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[54] **LIQUEFACTION PROCESS FOR GAS MIXTURES BY MEANS OF FRACTIONAL CONDENSATION**  
 7 Claims, 1 Drawing Fig.

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 F25j 3/02, F25j 3/06  
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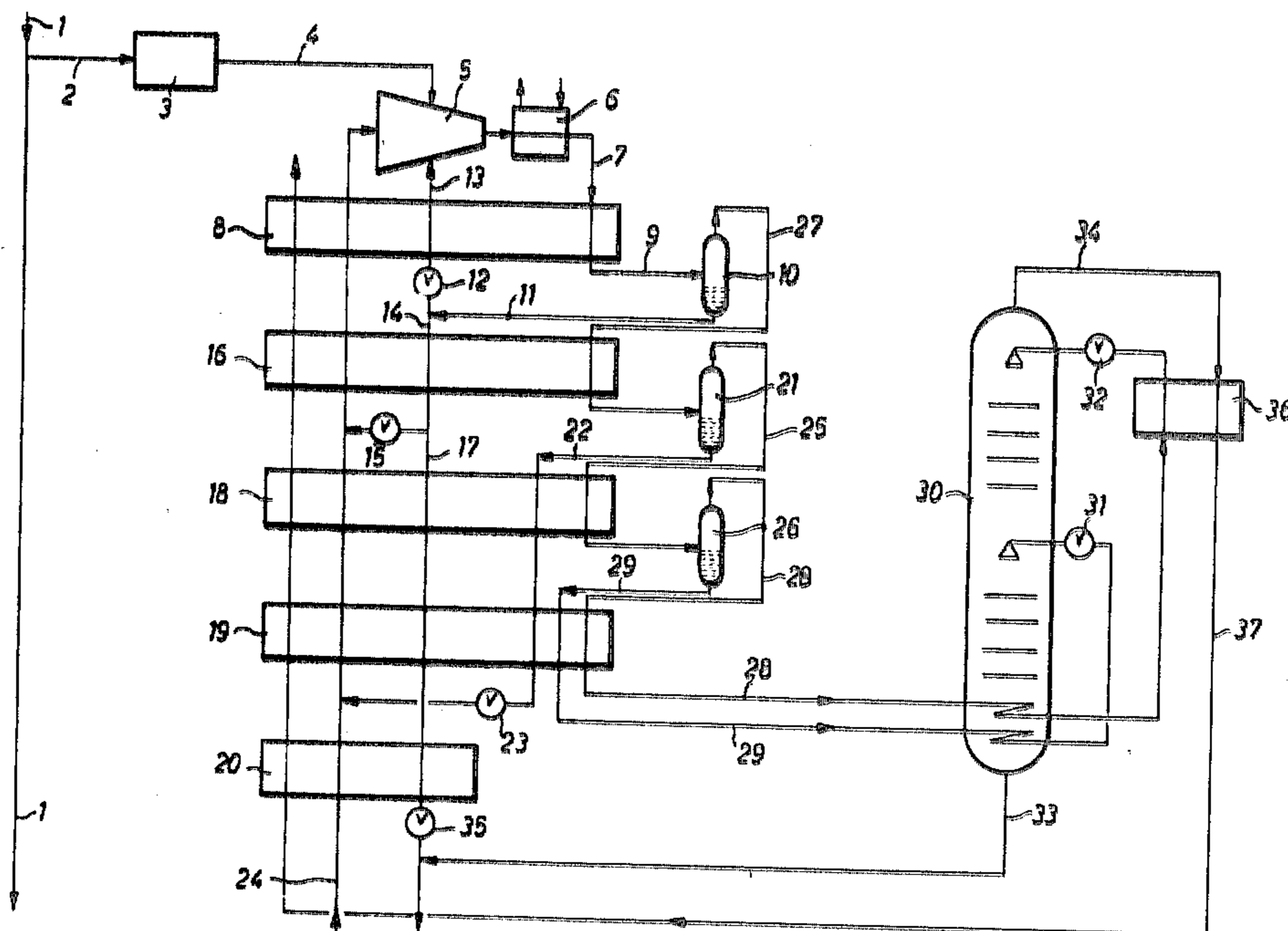
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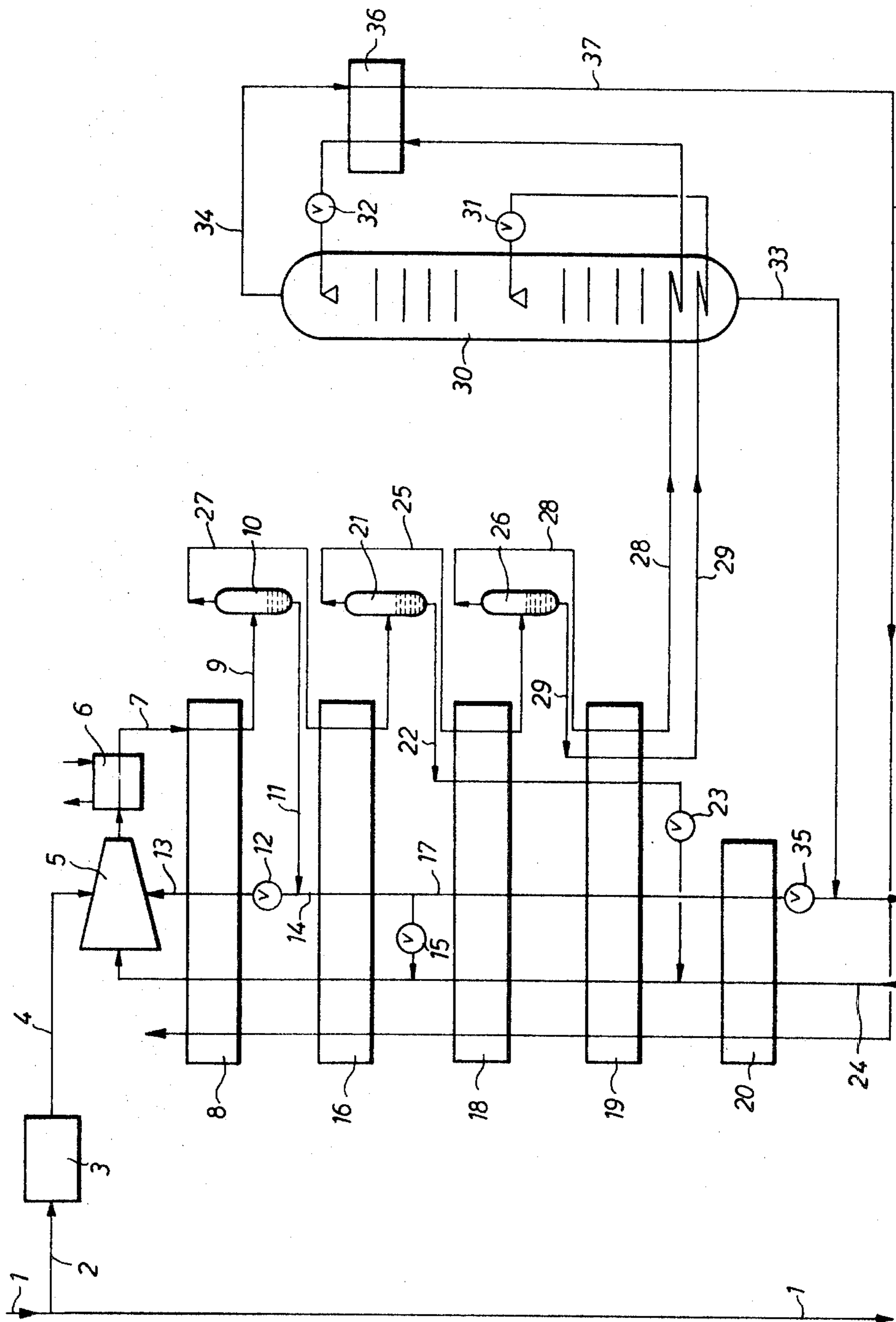
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**ABSTRACT:** A process for the liquefaction of gas mixtures by at least two open partial cycles with different boiling points includes premixing the gas mixture with the cycle media and by means of a compressor bringing it to an elevated pressure and subjecting it to a fractional condensation where the cycle media and the more difficultly boiling mixture constituents are precipitated as liquid fractions in separators. The liquid fraction of the first separator is divided into two partial streams. The first stream, which forms the first partial cycle, after expansion to an average pressure gives off coolness from cycle gas and gas mixture to be liquefied to the mixture streaming to the first separator and again conducts back to the compressor. The second stream is deep-cooled, expanded to about atmospheric pressure and admixed to the last cycle medium streaming back to the compressor. Furthermore, it is proceeded with the compressor of the subsequent separator accordingly, the expansion of the first partial streams occurring at average pressure until finally the liquid precipitating in the last separator after cooling of itself and expanding to about atmospheric pressure, gives off coolness to the gas mixture to be liquefied and to the other separated cycle media and is again conducted to the compressor.





## LIQUEFACTION PROCESS FOR GAS MIXTURES BY MEANS OF FRACTIONAL CONDENSATION

### BACKGROUND OF INVENTION

This invention relates to a liquefaction process for gas mixtures by means of fractional condensation where the cycles are open and the cycle media consist of constituents of the gas mixture to be liquefied.

Liquefaction processes according to this principle are known. French Pat. 1,302, 989, for example teaches a process wherein the cycle media obtained by fractional condensation from natural gas to be liquefied expanded to a common average pressure are mixed, recompressed to the pressure of the natural gas streaming in to the equipment, and are again admixed thereto. It is characteristic of this process that the individual cycle media are expanded to the common average pressure. The process requires an extensive distribution of the heat exchanger. Consequently, there results a complicated connection.

### SUMMARY OF INVENTION

The object of the invention is to provide a liquefaction process of the above type which in a simple connection is particularly suitable even for small liquefaction capacities.

A process has now been found for the liquefaction of gas mixtures by at least two open partial cycles with different boiling ranges where the gas mixture which previously was mixed with the cycle media and by means of which a compressor was brought to elevated pressure, was subjected to a fractional condensation, where the cycle media and the more difficult boiling mixture constituents precipitate as liquid fractions in separators. According to the invention, the liquid fractions of the first separator are distributed into two partial streams of which the first, forming the first partial cycle, after expansion to an average pressure, gives off coolness from the cycle gas and gas mixture to be liquefied to the mixture streaming to the first separator and again conducts back to the compressor, the second one is deep-cooled, expanded to about atmospheric pressure and is admixed to the last cycle medium streaming back to the compressor. Furthermore, it is proceeded correspondingly with the compressor of the following separator, the expansion of the first partial streams occurring at average pressure until finally the liquid precipitating in the last separator, after cooling against itself and expansion to about atmospheric pressure, cools the gas mixture to be liquefied and the other separated cycle media and is again conducted to the compressor.

The inventive process needs, independent of pressure, under which the gas mixture is available, only one compressor. It also allows with respect to small liquefaction capacities the introduction of turbocompressors in a suitable work range. In this connection, the connection is simple and the number of heat exchangers is small. Further advantages can be seen from the embodiment of the invention.

### THE DRAWINGS

The invention is now explained in more detail by way of an example. The example illustrated in the drawing shows the liquefaction of natural gas according to the inventive process, where besides the actual natural gas liquefaction there also occurs a nitrogen separation.

### DETAILED DESCRIPTION

From pipeline 1 is branched off a partial stream 2 of the natural gas under pressure. It is this gas which is to be liquefied and freed of nitrogen. In the purification equipment 3 the natural gas is first prepurified and through conduit 4 reaches the turbocompressor 5 wherein it is compressed to about 25—35 absolute pressure together with the cycle gas fractions. In the afterconnected water cooler 6 a part of the compressed

mixture is already liquefied through conduit 7 the mixture reaches heat exchanger 8 where it is further liquefied and through conduit 9 it reaches separator 10. In separator 10 there is the first decomposition into a liquid and a gaseous fraction. The liquid fraction contains above all the heavy hydrocarbons of ethyl hydride which is drawn off through conduit 11 from separator 10 and distributed into three partial streams. The largest stream is expanded in valve 12 and vaporized under 5—10 absolute pressure in heat exchanger 8. The cold from the largest stream cools the second cycle and the natural gas to be liquefied. By way of conduit 13 it returns in gas form into turbocompressor 5.

A second, smaller partial stream is conducted through conduit 14 into heat exchanger 16 where it is deep-cooled, subsequently expanded in valve 15 and admixed to the low-pressure cycle fraction. The third partial stream is very small and also flows through conduit 14 into heat exchanger 16, where it then branches off from the second partial stream and through conduit 17 reaches in sequence into heat exchangers 18, 19, and 20 where it is deep-cooled and finally admixed to the liquefied natural gas.

The top gas in separator 10 consists of nitrogen and light hydrocarbons which flows through conduit 27 into heat exchanger 16 and from there into the second separator 21. In heat exchangers 16 it is cooled to the extent that in the subsequent phase separation in the second separator 21 the gaseous fraction has about the same composition as the fraction to be processed. The condensate precipitating in the second separator 21 forms the cooling medium of the second cycle. It is drawn off by way of conduit 22, deep-cooled in heat exchangers 18 and 19, and expanded in valve 23 to about atmospheric pressure. Then it gives off the deep cold in the heat exchangers 18 and 19 to the natural gas to be liquefied and reaches then by way of heat exchangers 16 and 8 into turbocompressor 5. Before heat exchanger 19 there is still admixed to it the vaporization gas coming over conduit 24.

After the cycle fractions are separated, the top gas of the second separator 21 again forms the natural gas to be liquefied. The top gas can be liquefied in heat exchangers 18 and 19. However, if a separation of the nitrogen is desired—as assumed in this example—a predecomposition is required. For this purpose the top gas is conducted through conduit 25 into heat exchanger 18 where it is partially liquefied. Then the top gas reaches a third separator 26 where it is decomposed into a liquid fraction poor in nitrogen and into a gaseous fraction rich in nitrogen, both of which are expanded into the nitrogen column 30 through conduits 28 and 29 and valves 31 and 32 after further cooling in heat exchanger 19. In the nitrogen column occurs the decomposition into extensive nitrogen-free natural gas in the column absorption layer and nitrogen in the column top. The natural gas drawn off by way of conduit 33 contains very little heavy hydrocarbons. These are therefore, as described above, admixed to it through conduit 17 over expansion valve 35 from the condensate of the first separator 10. The nitrogen is drawn off at the top of column 30 through conduit 34 and conducted through the the nitrogen deep cooler 36. Its residual coolness is given off in sequence in heat exchangers 20, 19, 18, 16 and 8 and reaches with surrounding pressure and temperature the plot limit.

The above example shows that the inventive liquefaction process gets by with few subdivision of the heat exchanger; the connection is therefore simple. Despite this, good efficiency is achieved. Furthermore, only a compressor is necessary. Since it also compresses the cycle fractions, even with small liquefaction outputs turbocompressors can be set in without their having to be operated in a disadvantageous work range.

The gas circulating in the cycles is formed from the natural gas components automatically in the correct composition, so that no special precautions for the starting and running ready-position of the cycle gas are necessary.

The process can be expanded by one or more cycles. The cycle media would then be expanded to pressures which are situated between the pressure of conduit 13 and the at-

mospheric pressure. This broadening decreases the energy requirement and is recommended for liquefaction of gas mixtures with relatively many heavy hydrocarbons.

I claim:

1. A process for the liquefaction of hydrocarbon gas mixtures by means of at least two open refrigeration cycles of media, consisting of heavy components of the gas to be liquefied and having different boiling ranges wherein the gas mixture is premixed with the cycle media and brought to an elevated pressure by a compressor, and is subjected to a fractional condensation, the cycle gas and the high-boiling constituents being separated into liquid fractions in a plurality of separators, the improvement being dividing the liquid fraction of the first separator into a first and a second partial streams, the first stream forming one of the refrigeration cycles, after being discharged from the first separator the first stream being expanded to an intermediate pressure which is a pressure greater than atmospheric and less than that of the compressor, outlet after expansion the first stream being utilized for cooling the mixture fed into the first separator, and the first stream being fed back to the compressor; the second stream from the first separator being deep-cooled and expanded to about atmospheric pressure, the second stream then being admixed with one of the other of the refrigeration cycles and fed back to the compressor; and the condensates in the following separators are subdivided into first and second portions in the manner of the first separator, the respective first and second streams of the following separators are processed in the same manner as the first and second streams of the first separator

until finally the liquid of the last separator is cooled against itself and expanded to about atmospheric pressure and is utilized for cooling the gas to be liquefied and the other separated cycle gas media and then is mixed with the second partial streams to form the other of the circulation cycles which is fed back to the compressor.

2. A process according to claim 1 wherein each first partial stream is greater than its second partial stream.

3. A process according to claim 2, characterized in that from at least one of the first partial streams formed from the liquid fractions, a partial amount is branched off, deep-cooled, expanded, and again admixed to the liquefied gas mixture.

4. A process according to claim 3, characterized in that the gas mixture to be liquefied is natural gas and the cycle media consist preponderantly of high-boiling hydrocarbons.

5. A process according to claim 4, whereby nitrogen is to be removed from the natural gas, characterized in that the gaseous fraction drawn off from the last separator after further cooling and partial liquefaction is subjected to a predecomposition in an additional separator for the purpose of nitrogen separation, and before further cooling is expanded in the nitrogen column.

6. A process according to claim 5, characterized in that only two refrigeration cycles are used with two appropriate separators.

7. A process according to claim 1, characterized in that the gas mixture to be liquefied is natural gas and the cycle media consist preponderantly of high-boiling hydrocarbons.

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