

DESCRIPTION**Title of Invention:****INTERMEDIATE-MEDIUM-TYPE GAS VAPORIZER****Technical Field**

[0001] The present invention relates to an intermediate fluid type gas vaporizer.

Background Art

[0002] Conventionally, there are known intermediate fluid type gas vaporizers (IFV) for vaporizing a low-temperature liquefied gas such as liquefied natural gas (LNG) using an intermediate fluid (such as propane). For example, Patent Literature 1 discloses a gas vaporizer comprising a shell for containing an intermediate fluid, an intermediate fluid vaporization tube, a heat transfer tube, an NG heater, an NG conduit, a heat source fluid supply tube, and a heat source fluid conduit.

[0003] The intermediate fluid vaporization tube is disposed in a lower portion of the shell. A heat source fluid is supplied into the intermediate fluid vaporization tube. The intermediate fluid vaporization tube performs heat exchange between the heat source fluid flowing through the intermediate fluid vaporization tube and an intermediate fluid in the liquid phase to thereby vaporize the intermediate fluid.

[0004] The heat transfer tube is disposed in an upper portion of the shell. An LNG is supplied into the heat transfer tube. The heat transfer tube performs heat exchange between the LNG flowing through the heat transfer tube and the vaporized intermediate fluid to thereby vaporize the LNG.

[0005] The NG heater includes a plurality of heat source tubes and a housing accommodating these heat source tubes. The heat source fluid is supplied to each heat source tube through the heat source fluid supply tube, and the vaporized NG flowing out of the heat transfer tube is introduced into the housing through the NG conduit. The housing is separate from the shell.

[0006] The heat source fluid conduit guides the heat source fluid flowing out of the heat source tubes of the NG heater into the intermediate fluid vaporization tube in the shell. In other words, the heat source fluid flows through the heat source tubes and the intermediate fluid vaporization tube in series in this order.

[0007] In the intermediate fluid type gas vaporizer disclosed in Patent Literature 1, the NG heater is large in size. Specifically, the amount of heat required to heat the vaporized NG in the heat source tubes is smaller than the amount of heat required to vaporize the liquid intermediate

fluid in the intermediate fluid vaporization tube; however, in the above-mentioned intermediate fluid gas vaporizer, the heat source fluid flows through the heat source tubes and the intermediate fluid vaporization tube in series, so that the heat source fluid is supplied to the heat source tubes at the same rate as to the intermediate fluid vaporization tube. This requires a large number of heat source tubes of the heater, which results in an increase in the diameter of the housing (NG heater).

Citation List

Patent Literature

[0008] Patent Literature 1: Japanese Unexamined Patent Publication No. 2001-200995

Summary of Invention

[0009] An object of the present invention is to provide an intermediate fluid type gas vaporizer allowing reduction in the diameter of a housing.

[0010] In order to achieve the above-mentioned object, it is considered to supply the heat source fluid in parallel to the heat source tubes (hereinafter, referred to as “gas heating section”) and to the intermediate fluid vaporization tube (hereinafter, referred to as “intermediate fluid vaporizing section”), i.e. to provide a first heat source fluid supply channel for supplying the heat source fluid to the intermediate fluid vaporizing section and a second heat source fluid supply channel for supplying the heat source fluid to the gas heating section. Such a configuration would make it possible to set the flow rate of the heat source fluid being supplied to the gas heating section, independently of the flow rate of the heat source fluid required for the intermediate fluid vaporizing section. Consequently, it would be possible to reduce the number of heat source tubes of the gas heating section, which would allow reduction in the diameter of the housing of the heater. However, there is a possibility that the reduction in the diameter of the housing would increase the flow rate of the vaporized gas flowing through the housing, which would cause the gas heating section to vibrate due to the energy of the vaporized gas.

[0011] Accordingly, the inventors of the present invention have conducted intensive studies and found that the above-mentioned energy varies according to the flow rate of the vaporized gas per cross section of the housing, and therefore, it is possible to suppress vibration of the gas heating section by reducing this flow rate, i.e. to provide separate gas flow channels in the housing instead of causing the entire vaporized gas flowing out of the low-temperature liquefied gas vaporizing section to uniformly flow through the housing.

[0012] The present invention has been made based on the above findings. An intermediate fluid type gas vaporizer according to an aspect of the present invention is an intermediate fluid

type gas vaporizer for vaporizing a low-temperature liquefied gas using an intermediate fluid having a higher boiling point than the low-temperature liquefied gas, comprising: a container for containing the intermediate fluid; an intermediate fluid vaporizing section disposed in the container for receiving a heat source fluid; a low-temperature liquefied gas vaporizing section disposed in the container for receiving the low-temperature liquefied gas; a housing for receiving vaporized gas generated by vaporization of the low-temperature liquefied gas in the low-temperature liquefied gas vaporizing section; a gas heating section disposed in the housing for receiving the heat source fluid; a first heat source fluid supply channel for supplying the heat source fluid to the intermediate fluid vaporizing section; a second heat source fluid supply channel for supplying the heat source fluid to the gas heating section; and a gas flow channel for introducing the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section to the housing, wherein: the intermediate fluid vaporizing section performs heat exchange between the heat source fluid flowing through the intermediate fluid vaporizing section and the intermediate fluid existing outside the intermediate fluid vaporizing section to thereby vaporize at least part of the intermediate fluid; the low-temperature liquefied gas vaporizing section performs heat exchange between the low-temperature liquefied gas flowing through the low-temperature liquefied gas vaporizing section and the vaporized intermediate fluid existing outside the low-temperature liquefied gas vaporizing section to thereby vaporize at least part of the low-temperature liquefied gas; the gas heating section performs heat exchange between the heat source fluid flowing through the gas heating section and the vaporized gas existing outside the gas heating section to thereby heat the vaporized gas; the housing includes a body portion for housing the gas heating section, a first inflow portion disposed at one end of the body portion for allowing the vaporized gas to flow into the body portion, a second inflow portion disposed at the other end of the body portion for allowing the vaporized gas to flow into the body portion, and an outflow portion disposed in an area between the one end and the other end of the body portion for allowing the vaporized gas to flow out of the body portion; and the gas flow channel includes a first gas flow channel for supplying part of the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section to the first inflow portion, and a second gas flow channel for supplying a remaining part of the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section to the second inflow portion.

Brief Description of Drawings

[0013] FIG. 1 is a schematic diagram of a configuration of an intermediate fluid type gas vaporizer according to an embodiment of the present invention.

FIG. 2 is a plan view of the intermediate fluid type gas vaporizer shown in FIG. 1.

FIG. 3 shows a modified form of the intermediate fluid type gas vaporizer shown in FIG. 1.

FIG. 4 shows a modified relative arrangement of a container and a housing.

FIG. 5 shows a modified form of a heater.

Description of Embodiments

[0014] An intermediate fluid type gas vaporizer 1 according to an embodiment of the present invention will be described with reference to FIGS. 1 and 2. The intermediate fluid type gas vaporizer 1 is an intermediate fluid type gas vaporizer (IFV) for vaporizing a low-temperature liquefied gas using an intermediate fluid having a higher boiling point than the low-temperature liquefied gas. In the present embodiment, a liquefied natural gas (LNG) is used as the low-temperature liquefied gas, and propane is used as the intermediate fluid. However, the low-temperature liquefied gas may be, for example, ethylene, liquefied oxygen, or liquefied nitrogen. The intermediate fluid is not necessarily limited to propane. In the intermediate fluid type gas vaporizer 1, the intermediate fluid is heated by means of a heat source fluid (such as sea water or air).

[0015] As shown in FIG. 1, the intermediate fluid type gas vaporizer 1 includes an intermediate fluid 2, a container 10 for containing the intermediate fluid 2, an intermediate fluid vaporizing section E1, a low-temperature liquefied gas vaporizing section E2, a heater 30, a first heat source fluid supply channel 41, a second heat source fluid supply channel 42, and a gas flow channel 50.

[0016] The container 10 is in the form of a single casing that houses the intermediate fluid 2, the intermediate fluid vaporizing section E1, and the low-temperature liquefied gas vaporizing section E2 together. The container 10 has a cylindrical shape.

[0017] The intermediate fluid vaporizing section E1 is disposed in the container 10. More specifically, the intermediate fluid vaporizing section E1 is disposed in a lower portion (at a position where the intermediate fluid vaporizing section E1 is soaked in the intermediate fluid 2 in the liquid phase) of the container 10. The intermediate fluid vaporizing section E1 is constituted by a bundle of heat transfer tubes. A heat source fluid is introduced into the intermediate fluid vaporizing section E1. The intermediate fluid vaporizing section E1 performs heat exchange between the heat source fluid flowing through the intermediate fluid vaporizing section E1 and the liquid intermediate fluid 2 existing in the lower portion of the container 10 to thereby vaporize at least part of the intermediate fluid 2.

[0018] The low-temperature liquefied gas vaporizing section E2 is disposed in the container 10. More specifically, the low-temperature liquefied gas vaporizing section E2 is disposed in

an upper portion (an area where the intermediate fluid 2 in the gaseous phase exists) of the container 10. In the present embodiment, the low-temperature liquefied gas vaporizing section E2 is constituted by a heat transfer tube having the U-shape. A low-temperature liquefied gas is introduced into the low-temperature liquefied gas vaporizing section E2. The low-temperature liquefied gas vaporizing section E2 performs heat exchange between the low-temperature liquefied gas flowing through the low-temperature liquefied gas vaporizing section E2 and the vaporized intermediate fluid 2 in the container 10 to thereby vaporize part of the low-temperature liquefied gas.

[0019] An inlet chamber 21 and an outlet chamber 22 divided from each other by a partition plate 20 are connected to a lower portion of one end of the container 10. Each of the inlet chamber 21 and the outlet chamber 22 communicates with an inside of the intermediate fluid vaporizing section E1. A return chamber 23 is connected to a lower portion of the other end of the container 10. The return chamber 23 communicates with the inside of the intermediate fluid vaporizing section E1. In other words, the intermediate fluid vaporizing section E1 uses a so-called two-pass method.

[0020] An inlet chamber 25 and an outlet chamber 26 divided from each other by a partition plate 24 are connected to the upper portion of the container 10. One end of the low-temperature liquefied gas vaporizing section E2 is connected to the inlet chamber 25 so that an inside of the low-temperature liquefied gas vaporizing section E2 communicates with an inside of the inlet chamber 25. The other end of the low-temperature liquefied gas vaporizing section E2 is connected to the outlet chamber 26 so that the inside of the low-temperature liquefied gas vaporizing section E2 communicates with an inside of the outlet chamber 26.

[0021] The heater 30 heats vaporized gas generated by vaporization of the low-temperature liquefied gas. The heater 30 includes a gas heating section E3 for receiving the heat source fluid, and a housing 31 for housing the gas heating section E3.

[0022] The gas heating section E3 is constituted by a bundle of heat transfer tubes. The gas heating section E3 performs heat exchange between the heat source fluid flowing through the gas heating section E3 and the vaporized gas being supplied into the housing 31 to thereby heat the vaporized gas.

[0023] The housing 31 includes a body portion 32, a first inflow portion 32a, a second inflow portion 32b, and an outflow portion 32c.

[0024] The body portion 32 has a cylindrical shape capable of housing the gas heating section E3. The first inflow portion 32a is disposed at one end of the body portion 32 for allowing the vaporized gas to flow into the body portion 32. The second inflow portion 32b is disposed at the other end of the body portion 32 for allowing the vaporized gas to flow into the body portion

32. The outflow portion 32c is disposed in an area between the one end and the other end of the body portion 32 for allowing the vaporized gas to flow out of the body portion 32.

[0025] An inlet chamber 36 and an outlet chamber 37 divided from each other by a partition plate 35 are connected to one end of the body portion 32. Each of the inlet chamber 36 and the outlet chamber 37 communicates with an inside of the gas heating section E3. A return chamber 38 is connected to the other end of the body portion 32. The return chamber 38 communicates with the inside of the gas heating section E3. In other words, the gas heating section E3 uses a so-called two-pass method.

[0026] As shown in FIG. 2, the heater 30 is disposed in the upper portion of the container 10. In the present embodiment, a ratio $L3/D3$, i.e. a ratio of the length $L3$ of the body portion 32 to the diameter $D3$ of the body portion 32, is from 5 to 10. A ratio $D3/D1$, i.e. a ratio of the diameter $D3$ of the body portion 32 to the diameter $D1$ of the container 10, is 0.5. or less. A ratio $L1/L3$, i.e. a ratio of the length $L1$ of the container 10 to the length $L3$ of the body portion 32, is from 0.8 to 1.3.

[0027] The first heat source fluid supply channel 41 supplies the heat source fluid to the intermediate fluid vaporizing section E1. The first heat source fluid supply channel 41 is connected to the inlet chamber 21 connected to the container 10. A first on-off valve V1 whose opening degree is adjustable is disposed in the first heat source fluid supply channel 41.

[0028] The second heat source fluid supply channel 42 supplies the heat source fluid to the gas heating section E3. The second heat source fluid supply channel 42 is connected to the inlet chamber 36 connected to the body portion 32. A second on-off valve V2 whose opening degree is adjustable is disposed in the second heat source fluid supply channel 42.

[0029] The present embodiment further includes a common supply channel 40 and a heat source fluid joining channel 43.

[0030] The common supply channel 40 supplies the heat source fluid to the first heat source fluid supply channel 41 and the second heat source fluid supply channel 42. A flow rate regulator (such as on-off valve or flow meter) for adjusting the flow rate of the heat source fluid is disposed in the common supply channel 40. The respective opening degrees of the on-off valves V1 and V2 are set so as to render a ratio of the total of the flow rate of the heat source fluid flowing to the first heat source fluid supply channel 41 from the common supply channel 40 and the flow rate of the heat source fluid joining to the first heat source fluid supply channel 41 through the heat source fluid joining channel 43 with respect to the flow rate of the heat source fluid flowing to the second heat source fluid supply channel 42 from the common supply channel 40, i.e. a supply ratio of the supply amount of the heat source fluid to the intermediate fluid vaporizing section E1 to the supply amount of the heat source fluid to the gas heating

section E3, in a range from 3 to 5.

[0031] Each of the on-off valves V1 and V2 may be in the form of a restricted orifice whose opening degree is set in advance and which is replaceable.

[0032] The heat source fluid joining channel 43 joins the heat source fluid flowing out of the gas heating section E3 to the first heat source fluid supply channel 41. Specifically, an upstream end of the heat source fluid joining channel 43 is connected to the outlet chamber 37 connected to the body portion 32. A downstream end of the heat source fluid joining channel 43 is connected to a portion of the first heat source fluid supply channel 41 that lies between the first on-off valve V1 and the inlet chamber 21. The downstream end of the heat source fluid joining channel 43 may be connected directly to the inlet chamber 21.

[0033] The gas flow channel 50 guides the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section E2 to the housing 31. An upstream end of the gas flow channel 50 is connected to the outlet chamber 26 connected to the container 10. In the present embodiment, a downstream portion of the gas flow channel 50 is branched into two parts. Specifically, the gas flow channel 50 includes a first gas flow channel 50a for supplying part (in the present embodiment, half) of the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section E2 to the first inflow portion 32a, and a second gas flow channel 50b for supplying the remaining part of the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section E2 to the second inflow portion 32b. A downstream end of the first gas flow channel 50a is connected to the first inflow portion 32a, and a downstream end of the second gas flow channel 50b is connected to the second inflow portion 32b.

[0034] Upon activation of the intermediate fluid type gas vaporizer 1, the heat source fluid is supplied to the inlet chamber 21 through the first heat source fluid supply channel 41, and the heat source fluid is supplied to the inlet chamber 36 through the second heat source fluid supply channel 42, while the LNG is supplied to the inlet chamber 25.

[0035] The heat source fluid having been supplied to the inlet chamber 21 flows through the intermediate fluid vaporizing section E1, the return chamber 23, the intermediate fluid vaporizing section E1, and the outlet chamber 22 in this order before being discharged to the outside. At this time, the heat source fluid heats the liquid intermediate fluid 2 in the intermediate fluid vaporizing section E1 to thereby vaporize at least part of the intermediate fluid 2. The heat source fluid having been supplied to the inlet chamber 36 flows through the gas heating section E3, the return chamber 38, the gas heating section E3, and the outlet chamber 37 in this order before joining to the first heat source fluid supply channel 41 through the heat source fluid joining channel 43. At this time, the heat source fluid heats the vaporized gas (NG) in the gas heating section E3.

[0036] On the other hand, the LNG having been supplied to the inlet chamber 25 receives heat from the vaporized intermediate fluid 2 in the container 10 in the course of passing through the low-temperature liquefied gas vaporizing section E2 to thereby vaporize. The vaporized NG at a low temperature flowing out of the low-temperature liquefied gas vaporizing section E2 flows into the housing 31 through the outlet chamber 26 and the gas flow channel 50. Specifically, half of the low-temperature vaporized NG flowing out of the outlet chamber 26 flows into the body portion 32 through the first gas flow channel 50a and the first inflow portion 32a, and the remaining half of the low-temperature vaporized NG flowing out of the outlet chamber 26 flows into the body portion 32 through the second gas flow channel 50b and the second inflow portion 32b. Each of the low-temperature vaporized NG having entered the body portion 32 through the first inflow portion 32a and the low-temperature vaporized NG having entered the body portion 32 through the second inflow portion 32b is heated by the heat source fluid flowing through the gas heating section E3 in the course of moving to the outflow portion 32c, and then flows out through the outflow portion 32c at normal temperature.

[0037] As described above, in this intermediate fluid type gas vaporizer 1, the heat source fluid is supplied in parallel to the gas heating section E3 and the intermediate fluid vaporizing section E1 by means of the first heat source fluid supply channel 41 and the second heat source fluid supply channel 42. This allows reduction in the diameter of the housing 31. Furthermore, the separate gas flow paths are provided in the housing 31, which can suppress vibration of the gas heating section E3. Specifically, about half of the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section E2 flows into the body portion 32 through the first gas flow channel 50a and the first inflow portion 32a and then toward the outflow portion 32c, whereas the remaining about half of the vaporized gas flows into the body portion through the second gas flow channel 50b and the second inflow portion 32b and then toward the outflow portion. This allows reduction in the flow rate of the vaporized gas per cross section of the body portion 32. Consequently, the energy of the vaporized gas flowing through the body portion 32 is about a quarter of that in a case where the whole amount of the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section E2 uniformly flows through the body portion 32. This allows the suppression of vibration of the gas heating section E3.

[0038] Further, the parallel supply of the heat source fluid to the gas heating section E3 and the intermediate fluid vaporizing section E1 allows reduction in the number of heat transfer tubes constituting the gas heating section E3. This leads to reduction in the number of welds in the heat transfer tubes and the thickness of tube plates, which can significantly reduce the manufacturing cost.

[0039] Further, in the present embodiment, the opening degree of each of the on-off valves V1 and V2 is set so as to render the supply ratio in the range from 3 to 5. Therefore, it is possible to effectively achieve both the reduction in the diameter of the housing 31 and the suppression of vibration of the gas heating section E3.

[0040] Further, the present embodiment includes the heat source fluid joining channel 43, which makes it possible to secure an amount of the heat source fluid supplied to the intermediate fluid vaporizing section E1. Therefore, it is possible to increase the supply amount of the heat source fluid to the gas heating section E3 within the range of the above-mentioned supply ratio. Consequently, the amount of heat provided by the heat source fluid to the vaporized gas in the gas heating section E3 increases. Therefore, it is possible to improve the design flexibility of the gas heating section E3, such as reduction in the heat transfer area of the gas heating section E3.

[0041] It should be noted that the above-disclosed embodiment is exemplary in all respects and should not be regarded as restrictive. The scope of the present invention is indicated by the scope of the claims and not by the description of the embodiment described above, and includes all modifications within the same sense and scope as the claims.

[0042] For example, as shown in FIG. 3, it may be configured that an inlet chamber 36a is connected to one end of a body portion 32 and an outlet chamber 37a is connected to the other end of the body portion 32. In other words, the gas heating section E3 may be configured to use a so-called one-pass method. The same can be applied to the intermediate fluid vaporizing section E1.

[0043] Further, as shown in FIG. 4, the heater 30 may be disposed on a side of the container 10.

[0044] Further, as shown in FIG. 5, it may be configured that a housing 31 includes a body portion 32, a first outflow portion 32d disposed at one end of the body portion 32, a second outflow portion 32e disposed at the other end of the body portion 32, and an inflow portion 32f disposed in an area between the one end and the other end of the body portion 32. In this case, a downstream portion of the gas flow channel 50 is connected to the inflow portion 32f, without branching into two parts.

[0045] The intermediate fluid type gas vaporizer described above will be now summarized.

[0046] The intermediate fluid type gas vaporizer described above is defined as an intermediate fluid type gas vaporizer for vaporizing a low-temperature liquefied gas using an intermediate fluid having a higher boiling point than the low-temperature liquefied gas, comprising: a container for containing the intermediate fluid; an intermediate fluid vaporizing section disposed in the container for receiving a heat source fluid; a low-temperature liquefied gas vaporizing

section disposed in the container for receiving the low-temperature liquefied gas; a housing for receiving vaporized gas generated by vaporization of the low-temperature liquefied gas in the low-temperature liquefied gas vaporizing section; a gas heating section disposed in the housing for receiving the heat source fluid; a first heat source fluid supply channel for supplying the heat source fluid to the intermediate fluid vaporizing section; a second heat source fluid supply channel for supplying the heat source fluid to the gas heating section; and a gas flow channel for introducing the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section to the housing, wherein: the intermediate fluid vaporizing section performs heat exchange between the heat source fluid flowing through the intermediate fluid vaporizing section and the intermediate fluid existing outside the intermediate fluid vaporizing section to thereby vaporize at least part of the intermediate fluid; the low-temperature liquefied gas vaporizing section performs heat exchange between the low-temperature liquefied gas flowing through the low-temperature liquefied gas vaporizing section and the vaporized intermediate fluid existing outside the low-temperature liquefied gas vaporizing section to thereby vaporize at least part of the low-temperature liquefied gas; the gas heating section performs heat exchange between the heat source fluid flowing through the gas heating section and the vaporized gas existing outside the gas heating section to thereby heat the vaporized gas; the housing includes a body portion for housing the gas heating section, a first inflow portion disposed at one end of the body portion for allowing the vaporized gas to flow into the body portion, a second inflow portion disposed at the other end of the body portion for allowing the vaporized gas to flow into the body portion, and an outflow portion disposed in an area between the one end and the other end of the body portion for allowing the vaporized gas to flow out of the body portion; and the gas flow channel includes a first gas flow channel for supplying part of the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section to the first inflow portion, and a second gas flow channel for supplying a remaining part of the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section to the second inflow portion.

[0047] In this intermediate fluid type gas vaporizer, the heat source fluid is supplied in parallel to the gas heating section and the intermediate fluid vaporizing section by means of the first heat source fluid supply channel and the second heat source fluid supply channel. This allows reduction in the diameter of the housing. Furthermore, the separate gas flow paths are provided in the housing, which can suppress vibration of the gas heating section. Specifically, part of the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section flows into the body portion through the first gas flow channel and the first inflow portion and then toward the outflow portion, whereas the remaining part of the vaporized gas flows into the body portion through the second gas flow channel and the second inflow portion and then toward the outflow

portion. This allows reduction in the flow rate of the vaporized gas per cross section of the body portion. Consequently, vibration of the gas heating section is suppressed.

[0048] In this case, it is preferred that the intermediate fluid type gas vaporizer further comprises: a common supply channel for supplying the heat source fluid to the first heat source fluid supply channel and the second heat source fluid supply channel; a first on-off valve disposed in the first heat source fluid supply channel and whose opening degree is adjustable; and a second on-off valve disposed in the second heat source fluid supply channel and whose opening degree is adjustable, and that the opening degree of each on-off valve is set so as to render a supply ratio of an amount of the heat source fluid supplied to the intermediate fluid vaporizing section with respect to an amount of the heat source fluid supplied to the gas heating section in a range from 3 to 5.

[0049] Such a configuration makes it possible to effectively achieve both the reduction in the diameter of the housing and the suppression of vibration of the gas heating section.

[0050] Further in this case, it is preferred that the intermediate fluid type gas vaporizer further comprises a heat source fluid joining channel for joining the heat source fluid flowing out of the gas heating section to the first heat source fluid supply channel.

[0051] Such a configuration makes it possible to secure an amount of the heat source fluid supplied to the intermediate fluid vaporizing section. Therefore, it is possible to increase the supply amount of the heat source fluid to the gas heating section within the range of the above-mentioned supply ratio. Consequently, the amount of heat provided by the heat source fluid to the vaporized gas in the gas heating section increases. Therefore, it is possible to improve the design flexibility of the gas heating section, such as reduction in the heat transfer area of the gas heating section.

[0052] In the above-described intermediate fluid type gas vaporizer, it is preferred that a ratio of the length of the body portion to the diameter of the body portion is from 5 to 10.

[0053] In the above-described intermediate fluid type gas vaporizer, it is preferred that a ratio of the diameter of the body portion to the diameter of the container is 0.5 or less.

[0054] In the above-described intermediate fluid type gas vaporizer, it is preferred that a ratio of the length of the container to the length of the body portion is 1.3 or less.

[0055] The above-described intermediate fluid type gas vaporizer may further comprise: an inlet chamber connected to one end of the body portion to communicate with an inside of the gas heating section; an outlet chamber connected to the one end of the body portion to communicate with the inside of the gas heating section; a partition plate connected to the one end of the body portion to divide the inlet chamber from the outlet chamber; and a return chamber connected to the other end of the body portion to communicate with the inside of the gas heating section.

[0056] Such a configuration reduces the length of the gas heating section by about half, so that the entire length of a heater is shortened.

[0057] Further, the intermediate fluid type gas vaporizer described above is defined as an intermediate fluid type gas vaporizer for vaporizing a low-temperature liquefied gas using an intermediate fluid having a higher boiling point than the low-temperature liquefied gas, comprising: a container for containing the intermediate fluid; an intermediate fluid vaporizing section disposed in the container for receiving a heat source fluid; a low-temperature liquefied gas vaporizing section disposed in the container for receiving the low-temperature liquefied gas; a housing for receiving vaporized gas generated by vaporization of the low-temperature liquefied gas in the low-temperature liquefied gas vaporizing section; a gas heating section disposed in the housing for receiving the heat source fluid; a first heat source fluid supply channel for supplying the heat source fluid to the intermediate fluid vaporizing section; a second heat source fluid supply channel for supplying the heat source fluid to the gas heating section; and a gas flow channel for introducing the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section to the housing, wherein: the intermediate fluid vaporizing section performs heat exchange between the heat source fluid flowing through the intermediate fluid vaporizing section and the intermediate fluid existing outside the intermediate fluid vaporizing section to thereby vaporize at least part of the intermediate fluid; the low-temperature liquefied gas vaporizing section performs heat exchange between the low-temperature liquefied gas flowing through the low-temperature liquefied gas vaporizing section and the vaporized intermediate fluid existing outside the low-temperature liquefied gas vaporizing section to thereby vaporize at least part of the low-temperature liquefied gas; the gas heating section performs heat exchange between the heat source fluid flowing through the gas heating section and the vaporized gas existing outside the gas heating section to thereby heat the vaporized gas; the housing includes a body portion for housing the gas heating section, a first outflow portion disposed at one end of the body portion for allowing the vaporized gas to flow out of the body portion, a second outflow portion disposed at the other end of the body portion for allowing the vaporized gas to flow out of the body portion, and an inflow portion disposed in an area between the one end and the other end of the body portion for allowing the vaporized gas to flow into the body portion; and the gas flow channel has a downstream end connected to the inflow portion.

[0058] This intermediate fluid type gas vaporizer also allows reduction in the diameter of the housing and, furthermore, provides the separate gas flow paths in the housing, which can suppress vibration of the gas heating section.

CLAIMS

1. An intermediate fluid type gas vaporizer for vaporizing a low-temperature liquefied gas using an intermediate fluid having a higher boiling point than the low-temperature liquefied gas, comprising:

a container for containing the intermediate fluid;

an intermediate fluid vaporizing section disposed in the container for receiving a heat source fluid;

a low-temperature liquefied gas vaporizing section disposed in the container for receiving the low-temperature liquefied gas;

a housing for receiving vaporized gas generated by vaporization of the low-temperature liquefied gas in the low-temperature liquefied gas vaporizing section;

a gas heating section disposed in the housing for receiving the heat source fluid;

a first heat source fluid supply channel for supplying the heat source fluid to the intermediate fluid vaporizing section;

a second heat source fluid supply channel for supplying the heat source fluid to the gas heating section; and

a gas flow channel for introducing the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section to the housing, wherein:

the intermediate fluid vaporizing section performs heat exchange between the heat source fluid flowing through the intermediate fluid vaporizing section and the intermediate fluid existing outside the intermediate fluid vaporizing section to thereby vaporize at least part of the intermediate fluid;

the low-temperature liquefied gas vaporizing section performs heat exchange between the low-temperature liquefied gas flowing through the low-temperature liquefied gas vaporizing section and the vaporized intermediate fluid existing outside the low-temperature liquefied gas vaporizing section to thereby vaporize at least part of the low-temperature liquefied gas;

the gas heating section performs heat exchange between the heat source fluid flowing through the gas heating section and the vaporized gas existing outside the gas heating section to thereby heat the vaporized gas;

the housing includes

a body portion for housing the gas heating section,

a first inflow portion disposed at one end of the body portion for allowing the vaporized gas to flow into the body portion,

a second inflow portion disposed at the other end of the body portion for

allowing the vaporized gas to flow into the body portion, and

an outflow portion disposed in an area between the one end and the other end of the body portion for allowing the vaporized gas to flow out of the body portion; and

the gas flow channel includes

a first gas flow channel for supplying part of the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section to the first inflow portion, and

a second gas flow channel for supplying a remaining part of the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section to the second inflow portion.

2. The intermediate fluid type gas vaporizer according to claim 1, further comprising:

a common supply channel for supplying the heat source fluid to the first heat source fluid supply channel and the second heat source fluid supply channel;

a first on-off valve disposed in the first heat source fluid supply channel and whose opening degree is adjustable; and

a second on-off valve disposed in the second heat source fluid supply channel and whose opening degree is adjustable, wherein

the opening degree of each on-off valve is set so as to render a supply ratio of an amount of the heat source fluid supplied to the intermediate fluid vaporizing section with respect to an amount of the heat source fluid supplied to the gas heating section in a range from 3 to 5.

3. The intermediate fluid type gas vaporizer according to claim 2, further comprising:

a heat source fluid joining channel for joining the heat source fluid flowing out of the gas heating section to the first heat source fluid supply channel.

4. The intermediate fluid type gas vaporizer according to any one of claims 1 to 3, wherein

a ratio of the length of the body portion to the diameter of the body portion is from 5 to 10.

5. The intermediate fluid type gas vaporizer according to claim 1, wherein

a ratio of the diameter of the body portion to the diameter of the container is 0.5 or less.

6. The intermediate fluid type gas vaporizer according to claim 1, wherein

a ratio of the length of the container to the length of the body portion is 1.3 or less.

7. The intermediate fluid type gas vaporizer according to claim 1, further comprising:
 - an inlet chamber connected to one end of the body portion to communicate with an inside of the gas heating section;
 - an outlet chamber connected to the one end of the body portion to communicate with the inside of the gas heating section;
 - a partition plate connected to the one end of the body portion to divide the inlet chamber from the outlet chamber; and
 - a return chamber connected to the other end of the body portion to communicate with the inside of the gas heating section.
8. An intermediate fluid type gas vaporizer for vaporizing a low-temperature liquefied gas using an intermediate fluid having a higher boiling point than the low-temperature liquefied gas, comprising:
 - a container for containing the intermediate fluid;
 - an intermediate fluid vaporizing section disposed in the container for receiving a heat source fluid;
 - a low-temperature liquefied gas vaporizing section disposed in the container for receiving the low-temperature liquefied gas;
 - a housing for receiving vaporized gas generated by vaporization of the low-temperature liquefied gas in the low-temperature liquefied gas vaporizing section;
 - a gas heating section disposed in the housing for receiving the heat source fluid;
 - a first heat source fluid supply channel for supplying the heat source fluid to the intermediate fluid vaporizing section;
 - a second heat source fluid supply channel for supplying the heat source fluid to the gas heating section; and
 - a gas flow channel for introducing the vaporized gas flowing out of the low-temperature liquefied gas vaporizing section to the housing, wherein:
 - the intermediate fluid vaporizing section performs heat exchange between the heat source fluid flowing through the intermediate fluid vaporizing section and the intermediate fluid existing outside the intermediate fluid vaporizing section to thereby vaporize at least part of the intermediate fluid;
 - the low-temperature liquefied gas vaporizing section performs heat exchange between the low-temperature liquefied gas flowing through the low-temperature liquefied gas vaporizing

section and the vaporized intermediate fluid existing outside the low-temperature liquefied gas vaporizing section to thereby vaporize at least part of the low-temperature liquefied gas;

the gas heating section performs heat exchange between the heat source fluid flowing through the gas heating section and the vaporized gas existing outside the gas heating section to thereby heat the vaporized gas;

the housing includes

a body portion for housing the gas heating section,

a first outflow portion disposed at one end of the body portion for allowing the vaporized gas to flow out of the body portion,

a second outflow portion disposed at the other end of the body portion for allowing the vaporized gas to flow out of the body portion, and

an inflow portion disposed in an area between the one end and the other end of the body portion for allowing the vaporized gas to flow into the body portion; and

the gas flow channel has a downstream end connected to the inflow portion.