CLAIMS

1. Gas liquefaction method including

a first pressurising step of pressurising liquefied natural gas to a first pressure,

a second pressurising step of introducing into a main heat exchanger the liquefied natural gas pressurised in the first pressurising step, and then pressurising the pressure thereof to a second pressure higher than the first pressure,

a first natural gas discharging step of causing at least part of the liquefied natural gas pressurised in the second pressurising step to pass through the main heat exchanger, and discharging the same from the main heat exchanger as natural gas,

a feed gas compressing step of compressing a feed gas,

a feed gas cooling step of cooling the feed gas that has been compressed in the feed gas compressing step to a first temperature,

a gas-liquid separation step of decompressing and cooling the feed gas that has been cooled in the feed gas cooling step, and then subjecting the same to gas-liquid separation, and

a liquefied feed gas discharging step of discharging the liquefied feed gas obtained in the gas-liquid separation step, in a liquid state, wherein

the feed gas cooling step is a step of cooling the feed gas by means of heat exchange, in the main heat exchanger, between the liquefied natural gas pressurised in the first pressurising step and the liquefied natural gas pressurised in the second pressurising step, on the one hand, and the feed gas on the other hand.

2. Gas liquefaction method according to Claim 1, wherein the gas-liquid separation step additionally includes a feed gas recycling step of causing the gaseous feed gas obtained by the gas-liquid separation to flow together with the feed gas to be subjected to the feed gas compressing step.

3. Gas liquefaction method according to Claim 1 or Claim 2, additionally including a pre-cooling step of cooling the feed gas to a second temperature higher than the first temperature, wherein

the feed gas cooled in the pre-cooling step is compressed and is then subjected to the feed gas cooling step.

4. Gas liquefaction method according to any one of Claim 1 to Claim 3, additionally including an intermediate cooling step of cooling the feed gas compressed in the feed gas compressing step to a third temperature higher than the first temperature, wherein the feed gas cooled in the intermediate cooling step is further compressed and is then subjected to the feed gas cooling step.

5. Gas liquefaction method according to any one of Claim 1 to Claim 4, additionally including a second natural gas discharging step of vaporising in an evaporator part of the liquefied natural gas that has been pressurised in the second pressurising step and that is not introduced into the main heat exchanger, and discharging the same from the evaporator as natural gas.

6. Gas liquefaction method according to any one of Claim 1 to Claim 5, additionally including a sub-cooling step for further cooling the liquefied feed gas in a liquid state that has been discharged in the liquefied feed gas discharging step.

7. Gas liquefaction method according to any one of Claim 1 to Claim 6, wherein the feed gas is nitrogen gas, argon gas, oxygen gas, or a mixed gas containing any two or more of said gases.

8. Gas liquefaction device provided with

a first compressor for compressing a feed gas, a feed gas line which introduces the feed gas into the first compressor, and a compressed feed gas line which introduces the compressed feed gas into a main heat exchanger,

the main heat exchanger, which cools the feed gas that has been compressed by the first compressor,

a first pressure reducing valve which decompresses and cools the feed gas discharged from a cold end of the main heat exchanger,

a gas-liquid separator which subjects the feed gas that has been discharged from the first pressure reducing valve to gas-liquid separation,

a liquefied feed gas discharging line which discharges liquefied feed gas in a liquid state from the liquid phase of the gas-liquid separator,

a first pump which pressurises a liquefied natural gas to a first pressure,

a second pump which pressurises the liquefied natural gas to a second pressure higher than the first pressure,

a first liquefied natural gas line which introduces the liquefied natural gas that has been discharged from the first pump into the cold end of the main heat exchanger,

a second liquefied natural gas line which discharges from a first intermediate portion of the main heat exchanger, at a temperature lower than the critical temperature of the liquefied natural gas, the liquefied natural gas introduced into the main heat exchanger through the first liquefied natural gas introducing line, and introduces the same into the second pump,

a third liquefied natural gas line which introduces at least part of the liquefied natural gas discharged from the second pump into a second intermediate portion of the main heat exchanger, wherein the second intermediate portion is different portion from the first intermediate portion of the main heat exchanger, and

a first natural gas line which discharges from the warm end of the main heat exchanger the liquefied natural gas introduced into the main heat exchanger through the third liquefied natural gas line.

9. Gas liquefaction device according to Claim 8, additionally including a recycled feed gas line which discharges the gaseous feed gas from the gas phase of the gas-liquid separator and causes the same to flow together with the feed gas upstream of the first compressor.

10. Gas liquefaction device according to Claim 9, characterized in that the recycled feed gas line passes through the main heat exchanger.

11. Gas liquefaction device according to any one of Claim 8 to Claim 10, characterized in that the feed gas line passes through the main heat exchanger.

12. Gas liquefaction device according to any one of Claim 8 to Claim 11, additionally comprising a second compressor which further compresses the feed gas compressed by the first compressor, a feed gas intermediate cooling line which introduces the compressed feed gas into the second compressor by way of the main heat exchanger, and a pressurised feed gas line which introduces the feed gas compressed by the second compressor into the main heat exchanger.

13. Gas liquefaction device according to any one of Claims 8 to 12, additionally provided with an evaporator for vaporising part of the liquefied natural gas that has been pressurised by the second pump and that is not introduced into the main heat exchanger, and

a second natural gas line which discharges gaseous natural gas from the evaporator.

14. Gas liquefaction device according to any one of Claims 8 to 13, additionally provided with a sub-cooler for cooling the liquefied feed gas discharged from the liquefied feed gas discharging line,

a supercooled liquefied feed gas line which discharges liquefied feed gas in a supercooled state from the sub-cooler,

a second pressure reducing valve which decompresses and cools part of the supercooled liquefied feed gas discharged from the supercooled liquefied feed gas line,

a first low-pressure recycled feed gas line which introduces low-pressure recycled feed gas discharged from the second pressure reducing valve to a cold end of the sub-cooler,

a second low-pressure recycled feed gas line which introduces the low-pressure recycled feed gas discharged from a warm end of the sub-cooler into the cold end of the main heat exchanger, a third compressor which compresses the low-pressure recycled feed gas and causes the same to flow together with the feed gas upstream of the first compressor, and a third low-pressure recycled feed gas line which introduces the low-pressure recycled feed gas into the third compressor by way of the main heat exchanger.

15. Gas liquefaction device according to Claim 14, additionally provided with a low-pressure feed gas line which introduces low-pressure feed gas having a pressure lower than the feed gas into the third compressor.