CLAIMS

1. A cryogenic liquefaction device comprising:

a first heat exchanger;

a phase separator;

an expansion device;

a first arrangement of conduits, arranged such that a pressurised stream of gas is directed through the first heat exchanger, the expansion device and the phase separator;

a cold recovery circuit including first a heat transfer fluid and a second arrangement of conduits arranged such that the first heat transfer fluid is directed through the first heat exchanger in a counter-flow direction to the pressurised stream of gas; and

a refrigerant circuit including a second heat transfer fluid and a third arrangement of conduits arranged such that the second heat transfer fluid is directed through the first heat exchanger in a counter-flow direction to the pressurised stream of gas; wherein:

each of the second and third arrangements of conduits forms a closed pressurised circuit.

2. The cryogenic liquefaction device of claim 1, wherein the cold recovery circuit further comprises a second heat exchanger and a fourth arrangement of conduits arranged such that a first cold stream of gas or waste cold stream is directed through the second heat exchanger; and wherein:

the second arrangement of conduits is arranged such that the first heat transfer fluid is directed through the second heat exchanger in a counter-flow direction to the first cold stream of gas or waste cold stream.

3. The cryogenic liquefaction device of claim 1 or claim 2, wherein the refrigerant circuit further comprises a third heat exchanger and a fifth arrangement of conduits arranged such that a second cold stream of gas or waste cold stream is directed through the third heat exchanger; and wherein:

the third arrangement of conduits is arranged such that the second heat transfer fluid is directed through the third heat exchanger in a counter-flow direction to the second cold stream of gas or waste cold stream.

4. The cryogenic liquefaction device of claim 3, when dependent on claim 2, wherein the second and third heat exchangers are one and the same heat exchanger.

5. The cryogenic liquefaction device of claim 3 or claim 4, when dependent on claim 2, wherein the fourth and fifth arrangements of conduits are one and the same arrangement

of conduits, and the first and second cold streams of gas or waste cold streams are one and the same cold streams of gas or waste cold stream respectively.

6. The cryogenic liquefaction device of any of claims 2 to 5, wherein the first cold stream of gas is a waste stream.

7. The cryogenic liquefaction device of any of claims 3 to 6, wherein the second cold stream of gas is a waste stream.

8. The cryogenic liquefaction device of claim 6 or claim 7, wherein the waste stream is a waste stream from a liquefied natural gas (LNG) regasification process.

9. The cryogenic liquefaction device of any preceding claim, wherein the cold recovery circuit further comprises means for circulating the first heat transfer fluid through the second arrangement of conduits.

10. The cryogenic liquefaction device of claim 9, wherein the second arrangement of conduits is arranged such that the first heat transfer fluid is directed through the means for circulating the heat transfer fluid before being directed through the first heat exchanger.

11. The cryogenic liquefaction device of claim 9 or claim 10, wherein the means for circulating the first heat transfer fluid is a mechanical blower.

12. The cryogenic liquefaction device of claim 3, or of any one of claims 4 to 11 when dependant on claim 3, wherein the refrigerant circuit further comprises a compression device, and wherein the third arrangement of conduits is arranged such that the second heat transfer fluid is directed through the compression device before being directed through the third heat exchanger.

13. The cryogenic liquefaction device of claim 3, or of any one of claims 4 to 12 when dependant on claim 3, wherein the refrigerant circuit further comprises an expansion turbine, and wherein the third arrangement of conduits is arranged such that the second heat transfer fluid is directed through the expansion turbine before being directed through the first heat exchanger.

14. The cryogenic liquefaction device of any preceding claim, wherein the expansion device is a Joule-Thomson valve.

15. The cryogenic liquefaction device of any preceding claim, wherein the second arrangement of conduits is arranged adjacent to the first arrangement conduits in a first region of the first heat exchanger.

16. The cryogenic liquefaction device of any preceding claim, wherein the third arrangement of conduits is arranged adjacent to the first arrangement conduits in a second region of the first heat exchanger.

17. The cryogenic liquefaction device of claim 14, wherein the second region is closer to the expansion device, in a flow direction, than the first region.

18. A method for balancing a liquefaction process with the use of cold recycle from an external thermal energy source comprising:

directing a pressurised stream of gas through a first heat exchanger, an expansion device and a phase separator;

directing a first heat transfer fluid in a cold recovery circuit through the first heat exchanger in a counter-flow direction to the pressurised stream of gas; and

directing a second heat transfer fluid in an refrigerant circuit through the first heat exchanger in a counter-flow direction to the pressurised stream of gas; wherein:

each of the second and third arrangements of conduits forms a closed pressurised circuit.

19. The method for balancing a liquefaction process of claim 18, further comprising:

directing a first cold stream of gas or waste cold stream through a second heat exchanger; and

directing the first heat transfer fluid through the second heat exchanger in a counter-flow direction to the first cold stream of gas or waste cold stream.

20. The method for balancing a liquefaction process of claim 18 or claim 19, further comprising:

directing a second cold stream of gas or waste cold stream through a third heat exchanger; and

directing the second heat transfer fluid through the third heat exchanger in a counter-flow direction to the second cold stream of gas or waste cold stream.

21. The method of claim 20, when dependent on claim 19, wherein the second and third heat exchangers are one and the same heat exchanger.

22. The method of claim 20 or claim 21, when dependent on claim 19, wherein the first and second cold streams of gas or waste cold streams are one and the same cold streams of gas or waste cold stream, respectively.

23. The method for balancing a liquefaction process of any one of claims 19 to 22, wherein the first cold stream of gas is a waste stream.

24. The method for balancing a liquefaction process of any one of claims 20 to 23, wherein the second cold stream of gas is a waste stream.

25. The method for balancing a liquefaction process of claim 23 or claim 24, wherein the waste stream is a waste stream from a liquefied natural gas (LNG) regasification process.

26. The method for balancing a liquefaction process of claim 19, further comprising:

directing the second heat transfer fluid through a means for circulating the heat transfer fluid before directing it through the first heat exchanger.

27. The method for balancing a liquefaction process of claim 20, further comprising:

directing the second heat transfer fluid through a compression device before directing it through the third heat exchanger.

28. The method for balancing a liquefaction process of claim 20, further comprising:

directing the second heat transfer fluid through an expansion turbine before directing it through the first heat exchanger.

29. The method for balancing a liquefaction process of any one of claims 18 to 28, wherein the step of directing the pressurised stream of gas through the first heat exchanger comprises directing it past the cold recovery circuit before directing it past the refrigerant circuit.