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D E C I S I O N
of 18 July 2002

Case Number: T 0479/01 - 3.2.3

Application Number: 95301732.4

Publication Number: 0672878

IPC: F25J 3/04

Language of the proceedings: EN

Title of invention:
Air separation

Patentee:
The BOC Group plc

Opponent:
L'AIR LIQUIDE, Société Anonyme pour L'étude et l'exploitation
des procédés Georges Claude

Headword:
-

Relevant legal provisions:
EPC Art. 054, 056

Keyword:
"Novelty and inventive step - yes"

Decisions cited:
-

Catchword:
-



Case Number: T 0479/01 - 3.2.3

D E C I S I O N
of the Technical Board of Appeal 3.2.3
of 18 July 2002

Appellant:
(Opponent)

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Decision under appeal:

**Interlocutory decision of the Opposition Division
of the European Patent Office posted 22 February
2001 concerning maintenance of European patent
No. 0 672 878 in amended form.**

Composition of the Board:

Chairman: C. T. Wilson
Members: U. Krause
J. P. B. Seitz

Summary of Facts and Submissions

I. The appeal contests the Interlocutory decision of the Opposition division, dated 22 January 2001 and issued in writing on 22 February 2001, maintaining the European patent 0 672 878 in amended form. The amended independent claims 1 and 5 found to meet the requirements of the EPC, in particular of Articles 52, 54 and 56 EPC referred to in the opposition, read as follows:

"1. A method of separating air, comprising the steps of cooling a first compressed air stream to a temperature suitable for its separation by rectification, separating nitrogen from the cooled first air stream in a higher pressure rectification column into which the cooled first air stream is introduced below all liquid-vapour mass exchange devices located therein, employing directly or indirectly a stream of oxygen-enriched liquid air withdrawn from the higher pressure column as a feed stream to a lower pressure rectification column, withdrawing a liquid stream from an intermediate mass exchange region of the higher pressure rectification column and introducing the liquid stream into the lower pressure rectification column as a further feed stream, separating the said feed streams into nitrogen and oxygen in the lower pressure rectification column, withdrawing oxygen and nitrogen products from the lower pressure rectification column and employing them to cool incoming air for separation by indirect heat exchange therewith, collecting a liquid nitrogen product from a stream of liquid nitrogen flowing to the lower pressure rectification column, separating an argon product in a further rectification column from an argon-enriched

oxygen stream withdrawn from the lower pressure rectification column, cooling a second compressed air stream, expanding the cooled second air stream in a first expansion turbine, introducing the resulting expanded second air stream into the lower pressure rectification column, cooling a third compressed air stream, expanding the cooled third air stream in a second expansion turbine, introducing the resulting expanded third air stream into the higher pressure rectification column, and expanding a compressed fourth air stream in a third expansion turbine which has an outlet temperature above that of each the first and second turbines, further cooling the resulting expanded fourth air stream and introducing the further cooled fourth air stream into one or both of the higher pressure and lower pressure rectification columns."

"5. Apparatus for separating air comprising a main heat exchanger for cooling a first compressed air stream to a temperature suitable for its separation by rectification; a higher pressure rectification column for separating nitrogen from the cooled first air stream having an inlet for the first air stream located below all liquid-vapour mass exchange devices therein; a lower pressure rectification column for separating into nitrogen and oxygen a feed stream formed directly or indirectly from oxygen-enriched liquid air withdrawn in use from the higher pressure column; means for the withdrawal of a liquid stream from an intermediate mass exchange region of the higher pressure column, said withdrawal means communicating with the lower pressure rectification column; means for withdrawing oxygen and nitrogen products from the lower pressure rectification column and for returning them through the main heat exchanger countercurrently to the incoming air; means

for collecting a liquid nitrogen product from a stream of liquid nitrogen flowing to the lower pressure rectification column; a further rectification column for separating an argon product from an argon-enriched oxygen stream withdrawn in operation from the lower pressure rectification column; a first expansion turbine for expanding a cooled, second compressed air stream having an outlet communicating with the lower pressure rectification column; a second expansion turbine for expanding a cooled, third compressed air stream having an outlet communicating with the higher pressure rectification column; and a third expansion turbine for expanding a fourth air stream having an outlet communicating via air cooling means with one or both of the higher pressure and lower pressure rectification columns."

II. The notice of appeal was filed by the Opponent (hereinafter denoted Appellant) on 19 April 2001. The appeal fee was likewise paid on 19 April 2001 and a statement of the grounds of appeal was submitted on 2 July 2001.

In addition to the evidence

(D1): EP-A-0 576 314 and

(D2): EP-A-0 454 327

considered in the decision under appeal the Appellant makes reference to the following further documents:

(D3): EP-A-0 580 348

(D4): EP-A-0 542 539

(D5): GB-A-1 520 103

(D6): R.E.Latimer, "Distillation of Air", Chemical Engineering Progress Vol. 63 No. 2, February 1967, pages 35,36,42

In response to a communication issued by the Board as an annex to the summons to Oral proceedings the Respondent submitted on 18 June 2002 an auxiliary request comprising a new set of claims with a single independent claim 1 corresponding to a combination of claims 1 and 2 of the main request and new description pages 2 to 6. The Appellant stated that he would not attend the Oral proceedings.

Oral proceedings were held on 18 July 2002 in the absence of the Appellant.

III. The Appellant requested in writing that the decision under appeal be set aside and the patent be revoked.

The Respondent requested that the appeal be dismissed (main request) and, as an auxiliary request, that the decision under appeal be set aside and that the patent be maintained on the basis of amended claims 1 to 3 filed on 18 June 2002.

IV. The essential arguments of the parties can be summarized as follows:

Appellant:

The amended claims 1 and 5 of the patent as maintained did not meet the requirements of Article 123(2) EPC because the feature concerning the introduction or

inlet, respectively, of the first air stream below all liquid-vapour mass exchange devices in the higher pressure rectification column was taken out of context from the original application which described the introduction of a gaseous first air stream at the bottom of the high pressure column after compression to the pressure prevailing therein.

The subject-matter of claims 1 and 5 was known from document (D1) disclosing a similar process and apparatus with the same four compressed air streams and three expansion turbines, whereby the inlet of the first feed air stream to the higher pressure column was not specified and could well be below all liquid-vapour mass exchange devices. If this was seen as a difference it was obvious in view of documents (D3), (D4), (D5) and (D6) all showing the introduction of feed air, in the case of (D5) and (D6) of liquid and gaseous feed air, at the bottom of the high pressure column. As a consequence of employing, in D1, a single main compressor in order to reduce investment costs, the first air stream was compressed to a higher pressure and liquefied in the main heat exchanger, whereby it had to be introduced at a higher level of the higher pressure column than a gaseous stream. A staged compression as in the patent led to a lower pressure of the first stream, resulting in a gaseous stream which had to be introduced at the bottom. Starting from (D2), a desired production of liquids would require a further expansion turbine to generate the required refrigeration, and the shortage of liquid reflux in the low pressure column would have to be compensated by a liquid stream withdrawn from the high pressure column and passed into the low pressure column.

Respondent:

As stated in the decision under appeal, the added feature was disclosed in the final paragraph of page 6 of the original application without any link to further conditions such as a particular compression of the first air stream.

The subject-matter of claims 1 and 5 was novel because (D1) showed the introduction of the first air stream (22) at an intermediate level of the higher pressure column. This was necessary because the first air stream was a liquid stream which would pass to the lower pressure column, rather than being separated in the higher pressure column, if introduced at the bottom. Further differences concerned the "second" air stream which, in (D1), came from turboexpander (7) and, therefore, was an expanded stream rather than a compressed stream as in the patent, and the introduction of only part of the "fourth" air stream leaving expander (7) into the higher pressure column of (D1).

As to inventive step, the introduction of a feed air stream at the bottom was known from (D3) to (D6) only for either a gaseous air stream to be separated in the high pressure column or for a liquid stream to be passed to the lower pressure column. The separation in the high pressure column described on page 2, lines 105 to 110, of (D5) concerned the gaseous portion of the input only. Thus, the prior art did not provide a suggestion to introduce the liquid first feed air stream (22) of (D1) at the bottom of the high pressure column for separation therein. Further, such a modification would add to the thermodynamic

inefficiency of the process which was unwanted in a complex process as shown in (D1). A modification of this process to avoid liquefaction of the first feed air stream would be possible but require further changes to adjust the process, in particular to generate the required refrigeration. Moreover, substituting a compressed air stream for the expanded second air stream of (D1) avoided the high pressures involved in the two consecutive expansions in turbines (7) and (30) of (D1). A skilled person would neither consider (D2) as being an appropriate starting point nor combine it with (D1) because it related to a different refrigeration system which was not concerned with the production of liquid products and, therefore, did not require further means for generating refrigeration such as a third turbine, or additional reflux streams taken from the higher pressure column and introduced into the lower pressure column.

Reason for the Decision

1. The appeal meets the requirements of Articles 106 to 108 EPC and of Rules 1(1) and 64 EPC and is, therefore, admissible.

2. *Main request: amendments*

The feature concerning the introduction of the compressed first air stream into the higher pressure rectification column below all liquid-vapour mass exchange devices therein, i.e. at the bottom of this column, was added to claims 1 and 5 of the main request by an amendment made in the procedure before the Opposition division. This feature was taken from the

description of the original application in the final paragraph of page 6. This part of the original application makes no reference to the pressure of the first air stream or to its state after cooling. Thus, the Board cannot follow the argument of the Appellant that this feature was taken out of context from the original application and that the claims were not supported unless it was additionally specified that the first air stream was compressed to the pressure of the higher pressure rectification column and that it was in gaseous state. It is noted, however, that the latter feature is implicit, as will be set out below in section 4.1.

Since the added feature also limits the scope of the patent to that particular introduction point of the first air stream into the higher pressure rectification column, the amended claims are considered to meet the requirements of Articles 123(2) and (3) EPC.

3. *Novelty of the main request*

3.1 The process depicted in Figures 1 and 4 of (D1) exhibits a number of cooled air streams fed to the higher and lower pressure columns (hereinafter denoted HP column and LP column) which, in the language of claims 1 and 5 of the patent in suit, can be identified as follows:

- a first air stream compressed in compressor (3) and passing, without further compression in booster compressors (4,5) or expansion in turboexpanders (7,8), through the main heat exchanger (2) into the HP column (12);

- a third air stream which is, in the embodiment of figure 1, further compressed in booster compressors (4,5), cooled in the main heat exchanger (2) and expanded in turboexpander (8) before being introduced into the HP column (12), and, in the embodiment of Figure 4, branched off from the first air stream in the main heat exchanger, expanded in turboexpander (8) and introduced into the HP column;
- a fourth air stream which is, in the embodiment of Figure 1, branched off from the first air stream in the main heat exchanger (2), expanded in turboexpander (7), further cooled in the main heat exchanger and combined with the third air stream after expansion thereof in turboexpander (8), and, in the embodiment of Figure 4, further compressed in booster compressors (4,5), cooled in the main heat exchanger (2), expanded in turboexpander (7), further cooled in the main heat exchanger (2) and combined with the first air stream; and
- a second air stream which is branched off from the fourth air stream after expansion thereof in turboexpander (7), expanded in turboexpander (30) and introduced into the LP column (13).

3.2 In both embodiments of (D1) the first air stream is liquefied in the main heat exchanger (see column 4, lines 40 to 46) and introduced, after expansion in a throttle valve, into the HP column. As pointed out in the decision under appeal on page 4, the expansion will produce some flash gas but will not substantially change the liquid state of the first air stream. The point of introduction is shown in Figures 1 and 4 to be

separate from the introduction of the gaseous third stream and at a higher level of the HP column. This will be understood by a skilled person knowing the different composition curves of the liquid and vapour along the column in the sense that some liquid-vapour mass exchange devices are provided between the inlets of the first and third air streams. Hence, the disclosure of (D1) is limited to the introduction of the first air stream above some liquid-vapour mass exchange devices in the HP column, rather than at the bottom thereof. The argument of the Appellant that the introduction could "well" be at the bottom is irrelevant for the assessment of novelty because any considerations of circumstances under which the first stream could also be introduced at the bottom have no basis in the disclosure of (D1).

- 3.3 Other differences between the subject-matter of claims 1 and 5 and the disclosure of (D1) cannot be found. The first to fourth air streams are all pressurized streams derived from compressions in compressor (3) and booster compressors (4,5) and, thereby, qualify as "compressed" air streams. This is disputed by the Respondent with regard to the second air stream arguing that this stream is derived from the fourth stream after expansion thereof and is, therefore, an expanded rather than a compressed stream. The Board cannot follow this argument because the term "compressed stream" is usually understood to include any pressurized stream irrespective of whether or not it was subject to further changes of state, such as a purification or a partial expansion, after compression thereof. Moreover, the patent provides no support for a narrower interpretation of the term "compressed stream". The passage on page 2, lines 42 to 44,

referred to by the Respondent cannot be taken as such a basis because it relates to the expansion of a feed air stream to the pressure of the HP column, whereas the second air stream is expanded to the pressure of the LP column. The further argument of the Respondent concerning the partial introduction of the fourth air stream into the HP column of (D1) is likewise unable to distinguish the subject-matter of claims 1 and 5 which only calls for the introduction of the fourth stream into one or both of the columns, which includes feeding one part of the fourth stream into the HP column and another part into the LP column, as in (D1).

3.4 The other available prior art (D2) to (D6) does not disclose a method and apparatus as defined in claims 1 and 5, respectively, either. Since this was never disputed during the opposition and appeal proceedings there is no need for further detailed substantiation of this matter.

3.5 Consequently, the subject-matter of claims 1 and 5 is considered to be new.

4. *Inventive step of the main request*

4.1 There is no dispute that document (D1), disclosing a cryogenic air separation process and apparatus with the production of argon and liquid products and the generation of refrigeration by expanding various feed air streams without recycle, represents the most pertinent prior art. It was set out above in connection with the assessment of novelty that the subject-matter of claims 1 and 5 differs from the process and apparatus disclosed in (D1) only in that the cooled first air stream is introduced into the HP column below

all liquid-vapour mass exchange devices located therein, i.e. at the bottom of the HP column. This feature cannot, however, be taken in isolation. In fact, any liquid stream introduced at the bottom of the HP column would mix with the descending liquid and, due to the absence of a sump reboiler in the HP column, pass to the low pressure column for separation. Claims 1 and 5, however, specify that nitrogen is separated from the cooled first air stream in the HP column. This can only be achieved if the cooled first air stream is introduced at the bottom of the HP column in gaseous state, whereby it rises up through the HP column in heat and mass exchange with descending liquid for separation.

Thus, it will have to be determined whether it was obvious to modify the process and apparatus disclosed in (D1) in such a manner that the cooled first air stream is introduced in gaseous state at the bottom of the HP column.

- 4.2 The Appellant argues that in (D1) liquefaction of the first stream was caused by the compression of the air to a high pressure P1 in a single main compressor and that a staged compression as in the patent would leave the first stream at a lower pressure, resulting in a gaseous phase which could be introduced at the bottom of the HP column. This argument for obviousness in view of (D1) alone does not take into due account that, as shown in the heating and cooling curves depicted in Figure 2 of (D1) and in particular by the close match of the curves at steps A and I for evaporation of pressurized oxygen and condensation of the cooled first air stream, respectively, the process of (D1) requires the condensation of the first air stream in order to

produce oxygen at elevated pressure. Thus, the compression of the first air stream was deliberately chosen to enable the evaporation of the pressurized oxygen, rather than dictated by considerations of reducing the investment costs by employing a single compressor, and cannot be modified without putting at risk the production of pressurized gaseous oxygen in (D1).

Hence, the Board concurs with the conclusion drawn in point 6.3 of the decision under appeal that (D1) alone cannot render obvious the subject-matter of claims 1 and 5.

- 4.3 The further documents (D2), (D3) and (D4) show a variety of processes for cryogenic air separation with or without production of liquid products. Document (D4) corresponds to (D1) in that a portion of the feed air is condensed by heat exchange with evaporating pressurized oxygen and introduced into the HP column at a level somewhat above the bottom of that column where a second, gaseous feed stream is introduced. Document (D2) is concerned with a process whereby nitrogen and oxygen products are removed in gaseous form from the LP column and warmed in the main heat exchanger against three different compressed feed air streams all being introduced into the HP or LP column in gaseous state. This also applies to document (D3) where an additional liquid oxygen stream is withdrawn from the LP column which is, however, removed as a liquid product rather than evaporated.

It can be concluded from this prior art that the state of the feed air stream and its point of introduction into the HP column depends on the heat exchange in the

main heat exchanger, whereby a heat exchange with gaseous products, as in (D2) and (D3), involves the introduction of the feed air streams in gaseous form into the HP column preferably at its bottom and the heat exchange with a liquid oxygen product, as in (D4), involves condensing the feed air and introducing it at a higher level of the HP column. Since it is the main object of (D1), which is also reflected in the title of that document, to produce pressurized gaseous oxygen by a heat exchange of the feed air with a pressurized liquid oxygen removed from the LP column, only (D4) is a relevant prior art which, as far as the state of the feed air and its introduction into the HP column is concerned, does not go beyond what is disclosed in (D1).

4.4 Concerning (D5) and (D6) the Appellant argues that it was evident from both documents that a liquid feed air stream could be introduced into the HP column at the bottom thereof. Indeed, in the processes shown in (D5) and in Figure 1 of (D6) liquid products are withdrawn from the LP column but only a gaseous oxygen stream removed from the LP column is heat exchanged in (D5) with feed air streams introduced into the HP column at the bottom thereof. However, both documents disclose a partially liquid feed into the HP column below the liquid-vapour mass exchange devices therein, namely the feed stream 12 in (D5) and the feed air portion leaving the "liquefier heat exchanger" in Figure 1 of (D6). The double arrow at the feed air inlet shown in the latter figure indicates that the liquid portion is collected in the sump of the HP column, where it is mixed with the descending liquid in the HP column to be passed through the subcooler to the LP column as crude oxygen liquid for separation into nitrogen and oxygen. Thus,

this liquid feed air portion will not be separated in the HP column, as required by claims 1 and 5 of the patent in suit. This conclusion, which is consistent with the knowledge of the skilled person, could be challenged by referring to page 2, lines 105 to 110 of (D5) which seems to describe the separation of the liquid feed in the HP column. However, this passage can be interpreted in two ways, either meaning the separation of all input streams or the separation of the gaseous input stream whereby the liquid input stream determines the composition of the crude liquid oxygen stream, and the skilled person will follow the latter interpretation as being the only technically sensible one. Consequently, (D5) and (D6) cannot provide a pointer towards a modification of the process and apparatus disclosed in (D1) so that the cooled first air stream is introduced in gaseous state at the bottom of the HP column for separation therein.

- 4.5 The Appellant further argues that, starting from (D2), a desired production of liquids would require a further expansion turbine to generate the required refrigeration, and the shortage of liquid reflux in the low pressure column would have to be compensated by a liquid stream withdrawn from the high pressure column and passed into the low pressure column. The Board cannot follow this argument mainly for the reason that the refrigeration required for a recovery of liquid products and an additional reflux in the LP column could be generated in a number of ways, for example by providing a nitrogen recycle circuit as in (D3) and introducing a liquefied feed air stream into the LP column, respectively, whereas the evaporation of a liquid product would have an effect on the state of the feed air by partially condensing it, as in (D1) and

(D4), rather than increase the refrigeration requirements.

- 4.6 In summary, the subject-matter of claims 1 and 5 according to the main request is not rendered obvious by the available prior art. The invention defined therein, with dependent claims 2 to 4 and 6, is therefore considered to involve an inventive step.
5. Since the patent according to the main request meets the requirement of the EPC, the main request can be allowed and the auxiliary request need not be further considered.

Order

For these reasons it is decided:

The appeal is dismissed.

The Registrar:

The Chairman:

A. Counillon

C. T. Wilson