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(71) Applicant: **L'AIR LIQUIDE, SOCIETE ANONYME POUR L'ETUDE ET L'EXPLOITATION DES PROCEDES GEORGES CLAUDE**
75, Quai d'Orsay
F-75321 Paris Cédex 07 (FR)

(72) Inventor: **Takagi, Harumitsu - l'Air Liquide, Service des relations Industrielles - 75, quay d'Orsay**
FR-75321 Paris cedex 07 (FR)

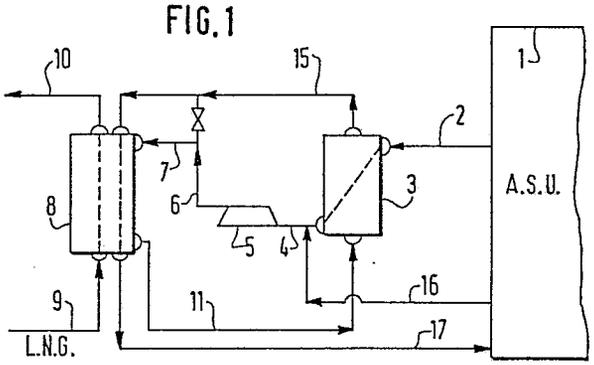
Nagamura, Takashi - l'Air Liquide - Services des Relations Industrielles, 75, quay d'Orsay
FR-75321 Paris cedex 07 (FR)

(74) Representative: **Jacobson, Claude et al**
L'AIR LIQUIDE, SOCIETE ANONYME POUR L'ETUDE ET L'EXPLOITATION DES PROCEDES GEORGES CLAUDE
75, quai d'Orsay
F-75321 Paris Cédex 07 (FR)

(54) Method of using an external cold source in an air separation apparatus.

(57) Method of using an external cold source (9) in an air separation apparatus (1) in which air is liquefied and rectified to manufacture products of oxygen, nitrogen and the like mainly in the form of liquid, characterized in that an inert gas (2) guided out of the air separation apparatus (1) is cooled by indirectly heat exchanging it (in 3) with a cooled, liquefied, recycling, pressure-raised inert gas (11), said inert gas guided out of the apparatus is joined with a low temperature inert gas (16) guided out also of said apparatus, the joined inert gas is compressed at low temperature by heat exchange (in 8) with the external cold source (9) up to a pressure required for liquefaction, said liquefied inert gas (11) is supplied as a cold source to a recycle heat exchanger (3), the low temperature inert gas evaporated in said heat exchanger is joined with a part of the low temperature inert gas compressed by compressor (5), the low temperature inert gas thus joined is again liquefied by heat exchange (in 8) with the external cold source (9), said liquefied inert gas (17) is introduced into the air separation apparatus to which the cold necessary therefore is supplied, and thereafter said liquefied inert gas is again recycled as inert gas out of the air separation apparatus.

FIG.1



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Description

METHOD OF USING AN EXTERNAL COLD SOURCE IN AN AIR SEPARATION APPARATUS

INDUSTRIAL FIELD OF THE INVENTION

This invention relates to an economical method in which an external cold source can be effectively used in an air separation apparatus.

PRIOR ART

When liquefied natural gas (hereinafter referred to as LNG) is used it must be gasified, and effective use of the cold which is generated at the time of gasification is tried in various ways. One of such known ways is to use an external cold source in an air separation apparatus in which air is liquefied and rectified to manufacture liquid products such as liquid oxygen and liquid nitrogen.

For example, Japanese Patent Publication Nos. 45,054/74 and 40,353/74 and Japanese Patent Kokai No. 34,083/81 disclose methods of using cold of LNG for cooling feed air, and Japanese Patent Publication Nos. 41,224/77, 15,993/78, 1,359/75 and 18,125/71 disclose methods of using the cold of LNG for cooling and liquefying recycle nitrogen. Further, Japanese Patent Publication Nos. 16,081/71, 19,685/71 and 20,123/71 describe methods of cooling both feed air and recycle nitrogen by LNG.

In the case of adopting nitrogen cycle for supplying a cold necessary for an air separation apparatus a cold is generated by compression and expansion of nitrogen. However, it can reduce power consumption much more to compress low temperature gas (nitrogen), and therefore in Patent Publication Nos. 15993/78, 1359/75, 18125/71, 16081/71, 19685/71 and 20123/71 among the above-mentioned known inventions, reduction of power cost is planned by adopting so-called cold compression in which compression is carried out to cold nitrogen which has been cooled by LNG or a low temperature gas separated by the air separation apparatus.

Furthermore, Japanese Patent Publication No. 34785/81 describes a method in which other cold (such as flon) besides recycle nitrogen is cooled by LNG thereby to be used for the precooling of feed air.

The Applicants of the present invention formerly proposed, as a method for using a cold source, a method (Patent Kokai No. 150,786/83) of using an external cold source in an air separation apparatus, in which method a recycling inert gas guided out of the air separation apparatus is cooled by being indierctly heat exchanged with a part of a liquefied inert gas, then it is compressed in a low temperature up to a pressure required for liquefaction by heat exchange with an external cold source, the compressed cold inert gas is liquefied by an indirect heat exchange with the external cold source, a part of the liquefied inert gas is raised to a desired pressure by pump thereby to be supplied as a cold source to said recycling heat exchanger where the evaporated cold inert gas is joined together with said cold inert gas compressed by said compressor, other parts of said liquefied inert gas are introdued into the air separation apparatus when a cold is supplied thereto, and thereafter such gas is again guided out of the air separation apparatus, as a recycling inert gas.

Since this known method uses a pump for raising a part of the liquefied inert gas to a desired risen-pressure, two units of a rotary machine are used for recycle equipment. This causes problems such as increase of installation cost, difficulty of operation, and complicated maintenance.

PROBLEM TO BE SOLVED BY THE INVENTION

The object of the invention is to provide a method for using an external cold source in an air separation apparatus, in which method it is possible to sufficiently utilize the cold of LNG further than said prior arts and to minimize the power cost necessary for the cycle of using an external cold source.

MEANS TO SOLVE THE PROBLEMS

The inventors of this invention have made various researches and studies to solve said problems, and as a result they have been successful in developing this invention. The constitution of the method of the invention is as clearly described in said claims.

The invention will now be described in detail as to its method with reference to the accompanying drawings which show some embodiments of the invention.

Fig. 1 to Fig. 4 are all flowsheets which show some embodiments the method according to the present invention.

In Fig. 1, reference numeral 1 designates an air separation apparatus. Since the details of said apparatus are not concerned with essential parts of the invention, they are omitted from the drawing and explanation. In the air separation apparatus 1, an inert gas which has given a cold necessary for the apparatus is taken out by a conduit 2, and it is fed to a recycling heat exchanger 3 where said inert gas is cooled to a temperature near that of LNG by the undermentioned liquefied inert gas and joined with a cold inert gas taken out from the air separation apparatus 1 by a conduit 16, and then the joined inert gases are introduced into a compressor 5 by a conduit 4. The cold inert gas is compressed in low temperature by the compressor 5 up to a pressure required for liquefaction by the heat exchange with undermentioned LNG, then it is fed to a conduit 6, and a part or the whole thereof is supplied to an LNG heat exchanger 8 through a conduit 7. In the LNG heat exchanger 8 the cold inert gas is liquefied by LNG introduced from a conduit 9, LNG is evaporated and guided out a conduit 10 whereby it is fed to the use destination. The liquefied inert gas liquefied in the LNG heat exchanger 8 is taken out by a conduit

11 so as to be fed into said recycling heat exchanger 3, said liquefied inert gas cools the inert gas introduced from the conduit 2 as described above, itself evaporates to become a cold inert gas, is joined in stream with a part of the cold inert gas from the bypass of the conduit 6 compressed by said compressor 5, and the thus joined gases are again supplied to the LNG heat exchanger 8. As described above, the cold inert gas is liquefied by LNG and discharged by a conduit 17 thereby to be fed into the air separation apparatus 1 where after supplying of a necessary cold the inert gas is again taken out from the conduit 2 for recycling.

Fig. 2, Fig. 3 and Fig. 4 are flowsheets of different embodiments in which the system illustrated in Fig. 1 has been modified.

In Fig. 2, a part of the liquefied inert gas taken out from the conduit 11 from the LNG heat exchanger 8 is branched to a conduit 18 from the conduit 11 and supplied to another heat exchanger 19. In the heat exchanger 19, other gas (such as feed air) introduced from a conduit 20 is cooled by the liquefied inert gas, it is fed to a desired destination through a conduit 21, while the liquefied inert gas becomes a cold inert gas, it is taken out by a conduit 22, and it is again joined with the stream of the cold inert gas taken out through the conduit 15 from the recycling heat exchanger 3.

Fig. 3 constitutes an assembly of the recycleing heat exchanger 3 in Fig. 1 and the LNG heat exchanger 8. In Fig. 3, instead of recycling the cold inert gas discharged from the compressor 5, in a plurality of sequences, the inert gas (nitrogen gas) at room temperature from the air separation apparatus 1 is directly supplied to the LNG heat exchanger 8 through the conduit 7. In the LNG heat exchanger 8 the inert gas at room temperature is cooled to a temperature near that of LNG, it is taken out by a conduit 23, and then it is guided to the compressor 5.

On the other hand, a part or the whole of the cold inert gas taken out of the air separation apparatus 1 by the conduit 16 is branched from the conduit 16 to a conduit 24, it joins with the stream in a conduit 23, and the joined flow is guided to the compressor 5.

A part of the cold inert gas of the conduit 16 is branched from the conduit 16 to a conduit 25, it is supplied to the LNG heat exchanger 8, it is joined with the cooled inert gas fed to the LNG heat exchanger 8 through said conduit 7, and cooled therein within the LNG heat exchanger 8, and it is possible to take the joined gas out of the conduit 23, as a cold inert gas. This cold inert gas is used to adjust the temperature at the inlet of the compressor 5.

Fig. 4 is a flowsheet in which the recycle system described in Fig. 3 is added with a cycle for using as a cold source of other gas similarly as in Fig. 2. That is, a part of the cold inert gas taken out of the air separation apparatus 1 through the conduit 16 is branched by a conduit 26 to allow it to be guided into the heat exchanger 19. In the heat exchanger 19, other gas (such as feed air) which is introduced by the conduit 20 is cooled, and it is fed to a desired destination by the conduit 21, on the other hand the cold inert gas is heated and is taken out through a conduit 27. After said inert gas has been joined with the flow which has come through the conduit 4 from said LNG heat exchanger (which also serves as a recycle heat exchanger) 8, it is introduced into the compressor 5.

As the recycling inert gases employed in each of the above embodiments, nitrogen and argon are industrially used.

In case nitrogen is used as a recycle gas, a part of liquid nitrogen is introduced from the conduit 11 to the air separation apparatus 1 thereby supplying a cold required therefor. The embodiment of this operation are known as referred to above, but generally, liquid nitrogen is blown as a reflux liquid into a rectifying column, while nitrogen gas in the same volume as the liquid nitrogen is taken out of the rectiflying column so as to be used to cool the feed air. Thereafter, the nitrogen gas is guided out of the air separation apparatus 1 through the conduit 2 whereby a nitrogen cycle is formed.

When argon is used as a recycle gas, for example as disclosed in Applicants' prior Application No. 64105/80, the nitrogen used as another recycle gas is cooled and liquefied by the liquefied argon introduced into the air separation apparatus 1 thereby to be a product liquid nitrogen or a reflux liquid in the rectifying column. It is also possible to cool the feed air with the low temperature argon gas which has been evaporated by such a heat exchanging.

EFFECTS OF THE INVENTION

(1) Since a pump for raising a portion of the liquefied inert gas to a desired pressure is not used, it is possible to reduce the unit of machines and to simplify the operation. Further, according to the invention it is possible to avoid complications such as cooling the pump by the liquefied gas before starting up and increasing the evaporated gas to be purged and simplify the starting up of the apparatus. Additionally, there is no admission of heat from the liquid pump to the liquefied gas.

(2) In the heat exchanging of LNG in the LNG heat exchanger with the cold inert gas, the inert gas is compressed by the compressor up to a pressure necessary for liquefaction by said heat exchange and it is cooled, before compression, up to a temperature near the LNG temperature in the recycling heat exchanger 3, so that sufficient use of the cold of LNG is possible.

Claims

1. A method of using an external cold source in an air separation apparatus in which air is liquefied and rectified to manufacture products of oxygen, nitrogen and the like mainly in the form of liquid, characterized in that an inert gas guided out of the air separation apparatus is cooled by indirectly heat exchanging it with a

cooled, liquefied, recycling, pressure-raised inert gas, said inert gas guided out of the apparatus is joined with a low temperature inert gas guided out also of said apparatus, the joined inert gas is compressed at low temperature by a heat exchange with the external cold source up to a pressure required for liquefaction, said liquefied inert gas is supplied as a cold source to a recycle heat exchanger, the low temperature inert gas evaporated in said heat exchanger is joined with a part of the low temperature inert gas compressed by a compressor, the low temperature inert gas thus joined is again liquefied by a heat exchange with the external cold source, said liquefied inert gas is introduced into the air separation apparatus when a cold necessary therefor is supplied, and thereafter, said liquefied inert gas is again guided as a recycling inert gas out of the air separation apparatus.

2. A method as described in Claim 1 wherein the recycling inert gas is nitrogen.

3. A method as described in Claim 1 wherein the recycling inert gas is argon.

4. A method as described in Claim 1 wherein the other cold sources are liquefied natural gas.

FIG. 1

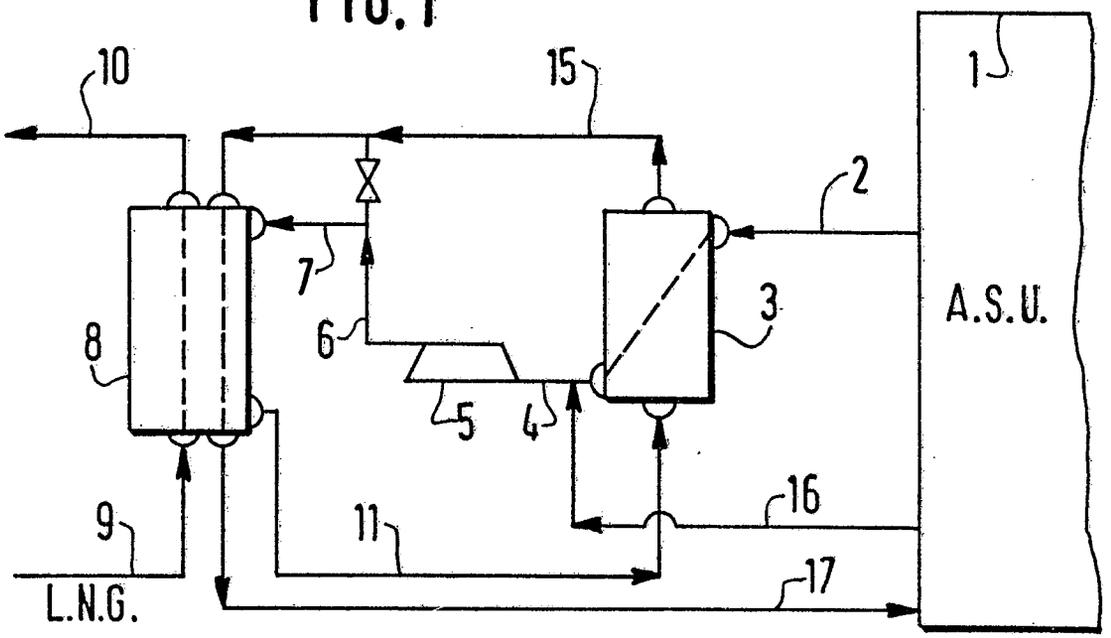
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FIG. 2

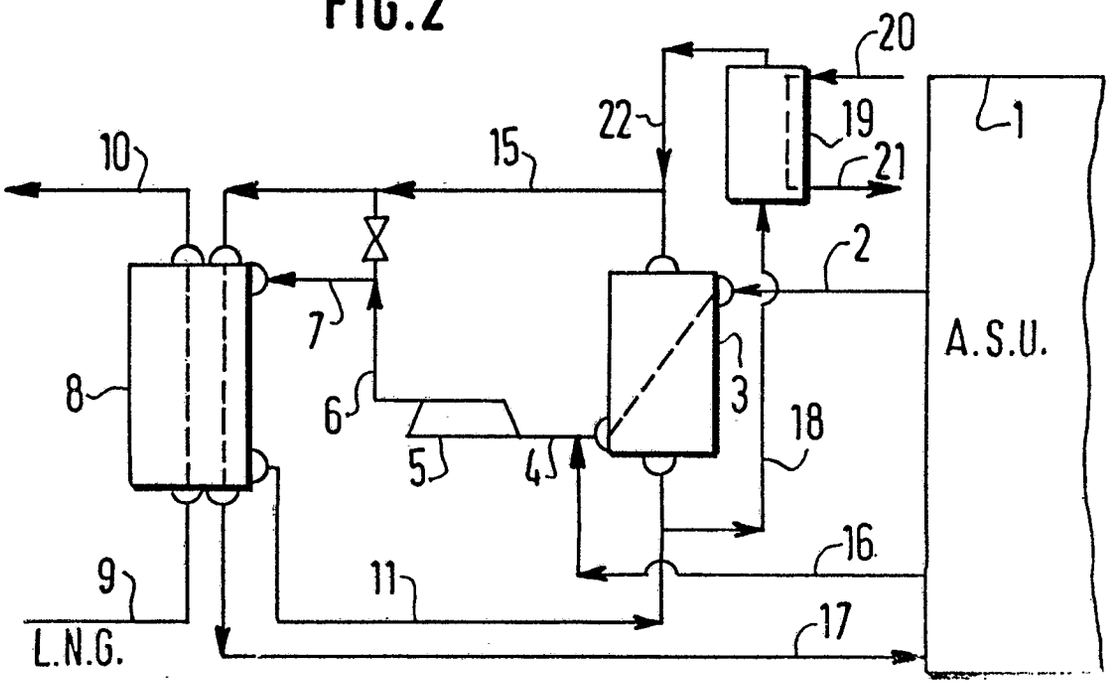
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FIG. 3

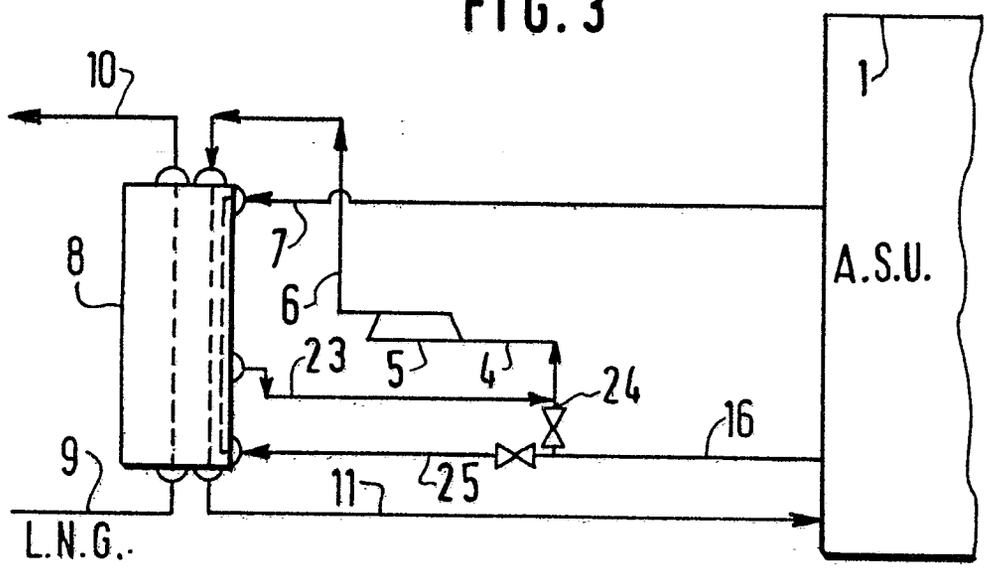
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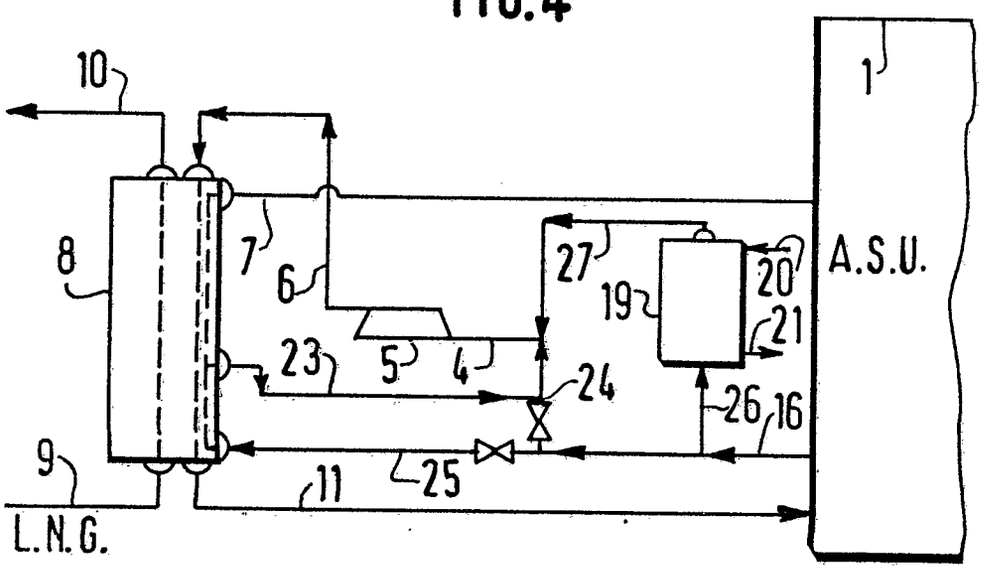
FIG. 4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European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 40 1888

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	CHEMICAL ABSTRACTS, vol. 93, no. 26, December 1980, page 148, abstract no. 242012t, Columbus, Ohio, US; & JP-A-80 77 680 (CHUBU EKISAN K.K.) 11-06-1980 * Figure 1 *	1,2,4	F 25 J 3/04 F 17 C 9/04
A	GB-A-1 565 159 (NIHON SANSO et al.) * Page 1, lines 54-71; page 2, line 26 - page 3, line 7; figure *	1,2,4	
A	FR-A-2 077 442 (L'AIR LIQUIDE) * Page 1, lines 1-8; page 3, line 36 - page 5, line 24; figure 1 *	1,2,4	
A	CHEMICAL ABSTRACTS, vol. 77, no. 22, 27th November 1972, page 98, abstract no. 141789r, Columbus, Ohio, US; & JP-B-71 20 126 (HITACHI LTD) 05-06-1971 * Figure *	1,2,4	
D,A	JP-A-58 150 786 (TEISAN) * Figure *	1,2,4	TECHNICAL FIELDS SEARCHED (Int. Cl.4) F 17 C F 25 J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	08-12-1988	SIEM T.D.

CATEGORY OF CITED DOCUMENTS

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