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D E C I S I O N
of 12 January 1998

Case Number: T 0203/96 - 3.2.3

Application Number: 91110568.2

Publication Number: 0464636

IPC: F25J 3/02, F25J 3/04

Language of the proceedings: EN

Title of invention:
Cryogenic air separation with dual temperature feed turboexpansion

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. 54, 56

Keyword:
"Main request: novelty, inventive step - yes"

Decisions cited:
-

Catchword:
-

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Case Number: T 0203/96 - 3.2.3

D E C I S I O N
of the Technical Board of Appeal 3.2.3
of 12 January 1998

Appellant: (Opponent)
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Decision under appeal: **Interlocutory decision of the Opposition Division of the European Patent Office posted 28 December 1995 concerning maintenance of the European patent No. 0 464 636 in amended form.**

Composition of the Board:

Chairman: C. T. Wilson
Members: H. Andrä
L. C. Mancini

Summary of Facts and Submissions

I. European patent No. 0 464 636 was granted on 22 September 1993 on the basis of European patent application No. 91 110 568.2..

II. An opposition against the granted patent was filed by the Appellant (Opponent) who requested revocation of the patent on the ground of lacking novelty and inventive step. The Appellant relied inter alia on the following prior art:

(D3) US-A-3 280 574

Evidence submitted after the expiry of the time limit provided for giving notice of opposition:

(D8) US-A-4 595 405
(D9) DE-B-1 112 997
(D11) US-A-4 883 518

III. In its decision given at the oral proceedings on 27 November 1995 and issued in writing on 28 December 1995, the Opposition Division held that the patent was to be maintained in amended form on the basis of the Claims 1 to 22 submitted on 1 December 1994 (main request). The Opposition Division was of the opinion that the subject-matter of independent Claim 1 and independent Claim 15 was novel and inventive over the cited prior art, in particular since none of the cited prior art documents discloses the claimed sequential heat exchange by condensing a first feed air portion and thereafter cooling a further feed air portion after expansion thereof.

IV. An appeal was filed against this decision by the Appellant on 28 February 1996 and the appeal fee paid on the same day. The Appellant requested that the decision under appeal be set aside and the patent be revoked in its entirety both according to the main request and the auxiliary request filed during the opposition procedure.

In the Statement of Grounds of Appeal filed on 26 April 1996, the Appellant cited

(D12) AT-A-389 526

and submitted that the skilled person intending to improve the process according to (D12) would be taught by (D8) to expand the air mass flow delivered from sieve (38) in an expansion turbine and to cool it in heat exchanger (33) by heat exchange with gaseous oxygen (44).

V. In his response dated 14 November 1996 the Respondent (Patentee) requested to reject the appeal, according to the main request, or to maintain the patent in amended form on the basis of Claims 1 and 15 as submitted with the letter dated 25 October 1995, according to the auxiliary request.

Claims 1 and 15 of the main request read as follows:

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

(A) turboexpanding a first portion (200) of cooled, compressed feed air, cooling the turboexpanded first portion (204) by heat exchange with return fluid, and introducing the resulting cooled

turboexpanded first portion (206) into a first column (105) of an air separation plant, said first column operating at a pressure generally within the range of from 4.1 to 6.9 bar (60 to 100 psia);

(B) cooling a second portion of the compressed feed air, turboexpanding the cooled second portion (103) at a temperature lower than that at which the turboexpansion of step (A) is carried out, and introducing the resulting turboexpanded second portion (104) into said first column;

(C) condensing at least part of a third portion (106) of the feed air and introducing resulting liquid (109) 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 (130) of said air separation plant, said second column operating at a pressure less than that of said first column;

(E) separating the fluids introduced into the second column into nitrogen-rich vapour (114) and oxygen-rich liquid;

(F) vaporizing oxygen-rich liquid (140) by indirect heat exchange with the third portion (106) of the feed air to carry out the condensation of step (C), the vaporized oxygen being used as return fluid in step (A), and

(G) recovering vapour resulting from the heat exchange of step (F) as product oxygen gas (143)."

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

(A) an air separation plant comprising a first column (105), a second column (130), a reboiler (162), means to pass fluid (161) from the first column to the reboiler and means to pass fluid (163,118) from the reboiler to the second column;

(B) a first turboexpander (201), means to provide feed air (200) to the first turboexpander, means to pass fluid (204) from the first turboexpander to a heat exchanger (202), and means to pass fluid (206) from the heat exchanger into the first column;

(C) a second turboexpander (102), means (101) to cool feed air and to provide cooled feed air (103) to the second turboexpander, and means to pass fluid (104, 206) from the second turboexpander into the first column;

(D) a condenser (107), means to provide feed air (106) to the condenser and means to pass fluid (109) from the condenser into the first column;

(E) means to pass oxygen-rich liquid (140,142) from the second column (130) to the condenser and means to pass oxygen product gas (143) from the condenser (107) to the heat exchanger (202), and

(F) means to recover oxygen product gas (143) from the heat exchanger (202)."

In Claim 1 a clerical error has been corrected by inserting in feature (C) between "third portion (106)" and "the feed air" the word "of".

VI. In the communication pursuant to Article 110(2) EPC dated 15 July 1997, the Board drew attention to the fact that (D12) had been filed late and did not appear to be more relevant than the documents already on file even if it were combined with the disclosure of (D8) as the Appellant proposed. In accordance with the jurisdiction of the Boards of Appeal, the Board intended to disregard this document (Article 114(2) EPC).

VII. In support of his request for revocation of the patent, the Appellant relied essentially on the following arguments:

- Neither Claim 1 nor Claim 15 indicates that the temperatures of the air of the inlet of the two expansion turbines are different. The independent claims do not, therefore, limit the scope of protection to the case that the two expansion turbines work at different temperatures.

- (D12) discloses a process of producing gaseous oxygen supplied by three feed air portions. One feed air portion is delivered to an expansion turbine (47) and another portion is fed from the sieve (38) directly to the column (39). The remainder of the feed air is cooled in the exchanger (33) and consequently condensed in the exchanger (34) in heat exchange with liquid oxygen which is vaporised before being heated in the exchanger (33) by feed air. The skilled person will try to optimize the performance of the exchanger (33) in order to reduce therein the temperature differences and will consult therefore (D8). This citation shows the use of an expansion turbine (114) in the case when chilling is not needed at the cold side of the exchanger but at an intermediate temperature. In this case, part of

the high pressure feed air is diverted from the heat exchange duct, expanded in turbine (114) and fed back to the heat exchange duct at an intermediate temperature for continuing cooling in countercurrent with the distillation products such as gaseous oxygen to the distillation column inlet temperature.

The skilled person is thus taught by (D8) that in order to improve the system of (D12) it would be required to expand the mass flow produced by the sieve (38) in an expansion turbine and to cool it afterwards in the exchanger (33) by heat exchange with the gaseous oxygen (44).

- It is well known to condense an air mass flow in heat exchange with liquid oxygen which is vaporised in the main heat exchanger of an air separation apparatus. This exchanger operates as a condenser whenever the pressure and temperature values of the fluids delivered to the exchanger enable this. It is contested that a condenser has necessarily a structure and a function that vary from those of an exchanger. The subject-matter of Claim 15 is not novel vis-à-vis the disclosure of (D11).

VIII. The Respondent contested the arguments of the Appellant and his submissions can be summarised as follows:

- The newly cited document (D12) deals with a method for the recovery of liquid pig iron utilizing a coal gasification system. In connection with such coal gasification an air separation process using a product boiler double column system is used to produce oxygen. When in the system of Figures 2 and 4 of (D12) the air stream passing through the single expansion turbine (47) is considered to be

a first portion of feed air and the stream condensed in vaporizer/condenser (34) is considered to be a third portion of feed air, the remaining feed air stream coming from unit (38) would have to be considered to constitute a second portion of feed air. Using this terminology, the turboexpanded first portion - different from the teaching of Claim 1 of the opposed patent - is not cooled before being passed into column (39). Thus, (D12) likewise fails to give any hint to carrying out two turboexpansion steps at different temperature levels. The Appellant uses Figure 4 of (D8) to show the cooling of the effluent of expander (114). Yet, when (D8) uses dual turbines (Figure 2) then the warm-level turbine illustrates rewarming of the turbine effluent instead of cooling.

Furthermore, the Appellant is incorrect in asserting that (D8) would lead one to add a high level turbine and expand the feed air from sieve (38). This would not be possible, since (D12) clearly states that the feed air in compressor (25) is compressed slightly above the pressure in the higher pressure column. Thus, one would have to add additional compression to the turboexpander. It is, therefore, apparent that (D12) and (D8) cannot be combined without hindsight to make the present invention obvious.

- Contrary to the Appellant's argumentation, Claim 1 clearly defines in step (B) thereof that the turboexpansion of step (B) is carried out at a temperature lower than that at which the turboexpansion of step (A) is carried out. Claim 15 refers to a condenser which is a

particular type of heat exchanger designed to cope with the production of liquid. A heat exchanger in general cannot be equated with the more specific definition "condenser".

Reasons for the Decision

1. The appeal is admissible.

2. *Main request*

2.1 Amendments (Article 123 EPC)

Claim 1 differs from the granted Claim 1 by the following amendments:

Insertion of the wording "by heat exchange with return fluid" in feature (A) after "first portion (204)"; substitution of "column (130)" for "column (103)" in feature (D);

insertion of the wording "the vaporized oxygen being used as return fluid in step (A)" in feature (F) after "step (C)".

In feature (C) of Claim 1, after "third portion (106)" obviously the word "of" has to be introduced.

The above cited insertions derive from Figure 1 of the original drawings in combination with page 7, last line to page 8, line 4, and with page 11, last paragraph, to page 12, paragraph 1, of the original description.

Claim 15 differs in substance from the granted Claim 15 in that in feature (E) "fluid" has been replaced by "oxygen rich liquid" and after "condenser" the wording "and means to pass oxygen product gas (143) from the

condenser (107) to the heat exchanger (202)" has been inserted. Furthermore, in feature (F) "product gas (143)" has been replaced by "oxygen product gas (143)" and "condenser" has been replaced by "heat exchanger (202)". These modifications, as far as they do not relate to an obvious correction (see the term "heat exchanger (202)"), are supported by Figure 1 of the original drawings in combination with page 11, last paragraph, to page 12, line 10 of the original description.

The above-cited insertions into Claims 1 and 15 either concern an obvious correction or lead to a narrowing of the scope of the respective granted Claims 1 and 15.

Independent Claims 1 and 15 and Claims 2 to 14 and 16 to 22, respectively, being dependent thereupon, comply, therefore, with the requirements of Article 123(2) and (3) EPC.

2.2 Late-cited document (D12)

In the Statement of Grounds of Appeal, the Appellant referred for the first time to (D12) without giving any reasons for justifying the citation of this document outside the time limit provided for filing the notice of opposition. This document must, therefore, be regarded as evidence not submitted in due time. In accordance with the jurisprudence of the Boards of Appeal, 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 its communication dated 15 July 1997, the Board explained why the disclosure of (D12) and the combination thereof with (D8) was not considered relevant for the decision to be taken. The Appellant did not dispute the Board's finding and, in his answer

of 12 September 1997, did not comment on (D12) further. The Board considers, therefore, that it is unnecessary to make any further remarks on this issue and decides to disregard this document in accordance with Article 114(2) EPC.

2.3 Novelty

It is not in dispute between the parties that (D11) describes the closest prior art with regard to the subject-matter of Claim 1 and Claim 15, respectively.

Figure 1 of (D11) discloses a method and an apparatus for the rectification of air comprising three feed air portions when taking account of the embodiment of the process described in column 3, lines 1 to 6 of (D11). A feed air portion (7) ("first portion") is cooled (13), expanded in expansion device (14) and subsequently introduced into the first column (21). The further feed air stream (8) is compressed in compressors (9, 11), cooled in heat exchanger (13) and split into the "second portion" (18) which is expanded in expansion device (19) and the "third portion" which is conducted through heat exchanger (15). The "second" and the "third" portions are then introduced into the first column (21). The expansion of the "second portion" (18) in expander (19) occurs at a lower temperature than the expansion of the "first portion" (7) in expander (14) (see column 4, lines 46 to 49, and column 5, lines 1 to 5 of (D11)). The "third portion" is cooled by indirect heat exchange with gaseous oxygen product stream (28) withdrawn from the second column (22).

The subject-matter of Claim 1 differs from the disclosure of (D11) in that oxygen-rich liquid instead of gaseous oxygen is used to condense the third feed air portion whereby after vaporization of the oxygen-rich liquid the gaseous oxygen is used for cooling the expanded first feed air portion (see features (F) and (C)).

The subject-matter of claim 15 differs from the disclosure of (D11) by a condenser, means to provide feed air to the condenser and means to pass fluid from the condenser into the first column (see feature (D)), means to pass oxygen-rich liquid from the second column to the condenser and means to pass oxygen product gas from the condenser to the heat exchanger (see feature (E)).

In his letter of 12 September 1997 the Appellant submits that a heat exchanger can be identified with a condenser so that Claim 15 lacks novelty in the light of (D11). In this context, the Appellant's references to (D3), column 3, lines 18 to 21, (D8) column 5, lines 48 to 51 and (D9), column 3, lines 65 to 67, all illustrate that an apparatus designated as heat exchanger is used to condense gases.

As is generally known, "heat exchanger" is the generic term for devices used to transfer heat between substances. A condenser is a particular type of heat exchanger which is designed to produce liquid from a vapour or a gas. As outlined in the Board's communication the term "heat exchanger" cannot therefore always be equated with the term "condenser" as a condenser is both functionally and structurally different from a heat exchanger in its general meaning. Due to the change of the fluid phase from "gaseous" to "liquid" and the change of the specific volume and heat transfer characteristics connected therewith a

condenser requires a construction of the ducts and the heat exchange surfaces which is different from that of a heat exchanger in which no change of the phase of the fluids involved occurs. This view is in line with the definition given for the term "condenser" in column 4, lines 28 to 30, of the patent in suit. The Board cannot, therefore, follow the argument put forth by the Appellant in this respect.

In the present case, (D11) clearly discloses that the product stream removed from the second stage (22) of the rectification column by way of conduit (28) is not in the liquid but in the gaseous phases (see column 5, lines 30 to 32) and that the heat exchanger (15) provided to pass cooled feed air into the first column is not a condenser but a heat exchanger in which the fluids involved are gases (see column 5, lines 10 to 13). The subject-matter of Claim 1 and Claim 15, respectively, differs therefore from the disclosure of (D11) by the above-cited features.

It follows from the foregoing that the subject-matter of Claim 1 and Claim 15, respectively, is novel in the sense of Article 54 EPC.

2.4 Inventive step

In the light of the relevant prior art disclosed by (D11) the technical problem to be solved by Claim 1 and Claim 15, respectively, is to arrive at a good match of the warming curve of the oxygen product stream with the cooling curve of the first and third feed air portions.

It is not in dispute that this problem is solved by Claim 1 and Claim 15, respectively, in particular by the above-cited distinguishing features (see section 2.3), namely, that as a product stream oxygen-rich liquid is withdrawn from the second column and is used

for condensing the third feed air portion and thereafter for cooling the expanded first feed air portion providing also the technical means required for carrying out these process steps.

Having regard to the issue of inventive step in respect of (D11), the Appellant, in the Statement of Grounds of Appeal, held in substance only that he maintains the arguments presented before the Opposition Division. He announced at the same time that he would submit shortly a declaration relating to (D11). Such a document has not, however, been filed.

In the decision under appeal, the Opposition Division has set out convincingly that none of the citations discussed discloses the claimed sequential heat exchange by condensing a first feed air portion and thereafter cooling a further feed air portion after expansion thereof so that no suggestion is derivable from the prior art to modify the disclosure of (D11) in the sense of Claim 1 and Claim 15, respectively.

Since the Appellant did not put forward any tangible argument which would put into doubt the presence of an inventive step, the Board considers that this issue requires no further discussion.

Summarising, the Board comes to the conclusion that the proposed solutions to the technical problem underlying the invention as defined in the independent Claims 1 and 15 involve an inventive step and therefore these claims as well as their respective dependent Claims 2 to 14 and 16 to 22 relating to particular embodiments of the invention are allowable.

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

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

N. Maslin C. T. Wilson