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Datasheet for the decision of 15 July 2021

Case Number: T 2683/19 - 3.2.03

Application Number: 07712790.0

Publication Number: 1989400

IPC: F01D15/00, F01D15/04, F02C1/05, F02C6/14

Language of the proceedings: EN

Title of invention:
A METHOD OF STORING ENERGY AND A CRYOGENIC ENERGY STORAGE SYSTEM

Patent Proprietor:
Highview Enterprises Limited

Opponent:
L'AIR LIQUIDE, SOCIETE ANONYME POUR L'ETUDE ET L'EXPLOITATION DES PROCEDES GEORGES CLAUDE

Headword:

Relevant legal provisions:
EPC Art. 123(2), 56
RPBA Art. 12(4)
RPBA 2020 Art. 13(1), 13(2)

Keyword:
Amendments - added subject-matter (yes) - intermediate generalisation
Inventive step - (yes)
Amendment to appeal case - amendment overcomes issues raised (yes)
Late-filed objection - admitted (no)

Decisions cited:
G 0002/10, J 0014/19

Catchword:

Europäisches Patentamt
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Beschwerdekammern

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Case Number: T 2683/19 - 3.2.03

D E C I S I O N
of Technical Board of Appeal 3.2.03
of 15 July 2021

Appellant: (Patent Proprietor)	Highview Enterprises Limited 1 Finsbury Circus London EC2M 7SH (GB)
Representative:	Carpmaels & Ransford LLP One Southampton Row London WC1B 5HA (GB)
Appellant: (Opponent)	L'AIR LIQUIDE, SOCIETE ANONYME POUR L'ETUDE ET L'EXPLOITATION DES PROCEDES GEORGES CLAUDE 75 Quai d'Orsay 75007 Paris (FR)
Representative:	Air Liquide L'Air Liquide S.A. Direction de la Propriété Intellectuelle 75, Quai d'Orsay 75321 Paris Cedex 07 (FR)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 26 July 2019 concerning maintenance of the European Patent No. 1989400 in amended form.**

Composition of the Board:

Chairman	C. Donnelly
Members:	B. Goers
	N. Obrovski

Summary of Facts and Submissions

I. European Patent 1 989 400 ("the patent") concerns a method and a system for a cryogenic energy storage and release.

II. An opposition was filed against the patent based on the grounds under Article 100(c) EPC in conjunction with Article 123(2) EPC, Article 100(b) EPC and Article 100(a) EPC in conjunction with Articles 54 and 56 EPC. With its decision the opposition division maintained the patent in amended form.

III. This decision was appealed by the patent proprietor and by the opponent. Since both the opponent and the patent proprietor have appealed, they will continue tobe referred to as such.

IV. With the consent of the parties, oral proceedings before the Board were held on 15 July 2021 by video conference using the Zoom platform.

V. At the end of the oral proceedings, the parties confirmed the following requests:

The patent proprietor requested that the decision under appeal be set aside and that a patent be granted on the basis of the main request or one of the first to eleventh auxiliary requests filed with the statement of grounds of appeal, the twelfth auxiliary request filed with the submission dated 21 April 2020 or, conditionally, the new second auxiliary request filed with the submission dated 15 February 2021.

The opponent requested that the decision under appeal be set aside and the patent be revoked.

VI. The following prior art documents submitted with the notice of opposition are relevant to the decision:

D2: E.M. Smith et al; "Storage of Electrical Energy Using Supercritical Liquid Air" and Discussion thereof; Proc Inst Mech Eng Vol 191 27/77, page 289-298, D57- D65; 1977
D21: JP 04132837 A and translation to English

VII. Independent claims 1 and 12 according to the main request correspond to the main request on which the decision under appeal was based and read as follows (amendments with respect to the originally filed version in bold and strike-through, amendments with respect to the granted version are underlined).

" *A method of storing energy* ***using a cryogenic energy storage system having a first (340) and a second (350) heat exchanger, said method*** *comprising* ***the steps of***
1) providing a gaseous input (120);
2) producing a cryogen (250) from the gaseous input
3) storing the cryogen;
4) ***pumping the cryogen to a form a pressurised cryogen;***
5) heating the pressurised cryogen in the second heat exchanger (350) using heat from the gaseous input;
6) superheating the heated pressurised cryogen in the first heat exchanger (340) using heat from the gaseous input;
7) expanding the ***superheated*** *cryogen ~~using the expanded cryogen to drive~~* ***through*** *a turbine (320) to drive ~~a~~* ***the*** *turbine; and*
8) recovering cold energy ~~from the expansion of the cryogen~~ ***by recycling at least a portion of the cold***

energy contained in the cryogen by extracting said cold energy through said first (340) and second (350) heat exchangers to cool down the gaseous input, thereby using the recovered cold energy to enhance production of more cryogen,
wherein steps 1 and 2 occur simultaneously with steps 4 to 8."

"*A cryogenic energy storage system (300) comprising:*
~~*a source of cryogen*~~ ***a gaseous input (120);***
means for producing cryogen from the gaseous input;
a cryogen storage facility (370);
a pump (380) for increasing the pressure of the cryogen;
a first heat exchanger (340) and a second heat exchanger (350), wherein the second heat exchanger (350) is arranged for heating the cryogen using heat from the gaseous input after the pressure has been increased by the pump (380); and
the first heat exchanger (340) is arranged for superheating the cryogen using heat from the gaseous input after the cryogen has been heated by the second heat exchanger (350);
~~*means*~~ ***a turbine (320)*** *for expanding the cryogen* ~~*a turbine*~~ *and capable of being driven by the expanding cryogen; and*
~~*means for recovering*~~ ***whereby in use,*** *cold energy* ~~*released during expansion of the cryogen*~~ ***is recovered by recycling at least a portion of the cold energy contained in the cryogen by extracting said cold energy through said first and second heat exchangers to cool down the gaseous input, thereby using the recovered cold energy to enhance production of more cryogen,***
wherein the means for producing cryogen, the first heat exchanger, the second heat exchanger, and the turbine are configured to operate simultaneously."

VIII. Independent claims 1 and 11 according to new second auxiliary request read as follows (amendments with respect to the main request in bold and strike-through).

"*A method of storing energy using a cryogenic energy storage system having a first (340) and a second (350) heat exchanger, said method comprising the steps of:*
1) providing a gaseous input (120), ***wherein the gaseous input is air;***
2) producing a cryogen (250) from the gaseous input, ***wherein the cryogen is liquid air, and comprising: compressing, in a compressor (310), the gaseous input; and after the compressed gaseous input has been cooled in the first (340) and the second (350) heat exchanger, feeding the compressed gaseous input to a throttling valve (360) to convert the compressed gaseous input into cryogen;***
3) storing the cryogen;
4) pumping the cryogen to a form a pressurised cryogen;
5) heating the pressurised cryogen in the second heat exchanger (350) using heat from the ***compressed*** *gaseous input;*
6) superheating the heated pressurised cryogen in the first heat exchanger (340) using heat from the ***compressed*** *gaseous input;*
7) expanding the superheated cryogen through a turbine (320) to drive the turbine; and
8) recovering cold energy by recycling at least a portion of the cold energy contained in the cryogen by extracting said cold energy through said first (340) and second (350) heat exchangers to cool down the ***compressed*** *gaseous input, thereby using the recovered cold energy to enhance production of more cryogen,*

wherein steps 1 and 2 occur simultaneously with steps 4 to 8."

"*A cryogenic energy storage system (300) comprising:*
a gaseous input (120), ***wherein the gaseous input is air;***
means for producing cryogen from the gaseous input, ***wherein the cryogen is liquid air, the means comprising:***
a compressor (310) for compressing the gaseous input; and a throttling valve (360) arranged to convert the compressed gaseous input into a cryogen after the compressed gaseous input has been cooled in a first (340) and a second (350) heat exchanger;
a cryogen storage facility (370);
a pump (380) ***arranged*** *for increasing the pressure of the cryogen* ***by pumping the cryogen from the cryogen storage facility;***
the ~~*a*~~ *first heat exchanger (340) and* ***the*** ~~*a*~~ *second heat exchanger (350), wherein the second heat exchanger (350) is arranged for heating the cryogen using heat from the* ***compressed*** *gaseous input after the pressure has been increased by the pump (380); and*
the first heat exchanger (340) is arranged for superheating the cryogen using heat from the ***compressed*** *gaseous input after the cryogen has been heated by the second heat exchanger (350);*
a turbine (320) for expanding the cryogen and capable of being driven by the expanding cryogen; and
whereby in use, cold energy is recovered by recycling at least a portion of the cold energy contained in the cryogen by extracting said cold energy through said first and second heat exchangers to cool down the ***compressed*** *gaseous input, thereby using the recovered cold energy to enhance production of more cryogen,*

wherein the means for producing cryogen, the first heat exchanger, the second heat exchanger, and the turbine are configured to operate simultaneously.

IX. The patent proprietor's arguments relevant to the present decision may be summarised as follows:

(a) Main request - Article 123(2) EPC

The subject-matter of claims 1 and 12 did not extend beyond the application as filed. The compression and throttling step was not inextricably linked to the other claimed features. Further, since in the original application documents different methods of liquefaction of the gaseous input were disclosed, a limitation to compression and throttling was not necessary. The location of the pump was clearly and unambiguously limited to downstream of the storage facility according to the claim language of both claims 1 and 12.

(b) First to twelfth auxiliary requests - Article 123(2) EPC

As far as objections against the main request applied, reference was made to the same arguments.

(c) New second auxiliary request

The request should be admitted since the objection of extension beyond the content as filed with respect to the omission of a compressor and throttling valve was raised by the Board for the first time in the provisional opinion attached to the summons to oral proceedings. New auxiliary request 2 addresses this objection and was submitted at the first opportunity.

The subject matter of claims 1 and 11 is not obvious starting from D21, Figure 7, as closest prior art since it has not been shown that the gas turbine of D21 could also be driven solely by expanding a cryogen without the energy provided by the further combustion of a fuel. Such turbines operate at significantly higher temperatures and have different design constraints. D21 concerns the optimisation of a process which relies on the combustion of fuel. In particular, D21 addresses the problem of preventing fires and explosions in the exhaust caused by fuel leakage. When searching for a solution to this problem, the skilled person would not consult a document describing a system with no gas turbine such as D2. Furthermore, the technical concepts of D21 (simultaneous operation) and D2 (sequential operation) are completely different and incompatible.

The objection based on D21, Figure 1 should not be admitted into the appeal procedure since this attack could have been raised already in the opposition procedure. Moreover, for the reasons given by the opposition division in the decision under appeal, Figure 1 of D21 is in any case a less promising starting point than Figure 7 of D21.

X. The opponent's arguments relevant to the present decision may be summarised as follows.

(a) Main request - Article 123(2) EPC

The subject matter of claims 1 and 12 extends beyond the application as filed since the original application documents provide no support for the feature "simultaneously". Furthermore, a number of features such as the location of the pump, a generator for producing electrical energy and an additional air

separation and liquefaction ("ASL") plant feeding the storage facility have been omitted from the independent claims, thereby resulting in an unallowable intermediate generalisation.

(b) First to twelfth auxiliary requests - Article 123(2) EPC

As far as not addressed by the amendments, the objections under Article 123(2) EPC apply also to first to twelfth auxiliary requests.

(c) New second auxiliary request

New auxiliary request 2 was only filed after the summons and should not be admitted in view of Article 13(2) RPBA 2020.

Claim 1 of new auxiliary request 2 fails to define a connection between the throttle and the storage facility. This constitutes an unallowable intermediate generalisation and is in contradiction to the requirements of Article 123(2) EPC.

The arguments against the main request under Article 56 EPC apply essentially also to new auxiliary request 2 . In view of the use of a fuel supplied gas turbine instead of an expansion turbine expanding the cryogen as the sole distinguishing feature, the objective technical problem is to reduce the pollution problems linked to a fuel driven gas turbine. The skilled person, in view of common general knowledge as disclosed by D2, would realize in an obvious manner that liquid cryogen could be used as the sole energy source. It would therefore be obvious for the skilled person to either replace the gas turbine in D21,

Figure 7, with an expansion turbine or to omit the combustion step.

Reasons for the Decision

Main request - Article 123(2) EPC

1. Any amendment to the claims is subject to the requirements of Article 123(2) EPC. Amendments can only be made within the limits of what a skilled person would derive directly and unambiguously, using common general knowledge, and seen objectively and relative to the date of filing, from the whole of the application documents as filed (see G 0002/10, OJ 2012, 376, referring to this test as the "gold standard").

1.1 Compared to claims 1 and 24 of the application as filed, claims 1 and 12 of the main request comprise the following features which were only originally disclosed in the description:

- Two heat exchangers for cooling the gaseous input and heating and superheating the cryogen.
- Simultaneous conduction of the heating and cooling processes (which requires direct heat exchange in recuperator type heat exchangers)
- Superheating the cryogen, achieved by using heat from the gaseous input.

1.2 The description of Figure 3 (see A-publication, pages 15 line 19 to page 16, line 32) explicitly describes the two heat exchangers and the superheating step. The embodiment of Figure 4 also encompasses these two features. Additionally, the cycle diagrams of Figures 8 and 9 disclose cycles in which cryogen superheating is at least partially possible due to heat from the

gaseous input, whose temperature is increased above ambient temperature T_0 in the compression step upstream of the heat exchangers.

However, both of the embodiments according to Figures 3 and 4 comprise a number of further features which are not defined in the claims, such as a compression and throttling step for the input gas, a feed to the tank from an ASL plant or a generator coupled to the turbine and compressor.

1.3 With respect to claims 1 and 12, the following objections under Article 123(2) EPC were discussed during the oral proceedings.

- It was not disclosed that "*steps 1 and 2 occur simultaneously with steps 4 to 8*".
- The omission of the following features constituted an unallowable intermediate generalisation:
  - a *compressor and throttle* to produce a cryogen from the gaseous input
  - undefined *location of the pump* in claim 1 and 12
  - *air separation device*
  - *electricity producing generator*.

2. Features "compressor" and "throttling valve"

2.1 The omission of a compression and throttling step in the liquefaction step 2 of claim 1, as well as of a compressor and throttling valve for the incoming gas in claim 12 constitutes an unallowable intermediate generalisation.

2.2 The patent proprietor is right in arguing that the originally filed documents disclose "*a number of ways in which the incoming air is liquefied*" in accordance

with step 2 of claim 1 (including pressurisation and throttling of the incoming gas and use of cold energy from cryogen streams followed by liquefaction of the pre-cooled incoming air in an ASL plant).

2.3 However, claim 1 requires "*superheating the cryogen using heat from the gaseous input*". In order to transfer heat from the gaseous input above the ambient temperature, the temperature of the input air first has to be increased. The only explicit disclosure for such a temperature increase is found on page 9, lines 20 to 21 of the A-publication: "*heat released from the compression of gaseous input can also be recovered and used to heat the cryogen*". Further, the cycle diagrams of Figures 8 and 9 confirm that compression of the incoming air is used for superheating of the cryogen (compression 0 to 1 provides the gaseous input at T_1) in addition to the use of waste heat. According to the embodiments of Figures 3, 4, 8 and 9, the compressor is always used in conjunction with a throttling valve to shift the state of the input air into the two-phase area in order to produce liquid cryogen. Therefore, superheating using heat from the gaseous input is only disclosed in combination with a compression and throttling step.

3. Feature "simultaneously"

3.1 The feature "*steps 1 and 2 occur simultaneously with steps 4 to 8*" together with the further features in claim 1 does not extend beyond the original disclosure.

3.2 The Board agrees with the opposition division (appealed decision, point 3.2.5) that the steps 1 to 2 and 4 to 8 have "*to be seen as concurrent processes*".

3.3 The whole disclosure of the patent is directed to an energy storage and release system using a cryogen as cold energy storage produced during off-peak times and released at peak times (see figure 2). Usually storage and release of energy are not foreseen to take place at the same time. This was argued by the opponent with reference to the A-publication, page 43, lines 12 to 15, emphasis added: "*The cold exergy application (in the energy release process) is based on the simultaneous cooling of incoming air (in the energy storage process) in a liquefaction unit.* ***In principle these two events do not occur at the same time.***".

3.4 However, the features of claims 1 and 12 are solely directed to one of the events referred to on page 43. This is the energy release step (referred to in the A-publication as "*exergy application*" on page 43, line 12 or as "*CES system*" on page 5, lines 19 to 23). Cryogen from a tank is consumed in the heating and expansion steps 4 to 8 according to claim 1 to drive a turbine. The tank is supplied with cryogen e.g. from an ASL plant (Figure 3: "*cryogen plant*", see also A-publication, page 15, lines 24 to 25). Whilst this step requires a stored cryogen as energy source, the wording of the preamble "*method of storing energy using a cryogenic energy storage system*" is insofar misleading as claims 1 and 12 are mainly directed to a method and system to release cold energy from a stored cryogen. The process of claim 1 includes further features for producing cryogen from input air using the released cold energy (steps 1, 2 and 8). These method features contribute to an improvement in efficiency, since they result in the production of top-up cryogen in the tank (A-publication, page 16, lines 21 to 23).

3.5 The method steps of heating and cooling are disclosed as occurring at the same time in this energy release phase (see A-publication, page 9, lines 13 to 16: "*electricity generation mode*"). Also, with respect to figure 4 it is stated that all steps occur "*At the same time,....*" (A-publication, page 17, line 12).

3.6 That steps 1, 2 and 4 to 8 are disclosed as being conducted simultaneously is further supported by the fact that the preferred heat exchangers for the process of the invention are of the plate and fin recuperator type (A-publication, page 50, lines 17 to 21 and page 56, lines 5 to 6). The Board does not agree with the opponent's argument that since such heat exchangers have an inherent heat storing capacity they can therefore also be used as regenerators. Using recuperator type heat exchangers as regenerators is technically unrealistic since they are not designed with this purpose in mind.

3.7 The opponent further argued that the "simultaneous" feature constituted an unallowable intermediate generalisation since by not including storage step 3, a state in which the simultaneous operation of steps 1, 2 and 4 to 8 while by-passing or omitting the storage facility now fell under claim 1.

3.8 However, in the Board's view, the skilled person would directly and unambiguously realize that such a state would not function since, due to inherent thermodynamic constraints, the same amount of cryogen as consumed in steps 4 to 7 cannot be re-produced with steps 1 to 2. As argued by the opponent, the maximum energy which can be transferred is limited by a required temperature difference in heat transfer.

3.9 Therefore, the skilled person understands from claim 1, that either all steps 1-8 occur simultaneously (i.e. at the same time) or only step 3 (storage) is done.

4. Feature "location of the pump" in claim 12

4.1 The Board agrees with the opposition division's finding (appealed decision, point II.3.3.1) that the failure to define the location of the pump in claim 12 as being downstream of the storage facility is an unallowable intermediate generalisation.

4.2 The embodiments of Figures 3, 4, 8 and 9 only provide support for a pump downstream of the storge facility. Claim 12 of the main request simply states that the heat exchanger is arranged "*after the pressure has been increased by the pump*". However, the claim wording does not exclude that the pressure is partially or completely increased before entering the storage facility, e.g. by separating the liquid cryogen in a flash drum and pumping the liquid part to the storage facility (in contradiction to Figure 3, in which the liquid-vapour separation is carried out in the storage facility). The patent proprietor's argument that it would be "*technically nonsensical*" to read an embodiment under claim 12 with the pump upstream of the storage is therefore not convincing.

5. Feature "location of the pump" in claim 1

5.1 The Board agrees with the finding of the opposition division (point II.3.3.1) that claim 1 is implicitly restricted to a location of the pump downstream of the storage tank. Therefore, no unallowable intermediate generalisation with respect to the location of the pump is present in claim 1.

5.2 The claim language distinguishes between "*cryogen*" (steps 2 to 4) and "*pressurized cryoge*n" (steps 4 to 6). Since it is the cryogen, which is stored according to step 3, claim 1 has to be construed such that the cryogen is not stored in a pressurized form. Consequently, the pump as defined in step 4 claim 1 cannot be located upstream of the storage.

6. Feature "ASL plant"

6.2 The opponent argued that the omission of the ASL plant in claims 1 and 12 infringes the requirements of Article 123(2) EPC since it was not disclosed how the system according to Figures 1 and 3 could function in absence of the ASL plant.

6.3 An ASL plant is disclosed in the application as filed as a suitable source of cryogen (see A-publication, page 15, line 24 to 25). The cryogen is e.g. produced during an energy storing period, see also page 43, lines 12 to 14, using such an ASL plant. However, other embodiments, such as the propulsion system according to the embodiment of Figure 4, only comprise a cryogen-filled tank without indicating the source of the cryogen. Therefore, the opponent is only in so far correct in that a storage facility pre-filled with cryogen is disclosed as an inherent requirement for conducting the process of claim 1. Such a storage facility is however disclosed in claims 1 and 12.

6.4 In view of this, the skilled person would not derive from the original application as a whole that an ASL plant must be the source of the cryogen in the storage facility and that this is inextricably linked to the function of the process of claim 1. It would be

sufficient that the storage facility is filled from another storage tank (see e.g. marine embodiment of Figure 4).

In conclusion, the Board agrees with the opposition division (appealed decision, point II.3.2.4) that the omission of the ASL plant is allowable under Article 123(2) EPC.

6.5 Feature "producing electricity with a generator"

The omission of the feature of producing electricity with a generator does not constitute an unallowable intermediate generalisation either.

It is directly and unambiguously apparent from the first sentence of the description on page 1, lines 4 and 5 of the application as filed, that the conversion of the energy gained by expansion of the cryogen in the turbine is not essential to the invention and has no impact on the other features.

First to twelfth auxiliary requests - Article 123(2) EPC

7. None of the first to twelfth auxiliary requests discloses a compression and throttling step and the corresponding equipment for the step of producing a cryogen from the incoming air. At least for this reason, none of these requests is allowable under Article 123(2) EPC (see point 2. above).

Admittance of new second auxiliary request

8. Under Article 13(2) RPBA 2020, any amendment to a party's appeal case made after notification of a summons to oral proceedings shall, in principle, not be

taken into account unless there are exceptional circumstances, which have been justified with cogent reasons by the party concerned.

8.1 In its communication under Article 15(1) RPBA 2020, annexed to the summons to the oral proceedings, the Board raised a new objection of added subject-matter. This objection concerned an unallowable intermediate generalisation due to the omission of a compression and throttling step in the independent claims. The patent proprietor filed new auxiliary request 2, drafted exclusively to overcome this newly raised objection by introducing the omitted features into the claims and which was only to be considered should the objection raised by the Board be maintained. Although this is an amendment to their appeal case, the patent proprietor could only submit new auxiliary request 2 after having received the summons and the Board's communication annexed thereto. The request was also submitted several months before the oral proceedings before the Board.

8.2 The Board considered these circumstances to be exceptional within the meaning of Article 13(2) RPBA 2020, and admitted new auxiliary request 2 into the appeal proceedings.

Non-Admittance of new Article 123(2) EPC objection

9. The opponent raised a new objection under Article 123(2) EPC against new second auxiliary request for the first time during the oral proceedings before the Board. They argued that claim 11 failed to specify a connection between the means for producing the cryogen, specifically the throttle valve, and the storage facility. Thereby subject-matter not originally

disclosed was created, since this connection was always provided according to the application as filed.

9.1 A new objection under Article 123(2) EPC constitutes an amendment of the opponent's appeal case within the meaning of Article 13(2) RPBA 2020 (cf. J 14/19, points 1.4 and 1.5).

9.2 It is undisputed by the opponent that the new objection was not occasioned by the amendments made in new second auxiliary request. Rather, in claim 12 of the main request no explicit link is defined between the means for producing the cryogen and the cryogen storage facility either. Therefore, the objection could and should have already been raised against the main request, already in the opposition procedure or at least with the statement of grounds of appeal.

9.3 The opponent did not provide any reasons, let alone cogent ones, why the circumstances for the late submission of this objection could be considered exceptional within the meaning of Article 13(2) RPBA 2020. Neither does the Board see any such reasons.

9.4 The Board further points out that the new objection does not seem suitable to lead to a different outcome of the case. In particular, the Board is convinced that the storage facility feature of claim 11 has to be understood as a storage facility **for the produced** cryogen, i.e. implying a connection to the (upstream) means for producing the cryogen.

9.5 In view of the above, the Board did not admit the new objection under Article 123(2) EPC into the appeal proceedings.

New second auxiliary request - Inventive step

10. It was agreed by the parties that the additional features compared to the main request do not add further distinguishing features over the disclosure of D21. In view of this, the opponent based its arguments solely on the objections of lack of inventive step previously raised against the main request (see statement of grounds of appeal, point 1).

11. D21, Figure 7, as starting point

11.2 D21 is directed to a supply system for compressed air for a non-continuously working gas turbine (translation of D21, page 2, first paragraph). The objective is to reduce the amount of space for the compressed air and to allow for overground storage, thereby achieving independence from the presence of natural cavities for this purpose (page 3, paragraph 3 and chapter "*problems to be solved by the invention*" on page 3 and 4). These problems are solved by storing the compressed air in form of a cryogen.

11.3 It was common ground between the parties that the embodiment of Figure 7 of D21 disclosed a system for carrying out a process including simultaneous operation of heating and cooling (translation of D21, page 10, last paragraph).

11.4 The Board agrees with the opposition division's analysis (appealed decision, point II.10.3.8) that Figure 7 of D21 discloses all method features of claim 1 beside feature 7. However, it disagrees with the conclusion under point II.10.3. 7, that in Figure 7 "*a turbine for expanding the cryogen and capable of being*

driven by the expanding cryogen" according to current claim 11 is disclosed.

11.5 The patent explicitly states that gas turbines with combustion are to be avoided (see paragraph [0019]). Although reference is made to a "*multi-stage gas turbine with continuous heat supply*" in paragraph [0055] of the patent, this statement refers to an expansion turbine with external heat supply in order to converge towards an isothermal expansion. Consequently claim 1 refers solely to the expansion of the cryogen and claim 11 to a turbine suitable therefore. This is not disclosed in D21 for the following reasons.

11.6 Firstly, the gas mixture resulting from the combustion step in D21, Figure 7, cannot be regarded as a "superheated cryogen" since it is a mixture of flue gases of a different composition than the cryogen wherein parts of the cryogen (oxygen) are already consumed and combustion products are present.

11.7 Secondly, the turbine T1 of the system in Figure 7 is not clearly and unambiguously disclosed as suitable for expanding the cryogen and capable of being driven by the expanding cryogen in the sense of claim 11. The assumption that "*the turbine would rotate under the impetus of incoming air having undergone evaporation and superheating in accordance with the claims*" is in the Board's view an unproven assertion. A "gas turbine" in the sense of D21 is designed to be driven by hot gases produced by combustion of fuel and air usually fed from a compressor. Therefore, it operates at a considerably higher temperature than an expansion turbine. Gas turbines are specifically designed for their intended range of operation (temperature, pressure and composition of the gas) in terms of blade

design, flow guidance and also possible additional compression steps. Whether the opposition division is correct in that the gas turbine T1 operates (though not *"efficiently (or even well)"*) using the working fluid from stream e is therefore neither inherently clear from D21 nor sufficiently proven. It is also possible that the impetus provided by an expanding cryogen is insufficient to move the gas turbine T1 at all in the absence of the energy of combustion, in particular if coupled to a generator providing a further resistance. Therefore, neither process step 7 of claim 1 nor a turbine capable of being driven by the expanding cryogen according to claim 11 is clearly and unambiguously disclosed in Figure 7 of D21.

11.8 The opponent identified the objective technical problem as being to reduce or prevent the pollution resulting from the combustion process. However, the problem mentioned in D21 refers to the independence of a gas turbine operation from natural caverns for storing the compressed gas. Pollution aspects are mentioned only in the context of promoting an optimal combustion in order to avoid fuel leakage into the off-gas.

11.9 According to the patent, contaminants should be avoided at all costs (see paragraphs [0019]/[0020]). In contrast, D21 is principally concerned with seeking ways to operate a fuel driven gas turbine while avoiding leakage of fuel into the flue gas rather than to replace the process concept. Insofar it is questionable that D21 is a suitable closest prior art at all.

11.10 Even when considering the objective technical problem identified by the opponent, the Board considers that

the subject-matter of claims 1 and 11 involves an inventive step.

11.11 The opponent argued that in view of this problem the skilled person would turn to the process disclosed in Figure 3 of D2 from which the skilled person would realize that energy could also be produced by simply expanding the cryogen without combustion (see D2, page 270, right column: "*the liquid air ... is rewarmed ... and delivered to the air turbine finally exhausting to atmosphere at 50°C without causing pollution*"). D2 discloses in Figure 3 a process and system which is, as in the patent, also directed to an energy storage and release process using the steps of the method of claim 1 with the sole difference that steps 1,2 and 4 to 8 are not carried out simultaneously, but sequentially, since instead of recuperator type heat exchangers regenerators are used.

11.12 However, in the Board's view it is not realistic, even when faced with the above technical problem, that a skilled person starting from D21 would completely abandon the gas turbine concept for producing energy in favour of an expansion process according to D2 since D21 is focused on the optimisation of a gas turbine process for producing energy in which the surplus energy produced is obtained from the combustion process. The skilled person seeking to solve the technical problem would rather look for possibilities to reduce pollution within the gas turbine process (fuel feedstock, operating conditions, off-gas treatment). Further, the patent proprietor is correct in pointing out that the difference in operating regimes (D21: simultaneously versus D2: sequentially) casts doubts on the compatibility of the processes.

11.13 Furthermore, the modifications necessary to the system of Figure 7 in order to arrive at the claimed invention go beyond simply omitting the burner. The opposition division is right that also with respect to the turbine "*significant extra modifications ... would be required to remove the burner from the device of D21*" (appealed decision, point II.12.7).

Therefore, taking Figure 7 of D21 as a starting point, the subject-matter of claims 1 and 11 involves an inventive step as required by Article 56 EPC.

12. D21, Figure 1 as starting point

12.1 In the embodiment of Figure 1 of D21 a gas turbine (4) is supplied with a gas mixture produced from the combustion of compressed air (e) and fuel (f). Therefore, this embodiment also lacks an expansion step of the cryogen as required by step 7 of claim 1, respectively a turbine suitable therefore as required by claim 11.

12.2 The Board also agrees with the opposition division's assessment (appealed decision, point 10.2.3) that the embodiment of Figure 1 of D21 "*clearly lacks two separate ... heat exchangers*" and that the embodiment of Figure 7 would be "*the most complete in relation to the subject matter of claim 1 ...*". The embodiment of Figure 1 is therefore a less suitable starting point for an inventive step objection compared to Figure 7.

12.3 Consequently, the Board also sees no need to further address the question of admittance of this objection.

13. In conclusion, the subject matter of claims 1 and 11 of the new second auxiliary request is considered not to

extend beyond the content of the application as filed and to involve an inventive step.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the opposition division with the order to maintain the patent with the following claims and a description to be adapted thereto:
   - Claims 1-17 of new auxiliary request 2 filed with the submission dated 15 February 2021.

The Registrar: The Chairman:

C. Spira C. Donnelly

Decision electronically authenticated