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D E C I S I O N
of 20 April 1999

Case Number: T 0177/96 - 3.2.3

Application Number: 90305936.8

Publication Number: 0402045

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:

T 0119/82

Catchword:



Case Number: T 0177/96 - 3.2.3

D E C I S I O N
of the Technical Board of Appeal 3.2.3
of 20 April 1999

Appellant: L'AIR LIQUIDE, S.A.
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Decision under appeal: Decision of the Opposition Division of the
European Patent Office dated 4 December 1995,
posted on 21 December 1995, rejecting the
opposition filed against European patent
No. 0 402 045 pursuant to Article 102(2) EPC.

Composition of the Board:

Chairman: C. T. Wilson

Members: H. Andrä

J.-P. Seitz

Summary of Facts and Submissions

- I. European patent application No. 90 305 936.8 filed on 31 May 1990 and published on 12 December 1990 under publication No. 0 402 045 was granted on 2 March 1994.

Claim 1 as granted reads as follows:

"1. A process for separating air and recovering work from a waste gas embodying low grade heat, comprising the steps of separating air by rectification into oxygen and nitrogen; taking a stream of nitrogen from a rectification column (30) in which the separation is performed; heating the stream of nitrogen at a pressure in the range of 203 to 709 kPa (2 to 7 atmospheres absolute) by heat exchange with a stream of fluid which enters at a temperature of less than 600°C into said heat exchange and which does not undergo a change of phase during said heat exchange, there being no compression of the nitrogen intermediate said rectification column and said heat exchange; and without any intervening step of further heating the heated nitrogen stream expanding the heated nitrogen stream in a turbine (58) with the performance of external work, wherein the said fluid comprises said waste gas or a heat transfer medium that has been heat exchanged without change of phase with a stream of said waste gas."

- II. The patent was opposed by the Appellant who requested that the patent be revoked on the grounds of lack of novelty and lack of inventive step.

The opposition was supported *inter alia* by the following documents:

(D1) DE-A-2 244 216

(D2) US-A-3 950 957

(D7) US-A-4 785 621

(D7) filed after expiry of the period stipulated for opposition was not admitted into the proceedings by the Opposition Division due to lack of relevance.

III. By the decision dated 4 December 1995, posted on 21 December 1995, the Opposition Division rejected the opposition.

The Opposition Division held that none of the cited documents or any combination thereof gives an indication to use directly or indirectly the heat of a waste gas stream at the claimed temperature level to warm low pressure nitrogen prior to expansion.

IV. On 19 February 1996 the Appellant lodged an appeal against this decision paying the appeal fee on the same day.

In the Statement of Grounds of Appeal filed on 12 April 1996 the Appellant referred for the first time to the further prior art

US-A-4 751 814 (referred to in (D7)) and

FR-A-985 200.

The Appellant argued that the subject-matter of Claim 1 is not inventive with regard to (D7) and with regard to FR-A-985 200 alone or the combination thereof with (D7).

V. With the letter dated 18 February 1996 received on 21 February 1997 the Appellant referred for the first time to the further prior art

"Stahl und Eisen" Heft 7, 1970, pages 321 to 331, and EP-A-0 225 864

and set out that the subject-matter of the claims is not inventive in the light of EP-A-0 225 864.

VI. In a communication dated 4 February 1998 the Board expressed its provisional opinion that neither the documents cited within the period stipulated for filing an opposition nor those filed outside this period seemed to prejudice maintenance of the patent in the form as granted.

VII. In response to the Board's communication the Appellant referred with Telefax of 16 March 1999 for the first time to the further prior art

"Klepzig Fachberichte", October 1970, containing an article by Günther Rückborn of Linde AG, and

"Blast Furnace Phenomena and Modelling", The Iron and Steel Institute of Japan, Committee on Reaction within Blast Furnace, Elsevier Applied Science, 1987.

The Appellant set out that by using the solution of FR-A-985 200 for the process of the article "Klepzig Fachberichte" the skilled person arrives necessarily at the invention.

VIII. In the oral proceedings of 20 April 1999 before the Board, the Chairman pointed out that also the documents cited for the first time with the letter of 18 February 1996 did not appear relevant for the decision to be taken.

IX. The Appellant requested that the decision under appeal be set aside and that the patent be revoked. He argued essentially as follows:

(D1) regarded to disclose the nearest prior art with respect to Claim 1 describes a process for separating air and recovering work from a waste gas in accordance with the subject-matter of Claim 1 with the exception of the features that the stream of nitrogen is at a pressure in the range of 203 to 709 kPa and that the stream of fluid enters at a temperature of less than 600°C into the heat exchange.

A pressure value of the nitrogen in the indicated range is, however, usual in prior art air separation plants. Furthermore, (D1) discloses on page 2, paragraphs 1 and 3, that the fluid components of the gas separation process to be heated and subsequently expanded are under such a pressure above atmospheric pressure that it is profitable to produce mechanical energy by expansion of the gas in an expansion machine. Such a pressure value will normally be in the range above 2 atmospheres absolute.

(D1) specifies on page 3, paragraph 4, that the heat source may comprise *inter alia* waste gases or any object from which heat can be transferred directly or by means of a further medium to one or several fluid components.

A stream of fluid with a temperature of less than 600°C used for heat exchange is less advantageous than a fluid stream under higher temperature the heat transferred being approximately proportional to the absolute temperature ratio of the streams. No evidence of a prejudice in the prior art that low grade heat cannot be used to improve process efficiency has been shown.

"Klepzig Fachberichte" discloses on page 558, right-hand column, that in an air separation process nitrogen under pressure (3,5 atmospheres absolute) can be produced, heated to 700°C and expanded to a turbine whereby with a volume of nitrogen of 10 000 Nm³/h a power of 630 kW can be produced. The value of 700°C has to be regarded merely as an example, a lower temperature of the heated nitrogen being an obvious choice.

The subject-matter of Claim 1 is not, therefore, inventive in the light of a combination of (D1) and the "Klepzig Fachberichte".

- X. In support of his request for maintenance of the patent as granted the Respondent argued essentially as follows:

(D1) does not teach to make use of low grade heat in the heat exchange between waste gas and nitrogen. As can be seen for example from Figure 2 of (D1) the heated nitrogen fraction is fed from the burner (88) to the gas turbine (910). After expansion in the turbine the nitrogen is conducted to a steam generator (101) in which the main portion of its thermal capacity is transferred to the working fluid of the steam generator.

Such a transfer of heat would be impossible with the use of low grade heat waste gas. The heating of the stream of nitrogen at a pressure in the range of 203 to 709 kPa safeguards optimum use of low grade heat.

Achieving the temperatures of the heated nitrogen of 700°C according to "Klepzig Fachberichte" requires a much higher temperature of the heating source. This citation as well as (D2) relates to high grade heat and cannot suggest the use of a waste gas embodying low grade heat for heating a stream of nitrogen destined for expansion in a turbine.

Reasons for the Decision

1. The appeal is admissible.

2. *Novelty*

The objection as to lack of novelty which had been raised by the Appellant in his notice of opposition had already been dropped in the oral proceedings before the Opposition Division. Also in the appeal proceedings

novelty was no longer disputed by the Appellant so that this issue requires no further argument.

3. *Inventive step*

- 3.1 In agreement with the parties to the proceedings, the Board considers the closest prior art with regard to the subject-matter of Claim 1 to be disclosed by (D1).

This citation describes a process for separating air and recovering work from a waste gas comprising the steps of separating air by rectification into oxygen and nitrogen, taking a stream of nitrogen from a rectification column in which the separation is performed, heating the stream of nitrogen by heat exchange with a stream of fluid which enters into said heat exchange and which does not undergo a change of phase during said heat exchange, there being no compression of the nitrogen intermediate said rectification column and said heat exchange, and without any intervening step of further heating the heated nitrogen stream expanding the heated nitrogen stream in a turbine with the performance of external work, wherein the said fluid comprises said waste gas.

The heat source used for heat exchange between the waste gas and the separated fluid component, such as nitrogen, may be a hot gaseous mixture, waste gas of a steam generator, fuel elements in a nuclear power plant or any object from which heat is transferred directly or by means of a medium to one or several fluid components. The heat source may also consist of oxygen or air and/or fuel which is fed into the fluid component and burnt therein (see (D1), page 3,

paragraph 4).

The skilled person investigating further the disclosure of (D1) is taught by the embodiments described in connection with Figures 1 to 3 of the drawings that the hot gaseous mixture used for heat exchange with the nitrogen stream is obtained by combustion of fuel (see "burning chamber of steam generator 89", Figure 1; "burner 88", Figures 2 and 3). He will therefore conclude that the hot gaseous mixture indicated on page 3 of (D1) consists of a gas having a temperature which prevails at the outlet of a fuel burning chamber of well above 600°C (high grade heat).

Claim 1 differs from the disclosure of (D1) in that

- (a) the stream of nitrogen is at a pressure in the range of 203 to 709 kPa, and
- (b1) the stream of fluid comprises said waste gas and enters at a temperature of less than 600°C into said heat exchange, the waste gas embodying low grade heat, or, according to an alternative, that
- (b2) the stream of fluid comprises a heat transfer medium that has been heat exchanged without change of phase with a stream of said waste gas and enters at a temperature of less than 600°C into said heat exchange, the waste gas embodying low grade heat.

3.2 As outlined on page 5, lines 28 to 31 of the patent, the process disclosed leads to a net power saving over comparable prior art processes. The technical problem

to be solved can therefore be seen in improving the efficiency of a process such as known from (D1).

It has been illustrated by means of examples discussed in the description of the patent in the passage from page 4, line 31, to page 5, line 25, that the net power consumption is notably smaller in a process in which the low grade waste heat is transferred to the nitrogen stream to be expanded than in processes in which such a use of the waste gas stream is not envisaged, that is a net power consumption of 8.7 MW for the embodiment described compared with a net power consumption of at least 10.7 MW in processes of the latter type.

It has not been substantiated by the Appellant that the examples presented in the patent are incorrect and the Board also has no reason to call these results in question. The problem as defined above is therefore credibly solved by Claim 1.

- 3.3 The Appellant argues with regard to the issue of inventive step that a stream of fluid with a temperature of less than 600°C used for heat exchange yields less advantageous results than a fluid stream under a higher temperature from which a greater work output can be obtained.

As already set out in the decision under appeal, it forms part of the common knowledge of the person skilled in the art that the higher the temperature of the fluid to be expanded at the inlet of a gas turbine is, the greater the amount of mechanical energy produced will be.

The problem to be solved in the present case does not, however, consist in maximizing the amount of external work produced without taking account of the energy input in the process, but in increasing the efficiency of the process, that is to make optimum use of the energy available in the process with regard to the performance of external work.

- 3.4 In the Telefax of 16 March 1999 the Appellant cited for the first time *inter alia* "Klepzig Fachberichte" of October 1979, containing an article by Günther Rückborn of Linde AG, referring to Figure 1, page 556, section 3, first paragraph, page 557, last paragraph, Table 3 and the last complete paragraph on page 558.

According to the above-cited paragraph on page 558, the air separation apparatus of the type L indicated in Table 3 can produce a considerable amount of nitrogen under pressure (2.5 atmospheres above atmospheric) which can be heated to 700°C. In this case, by expansion of the nitrogen in a turbine a power of 630 kW per 10 000 Nm³ N₂ can be produced.

The citation neither discloses by which means the nitrogen is to be heated nor that waste gas at a temperature of less than 600°C is used in heat exchange with nitrogen. It is clear for the skilled person that the heating of the nitrogen to a temperature of 700°C requires a heat source temperature well above 700°C.

Contrary to the opinion of the Appellant, the combination of the description of (D1) and "Klepzig Fachberichte" cannot lead in an obvious manner to the subject-matter of Claim 1 as neither of those citations

suggests the use of low grade heat waste gas in the heat exchange with the nitrogen stream.

(D2) which also was taken up by the Appellant as being relevant to Claim 1, teaches heating of nitrogen to be expanded in a first step against incoming feed air and, in a second step, further heating the nitrogen, prior to expansion, by means of combustion gases to a temperature well above 600°C such as 1290°C. It follows that (D2), similar to (D1), also teaches employing waste gas of high grade heat and cannot therefore suggest utilization of low grade heat waste gas in the above-said heat exchange.

- 3.5 In assessing the issue of inventive step the proper question to be asked is not whether the person skilled in the art could have made use of a waste gas stream at a temperature below 600°C for heat exchange with the stream of nitrogen but whether he would have done so in expectation of an increased process efficiency.

The Appellant has argued that no evidence of a prejudice in the prior art that low grade heat cannot be used to improve process efficiency has been shown by the Respondent.

It is acknowledged by the Boards of Appeal that an Applicant or Patentee who seeks to rely on the existence of an alleged prejudice in the art has the burden of proving its existence (see e.g. T 119/82, OJ EPO 1984, 217).

In the present case the Respondent did not, however, rely on the existence of such a prejudice so that there

is no obligation for him to prove the prejudice. Contrary to the Appellant's opinion the establishment of a prejudice in the art does not constitute a requirement of the EPC for expounding the presence of an inventive step.

- 3.6 It has not been shown by the Appellant that any of the citations submitted suggests amending the process for separating air and recovering work from a waste gas as known from (D1) such that low grade heat waste gas at an inlet temperature of less than 600°C is used in the heat exchange with the nitrogen stream to be expanded.

The question of whether and in which manner the step of choosing the pressure of the stream of nitrogen in the range of 203 to 709 kPa under which it is heated contributes to the solution of the underlying technical problem, can be left unanswered since the inventive step of the subject-matter of Claim 1 is already supported by the step of using waste gas at a temperature below 600°C for heat exchange with the nitrogen stream.

At the oral proceedings before the Board, only the citations (D1), (D2) and "Klepzig Fachberichte" were discussed. The other documents cited in the opposition proceedings as well as those submitted by the Appellant with the Statement of Grounds of Appeal, the letter dated 18 February 1996 and the Telefax of 16 March 1999 were no longer dealt with. The Board is satisfied that these documents can also not challenge the validity of the patent in the version as granted.

- 3.7 To summarize, the Board considers that the solution to

the technical problem underlying the invention as defined in the independent Claim 1 involves an inventive step and therefore this claim as well as its dependent Claims 2 to 10, relating to particular embodiments of the invention, are to be maintained.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

N. Maslin

C. T. Wilson