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D E C I S I O N
of 2 February 1998

Case Number: T 0589/96 - 3.2.3

Application Number: 90301778.8

Publication Number: 0384688

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
Linde Aktiengesellschaft, Wiesbaden

Headword:
-

Relevant legal provisions:
EPC Art. 52, 56

Keyword:
"Inventive step - yes"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0589/96 - 3.2.3

D E C I S I O N
of the Technical Board of Appeal 3.2.3
of 2 February 1998

Appellant 1: (Opponent)
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Decision under appeal: **Interlocutory decision of the Opposition Division of the European Patent Office of 26 March 1996 posted 3 May 1996 concerning maintenance of European patent No. 0 384 688 in amended form.**

Composition of the Board:

Chairman: C. T. Wilson
Members: H. Andrä
M. K. S. Aúz Castro

Summary of Facts and Submissions

I. European patent No. 0 384 688 was granted on 8 December 1993 on the basis of European patent application No. 90 301 778.8.

II. Oppositions against the granted patent were filed by the Appellants 1 and 2 (Opponents 1 and 2). Both Appellants requested revocation of the patent on the ground of lack of inventive step with respect to the state of the art reflected inter alia by the following prior art documents:

(D2) US-A-4 224 045

(D4) US-A-4 557 735

(D5) US-A-4 705 548

(D9) US-A-3 375 673

(D11) US-A-2 729 954

(D9) and (D11) were referred to after expiry of the period stipulated for filing a notice of opposition.

III. In its decision given at the oral proceedings on 26 March 1996 and issued in writing on 3 May 1996 the Opposition Division held that the patent was to be maintained in amended form on the basis of the Claims 1 to 10 filed during the oral proceedings according to the first auxiliary request then on file.

The Opposition Division was of the opinion that the subject-matter of independent Claims 1 and 8 as amended according to the first auxiliary request met the requirement of inventive activity.

The wording of these claims is as follows:

"1. A method of separating air comprising:
(a) removing carbon dioxide and water vapour from a compressed air feed stream and reducing the temperature of at least part of the thus purified feed stream to a level suitable for its separation by rectification at cryogenic temperatures;
(b) introducing the thus cooled air stream into a higher pressure rectification column (10), providing liquid nitrogen reflux for the higher pressure rectification column (10), and separating the air therein into oxygen-enriched and nitrogen-enriched fractions;
(c) withdrawing a liquid stream of oxygen-enriched fraction from the higher pressure column (10) and passing it into a lower pressure rectification column (12) in which it is separated into oxygen and nitrogen;
(d) withdrawing a gaseous nitrogen stream and a gaseous product oxygen stream from the lower pressure rectification column (12);
(e) withdrawing a liquid stream of nitrogen-enriched fraction from the higher pressure column (10) and employing it as reflux in the lower pressure column (12);
(f) reboiling liquid oxygen produced in the lower pressure column (12);
(g) taking a first part of the said gaseous nitrogen stream, compressing it, cooling it, at least partially condensing it, and employing the resulting liquid nitrogen as additional reflux in the lower pressure column (12);
(h) taking a second part of the said gaseous nitrogen stream as a gaseous nitrogen product stream;

(i) withdrawing a gaseous nitrogen product stream of said nitrogen-enriched fraction from the higher pressure column (10); and
(j) recovering work from both gaseous nitrogen product streams, in which at least part of the said gaseous product stream of said nitrogen-enriched fraction withdrawn from the higher pressure column (10) is further compressed upstream of the recovery of work from it, and the second part of the gaseous nitrogen product stream withdrawn from the lower pressure column (12) is further compressed upstream of the recovery of power from it."

In step (j) of Claim 1 the term "recovery of power" is obviously intended to read "recovery of work" in analogy to the preceding amendment in step (j) from "recovery of power" to "recovery of work".

"8. Apparatus for separating air, comprising:
(a) means (4) for separating carbon dioxide and water vapour from a compressed feed air stream;
(b) heat exchange means (6) for reducing the temperature of at least part of the thus purified air stream to a level suitable for separation by cryogenic rectification;
(c) a higher pressure rectification column (10) for separating the air into nitrogen-enriched and oxygen-enriched fractions in communication with the lower temperature end of a passage through the heat exchange means (6) for the air stream; the higher pressure rectification column (10) having an inlet for liquid nitrogen reflux, an outlet for liquid nitrogen reflux to the lower pressure column, an outlet for a first gaseous product nitrogen stream comprising the nitrogen-enriched fraction and another outlet (26) for a liquid stream of oxygen-enriched fraction;

(d) a lower pressure rectification column (12) for separating the oxygen-enriched fraction into oxygen and nitrogen having an inlet in communication with the said outlet (26) for the liquid stream of oxygen-enriched fraction and having outlets (32,36) for separate gaseous oxygen and nitrogen streams, the outlet (36) for the nitrogen streams communicating with a passage through the heat exchange means (6) to enable the nitrogen stream to be warmed;
(e) means (14) for reboiling liquid oxygen produced in the lower pressure column;
(f) a compressor (38) for compressing a first part of the warmed nitrogen stream;
(g) a condenser (40) for condensing said compressed nitrogen stream and means for combining the resulting liquid nitrogen with the liquid nitrogen reflux;
(h) one further compressor (62) for compressing the first gaseous product stream of nitrogen-enriched fraction and another further compressor (60) for compressing the second part of the warmed nitrogen stream; and
(i) means (64,66,68) for recovering work from the said compressed first gaseous nitrogen product stream and from a second gaseous nitrogen product stream comprising the compressed second part of said warmed nitrogen stream."

IV. An appeal was filed by the Appellant 1 on 2 July 1996 and by the Appellant 2 on 5 July 1996, the appeal fees having been paid on the same respective days. The Statement of Grounds of Appeal was filed by the Appellant 1 on 30 August 1996 and by the Appellant 2 on 13 September 1996.

In the Statement of Grounds of Appeal the Appellants cited the following new documents:

(D12) US-A-4 806 136 (by Appellant 1).

(D13) Abrardo et. al.: "Optimization of Cryogenic Plants" IOMA BROADCASTER, Nov-Dec 1988, Figures 3 and 7 (by Appellant 1).

(D14) Hausen/Linde: "Tieftemperaturetechnik" Springer-Verlag, 1985, Figures 4.18, 4.20, 4.21, 4.23, 4.26 and 4.28 in section 4.5.1 and 4.5.2 (by Appellant 2).

The Appellants submitted that the subject-matter of both independent Claims 1 and 8 lacked an inventive step.

V. In his response dated 29 January 1997 the Respondent (Patentee) contested the Appellants' view and argued that none of the documents cited by the Appellants taken alone or in combination with any other cited document deprived any claim of his request of novelty or rendered it obvious.

VI. With letter dated 14 May 1997 the Appellant 2 withdrew his request for oral proceedings.

VII. In a communication pursuant to Article 110(2) EPC dated 22 August 1997 the Board expressed the provisional opinion that neither the documents discussed in the opposition proceedings nor those cited for the first time in the Statements of Grounds of Appeal would appear to lead the skilled person in an obvious manner to the subject-matter of Claim 1 and 8, respectively, so that a success of the appeals was not to be expected.

VIII. The Appellants request that the decision under appeal be set aside and the patent be revoked.

In support of their request for revocation of the patent the Appellants relied essentially on the following submissions:

Appellant 1:

(D2) describes all the features of Claim 1 with the exception of feature (g). The skilled person knows that in order to withdraw more nitrogen under medium pressures without reducing the purity of oxygen, he would have to make use of a low pressure nitrogen cycle such as described by (D11).

(D4) discloses all the features of Claim 1 with the exception of feature (g). If it were necessary to modify Figure 1 of (D4) such as to provide the production of medium pressure nitrogen withdrawn from conduit (48), this would reduce the quantity of nitrogen flowing to condenser (55) thus lowering the purity of the oxygen in conduit (49). The skilled person is informed by (D11) that by increasing the reflux of the low pressure column, he can improve the purity of the oxygen. In order to permit the production of medium pressure nitrogen without degradation of the distillation, he would apply the low pressure nitrogen cycle of Figure 1 of (D11) to (D4).

(D12) cited for the first time discloses all the features of Claim 1 with the exception of feature (g). This system can be used to withdraw nitrogen from conduit (59) in which case the loss in distillation in the low pressure column must be compensated. The solution is provided by (D11) the object of which is to augment at will the reflux of a double rectification column.

(D13), Figures 3 and 7, describe all the features of Claim 1 except the compression of the medium pressure nitrogen before its expansion. It is obviously well-known to compress a gas destined to be expanded, in particular in a gas turbine which in general has an optimum inlet pressure slightly below the mean pressure of the air separation device. The subject-matter of Claim 1 and Claim 8, respectively, is not inventive with regard to (D13).

Appellant 2:

Claim 1 differs from the disclosure of (D4) which describes the nearest prior art by the nitrogen cycle of the low pressure column. This measure solves the underlying problem consisting in a lack of reflux due to increased withdrawal of nitrogen from the high pressure column. The solution to this problem is obvious by the teaching of (D11) or of (D5). The skilled person could easily recognise the lack of reflux since in a usual double column process of air separation the total nitrogen amount available at the top of the high pressure column is used as reflux liquid. This is shown in (D14) which constitutes a piece of standard literature in the field of cryogenics and should therefore be introduced into the proceedings. Thus, (D14), forms a bridge between the nearest prior art, (D4), and (D11) which leads the skilled person to the obvious solution of the inherent problem.

(D2) also describes all the features of Claim 1 except step (g). The disclosure of (D2) differs from the subject-matter of Claim 1 in the same manner as the teaching of (D4) so that the skilled person starting out from (D2) will also arrive in an obvious way at the subject-matter of Claim 1.

When starting out from (D9) as the nearest prior art Claim 1 contains two measures which go beyond the teaching of (D9), that is (a) the compression of the mass flows producing work on being expanded and (b) the nitrogen cycle of the low pressure column. These measures solve different problems and there is no mutual effect. Feature (b) has no inventive quality in view of the combination of (D9) and (D11) as established by the Opposition Division, and feature (a) is manifestly obvious and known from (D2) or (D4). It follows that the process according to Claim 1 is not based on an inventive activity.

IX. The Respondent requests that the appeals be dismissed. Its contentions maybe summarized as follows:

Both Appellants argue that (D2) discloses all the features of Claim 1 except feature (g). As found by the Opposition Division, the step of further compressing at least part of a nitrogen-enriched fraction withdrawn from the high pressure column is also not disclosed by (D2). As regards the assertion of the Appellants that it would have been obvious to combine the teachings of (D2) and (D11), there is nothing in (D2) which suggests that a part of the gaseous nitrogen stream from the low pressure column should be compressed, cooled, at least partially condensed and employed as additional reflux in the lower pressure column.

(D11) recommends against using its process in air separation. Whilst it maintains that separation of air is "rather easy" when a conventional double column apparatus is used, it points out this is not the case for instance for a mixture of carbon dioxide and nitrogen or of ethane and ethylene. Also, air is normally fed into a bottom region of the higher

pressure columns and not at a level well above the bottom thereof as according to Figure 1 of (D11). This further shows that the apparatus shown in Figure 1 is not intended for use in air separation.

According to (D5) the nitrogen is recompressed and recondensed so as to form a liquid product. It is not employed to supplement the reflux to the lower pressure column. Claims 1 and 8 are not, therefore, rendered obvious by (D2) or a combination of (D2) with (D11) or (D5).

(D4) neither describes the feature (g) of Claim 1 nor the feature of further compressing the nitrogen-enriched fraction withdrawn from the higher pressure column. Appellant 2 suggests that there is a deficiency of reflux in the process shown in (D4) and refers to (D14) for support. (D14) discloses a number of processes which, however, do not remove nitrogen product from the high pressure column. There is no disclosure of a lack of reflux in (D4). The argument that the skilled person would as a matter of course realise that the process of (D4) lacks reflux, therefore lacks credibility. The skilled person would not have combined the teachings of (D4) and (D11) or (D5).

(D9) shows neither compression of the nitrogen product streams nor the nitrogen recycle feature (g) of Claim 1. The process of (D9) is analogous to that of (D4) because it employs a high pressure nitrogen stream to feed a turboexpander in order to generate refrigeration for the air separation process. Claims 1 and 8 are not rendered obvious by (D9) alone or (D9) in combination with (D5).

According to (D12) no nitrogen product is taken from the higher pressure column. Furthermore, there is no disclosure of the feature (g) of Claim 1 and no clear teaching to compress both the nitrogen from the high pressure column and the low pressure column. It is clear that (D12) alone or in combination with (D11) or (D5) does not deprive Claim 1 or Claim 8 of an inventive step.

It is agreed with Appellant 1 that (D13) discloses operating a heat pump system to improve argon recovery as shown in Figure 7 in the low pressure cryogenic cycle shown in Figure 3. According to Figure 7 nitrogen from the low pressure column is recompressed and a part of it is passed to the top of the high pressure column, another part being expanded in a turbine to create refrigeration. In combining Figures 3 and 7 the expander shown in Figure 7 would appear to take the place of that shown in Figure 3. Making the modification will thus result in no high pressure nitrogen product being produced at all. (D13) also does not show feature (g) of Claim 1. Also for this reason, (D13) does not deprive any of the claims of the patent of inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. *Articles 123(2) and (3) EPC*

2.1 Claim 1 has been amended with regard to the granted version by incorporating essentially the features of Claim 4 as granted. These features are supported by the original Claims 4 and 6 in combination with Figures 1 and 2 of the original drawings.

Claim 8 has been amended with regard to the granted version of the corresponding Claim 9 by the following amendments:

(A) insertion of the wording "an outlet for liquid nitrogen reflux to the lower pressure column" in step (c) after "reflux",

(B) insertion of the additional wording "(h) one further compressor (62) for compressing the first gaseous product stream of nitrogen-enriched fraction and another further compressor (60) for compressing the second part of the warmed nitrogen stream, and ",

(C) redesignation of section (h) of granted Claim 9 as section (i) and replacement of the wording "from said first" by "from the said compressed first" and of the wording "second part" by "the compressed second part" in section (i).

Amendment (A) derives from page 6, second paragraph, of the original description and amendments (B) and (C) derive from Figures 1 and 2 of the originally filed drawings.

The amendments made in respect of Claims 1 and 8 are not, therefore, objectionable under Article 123(2) EPC.

2.2 The above-cited amendments are of a character restricting the scope of protection of the corresponding claims of the granted version.

Independent Claims 1 and 8 and the claims dependent thereupon therefore satisfy also the requirement of Article 123(3) EPC.

3. *Inventive step*

3.1 The Board considers in agreement with Appellant 2 that the nearest prior art with regard to the subject-matter of Claims 1 and 8, respectively, is described by the air separation system of (D4).

According to this citation (see Figure 1), a high pressure nitrogen stream (48) is withdrawn from the high pressure column (52), expanded in turbine (43) to the pressure of the low pressure column (57) to generate refrigeration, warmed in heat exchanger (39) and compressed in compressor (23) together with the nitrogen removed from the low pressure column (57) before being expanded in turbine (31) for recovering work.

3.2 Claim 1 differs from the disclosure of (D4) by its feature (g). That is the steps of taking a first part of the said gaseous nitrogen stream (i.e. a stream withdrawn from the lower pressure column), compressing it, cooling it, at least partially condensing it and employing the resulting liquid nitrogen as additional reflux in the lower pressure column.

The inherent technical problem of the patent in suit (see column 1, penultimate paragraph, and column 3, lines 23 to 32) is seen in making possible a reduction in the work that needs to be performed in compressing nitrogen. By withdrawing nitrogen from the lower pressure column and using at least part of it to form reflux for this column, it becomes possible, without adverse effects on the reflux to the low pressure column to increase the high pressure nitrogen stream from the high pressure column and to recover work from this nitrogen stream and from at least part of the low pressure nitrogen stream. The further compression of

the nitrogen streams withdrawn from the high pressure column and from the low pressure column allows the columns to be operated at optimum pressure independent of the respective optimum expansion turbine inlet pressure whereby the gas separation process and the recovery of work by expansion of the nitrogen streams can be optimised.

The above-cited object is credibly achieved by the subject-matter of Claim 1 and 8, respectively, and thus constitutes the objectively inherent technical problem.

3.3 (D11) describes a process for separating gaseous mixtures which comprises the steps of taking a part of the gaseous nitrogen stream from the low pressure column, compressing it, cooling it, at least partially condensing it, and employing the resulting liquid nitrogen as additional reflux in the low pressure column.

In the introductory part of this citation it is set out that in the case of air to be separated into industrially pure oxygen and nitrogen, the difference in the boiling points of oxygen and nitrogen (-183°C and -196°C, respectively) and the relative amounts (21% and 79%, respectively) thereof make the separation rather easy by using the conventional double column apparatus. It is then pointed out that this is not the case for instance for a mixture of carbon monoxide and nitrogen the boiling points of which are -190°C and -196°C, respectively. (D11) regards as a first object of the invention to make easier than by the known processes the separation of components with close boiling points. Further objects relate to obtaining a good yield and a high purity of the separated components and to augmenting the liquid reflux ratio.

These problems are remote from the problem of optimising the recovery of work from the high pressure and low pressure nitrogen streams underlying the patent in suit. Due to this difference in the inherent problems the skilled person would not be induced to incorporate the low pressure column nitrogen cycle disclosed by (D11) into the method according to (D4).

Besides, (D11) relates expressly to a process for separating gaseous mixtures of components with close boiling points (see the claim in column 6 of (D11)). According to the definition given in column 1, paragraph 2 of (D11), nitrogen- and oxygen-enriched fractions of air being the components to be separated according to the patent in suit are not to be regarded as components having close boiling points. Also for this reason, the skilled person will not derive any suggestion from (D11) to envisage a combination of its teaching with the process known from (D4) in order to arrive at the subject-matter of Claim 1, as proposed by the Appellants.

(D14) was cited by the Appellant 2 in the Statement of Grounds of Appeal to show that a deficiency of reflux in the low pressure column would be recognised by the skilled person as this citation relates to the general knowledge of the person skilled in the art. The passages cited concern a number of diagrams showing systems for separating air. No details as to the components of each system have been given by the Appellant. In the diagrams, it is shown that the nitrogen at the top of the high pressure column is used as reflux in the column system.

None of the diagrams shows, however, that a nitrogen product stream is withdrawn from the high pressure column. Hence, there is no suggestion of increasing the amount of a nitrogen stream withdrawn from the high

pressure column for recovering work from this stream and for optimising the recovery of work from the high pressure and low pressure nitrogen streams according to the problem to be solved by the patent in suit. (D14) cannot, therefore, serve the purpose of constructing a bridge between (D4) and (D11) in the sense of arriving thereby at the subject-matter of Claim 1

These considerations are equally valid for the subject-matter of Claim 8 which is substantially directed to the process steps of Claim 1 in the form of structural features.

The above considerations with regard to a combination of the teachings of (D4) and (D11) are valid in logical conclusion for any combination of citations produced by the Appellants in which (D11) forms a component, that is also the combinations with (D2), (D9) or (D12).

3.4 (D5) relates to a process for the cryogenic distillative separation of air in which the problem to be solved is seen in increasing the recovery of liquid nitrogen in an efficient manner. As substantiated in the Board's communication dated 22 August 1997, the process step of Claim 1 "employing the resulting liquid nitrogen as additional reflux in the low pressure column" cannot be derived from (D5).

(D2) which was cited by the Appellant 2 in combination with (D5) discloses on air separation process showing the withdrawal of nitrogen vapour from the high pressure column. (D2) does not, however, show a nitrogen recycle circuit in the low pressure column (feature (g) of Claim 1) and it does not disclose the compression of the high pressure nitrogen stream (31A, Figure 1) before expansion thereof for work recovery.

It follows therefrom that a combination of the processes of (D2) or (D4) with that of (D5) does not lead in an obvious manner to the teaching of Claims 1 and 8, respectively, since there would be no suggestion of providing the nitrogen recycle in the low pressure column.

In reaction to the Board's communication dated 22 August 1997 in which the citations (D2), (D4) and (D5) were commented, the Appellant 2 no longer referred to these combinations of documents and no further response was filed by the Appellant 1. This issue requires, therefore, no further discussion.

3.5 The documents (D12) and (D13) were cited by the Appellant 1 for the first time in the Statement of Grounds of Appeal without giving any reason for the late submission of these documents only at this stage of the proceedings.

In accordance with the jurisprudence of the Boards a late-filed prior art document will be taken into account only if it is clearly more relevant than the documents already on file.

In the communication of 22 August 1997 the Board explained why the disclosures of (D12) and (D13) were not considered relevant. The Appellants did not dispute the Board's findings in this respect, and the Board has decided to disregard those documents pursuant to Article 114(2) EPC.

3.6 Summarising, the solutions to the technical problem underlying the invention as defined in the independent Claims 1 and 8, respectively, are based on an inventive step.

4. Dependent Claims 2 to 7, 9 and 10 concern particular embodiments of the invention in accordance with Rule 29(3) EPC and are therefore likewise allowable.

5. Since the request of the Appellant 2 for oral proceedings had been withdrawn, the decision can be taken without conducting such proceedings.

Order

For these reasons it is decided that:

The appeals are dismissed.

The Registrar: The Chairman:

N. Maslin C. T. Wilson