle according to an exemplary embodiment of the present invention is adapted to flow the LPG fuel into the bomb 5 after the temperature of the LPG fuel is lowered through heat-exchange between the refrigerant circulating through the air conditioning and the LPG fuel returned to the bomb 5. Therefore, increase of the internal pressure in the bomb 5 may be prevented.

In addition, since increase of the internal pressure in the bomb 5 is prevented, supply of the fuel may be smoothly performed and marketability may be improved.

In addition, the heat exchanger \textbf{100} for the LPI vehicle according to an exemplary embodiment of the present invention is adapted to perform heat-exchange of the liquid refrigerant of moderate temperature and high pressure supplied from the condenser 20 and the gas refrigerant of low temperature and low pressure supplied from the evaporator 40. In this case, cooling efficiency of the refrigerant may be improved by overcool effect of the refrigerant, performance deterioration of the air conditioning may be prevented, and cooling performance may be improved.

In addition, since overcool of the refrigerant and cooling of the LPG fuel are simultaneously performed in the small engine compartment, space utilization may be improved and layout may be simplified.

For convenience in explanation and accurate definition in the appended claims, the terms “upper”, “lower”, “inner” and “outer” are used to describe features of the exemplary embodiments with reference to the positions of such features as displayed in the figures.

The foregoing descriptions of specific exemplary embodiments of the present invention have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the invention to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teachings. The exemplary embodiments were chosen and described in order to explain certain principles of the invention and their practical application, to thereby enable others skilled in the art to make and utilize various exemplary embodiments of the present invention, as well as various alternatives and modifications thereof. It is intended that the scope of the invention be defined by the claims appended hereto and their equivalents.

What is claimed is:

1. A heat exchanger apparatus for an LPI vehicle that is adapted to cool an LPG fuel returned from an engine in the LPI vehicle using the LPG fuel, the heat exchanger comprising:

a heat radiating portion provided with first, second, and third connecting lines formed by stacking a plurality of plates, and receiving first, second, and third operating fluids respectively into the first, second, and third connecting lines, the first, second, and third operating fluids exchanging heat with each other during passing through the first, second, and third connecting lines and the first, second, and third operating fluids supplied to the first, second, and third connecting lines not being mixed with each other and being circulated;

first, second, and third inlets formed at a surface of the heat radiating portion, and connected respectively to the first, second, and third connecting lines so as to supply the first, second, and third operating fluids respectively to the first, second, and third connecting lines; and

first, second, and third outlets formed at the other surface of the heat radiating portion corresponding respectively to the first, second, and third inlets, and connected respectively to the first, second, and third connecting lines so as to exhaust the first, second, and third operating fluids respectively from the first, second, and third connecting lines.

2. The heat exchanger apparatus of claim 1, wherein the first operating fluid is the LPG fuel returned from the engine, the second operating fluid is a liquid refrigerant supplied from a condenser of an air conditioning, and the third operating fluid is a gas refrigerant supplied from an evaporator.

3. The heat exchanger apparatus of claim 1, wherein the first inlet is formed at a corner portion on the surface of the heat radiating portion, and the first outlet is formed at a corner portion diagonally facing the first inlet on the other surface of the heat radiating portion.

4. The heat exchanger apparatus of claim 1, wherein the second inlet is formed at a corner portion opposite to the first inlet in a length direction on the surface of the heat radiating portion, and the second outlet is formed at a corner portion opposite to the second inlet in a width direction on the other surface of the heat radiating portion.

5. The heat exchanger apparatus of claim 1, wherein the third inlet is formed apart from the first inlet in a length direction on the surface of the heat radiating portion, and the third outlet is formed at a position opposite to the third inlet in a width direction on the other surface of the heat radiating portion.

6. The heat exchanger apparatus of claim 1, wherein the LPG fuel circulates through the first inlet, the first connecting line, and the first outlet, the gas refrigerant circulates through the second inlet, the second connecting line, and the second outlet, and the liquid refrigerant circulates through the third inlet, the third connecting line, and the third outlet.

7. The heat exchanger apparatus of claim 6, wherein the first connecting line is positioned at a center portion in the heat radiating portion,

the second connecting line is positioned adjacent to the first connecting line at an upper portion of the heat radiating portion and is positioned apart from the first connecting line at a lower portion of the heat radiating portion, and fluid-communicates therebetween via a first intermediate hole formed in the plurality of plates, and

the third connecting line is positioned above the second connecting line at the upper portion of the heat radiating portion and is positioned between the first connecting line and the second connecting line at the lower portion of the heat radiating portion in sequence.

8. The heat exchanger apparatus of claim 7, wherein the first, second and third connecting lines are aligned as the third, the second, the first, the third, and the second connecting lines from the upper portion to the lower portion of the heat radiating portion in sequence.

9. The heat exchanger apparatus of claim 6, wherein the gas refrigerant and the liquid refrigerant flow in opposite directions in the second connecting line and the third connecting line, respectively.

10. The heat exchanger apparatus of claim 1, wherein the first inlet is connected to the engine, the second inlet is connected to the condenser of the air conditioning, and the third inlet is connected to the evaporator of the air conditioning.
11. The heat exchanger apparatus of claim 1, wherein the first outlet is connected to a bombe which the LPG fuel is returned to and is stored in, the second outlet is connected to a compressor of the air conditioning, and the third outlet is connected to an expansion valve of the air conditioning.

12. The heat exchanger apparatus of claim 1, wherein the heat radiating portion is a heat radiating portion of plate type where the plurality of plates is stacked.

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