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D E C I S I O N
of 28 January 1999

Case Number: T 0153/96 - 3.2.3

Application Number: 91110567.4

Publication Number: 0464635

IPC: F25J 3/02, F25J 3/04

Language of the proceedings: EN

Title of invention:
Cryogenic air separation with dual feed air side condensers

Patentee:
Praxair Technology, Inc.

Opponent:
L'Air Liquide, S.A. pour l'étude et l'exploitation des procédés Georges Claude

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - yes"

Decisions cited:
-

Catchword:
-

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Case Number: T 0153/96 - 3.2.3

D E C I S I O N
of the Technical Board of Appeal 3.2.3
of 28 January 1999

Appellant: (Opponent)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office of 27 November 1995, posted on 18 December 1995 rejecting the opposition filed against European patent No. 0 464 635 pursuant to Article 102(2) EPC.**

Composition of the Board:

Chairman: C. T. Wilson
Members: H. Andrä
J.-P. Seitz

Summary of Facts and Submissions

I. European patent application No. 91 110 567.4, filed on 26 June 1991 and published on 8 January 1992 under publication No. 0 464 635, was granted on 3 November 1993.

Independent Claims 1 and 14 as granted read as follows:

"1. Method for the separation of air by cryogenic distillation to produce product gas comprising:

(A) condensing at least some of a first portion of cooled compressed feed air and introducing resulting liquid into a first column of an air separation plant, said first column operating at a pressure generally within the range of from 4 to 7 bar (60 to 100 psia);
(B) turboexpanding a second portion of the cooled, compressed feed air and introducing a first part of the resulting turboexpanded feed air into said first column in vapor form;
(C) condensing at least some of a second part of the turboexpanded feed air and introducing the resulting fluid into said first column;
(D) separating the fluids introduced into said first column into nitrogen-enriched and oxygen-enriched fluids and passing said fluids into a second column of said air separation plant, said second column operating at a pressure less than that of said first column;
(E) separating the fluids passed into the second column into nitrogen-rich vapor and oxygen-rich liquid;
(F) withdrawing oxygen-rich liquid from the second column and vaporising a first portion of the withdrawn oxygen-rich liquid by indirect heat exchange with the second part of the turboexpanded feed air to carry out the condensation of step (C);

(G) increasing the pressure of a second portion of the withdrawn oxygen-rich liquid and vaporising the resulting liquid by indirect heat exchange with the first portion of the feed air to carry out the condensation of step (A); and
(H) recovering vapor resulting from the heat exchange of steps (F) and (G) as lower and higher pressure product oxygen gas, respectively."

"14. Apparatus for the separation of air by cryogenic distillation to produce product gas comprising:

(A) an air separation plant comprising a first column, a second column, a reboiler, means to pass fluid from the first column to the reboiler and means to pass fluid from the reboiler to the second column;
(B) a first condenser, means to provide feed air to the first condenser and means to pass fluid from the first condenser into the first column;
(C) a turboexpander, means to provide feed air to the turboexpander and means to pass fluid from the turboexpander into the first column;
(D) a second condenser, means to pass fluid from the turboexpander to the second condenser and means to pass fluid from the second condenser into the first column;
(E) means to pass a first liquid product stream from the second column to the second condenser and means to recover the evaporated first liquid product stream from the second condenser as a lower pressure product gas; and
(F) means to pass a second liquid product stream from the second column to the first condenser, said means comprising means to increase the pressure of the liquid stream, and means to recover the evaporated second liquid product stream from the first condenser as higher pressure product gas."

II. The patent was opposed by the Appellant who requested revocation of the patent on the ground of lack of inventive step.

The opposition was supported inter alia by the following documents:

(D1) US-A-4 303 428
(D4) US-A-3 210 951

After expiry of the period stipulated for filing an opposition the following documents were cited in the opposition proceedings:

(D7) US-A-4 817 394
(D8) US-A-4 854 954
(D9) US-A-3 086 371

Among these citations (D7) and (D8) were not admitted into the proceedings due to lack of relevance of their disclosures.

III. By decision of 27 November 1995, posted on 18 December 1995, the Opposition Division rejected the opposition.

The Opposition Division held that the grounds of opposition did not prejudice maintenance of the patent in the form as granted.

IV. On 16 February 1996 the Appellant lodged an appeal against the decision paying the appeal fee on the same day. The Statement of Grounds of Appeal was received on 17 April 1996 in which Statement the Appellant attacked the subject-matter of Claim 1 and Claim 14, respectively, on the ground of lacking inventive step in the light of a combination of the citations (D9) and (D7) or (D1) (Claim 1) and of the citation (D7)(Claim 14).

V. In response to the communication pursuant to Article 110(2) EPC dated 12 May 1997 in which the Board expressed its provisional opinion the Appellant, by telefax dated 18 August 1997, cited for the first time the following documents:

(D10) D.E. Smith: "Comparison of Liquid Pumping and Gas Compression in Gas-Producing Oxygen Plants" Proceedings of the 1960 Cryogenic Engineering Conference, University of Colorado and National Bureau of Standards, Boulder, Colorado, 23 to 25 August 1960

(D11) P. Petit: "Air separation units with liquid production" Proc. Fourth Nat.Symp.Cryog. 17 to 19 December 1979, Bombay

(D12) EP-A-422 974

(D13) EP-A-093 448

(D14) EP-A-044 679

(D15) EP-A-042 676

The Appellant held that (D10) describes a method of separating air in which cooling is provided by expansion in a turbine "Claude" and liquid oxygen is vaporised by heat exchange with air. It would be obvious to adapt the scheme of (D9) in order to utilise the cooling method of (D10), namely the turbine "Claude". The same arguments as for the "method" claims would apply to the "apparatus" claim 14.

VI. In his letter dated 8 June 1998 the Respondent (Patentee) contested the arguments of the Appellant and pointed out that the Appellant had not given any reason for citing at this stage of the proceedings additional

prior art and this in particular in view of the fact that the claims have not been amended. He requested not to introduce such late-cited prior art into the proceedings.

VII. The Appellant requested that the patent be revoked. He argued essentially as follows:

(D7) shows the use of two air mass flows at different pressures in order to vaporize two liquid oxygen mass flows in separated condensers. The embodiment of Figure 2 corresponds to that of Figure 5 of (D9), since the refrigeration is effected by expansion of nitrogen in turbine (27), only part of the air being compressed by compressor (25) to a higher pressure.

(D7) explains that if it is desired to produce nitrogen under pressure, one generates refrigeration by using an expansion turbine (turbine "Claude") (38) which expands part of the air serving afterwards the purpose of vaporising the liquid oxygen (Figure 3).

Thus, the skilled person is taught by (D7) that instead of expanding nitrogen in order to maintain the system with regard to refrigeration, he can split the air into two portions one of which is expanded in an expansion turbine and in the following partially condensed in the condenser (23) (via valve (45)).

The subject-matter of Claim 1 is not inventive with regard to the combination of (D9) and (D7).

The skilled person will also note the resemblances of the pressures of the mass flows in (D1) and (D9). If he wishes to modify (D9) in order to produce a gaseous oxygen mass flow at low pressure, he is taught by (D1) to vaporize liquid oxygen at low pressure by heat exchange with the mass flow (30) from the expansion turbine (29).

The subject-matter of Claim 1 is not inventive with regard to a combination of (D9) and (D1).

Having regard to the apparatus-claim 14 there can be no distinction between a condenser and a simple heat exchanger since the term "condenser" is a functional feature rather than a structural feature.

When comparing Figure 3 of (D7) with Claim 14 of the patent in suit most of the features (expansion turbine (38) which feeds the second condenser (22), the first condenser (23)) can be found. Figure 3 shows only the production of an oxygen mass flow but it is explained that the integration of the condensers (22, 23) is optional and that the arrangement of the condensers could be that according to Figure 2 in which two separated liquid oxygen mass flows are fed to the condensers. Due to the differences of the hydrostatic pressures these two mass flows will not be exactly under the same pressure and could therefore be recovered at two different pressures. The subject-matter of Claim 14 is not, therefore, inventive in view of (D7).

Moreover, having regard to Claim 1, (D10) describes a method of separating air in which refrigeration is provided by expansion in a turbine "Claude" and liquid oxygen is vaporised by heat exchange with air. It would be obvious to adapt the scheme of (D9) in order to make use of the refrigeration of (D10), namely the turbine "Claude".

Having regard to the "apparatus" claims it is clearly indicated in (D4), column 4, lines 65 to 67, that reboilers 44 and 45 may comprise a heat exchanger of conventional construction. (D1) shows also the vaporisation of liquid oxygen in the main heat exchanger of an air separation apparatus. Other examples of the case in which condensation and evaporation are effected in conventional exchangers are given in citations (D12) to (D15). It is thus clear that any heat exchanger can serve as reboiler-condenser as soon as the temperatures and the pressures of the fluids allow this. Claim 14 does not involve an inventive step with regard to the combination of (D9) with (D1) or (D10) the same arguments in this respect applying as to the "method" claims.

VIII. The Respondent requested that the appeal be dismissed, by means of auxiliary request that the patent be maintained on the basis of Claims 1 and 14 handed over during the oral proceedings before the Opposition Division on 27 November 1995.

The arguments in support of his request can be summarised as follows:

The subject-matter of Claims 1 and 14 according to the main request differs from (D9) in two basic aspects, namely in the manner in which the various pressure levels are obtained and the condition of the feed air before introduction thereof into the first column.

Whilst according to (D9) the higher pressure feed air is obtained by further compressing a divided portion of the feed air, the lower pressure feed air portions according to the invention are obtained by expanding a portion of the feed air in a turbo-expander. In contrast to the invention, (D9) does not disclose condensation of the feed air before its introduction into the first column.

The oxygen boilers described by (D7) produce oxygen at the same pressure as the oxygen leaving the main heat exchanger in a single stream that is, not as lower and higher pressure oxygen gas streams. Furthermore, (D7) teaches to pass all of the feed air through one or the other of the condensers whereas according to the invention the first part of the second (turbo-expanded) feed air portion is introduced into the first column in vapour form. Even the combination of (D9) and (D7) could not, therefore, result in the subject-matter of Claim 1 or Claim 14.

According to (D1) the requested refrigeration of the air separating system is provided by turbo-expanding a portion of the feed air and feeding this expanded portion directly into the first column in vapour form. (D1) cannot, therefore, suggest condensing the turbo-expanded portion of the feed air when combined with (D9).

As to the newly cited documents (D10) to (D15) the Appellant did not give any reason for citing at this late stage of the proceedings additional prior art. It is pointed out particularly that the claims have not been further amended. As these late-cited documents neither anticipate nor make obvious the subject-matter of independent Claims 1 and 14, it is requested not to introduce these citations into the proceedings.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request*

3. *Inventive step*

3.1 The Board considers that (D9) discloses the nearest prior art with regard to the subject-matter of Claim 1 and Claim 14, respectively, which is not challenged by the parties to the proceedings.

According to the gas fractionating system shown in Figure 5 of (D9) cooled feed air (300) compressed to a first pressure is divided into three portions (309, 302 and 310). The first portion (309) is cooled at the first pressure by heat exchange with gaseous nitrogen in heat exchanger (375, 376) and the second (302) and the third (310) portions are cooled by heat exchange with liquid oxygen at different pressures. The third portion (310) is further compressed to a second, higher pressure in compressor (311), thereafter cooled in heat exchangers (331, 334) by liquid oxygen which has been pressurized in a pump (366), and expanded in valve (336) before being introduced into the first column (339). The second portion (302) is cooled at the first pressure level in heat exchanger (337) by heat exchange with depressurized liquid oxygen before being combined with the third portion for introduction into the first column (339).

As described by (D9) the higher pressure of the third feed air stream is obtained by further compressing (311) a portion of the feed air whereas according to Claims 1 to 14 of the patent in suit the feed air stream is compressed initially to a high pressure and

the pressure of the lower pressure air portion is arrived at by expanding a portion of the feed air in a turbo-expander, thereby avoiding the use of a process stream for producing refrigeration such as a nitrogen stream (387) in an expansion engine (386) acccrding to (D9).

As a further difference (D9) does not disclose condensing at least some of the first portion of cooled compressed feed air and at least some of a (second) part of turbo-expanded feed air of the second feed air portion by heat exchange with liquid oxygen before introduction into the first, higher pressure column.

Although liquid fractions of the cooled supercritical air which is expanded from 1500 psia (103.4 bar) to 87 psia (6.0 bar) in expansion valve (336) may occur according to (D9) this does not constitute condensation of the feed air portions as commonly understood.

3.2 Claim 1 and Claim 14 differ from the disclosure of (D9) essentially in that

(a) the second, lower pressure feed air portion is obtained by expanding the feed air in a turbo-expander, and

(b) the first portion and at least some of the second part of the second portion of the feed air are condensed by heat exchange with the liquid oxygen.

Having regard to the subject-matter of Claim 14 of the category "apparatus" (D9) does not disclose means to provide feed air to the turbo-expander and means to pass fluid from the turbo-expander into the first column (feature (C)) and, furthermore, means to pass fluid from the turbo-expander to the second condenser (feature (D)).

On the basis of the system described by (D9) the technical problem underlying the subject-matter of Claim 1 and Claim 14, respectively, can be seen in improving the known cryogenic air separation system by maintaining high reflux ratios and providing more refrigeration to the column system with the aim of achieving higher product purities and recoveries.

By the above-cited feature (a) a feed airstream is used for expansion avoiding thus the use of a process stream as in the expansion engine (326) according to (D9) in which the low boiling point fraction (385) is used for generating refrigeration. It is credible to the Board and has not been challenged by the Appellant that the above-cited distinguishing features (a) and (b) interact with each other to maintain high reflux ratios, provide more refrigeration and allow higher product purities and recoveries.

3.3 In the air separation process known from (D1), a portion (28) of the compressed feed air (16) is cooled, expanded in an expansion turbine (29) and thereafter introduced into the first column (3). The other portion of the feed air is further compressed (compressor stage 13), cooled (exchanger 23) and fed to the first (3) and the second (5) column, respectively.

There is no hint of further cooling, in particular condensing of the expanded feed air before its introduction into the column.

Since neither (D9) nor (D1) discloses the feature of condensing the turbo-expanded portion of the feed air, a combination of these citations cannot lead in an obvious manner to the subject-matter of Claim 1 and of Claim 14, respectively.

3.4 (D7) which had been cited by the Appellant after expiration of the opposition period was not admitted into the proceedings by the Opposition Division on the ground that it did not appear any more relevant than the documents already on file.

(D7) relates to a process and an apparatus for the fractional distillation of air to high purity oxygen and crude argon, optionally also nitrogen. The overall objective is seen in achieving near-equilibrium conditions in both the HP rectifier and the N_2 removal column at the overhead location, the intermediate reflux height and the feed height.

As shown in the embodiment of Figure 2 two air condensers (22, 23) are provided each being fed with part of the feed air and the condensers being in heat exchange with liquid oxygen bottom product from argon column stripper (1f).

The two condensers produce oxygen at the same pressure and the two oxygen mass flows are recombined downstream of the condensers, the oxygen leaving the main heat exchanger (4) as a single stream.

The Appellant puts forward that due to the differences of the hydrostatic pressure these two main flows will not be exactly under the same pressure and could therefore be recovered at two different pressures.

In the case that two streams being under different pressures lead into a common duct it is normal practice to adapt the pressures of the streams by means of throttles or valves. Since in Figure 2 of (D7) no such means are shown and no difference of the hydrostatic pressures of the streams to be combined is mentioned, the Appellant's argument in this respect is purely speculative.

In contrast to the embodiments of Figure 2 and also of Figure 3 of (D7), oxygen is produced according to Claim 1 and Claim 14 of the patent in suit as lower and higher pressure oxygen gas (Claim 1, features (F) and (G) and Claim 14, features (E) and (F)).

As a further substantial difference, the embodiments of Figure 2 and of Figure 3 of (D7) teach to pass all the feed air through one or the other or both of the condensers (22, 23). According to the patent in suit, however (see Claim 1, feature (B) and Claim 14, feature (C)), a first part of the turbo-expanded portion of the feed air is introduced into the first column in vapour form, that is without being passed through a condenser (see streams 104, 147 in Figure 1).

Having regard to the combination of (D7) and (D9) as stated by the Appellant to lead in an obvious way to the patent's solutions, the Board considers that the skilled person would not combine the disclosures of these citations. As (D7) relates to a single pressure oxygen system, (D9), however, to a plural pressure oxygen system, these systems are inconsistent with each other due to their different energy balances. As a further point, neither of the citations (D7) and (D9) describes introducing a first part of the turbo-expanded portion of the feed air into the first column in vapour form so that no combination of these documents whatsoever would lead to the subject-matter of Claim 1 and Claim 14, respectively.

For these reasons, the exclusion of late-filed document (D7) from the proceedings by the first instance due to lack of relevance of its disclosure is unobjectionable (Article 114(2) EPC).

3.5 In his letter dated 14 August 1997 the Appellant cited for the first time documents (D10) to (D15). No reason was given by the Appellant or can be recognised by the Board which could justify the citation of these documents only at this stage of the proceedings, that is approximately three years after expiry of the period for filing opposition. In accordance with the jurisprudence of the Boards of Appeal is has to be investigated whether these documents are sufficiently relevant as to admit them into the proceedings.

3.5.1 (D10) relates to the "Comparison of Liquid Pumping and Gas Compression in Gas-Producing Oxygen Plants". The Appellant refers to Figure 2 and page 206, first paragraph of (D10). In these passages including a reference to Figure 1 ("Air refrigeration cycle with oxygen gas compressor") and to Figure 2 ("Air refrigeration cycle with liquid oxygen pump") schematic illustrations of air refrigeration cycles are shown which dispose only of a single pressurized oxygen product instead of providing a lower and a higher pressure product oxygen gas, as according to Claims 1 and 14, respectively. As a further distinction, feed air is turbo-expanded and is fed thereafter immediately to the separation column without any condensation by heat exchange with oxygen-rich liquid. No combination of (D10) and (D9) would result in an obvious manner in the claimed subject-matter since none of these citations suggests the introduction of a condensed part of the turbo-expanded feed air into the first column.

Due to these basic differences between the known system and the system according to the invention, (D10) is more remote from the subject-matter of Claims 1 and 14, respectively, than the prior art on file and is not admitted to the proceedings for lack of relevance to the decision to be taken.

3.5.2 (D11) was cited by the Appellant with the remark that for the purpose of optimising the production of oxygen the skilled person will try to avoid the expansion of nitrogen and will prefer the solution of the total distillation (see (D11), page 5) that allows the simultaneous production of oxygen of 99.5% and of argon.

Irrespective of the fact that the simultaneous production of oxygen and argon does not constitute the subject-matter of independent Claims 1 and 14, the passages of (D11) cited by the Appellant do not reveal the relevant details of the air separation system as claimed, in particular the features relating to recovering a higher and a lower pressure oxygen gas and the use of the feed air streams to recover these gas streams from the oxygen-rich liquid column product.

(D12) to(D15) were cited collectively by the Appellant with the statement that these citations show other examples of the case where condensation and vaporisation are effected in conventional heat exchangers. No observations were made in respect of the question which features disclosed in these documents correspond with the features claimed in the patent in suit. It cannot, therefore, be recognised that and in which manner the disclosures of these citations would challenge patentability of the subject-matter as claimed.

In respect of the construction of heat exchangers and in particular of condensers the Board disagrees with the Appellant's statement that the term "condenser" is only a functional feature rather than a structural feature. Although it is true that basically any heat exchanger may be used for cooling and condensing the feed air, a condenser is distinguished from the more general term "heat exchanger" in that it is optimised

in respect of the condensing function. Because of the production of liquid from gas or vapour as starting product an optimised efficiency of heat transfer requires a particular configuration and size of the heat transfer surfaces and the flow cross-sections in the region of the phase change. A condenser having an optimised efficiency of heat transfer which the skilled person will strive for is therefore also structurally different from a heat exchanger in general.

The Appellant's reference (see page 6, paragraph 4 of his letter dated 14 August 1997) to (D4), column 4, lines 65 to 67 in this context is irrelevant since the passage of (D4) referred to, that is "The reboilers 44 and 45 may each comprise a two-pass heat exchanger of conventional construction", is silent as to the question of what has to be understood by a heat exchanger of "conventional construction".

For the above reasons (D12) to (D15) are not considered to be sufficiently relevant to the decision to be taken. They are not, therefore, admitted into the proceedings (Article 114(2) EPC).

3.6 Summarising, the Board considers that the solutions to the technical problem underlying the invention as defined in the independent Claims 1 and 14, respectively, are based on an inventive step so that these claims can be maintained.

4. Dependent Claims 2 to 13 and 15 to 20 concern particular embodiments of the invention in accordance with Rule 29(3) EPC and can likewise be maintained.

5. Since the main request of the Respondent has been allowed, the auxiliary request does not need to be considered.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

S. Fabiani C. T. Wilson