**BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS**

**BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE**

**CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS**

**Internal distribution code:**
(A) [ ] Publication in OJ
(B) [ ] To Chairmen and Members
(C) [X] To Chairmen

# D E C I S I O N
# of 15 June 1999

**Case Number:** T 0328/97 - 3.2.3

**Application Number:** 91303237.1

**Publication Number:** 0454327

**IPC:** F25J 3/04

**Language of the proceedings:** EN

**Title of invention:**
Air separation

**Patentee:**
The BOC Group plc

**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:**
G 0009/91

**Catchword:**
-

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

**Case Number:** T 0328/97 - 3.2.3

**D E C I S I O N**
**of the Technical Board of Appeal 3.2.3**
**of 15 June 1999**

**Appellant:** (Opponent)
L'air Liquide, S.A.
pour l'étude et l'exploitation
des procédés Georges Claude
75 quai d'Orsay
75321 Paris (FR)

**Representative:**
Mercey, Fiona Susan
L'air Liquide, Societe Anonyme pour
pour l'étude et l'exploitation
des procédés Georges Claude
75 quai d'Orsay
75321 Paris (FR)

**Respondent:** (Proprietor of the patent)
The Boc Group plc
Chertsey Road
Windlesham
Surrey GU20 6HJ (GB)

**Representative:**
Wickham, Michael
c/o Patent and Trademark Department
The BOC Group plc
Chertsey Road
Windlesham
Surrey GU20 6HJ (GB)

**Decision under appeal:** **Interlocutory decision of the Opposition Division of the European Patent Office dated 12 December 1996, posted on 20 January 1997 concerning maintenance of European patent No. 0 454 327 in amended form.**

**Composition of the Board:**

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

## Summary of Facts and Submissions

I. European patent No. 0 454 327 was granted on 7 December 1994 on the basis of European patent application No. 91 303 237.1.

II. A notice of opposition was filed by the Appellant who requested revocation of the patent on the ground of lack of inventive step (Article 100(a) EPC). The state of the art cited by the Appellant is reflected *inter alia* by the following documents:

(D2) US-A-4 705 548

(D9) EP-A-0 321 163

Document (D9) was cited after expiry of the opposition period.

III. In the decision given at the oral proceedings on 12 December 1996 and issued in writing on 20 January 1997 the Opposition Division held that the patent was to be maintained in amended form on the basis of the amended set of claims submitted with the letter of 19 February 1996 (main request).

Claim 1 according to this request reads as follows:

"1. A method of separating an oxygen product and a gaseous product nitrogen stream from air, including reducing the temperature of a compressed air stream by heat exchange in heat exchange means to a value suitable for its separation by rectification,

introducing the thus cooled air stream into the higher pressure stage of a double rectification column for the separation of air, said double rectification column comprising a lower pressure stage and a higher pressure stage, employing the higher pressure stage of the column to provide liquid nitrogen reflux and an oxygen enriched air feed for the lower pressure stage, and withdrawing oxygen product and a gaseous nitrogen stream from the lower pressure stage, wherein at least the lower pressure stage includes a low pressure drop liquid-vapour contact means, that is a liquid-vapour contact means having a pressure drop of less than 400 Pa per theoretical stage of separation, for effecting intimate contact and hence mass transfer between liquid and vapour, the higher pressure stage of the double rectification column operates at a pressure (half way up the higher pressure stage) in the range of 450 to 550 kPa (4.5 to 5.5 bar) and refrigeration for the method is created by carrying out a first expansion of fluid with the performance of external work, such expansion producing fluid at a lowermost temperature at or below that at which the said compressed air stream leaves the cold end of the heat exchange means,

**characterised in that**

more than 90% of the oxygen product and all the nitrogen product are taken as gas from the double rectification column, and that a second expansion of fluid with the performance of external work is carried out separately from said first expansion, said second expansion taking fluid from the heat exchange means at a higher intermediate temperature and returning the fluid thereto at a lower intermediate temperature, both said intermediate temperatures being between the temperature of the air stream at the cold end and that

at the warm end of the heat exchange means."

The Opposition Division was of the opinion that the subject-matter of independent Claim 1 according to the main request was inventive over the cited prior art, in particular since none of the prior art documents even addresses the underlying problem.

IV. An appeal was filed against this decision by the Appellant on 20 March 1997, the appeal fee being paid on the same day. The Statement of Grounds of Appeal was filed on 20 May 1997, citing two further documents:

(D11) CS-A-185 550

(D12) GB-A-1 325 881

V. In a communication dated 3 July 1998 issued in preparation of oral proceedings the Board expressed the provisional opinion that (D2) appeared to teach neither employing liquid-vapour contact means having a low pressure drop in the low pressure column nor producing a substantial part of the oxygen product and all of the nitrogen product in the gaseous state. The Board further questioned whether (D11) and (D12) were so relevant as to justify their admittance to the proceedings.

VI. The Appellant requested that the decision under appeal be set aside and that the patent be revoked. In support of its request, the Appellant relied essentially on the following submissions:

The sole figure of (D11) shows that in this known

method of cryogenic air separation only gaseous products are produced. The method makes use of a first (3) and a second (2) expansion turbine, the second expansion turbine taking fluid from the heat exchange means at a higher intermediate temperature and returning the fluid thereto at a lower intermediate temperature.

The lower rectification column is under an input pressure of 6 bar whereby the pressure at the middle of the lower column is below this value.

The expansion turbines enable a reduction of pressure from 12 bar to 8 to 9 bar. In order to further reduce the pressure of the air, the skilled person will replace the distillation trays provided in (D11) by structured packing which in the contested patent has been indicated to be well known.

The reference to products in the liquid state serves just the purpose of illustrating the advantages to be obtained by the method of (D11).

Having regard to the method disclosed in (D2) the production of argon as the only product is one of the possible choices. Besides the arrangement of a second expansion as according to the patent, a pressure of approximately 4.5 bar in the higher pressure column is taught. Assuming that distillation trays are used in the low pressure column it would be obvious to substitute structured packing for the distillation trays. The skilled person would thereby arrive at the subject-matter of Claim 1 without the exercise of any inventive activity.

As regards the description of the patent, column 11, lines 26 to 28, specify that the maximum delta T of the plant according to curve B in Figure 4 rises to almost 5.5°K. According to the corresponding passage of the published application in column 12, lines 3 to 5, however, it is the maximum delta T of the plant according to curve A in Figure 4 which rises to almost 5.5°K. The cited passage of the patent is not, therefore, supported by the original disclosure which is an additional aspect for justifying revocation of the patent.

VII. The Respondent requested that the appeal be dismissed and that the patent be maintained in the form of the main request as set out in the decision under appeal, or subsidiarily, in the form of the first or the second auxiliary request, respectively, according to the impugned decision. The Respondent's arguments can be summarised as follows:

The nearest prior art as disclosed by (D9) employs in the separation process a single expansion turbine and as liquid-vapour contact means structured packing having a pressure drop of less than 400 Pa per theoretical stage of separation. It was found that in this type of gas separation the problem of a rising temperature difference in the heat exchanger between the streams warmed and the streams cooled existed with a corresponding reduction of the thermodynamic efficiency of the process. It was discovered that this problem could be solved by providing in the process a second expansion turbine.

(D11) relates to a rectification system specifically

designed and dimensioned to use distillation trays. The operating pressure of 6 bar in the higher pressure column is higher than that indicated in Claim 1. The citation deals with the problem of replacing reciprocating machinery used for compression and expansion of gas which problem having been solved a long time ago does not interest any more the person skilled in the art. It deals essentially with the production of liquid products and for this purpose makes use of two expansion processes. The problem underlying the patent is not addressed in the citation.

(D2) is essentially concerned with the production of liquid nitrogen as for example indicated in the introductory part and in column 8, lines 2 to 13 of the description. The conditions of a process for producing just argon have not been described. This citation moreover does not disclose liquid-vapour contact means having a low pressure drop of less than 400 Pa per theoretical stage of separation in the low pressure column. The low purity of the oxygen is rather indicative of the use of conventional distillation trays where the underlying problem does not exist.

(D12) relates to a process for the low temperature separation of air into one or more liquid products and optionally one or more gaseous products. According to Figure 1, all the oxygen and a quarter of the total nitrogen product is produced as liquid. According to Figure 2, a process is shown for the cryogenic separation of air to provide "maximum liquid oxygen". In the example given in the context of Figure 2, approximately 40% of the oxygen product is produced as liquid. Further, (D12) discloses neither an operating

pressure in the middle of the higher pressure column in the range of 4.5 to 5.5 bar, nor liquid-vapour contact means of low pressure drop in the lower pressure column so that the inherent problem of the invention is not tackled.

None of the citations (D2), (D11) and (D12) can lead the skilled person in an obvious manner to Claim 1.

## Reasons for the Decision

1. The appeal is admissible.

2. *Main request*

2.1 Articles 123, 100(c) EPC

2.1.1 Besides the replacement in Claim 1 of the wording "and a gaseous nitrogen stream ..." by "... and a gaseous nitrogen product stream" which is supported by page 1, paragraph 2 of the original description, Claim 1 differs from Claim 1 as granted in that after "... more than 90% of the oxygen product" the wording "and all the nitrogen product are" has been inserted. The feature that all the nitrogen product is taken as gas from the double rectification column derives from page 10, first paragraph and page 11, second paragraph, of the original description in combination with Figures 1 and 2 of the original drawings where it is indicated that all the nitrogen streams are withdrawn in the gaseous phase (see outlets 18, 38 and 40). The additional features restrict the scope of granted Claim 1, so that Claim 1 on file complies with Article 123(2) and (3) EPC.

Claims 2 to 8 correspond with Claims 2 to 8 as granted so that these claims are also not objectionable under Article 123(2) and (3) EPC.

2.1.2 The appellant has objected that the description of the patent in column 11, lines 26 to 28 specifies that the maximum delta T of the plant according to curve B in Figure 4 rises to almost 5.5°K. According to the

corresponding passage of the published application in column 12, lines 3 to 5 (page 14, lines 5 and 6 of the second paragraph of the original description), it is the maximum delta T of the plant according to curve A that rises to almost 5.5°K.

This objection relates to the ground of opposition under Article 100(c) EPC which in the present case constitutes a fresh ground not raised in the proceedings before the Opposition Division. In accordance with the Decision G 9/91 and the Opinion G 10/91 of the Enlarged Board of Appeal, fresh grounds of opposition may not be introduced at the appeal stage save that the patentee agrees that such ground may be considered. In the present case, there is, however, no such declaration from the patentee so that this ground may not be dealt with in substance by the Board of Appeal.

2.2 Inventive step

2.2.1 It is not in dispute between the parties that the closest prior art with regard to Claim 1 is described by (D9) which discloses the features according to the preamble of Claim 1.

Claim 1 is distinguished from this prior art by the features that more than 90% of the oxygen product and all the nitrogen product are taken as gas from the double rectification column, and that a second expansion of fluid with the performance of external work is carried out separately from said first expansion, said second expansion taking fluid from the heat exchange means at a higher intermediate

temperature and returning the fluid thereto at a lower intermediate temperature, both said intermediate temperatures being between the temperature of the air stream at the cold end and that at the warm end of the heat exchange means.

2.2.2 According to (D9), a low pressure drop liquid-vapour contact means having a pressure drop of less than 400 Pa per theoretical stage of separation in the form of a structured packing is used. In order to provide the necessary refrigeration in the separation process a single-turbine expansion (116) expanding a gaseous side stream (114) withdrawn from the high pressure column is employed.

In such a process in which the pressure in the high pressure column halfway up this stage can be reduced to the range of 450 to 550 KPa, it was found that this pressure drop caused by the arrangement of low pressure drop liquid-vapour contact means resulted unexpectedly in a reduction of the thermodynamic efficiency in the heat exchange (see column 2, last paragraph, to column 4, paragraph 1 of the patent.) The problem to be solved is therefore to be seen in increasing the thermodynamic efficiency in the heat exchange of the process according to the preamble of Claim 1.

This problem is solved by the steps of taking more than 90% of the oxygen product as gas from the double rectification column and of providing a second expansion turbine separately from the first expansion turbine according to the features of the characterising portion of Claim 1.

The Respondent has provided evidence of the lowering of the temperature difference delta T between the streams being warmed and the streams being cooled against the heat load in a heat exchanger having low pressure drop liquid-vapour contact means and two expansion turbines (see Figures 4 and 5 of the patent) whereby the reduced temperature difference (see curve C of Figure 5 of the patent) reflects an increased efficiency in the heat exchange.

Moreover, the fact that this problem is solved by the subject-matter of claim 1 has not been challenged by the Appellant and the Board also sees no reason to call this in question.

2.2.3 At the oral proceedings before the Board, the Appellant based its argumentation as to lack of inventive step primarily on (D11) which was cited for the first time in the Statement of Grounds of Appeal (see the English translation filed by the Appellant with the letter dated 29 July 1997 referred to in the following).

(D11) relates to a method of separation of air under low temperatures and deals with the problem of avoiding the use of machines with pistons for compression and expansion due to the high investment costs and operational and maintenance problems arising with this type of machine. The solution proposed by (D11) to this problem is a two-phase expansion of compressed air by means of a series arrangement of two turbines as a source of refrigeration.

Whilst the Appellant's statement that the only figure of (D11) does not illustrate the production of liquid

products is true, the description of the citation discloses that a considerable part of the production may be produced in a liquid state (see page 2, last paragraph) and, respectively, that it is possible to manufacture even in small quantities liquid products of the separation of air (see page 4, second paragraph). The skilled person will conclude from these passages that (D11) discloses a process for producing substantial amounts of liquid products. The production of such amounts of liquid products in combination with the use of two expansion turbines is in agreement with the concept given in (D2) that the required refrigeration necessary for recovery of liquid products is achieved by utilizing a double recycle and, respectively, expansion step (see (D2), column 4, lines 4 to 18 and column 8, lines 2 to 13). (D11) teaches the skilled person therefore that in order to produce substantial amounts of liquid products a process having two expansion turbines is required.

Furthermore, (D11) does not describe what the pressure drop per theoretical stage of the liquid-vapour contact means is in the lower pressure column so that the problem connected with the use of low pressure drop liquid-vapour contact means inherent to the patent is not addressed. The above-said teaching of (D11), namely to use two expansion turbines in an air separation process aiming at the production of substantial amounts of liquid products, for the purpose of avoiding piston machines for compression and expansion of air, leads in a different direction as compared to that of Claim 1 of the patent according to which two expansion turbines are used in a process of producing more than 90% of its oxygen product and all its nitrogen product in the

gaseous state for the purpose of increasing the thermodynamic efficiency in the heat exchange.

Thus, the Appellant's contention that the skilled person will replace the distillation trays used according to (D11) by structured packing and arrive thereby in an obvious manner at Claim 1 of the patent, does not take account of the actual teaching of (D11) and in particular of the different technical problems underlying (D11) on the one hand and the patent on the other hand. It must therefore be concluded that this contention is based on an inadmissible *ex-post facto* analysis.

2.2.4 (D2) relates to a process for the cryogenic distillative separation of air by fractionation in a distillation column to produce at least one liquid product stream selected from the group consisting of liquid nitrogen, liquid oxygen and/or liquid argon. Refrigeration required for the recovery of liquid product(s) is provided by employing a first (38) and a second (116) turbine for expanding fluid (see Figure 1).

There is no disclosure in (D2) of the feature that the pressure drop per theoretical stage of the liquid-vapour contact means in the low pressure column is less than 400 Pa. As the Respondent argues convincingly and undisputed by the Appellant, if the objective of the separation is to obtain a pure nitrogen product at the top of the low pressure column and there is no demand for an oxygen product of high purity, then there is no need to separate oxygen from argon in the low pressure column and typically approximately 20 theoretical

stages may be used. This situation applies to (D2) in that the oxygen-enriched stream withdrawn from the low pressure column is discarded as waste stream (line 108). It follows therefrom that with such a low number of theoretical stages a pressure drop per theoretical stage in the order of 700 Pa has to be expected in the low pressure column which is a value typical for distillation trays. The Board is therefore convinced that (D2) does not describe liquid-vapour contact means having a pressure drop of less than 400 Pa per theoretical stage. At the oral proceedings, this fact was also no longer disputed by the Appellant.

Due to the absence of low pressure drop liquid-vapour contact means the problem of a decreased thermodynamic efficiency of the heat exchange according to the patent does not arise in the process of (D2). The teaching of this citation, that is to employ two expansion turbines for obtaining sufficient refrigeration required to produce liquid products(s), leads therefore away from Claim 1 of the patent in which such expansion steps are employed for the production of essentially gaseous products for the purpose of improving the efficiency of heat exchange.

2.2.5 (D12) which was cited together with (D11) for the first time in the Statement of Grounds of Appeal, concerns an air separation process capable of producing one or more liquid products and, optionally, one or more gaseous products. In the embodiment according to Figure 1, all the oxygen and approximately a quarter of the total nitrogen are produced as liquid products.

According to Figure 2, a process is shown for the

cryogenic separation of air to provide "maximum liquid oxygen". In this example approximately 40% of the oxygen product is produced in the liquid state.

Furthermore, the process of (D12) does not comprise employing liquid-vapour contact means in the lower pressure column in which the pressure drop is less than 400 Pa per theoretical stage. Thus, in analogy to the conditions existing in the processes of (D11) and (D2), the problem of improving the thermodynamic efficiency of the heat exchange does not arise so that (D12) also does not motivate the person skilled in the art to make enquiries in view of the solution to this problem.

At the time of the oral proceedings, (D12) was not discussed so that also the Appellant did not consider it to be relevant. The same applies to the remaining citations (D1), (D3) to (D8) and (D10) discussed in the proceedings before the Opposition Division which were no longer taken up by the parties in the oral proceedings before the Board.

2.3 To summarise, the Board considers that the solution to the technical problem underlying the invention as defined in independent Claim 1 involves an inventive step and that therefore this claim as well as dependent Claims 2 to 8 relating to particular embodiments of the invention in accordance with Rule 29(3) EPC are to be maintained.

2.4 The description and the drawings are in agreement with the actual wording of the claims (Article 84 EPC). The description also complies with Rule 27(1)(c) and (d) EPC.

3. The grounds of opposition do not prejudice maintenance of the patent in amended form in accordance with the Respondent's main request and it is therefore not necessary to consider the Respondent's auxiliary requests.

## Order

## For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

N. Maslin C. T. Wilson